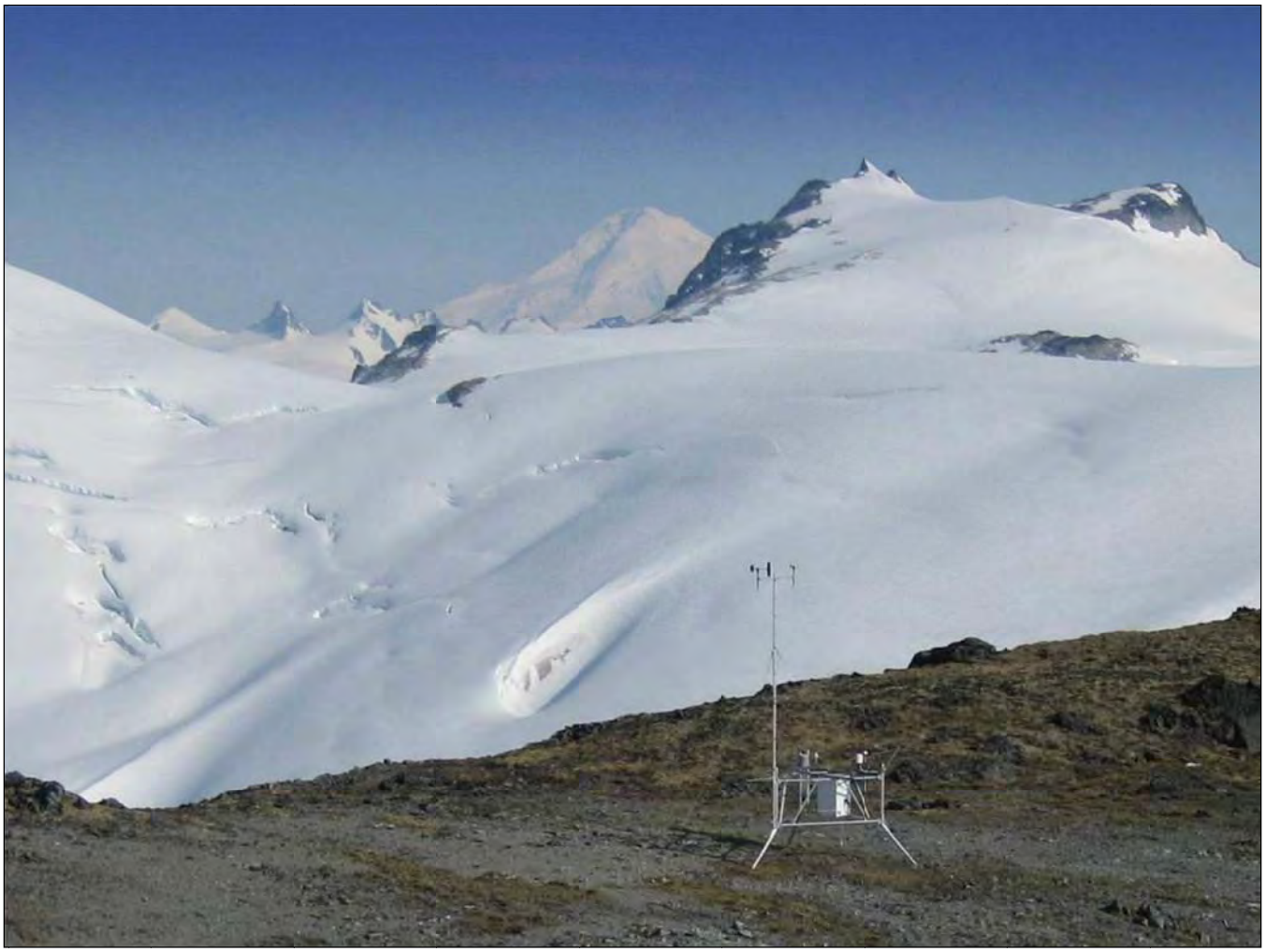
National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Methods for Monitoring Climate in Southwest Alaska Network Parks

Version 1.0

Natural Resource Report NPS/SWAN/NRR—2012/582



ON THE COVER
Remote automated weather station (RAWS) in the Chigmit Mountains, Lake Clark National Park and Preserve
Photograph by: Chuck Lindsay

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Version 1.0

Natural Resource Report NPS/SWAN/NRR—2012/582

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National Park Service
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List of Acronyms

AFF	Automated Flight Following
AICC	Alaska Interagency Coordination Center
ALAG	Alagnak Wild River
AMBCS	Alaska Snow, Water, and Climate Services
ANIA	Aniakchak National Monument and Preserve
ARA	Aircraft Rental Agreement
ARES	Acquisition and Reporting Environmental System
ASOS	Automated Surface Observing System
AWOS	Automated Weather Observing System
BLM	Bureau of Land Management
CHMO	Chigmit Mountains
CMAN	Coastal-Marine Automated Network
COCR	Contact Creek
COOP	Cooperative Observing Program
COVI	Coville
CRN	Climate Reference Network
CSV	Comma-Separated Values file format
DC	Direct Current
DLP	Data Logger Program
DOI	Department of the Interior
EA	Environmental Assessment
ENSO	El Niño Southern Oscillation
EXIF	Exchangeable Image File Format
FAA	Federal Aviation Administration
FGDC	Federal Geographic Data Committee
FOUR	Fourpeaked
FTCP	Field Travel and Communication Plan
FTE	Full-Time Equivalent
FTS	Forest Technology Systems
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
GUI	Graphical User Interface
HAIC	Harding Icefield
HILA	Hickerson Lake
IAR	Investigator's Annual Report
I&M	Inventory and Monitoring
IDLE	Integrated Development Environment for Python
JHA	Job Hazard Analysis
JPG	Joint Photographic Experts Group file format
KATM	Katmai National Park and Preserve
KEFJ	Kenai Fjords National Park
LACL	Lake Clark National Park and Preserve
LHS	Left Hand Side
MCPA	McArthur Pass

M/V	Motor Vessel
NCDC	National Climatic Data Center
NDBC	National Data Buoy Center
NEPA	National Environmental Policy Act
NESDIS	National Environmental Satellite, Data, and Information Service
NIFC	National Interagency Fire Center
NOAA	National Oceanic and Atmospheric Administration
NOMAD	Navy Oceanographic Meteorological Automated Device
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
NWSTG	National Weather Service Telecommunications Gateway
OAS	Office of Aircraft Services
PELA	Pedersen Lagoon
PDO	Pacific Decadal Oscillation
PFMI	Pfaff Mine
PI	Project Investigator
PLB	Personal Locator Beacon
PRISM	Parameter-Elevation Regressions on Slopes Model
PTW	Performance Tracking Worksheet
QA/QC	Quality Assurance / Quality Control
RAWS	Remote Automated Weather Station
RGTB	Rain Gauge Tipping Bucket
RH/AT	Relative Humidity / Air Temperature
ROMAN	Real-time Observation Monitoring and Analysis Network
SC	Snow Course
SD	Snow Depth
SDI	Serial Digital Interface
SNLA	Snipe Lake
SNOTEL	Snowpack Telemetry Network
SOP	Standard Operating Procedure
SRAD	Solar Radiation
SWAN	Southwest Alaska Network
SWE	Snow Water Equivalent
URL	Uniform Resource Locator
USB	Universal Serial Bus
USDA	United States Department of Agriculture
USFS	United States Forest Service
UTC	Coordinated Universal Time
VHF-FM	Very High Frequency - Frequency Modulation
WBAN	Weather Bureau Army Navy
WD	Wind Direction
WFMI	Wildland Fire Management Information
WIMS	Weather Information Management System
WRCC	Western Regional Climate Center
WS	Wind Speed

Abstract

The Southwest Alaska Network Inventory and Monitoring Program is an office of the National Park Service dedicated to providing the scientific foundation for effective, long-term protection and management of natural resources in five units of the national park system. Collectively these units comprise approximately 9.4 million acres, 11.6 percent of the land managed by the National Park Service, or two percent of the Alaska landmass, and include a diversity of geologic features, ecosystems, fish, wildlife, and climatic conditions that are equaled few places in North America. The Southwest Alaska Network Inventory and Monitoring Program collects, manages, analyzes and reports long-term data on a modest set of vital signs – selected physical, chemical, and biological elements and processes of park ecosystems that represent the overall health or condition of a park.

Climate is one of the primary drivers of physical and ecological processes. For these reasons, the Southwest Alaska Network Inventory and Monitoring program identified climate as a vital sign. This document presents methods for monitoring climate in five national park units in Southwest Alaska: the Alagnak Wild River, Aniakchak National Monument and Preserve, Katmai National Park and Preserve, Kenai Fjords National Park, and Lake Clark National Park and Preserve. The goal is to acquire a comprehensive and high-quality climate dataset for use in understanding how climate is affecting other vital signs. Specifically, the monitoring objectives are to:

1. Record and archive hourly weather observations, including temperature, relative humidity, precipitation, wind speed and direction, solar radiation, and snow depth at weather stations located in representative areas within Southwest Alaska Network parks.

2. Produce monthly and annual summaries of weather observations and identify extremes of climatic conditions for common parameters (precipitation and air temperature), and other parameters for which sufficient data are available (e.g. wind speed and direction, solar radiation, soil temperature).

By design, these methods benefit from - and build upon - existing climate monitoring programs. Ten new climate monitoring stations have been established by the Southwest Alaska Network Inventory and Monitoring program in three network parks. This document outlines procedures for the long-term operation and maintenance of these new stations. Methods are also included to acquire, quality control, archive, and process climate data from existing stations in or near network parks that provide consistent, long-term, and high-quality records. These climate data will be made available for use in a standardized format. Procedures are also outlined for annual reporting, which will provide summaries of the recent climate to support park management and planning decisions and for correlation with other monitoring and park science efforts.

Acknowledgments

These methods for monitoring climate in southwest Alaska network parks were developed through consultation with the Alaska Regional Headquarters and Alaska Pacific River Forecast Center of the National Weather Service, the Alaska Snow Survey Program of the Natural Resources Conservation Service, the Alaska State Climate Center at the University of Alaska Anchorage, the Western Regional Climate Center, and the Central Alaska Network Inventory and Monitoring Program. Careful reviews by Fritz Klasner, Rebecca Lofgren, and Pam Sousanes significantly improved earlier versions of these methods.

Background and Objectives

Rationale for Monitoring Climate

The use of climatic data to help understand and interpret resource inventories and ecosystem monitoring is an important component of the National Park Service (NPS) Inventory and Monitoring (I&M) program (Gray 2008). Climate is identified as a primary vital sign by all I&M networks. Because it affects the physical, chemical, and biological processes of both terrestrial and aquatic systems, climate is recognized as one of the most important determinants of the ecological setting of the Southwest Alaska Network (SWAN) (Bennett et al. 2006).

The SWAN climate monitoring effort benefits from - and builds upon - existing climate monitoring programs. These programs provide consistent monitoring of climatic conditions, and in a few cases, provide a long-term period of record. Information from climate stations in and adjacent to SWAN parks provides information key to understanding coarse-scale changes in climatic patterns in the SWAN, and aids in the interpretation and analyses of trends in other monitored vital signs. Because climate stations are sparsely distributed across the SWAN park units, this information will likely benefit other programs (e.g. weather forecasting, up/downscaling climate models).

Weather vs. Climate

Although the terms weather and climate 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. Climate monitoring is used in this document to indicate the long-term monitoring of both discrete weather events and climatic conditions.

Climate Overview

Climatic conditions of the SWAN are largely influenced by the region's high latitude, proximity to oceans, complex topography, and the interaction of these features with global circulation (Simpson et al. 2002). The park units in the SWAN are aligned along the northern Gulf of Alaska (Figure 1) and span three bioclimatic regimes – boreal, maritime, and polar – as defined by Nowacki et al. (2001). The climates of Kenai Fjords National Park (KEFJ), the coastal areas of Aniakchak National Monument and Preserve (ANIA) and Katmai National Park and Preserve (KATM), and (to some extent) the small coastal area of Lake Clark National Park and Preserve (LACL) are maritime subarctic – characterized by moderate temperatures (Figure 1) and abundant precipitation (Figure 2). Moist air masses are intercepted by the Kenai Mountains and the Aleutian and Alaskan Ranges and heavy precipitation falls on their windward (east) sides. The boreal climate of northeastern LACL and the Cook Inlet region is generally protected from maritime influence by complex topography. Temperatures are moderate here, when compared to more interior regions, with most precipitation occurring in late summer and early fall. The climate of the northwestern interior side of LACL is more continental in nature – characterized by large annual temperature variability and a small annual range in precipitation. This region experiences cold winters, warm summers, and receives little precipitation. The climates of the Alagnak Wild River (ALAG) and western portions of KATM and ANIA is transitional between polar (tundra climate) and maritime (maritime subarctic). 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 several maps showing spatial and temporal patterns of temperature and precipitation, are provided by Redmond et al. (2005) and Davey et al. (2007).

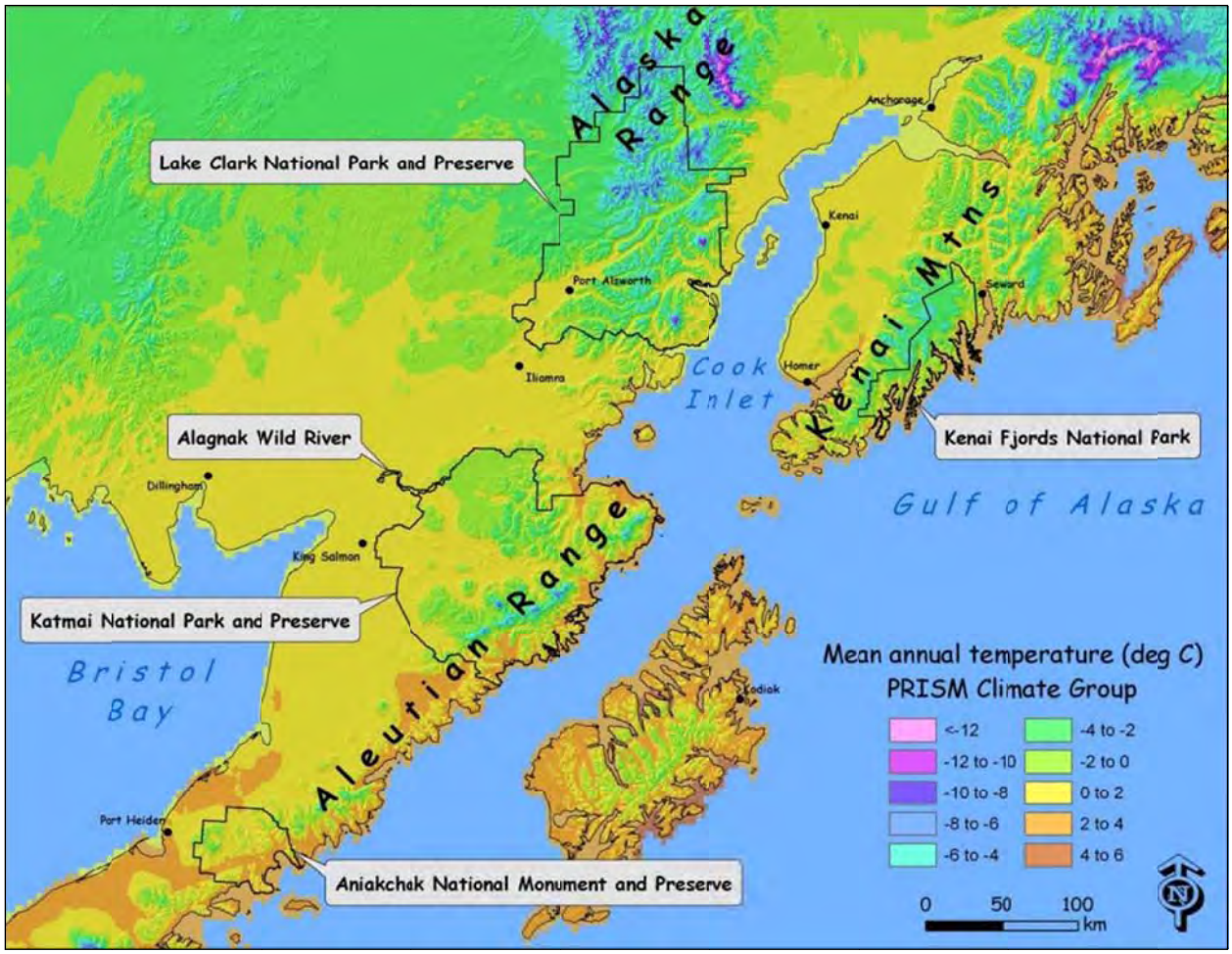


Figure 1. Mean annual temperature for southwest Alaska. Map was derived from the Parameter-Elevation Regressions on Slopes Model (PRISM) for the base period 1971-2000. The PRISM model uses point climate station data and a digital elevation model to generate gridded interpolations of temperature and precipitation (Daly 2009).

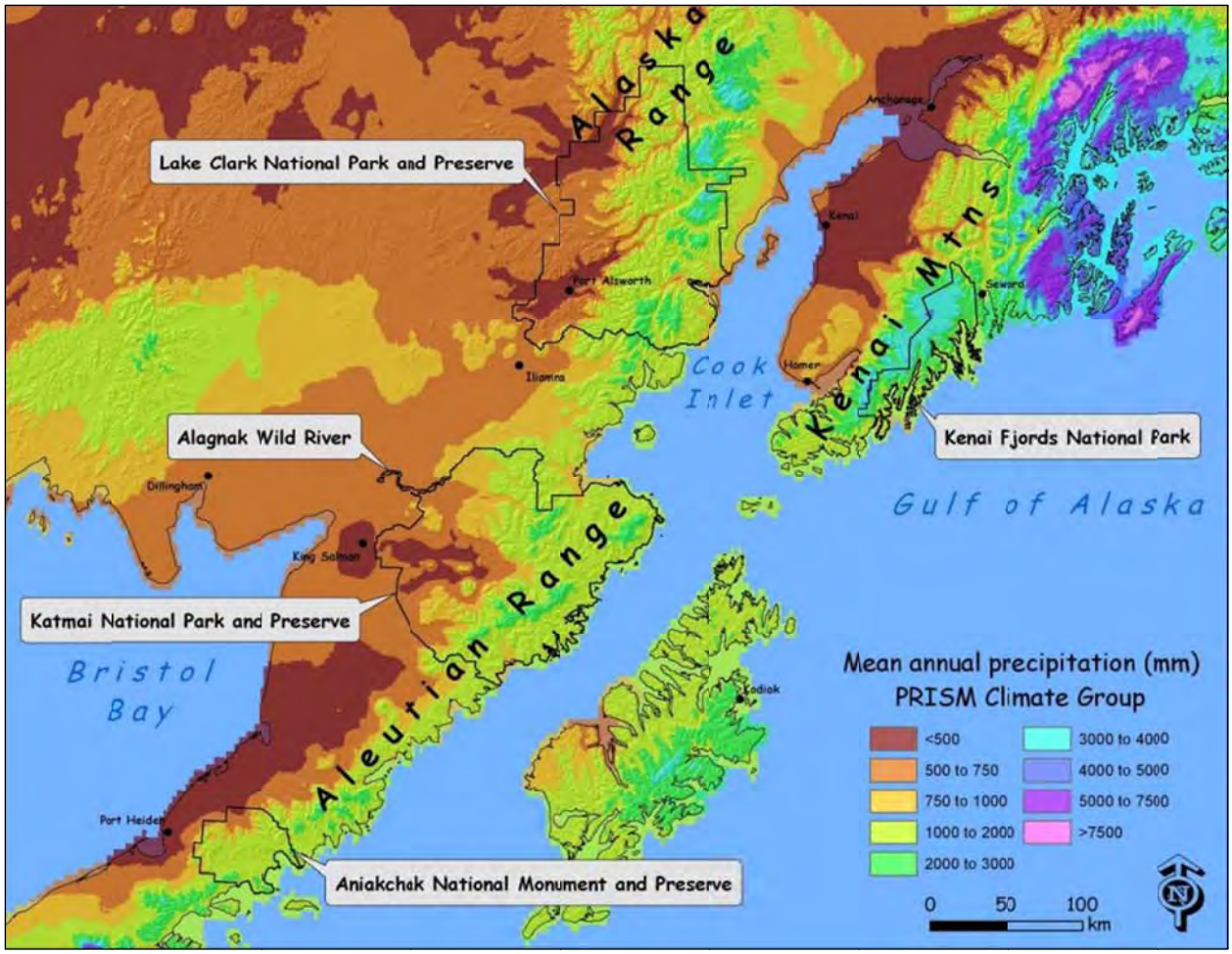


Figure 2. Mean annual precipitation for southwest Alaska. Map was derived from the Parameter-Elevation Regressions on Slopes Model (PRISM) for the base period 1971-2000 (Daly 2009).

Intrinsic Climate Variation

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 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 1-2 °C 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 International Panel on Climate Change (IPCC) Fourth Assessment Report summarized the evidence that the global climate is changing rapidly and that rates of change are dramatically accelerated at northern latitudes. Alaska has warmed substantially over the 20th 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 adjacent to the SWAN show a significant increase in both mean wintertime and mean annual temperatures for 1949-2011 (Alaska Climate Research Center, 2012). Mean winter temperatures at King Salmon have increased by 4.4 °C (8.0 °F) and mean annual temperatures have increased by 1.9 °C (3.4 °F). Mean winter temperatures at Homer have increased by 3.0 °C (5.4 °F) and mean annual temperatures have increased by 1.9 °C (3.4 °F). It is important to note that 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 0.5-0.6 °C (0.9-1.1 °F) per decade (Scenarios Network for Alaska Planning 2008). Precipitation is also generally projected to increase with 11-26% more snowfall in winter and 10-12% more rain in summer. It appears that the most severe environmental stresses in Alaska at present are climate related.

Importance of Climate Monitoring

Ecosystem connectivity is a key feature of the SWAN (Bennett et al. 2006) and a mechanistic understanding of the role of climate as an ecological determinant (Figure 3) is the basis for monitoring climate in the SWAN. Climate drives the hydrologic cycle, affects hydrographic structure and circulation in ocean and lakes, affects primary production, controls the timing of ecological processes, and influences the frequency and intensity of disturbances. Understanding the role of climate as a forcing agent is key to monitoring other vital signs monitored in the

SWAN. Accurate, long-term climate data sets are fundamental to understanding this role. For example, without climate data, it is difficult to appreciate the cause of a variety of ecosystem changes – from changes in vegetative cover to shifts in aquatic and terrestrial plant and animal communities. Furthermore, untangling the effects of intrinsic climatic variation and climate change will provide useful insights into regional trends in environmental change.

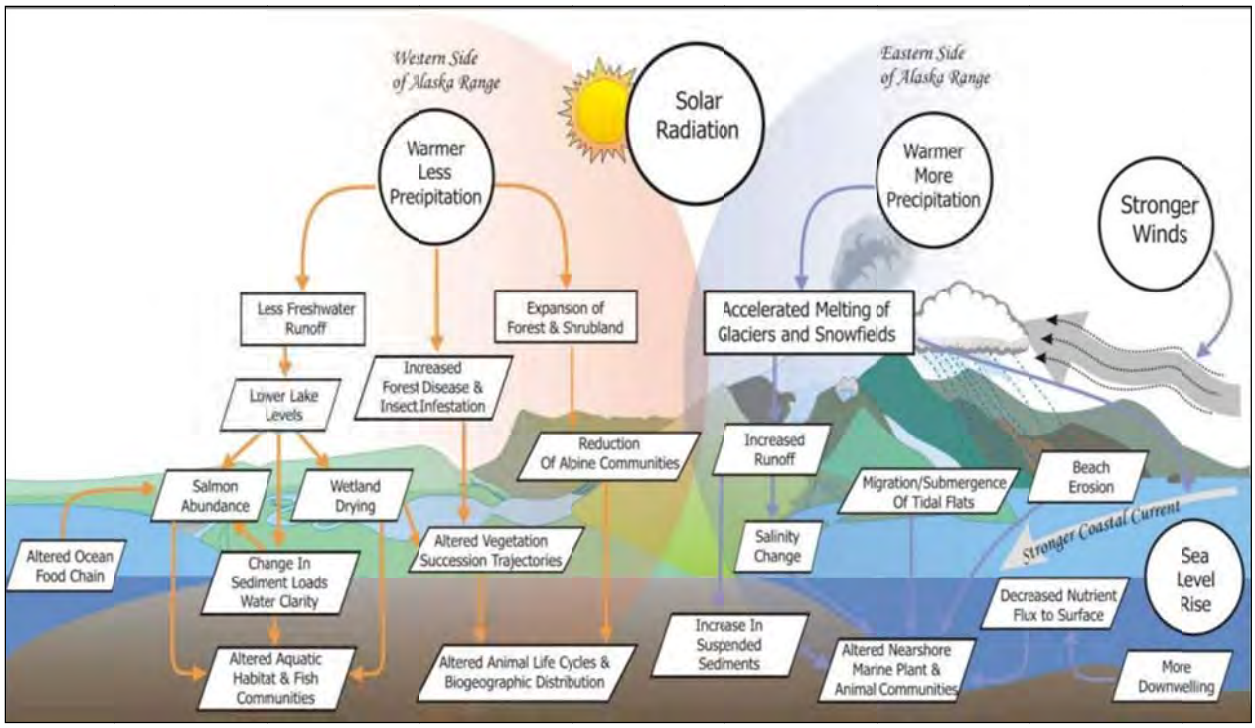


Figure 3. Key linkages between climate change and ecosystems for conceptual SWAN ecosystems (Bennett et al. 2006). Global climate models indicate that anticipated affects to subarctic ecosystems like those in the SWAN will include increased warming, increased precipitation, and a decrease in wintertime sea level pressure for the Bering Sea region resulting in more frequent northerly storm tracks (Chapman and Walsh 2007).

Objectives

These methods for monitoring climate were developed in order to address the monitoring question: *What is the natural variability of weather (temperature, relative humidity, precipitation, and wind) and what are the long-term climate trends in SWAN parks?*

Specifically, the objectives are to:

1. Record and archive hourly weather observation, including temperature, relative humidity, precipitation, wind speed and direction, solar radiation, and snow depth at weather stations located in representative areas within SWAN parks.

2. Produce monthly and annual summaries of weather observations and identify extremes of climatic conditions for common parameters (precipitation and air temperature), and other parameters for which sufficient data are available (e.g. wind speed and direction, solar radiation, soil temperature).

Challenges

Measuring winter-time precipitation (i.e. snowfall, snow depth, and snow water equivalent) has proven difficult to accomplish across the SWAN. Snow surveys are relatively accurate, but they are only measured monthly and the cost of access makes them impractical to conduct more frequently or at more than a few key locations. Most remote automated climate stations have limited 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 stations operated and maintained by the SWAN, snow water equivalent is not measured. A few remote automated climate stations utilize storage or displacement precipitation gauges or snow pillows. The logistical challenges and cost associated with maintaining these gauges or pillows (which are filled with an antifreeze solution) and protecting them from wildlife are significant and makes them impractical to operate at more than a few key locations. Undercatch (the difference between the actual amount of snow and the amount measured by a precipitation gauge) is a significant problem at one of these stations that is capable of measuring solid precipitation because of the windy nature of the site. Currently, accurate year-round precipitation is only measured at a few locations within the SWAN.

History of Climate Monitoring in the SWAN

There are very few climate stations within SWAN park units that have even moderately long-term and reliable records. A complete inventory of land-based weather and climate monitoring stations in the SWAN was completed by Davey and others (2007). Climate conditions have been monitored at just a few locations near SWAN park units since the 1930s (one station record extends to 1908). Several federal agencies administer six different climate monitoring programs in or near SWAN parks (Table 1).

Of the 40 climate monitoring stations listed in Table 1, 25 stations existed prior to the formation of the SWAN in 2001 (11of these stations were located within SWAN park units). The development of the SWAN climate monitoring program took approximately six years and included scoping workshops and meetings, site evaluations and documentation, and external reviews followed by equipment acquisition, testing, and deployment. A more detailed discussion of the historical development of the SWAN climate monitoring program and the identification and evaluation of SWAN climate station locations can be found in Redmond et al. (2005) and Giffen (2007). Since its inception, the SWAN has installed 10 Remote Automated Weather Stations (RAWS) in three SWAN park units. During this same timeframe, the National Oceanic and Atmospheric Administration (NOAA) has installed two Climate Reference Network (CRN) stations (KATM and LACL) and one moored buoy that monitors climatic conditions near KATM; the Natural Resources Conservation Service (NRCS) has installed a snowpack monitoring station in KEFJ; the Federal Aviation Administation and National Weather Service (NWS) have installed one new weather station at the airport in Port Heiden, and LACL is currently upgrading one station to meet NWS Cooperative Observing Program (COOP) standards.

Table 1. Climate monitoring programs used for monitoring climate in the SWAN. Numbers indicate the number of stations located within park boundaries – numbers inside of parentheses indicate stations located outside, but nearby, park boundaries.

Climate monitoring program	Agency	No. stns.
RAWS (Remote Automated Weather Stations)	National Interagency Fire Center (NIFC); NPS, BLM, USFS, etc.	12 (0)
COOP (National Weather Service Cooperative Observing Program)	National Oceanic and Atmospheric Administration (NOAA)-National Weather Service (NWS)	3 (5)
ASOS (Automated Surface Observing System); AWOS (Automated Weather Observing System)	NOAA-NWS; Federal Aviation Administration (FAA)	0 (6)
Snow Course (SC); SNOTEL (SNOwpack TELemetry)	National Resources Conservation Service (NRCS)	8 (1)
C-MAN (Coastal-Marine Automated Network); Moored Buoy (Navy Oceanographic Meteorological Automated Device or NOMAD)	NOAA-National Data Bouy Center (NDBC)	0 (3)
CRN (Climate Reference Network)	NOAA-National Climatic Data Center; NOAA-Atomospheric Turbulence and Diffusion Division	2 (0)

Remote Automated Weather Station (RAWS) Network

The RAWS network in the SWAN is administered primarily by the NPS and the Bureau of Land Management (BLM). Although RAWS are typically used by fire-management personnel to estimate a fire-danger rating and to forecast the behavior of wildland fires, they are increasingly being used for climate monitoring in remote locations. Two RAWS in SWAN parks (LACL) were established in 1992; 10 RAWS were installed by the SWAN in KATM, KEFJ, and LACL between 2004 and 2011. All 12 of these RAWS are currently monitored by the SWAN (Appendix A-1). Hourly meteorological elements are measured by automated sensors that record air temperature and relative humidity, precipitation, wind speed and direction, solar radiation, and optional measures of fuel moisture, soil temperature, and snow depth (Appendix A-2). Data are transmitted to the National Interagency Fire Center (NIFC) in Boise, Idaho via the Geostationary Operational Environmental Satellite (GOES). The GOES is operated by the National Oceanic and Atmospheric Administration (NOAA). The Wildland Fire Management Information (WFMI) system retrieves data from the GOES, converts and forwards it in a format compatible with the Weather Information Management System (WIMS) to the Western Regional Climate Center (WRCC) in Reno, Nevada. RAWS data is also sent to the Real-time Observation Monitoring and Analysis Network (ROMAN), MesoWest, and the Alaska Interagency Coordination Center (AICC). The WRCC is the official repository for RAWS data (www.wrcc.dri.edu).

Cooperative Observing Program (COOP)

The NWS COOP has been a foundation of the U.S. climate program for decades and continues to play an important role. The COOP was created in 1890 to provide: 1) observational data required to define the climate of the United States and to help measure extreme weather events, climate variability, and long-term climate changes; and 2) observational data in support of forecast, warning, and other public service programs of the NWS. Five COOP stations have been historically active in SWAN park units. Two of these COOP weather stations (Seward 8NW in KEFJ and Port Alsworth in LACL) and one that is currently being upgraded to a COOP station (Telaquana Lake in LACL) are currently active in SWAN park units. Five additional COOP stations with long station histories (e.g. 1931-present) located nearby SWAN park units are also

monitored (Appendix B-1). Core observations from the NWS COOP stations include 24-hour minimum and maximum temperatures and 24-hour precipitation totals (rain and – at some stations – water-equivalent of snow fall) (Appendices B-2). Additionally, observations of precipitation duration and other general climatic conditions are recorded daily. Observers are responsible for recording daily measures and reporting monthly tallies of all climatic observations to the NWS (Appendix B-3). The COOP stations have the longest period of record of all weather stations in and adjacent to the SWAN. The NWS maintains all COOP weather stations. The National Climatic Data Center (NCDC) in Asheville, North Carolina is the official repository for COOP data.

Automated Surface Observing System (ASOS) Network

The Automated Surface Observing System (ASOS) network is a joint effort of the National Weather Service (NWS), the Federal Aviation Administration (FAA), and the Department of Defense (DOD). ASOS stations are typically installed at major airports and military bases and are designed primarily to support aviation needs and weather forecast activities. These stations also support the needs of meteorological, hydrological, and climatological research communities. Five ASOS stations are currently monitored by the SWAN (Homer, Iliamna, Kenai, King Salmon, and Seward; Appendix C-1). Although none of these stations are located in SWAN park units, they are located nearby in gateway communities. These stations collect easily accessible, high quality data that can be coupled to historic climatic data from often co-located COOP sites (with long-term station records). ASOS stations are fully automated and collect hourly or sub-hourly observations. Meteorology elements that are measured include temperature, precipitation, humidity, wind, barometric pressure, sky cover, ceiling, visibility, and current weather (Appendix C-2). Hourly data are archived by the NCDC.

Automated Weather Observing System (AWOS) Network

The Automated Weather Observing System (AWOS) network is administered solely by the FAA. AWOS stations are typically installed at airports and are also designed primarily to support aviation needs and weather forecast activities. The Port Heiden AWOS located near ANIA is currently monitored by the SWAN (Appendix C-1). AWOS stations are fully automated and collect sub-hourly (20 minute) observations. Meteorological elements that are measured include temperature, humidity, wind, barometric pressure, sky cover, ceiling, and visibility (Appendix C-2). Precipitation is not measured. Sub-hourly data are archived by the NCDC.

Snow Course (SC) Network

The US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Snow Courses are observer-based sites where measures of snow depth and snow-water equivalent are collected manually along a permanent transect. Although climate information from Snow Courses is limited in scope, observations provide useful information about the temporal variation in snow pack, which is difficult to capture at most remote automated stations. Seven Snow Courses have been historically active in SWAN park units. Three of these Snow Courses in KEFJ and LACL (Exit Glacier, Port Alsworth, Telaquana Lake; Appendices D-1, 2, and 3) are currently active, regularly observed, and monitored by the SWAN. Four of these Snow Courses in KATM and LACL (Brooks Camp, Fishtrap Lake, Three Forks, and Upper Twin Lakes) are still active, sporadically observed, and monitored by the SWAN. Measurements are usually taken around the first day of the month during winter and spring. Observations are sent

by mail to the Alaska Snow Survey Program in Anchorage, Alaska. The NRCS is the official repository for Snow Course data.

SNOpack TELemetry (SNOTEL) Network

The SNOTEL (SNOwpack TELemtery) network of stations is administered by the USDA Natural Resources Conservation Service (NRCS). One SNOTEL station (Nuka River) was historically located in KEFJ, but is no longer in service. The Nuka Glacier SNOTEL is located outside KEFJ, but it is in close proximity to the park. The Exit Glacier SNOTEL was installed in 2011 (Appendices D-1, 4). SNOTEL stations provide near real-time snow and weather observations from sites in the mountainous regions of the Western United States. Observed data include snow water equivalent, snow depth, precipitation, temperature and other climatic elements at hourly intervals. Data are primarily used for forecasting and management of water supplies in the West. SNOTEL data are transmitted to two master receiving stations using a meteor burst communication technique. This technique involves bouncing VHF signals off gas trails of meteors that disintegrate in the 50-80 mile high region of the atmosphere. Master stations located in Alaska, Idaho, and Utah receive the data and transmit it to the Central Computer Facility of the National Water and Climate Center located in Portland, Oregon, where data is archived. Alaska SNOTEL stations are currently being converted to use Iridium satellite data transmissions.

Coastal-Marine Automated Network (C-MAN)

The Coastal-Marine Automated Network (C-MAN) was established by the NOAA National Data Bouy Center (NDBC) for the NWS in the early 1980s. C-MAN stations typically installed at lighthouses, at capes and beaches, or on near shore islands and offshore platforms. These automated stations record and transmit meteorological observations in U.S. coastal areas where observations were often previously made by U.S. Coast Guard personnel. Two C-MAN stations (Drift River Terminal and Pilot Rock) are currently monitored by the SWAN (Appendix E-1) C-MAN station observations typically include barometric pressure, wind direction, speed, and gust, and air temperature. Some stations also measure sea water temperature, water level, waves, relative humidity, precipitation, and visibility (Appendix E-1 and E-2). Data are processed and transmitted hourly via GOES to the National Weather Service Telecommunications Gateway (NWSTG) and the NDBC. Data are archived by the NDBC.

Moored Buoy Network

The Navy Oceanographic Meteorological Automated Device (NOMAD) boat-shaped buoy (6-m aluminum-hulled) is part of the NOAA NDBC's fleet of moored buoys. In addition to their use in operational weather forecasting, warnings, and atmospheric models, moored buoy data are useful for climate monitoring. One NOMAD buoy (Shelikof Strait) equipped with the Acquisition and Reporting Environmental System (ARES) payload is currently monitored by the SWAN (Appendix E-1). Hourly meteorological observations that are measured include barometric pressure, wind direction, speed, and gust, air temperature, visibility, wave height, and both dominant and average wave period (Appendix E-1 and E-3). Data are processed and transmitted hourly via GOES to the National Weather Service Telecommunications Gateway (NWSTG) and the NDBC. Data are archived by the NDBC.

Climate Reference Network (CRN)

Two Climate Reference Network (CRN) station have been established in SWAN parks (LACL in 2009 and KATM in 2012) (Appendix F-1). This CRN station is part of a network of climate stations being developed as part of a NOAA initiative. Its primary goal is to provide long-term homogenous 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. The primary purpose of the CRN network is to monitor air temperature and precipitation. Ground surface temperature, solar radiation, wind speed, and several values that monitor the operating condition of the equipment are also measured (Appendix F-2). CRN stations are unique in part because temperature measurements are made by three or more separate aspirated temperature sensors. Battery powered fans continuously draw air across each thermometer, reducing errors that can be as large as several degrees C in standard passively shielded thermometers under calm wind and strong solar radiation/sunlight conditions. The measurement of precipitation is complicated by the fact that it can occur in liquid or solid form. CRN stations measure both forms using an intermittently heated collecting bucket and tipping bucket. Several independent measurements of precipitation are made. Data are transmitted to the NCDC data management and processing facility in Asheville, North Carolina via Geostationary Operational Environmental Satellite (GOES). The NCDC is currently the official repository for CRN data.

Sampling Design

Sampling Design and Site Selection

In general, Alaska has a sparse distribution of weather stations and climate monitoring sites (Simpson et al. 2002). The goals and objectives of external programs have primarily determined the location of climate stations in and adjacent to the SWAN. In most cases, a rigorous sampling design was not used to locate stations and most locations are biased toward low elevation areas of human habitation outside the parks. For example, most weather stations support the needs of the aviation community. A sampling design is more apparent for SNOTEL locations where coverage of high elevation areas constrains station placement. However, KEFJ is the only SWAN park unit that has SNOTEL stations located nearby. The newly established CRN stations in LACL and KATM are part of an attempt by NOAA to establish a systematic grid of climate monitoring stations across the U.S. The installation of 10 new RAWS stations by the SWAN accounts, in part, for gaps in the existing network of stations. Despite all these recent efforts, there are still large regions within SWAN parks with no climate monitoring stations.

The site selection process for identifying new locations for climate monitoring stations in the SWAN was multifaceted and utilized multiple datasets. It benefited greatly from input by the NWS (Alaska Region Headquarters, Anchorage Forecast Office, and the Alaska-Pacific River Forecast Center), the NRCS, the University of Alaska Anchorage, the NPS Central Alaska Network I&M Program, and the WRCC. A comprehensive description of this process is provided by Giffen (2007). The criteria used in identifying potential sites included exposure, representativeness, elevation, logistics and practical factors, and potential impacts. These criteria were chosen with the designed intent of: 1) maximizing regional climate exposure while minimizing local influences, 2) representing basic climatic averages identified by climate models (e.g. PRISM) for a variety of ecoregions, 3) offsetting the low elevation bias of existing weather stations and climate monitoring programs, 4) providing for ease of access (which is critical for the long-term success of a climate monitoring program), and 5) minimizing potential environmental impacts in accordance with the National Environmental Policy Act (NEPA, NPS 2008). As a result of this effort, 10 climate monitoring stations (RAWS) were installed by the SWAN in 2004-2011.

Stations Being Monitored

In addition to operating and maintaining 10 RAWS, the SWAN monitoring strategy includes obtaining climate data for reporting and analysis from other stations located in and near SWAN parks. Stations being monitored by the SWAN were initially selected from the results of an inventory of weather and climate stations in and near SWAN park units (Table 4.3 *in* Davey et al. 2007). An additional population of stations, including recently established stations and NOAA coastal stations and moored buoys that were not included in the 2007 inventory, were also considered. A ranking process based on expert opinion was used to distill this original population of 211 stations. The criteria used for ranking are summarized in Table 2.

Table 2. Criteria used to select climate stations being monitored in the SWAN.

Criteria	Description of criterion
Distance from park unit	Station located within or nearby SWAN park units? (Yes/No)
Station activity	Station currently active? (Y/N) (Some RAWS adjacent to ANIA were excluded based on this criterion.)
Network purpose	Station network purpose supportive of monitoring climate in SWAN? (Y/N) (Acceptable networks are described in Background and Objectives – Historical Development of Climate Monitoring in the SWAN. For various reasons, the Citizen Weather Observing Program (CWOP) and Alaska Road Weather Information System (RWIS) were excluded, partly because of this criterion.)
Observational frequency	Station observation frequency hourly or sub-hourly (Y/N) (COOP stations and Snow Courses located within SWAN park units were not excluded based on this criterion. NWS Aviation Paid Observing Program (APAID) stations were excluded, partly because of this criterion.)
Quality of data	Data easy to access? (Y/N) Individual stations were excluded if access to data is proprietary, if metadata is not available, or if instrumentation/measurement standards are not available.
Accessibility of data	Near real-time data available? (Y/N) Individual stations were excluded if access to real-time data is not available. (COOP stations and Snow Courses located within SWAN park units were not excluded based on this criterion.)
Period of record	Complete period of record? (Y/N) Individual stations were excluded if there are significant gaps in the period of record or if observations are sporadic. (Several APAID stations were excluded because of this criterion. The long (>50 year) period of record of six COOP stations co-located with automated stations located near SWAN parks warranted their inclusion.)
Uniqueness vs. redundancy	Do stations provide unique information? (Y/N) Individual stations were excluded if they are located in close proximity and do not provide unique information (e.g. different meteorological observations or long period of record useful for temporal correlation). Some SNOTEL sites were excluded because of this criterion. Some COOP sites were included because of this criterion.

The locations of the 40 climate monitoring stations currently monitored by the SWAN are shown in Figure 4. Stations are tallied by park in Table 3 and identified by name in Table 4. Collectively, these stations sample a wide-range of basic climatic averages for a variety of ecoregions over a range of elevations. Within the geographic area of the SWAN there are an additional 88 COOP stations, 27 Snow Courses, 18 automated airport weather stations (ASOS & AWOS), 18 RAWS, 15 SNOTEL stations, 6 C-MAN stations, 6 buoys, and 1 CRN station. Where necessary, current and historical data from these climate stations can be accessed and combined with data from stations being monitored by SWAN for analyses. In this regard, the larger collection of available stations provides samples of climatic conditions that begin to approximate the scale of the SWAN region.

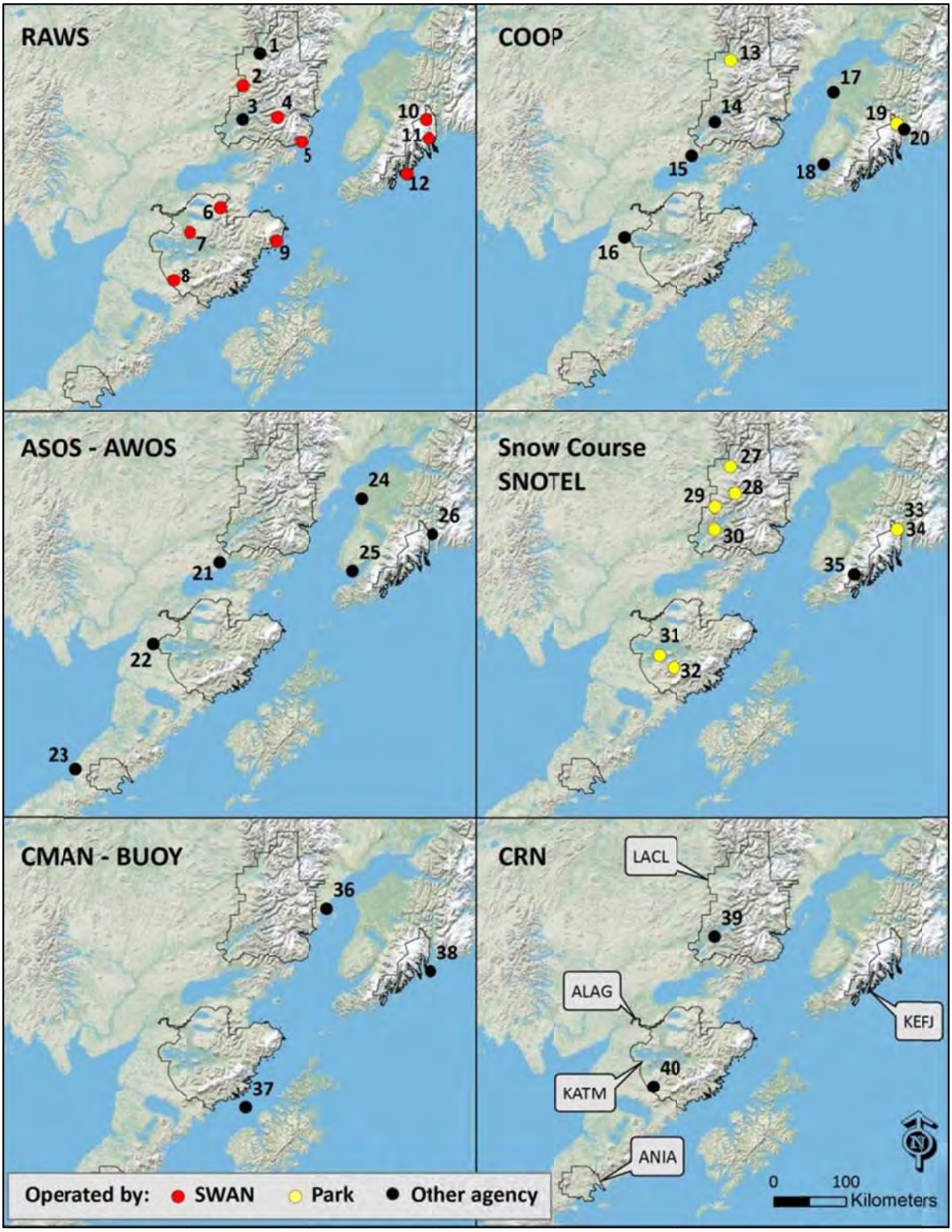


Figure 4. Locations of climate monitoring stations monitored by the SWAN. Each map identifies different station types, grouped by program. Climate stations that are operated and maintained by the SWAN are shown in red, stations that are monitored (but not operated or maintained) by the SWAN are shown in black. See Table 1 for definition of climate-monitoring program acronyms. Numbers shown are used to identify the stations in Table 4.

Table 3. Number of climate stations used for monitoring climate in the SWAN listed by park. Numbers indicate the number of stations located within park boundaries – numbers inside of parentheses indicate stations located outside, but nearby, park boundaries. Asterisk denotes that two stations (King Salmon Airport COOP & ASOS) were tabulated twice – once for ALAG and once for KATM. See Table 1 for definition of climate-monitoring program acronyms.

Park Unit	Acronym	Total no. stns.	RAWS	COOP	ASOS AWOS	SNOTEL SC	CMAN BUOY	CRN
Alagnak Wild River	ALAG	0 (2*)	0 (0)	0 (1*)	0 (1*) 0 (0)	0 (0) 0 (0)	0 (0) 0 (0)	0 (0)
Aniakchak National Monument and Preserve	ANIA	0 (1)	0 (0)	0 (0)	0 (0) 0 (1)	0 (0) 0 (0)	0 (0) 0 (0)	0 (0)
Katmai National Park and Preserve	KATM	7 (3*)	4 (0)	0 (1*)	0 (1*) 0 (0)	0 (0) 2 (0)	0 (0) 0 (1)	1 (0)
Kenai Fjords National Park and Preserve	KEFJ	6 (6)	3 (0)	1 (2)	0 (2) 0 (0)	1 (1) 1 (0)	0 (1) 0 (0)	0 (0)
Lake Clark National Park and Preserve	LACL	12 (5)	5 (0)	2 (2)	0 (2) 0 (0)	0 (0) 4 (0)	0 (1) 0 (0)	1 (0)

Observation Frequency and Replication

Observational frequency varies among the climate station types. Observations from COOP stations are generally 24-hour measures and are reported monthly to climate data centers. The Snow Course sites at KEFJ and LACL are monitored monthly during the winter and reporting is submitted soon thereafter. All the other climate monitoring stations (RAWS, ASOS, AWOS, SNOTEL, C-MAN, Buoys, and CRN) are automated and record information hourly or sub-hourly. Data from these stations are automatically transmitted every hour to regional and national climate data centers. Data from SWAN operated and maintained RAWS are also manually retrieved every year and sent to the WRCC in order to eliminate data gaps caused by missed GOES transmissions (which are usually a result of antenna icing).

Table 4. Climate stations monitored by the SWAN. Map numbers refer to locations in Figure 4. 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	CRN	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	12	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	0	10/2005
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	TBD	60.984	153.924	1250	6/1997
Telaquana Lake	TELA	SNCO	27	53L01	60.983	153.917	1550	8/1991
Three Forks	THFO	SNCO	32	55J02	58.367	155.383	900	1995
Upper Twin Lakes	UTLA	SNCO	28	53L02	60.650	153.800	2000	8/1991

Field Methods

Responsibilities for Station Operation and Maintenance

Field maintenance of climate monitoring stations is necessary to provide for the continuous acquisition of quality meteorological data, retrieval of complete station data, and fulfilling the station standards issued by the respective climate monitoring program. Currently, the SWAN is responsible for the long term operation and maintenance of 10 RAWS in three network parks. Park staff or personnel from respective climate monitoring programs are responsible for the operation and maintenance of the other stations located in and near SWAN parks that are discussed in these methods. However, SWAN staff will provide technical and field assistance to parks and other climate monitoring programs when possible. Responsibilities for station operation and maintenance are outlined in Table 5.

Table 5. Personnel responsible for recording and reporting climate data and maintaining climate stations.

	Station Operation (Observations & Reporting)		Maintenance and Calibration	
Climate network	**Manual or Automatic**	**Responsible Personnel**	**Frequency**	**Responsible Personnel**
RAWS	Automated	NPS network staff (SWAN) NPS radio shop (AKRO)	Once or more per year	SWAN staff Radio shop staff
COOP	Manual	NPS park staff (KEFJ, LACL) NWS COOP Observers	As needed	Regional district NWS staff (Park staff assist)
ASOS AWOS	Automated	NWS, FAA	Unknown	Regional district NWS & FAA staff
Snow Course	Manual	NPS park staff (KEFJ, LACL)	As needed	Park staff and NRCS
SNOTEL	Automated	NRCS	Once or more per year	NRCS
C-MAN Moored Buoy	Automated	NDBC	Unknown	NDBC and USCG
CRN	Automated	NOAA	Once or more per year	NOAA (Park and SWAN staff assist)

Detailed methods for the operation and maintenance of stations in this protocol are focused on SWAN operated and maintained RAWS. Methods for the operation and maintenance of COOP stations and Snow Courses operated within network parks by the NPS can be obtained from the NWS and NRCS, respectively. Discussion of methods pertinent to other stations is provided only where necessary in order to foster a general understanding of how they work.

Safety and Logistics

Access to SWAN operated and maintained stations is by fixed-wing aircraft, helicopters, and boats. Occasionally, access requires glacier travel by foot or ski. Recognizing the risks associated with both flying and working in remote mountainous areas that are subject to both harsh environmental conditions and the potential for human-wildlife encounters (e.g. moose, black bear, and brown bear), standards for safety are provided in Standard Operating Procedure (SOP) #1.

Significant logistical preparations are necessary prior to conducting field work. These include: travel and lodging arrangements, soliciting assistance from park staff, scheduling of park aircraft or boats, and contracting helicopters through DOI Office of Aircraft Services (OAS). Additionally, detailed operational plans are provided to network parks. Procedures for making these logistical preparations are also described in SOP #1.

Equipment Setup, Maintenance, and Inspection

Seasonal preparations and equipment setup are minimal given that most climate stations are currently in place and operate year-round. Maintenance and calibration of climate stations tend to be the responsibility of external agencies (Table 5) with the exception of NPS operated RAWS, COOP, and Snow Courses that are discussed below.

RAWS require annual maintenance each summer. Procedures for maintaining research permits required to support this work are documented in SOP #2. SWAN staff are responsible for the maintenance of 10 RAWS in SWAN park units (the NPS radio shop is responsible for the maintenance of two additional RAWS in LACL). Instructions for setting up a field laptop computer are documented in SOP #3. Interagency weather station standards and guidelines for RAWS are available from the NIFC (National Wildfire Coordinating Group 2012). The configuration of the satellite telemetry used by RAWS is explained in SOP #4. Programming instructions for RAWS data loggers and current programs in use are presented in SOP #5. Ten SWAN RAWS are covered under a maintenance agreement with the RAWS Depot – part of the NIFC in Boise, Idaho. Contact information and instructions for sensor replacement through the RAWS Depot are included in SOP #6. Instructions for documenting station maintenance and sensor performance are described in SOP #7. Detailed instructions for the field maintenance of network RAWS are provided in SOP #8. Other documents related to RAWS operation and maintenance are available on the Interagency RAWS web page (http://raws.fam.nwcg.gov/) under “Resources”. During standard operation of RAWS, equipment malfunction is reported to the RAWS Depot. Data from RAWS stations are automatically monitored by the Wildland Fire Information Management (WFMI) system, which processes RAWS data for display and distribution to downstream applications, and notifications are sent weekly by electronic mail when anomalous or missing values are observed. SWAN staff are ultimately responsible for monitoring RAWS status and resolving equipment problems in a timely manner within budget constraints.

Data from COOP stations and Snow Courses are monitored by the NWS and NRCS, respectively, to determine anomalous values and possible equipment malfunction (at COOP stations). Park staff are responsible for minor maintenance of COOP stations and Snow Course sites (brushing vegetation) and coordinating the replacement of malfunctioning equipment with the NWS or NRCS. SWAN staff will provide assistance if necessary.

Observation Methods

Automated Stations (RAWS, ASOS, AWOS, SNOTEL, CMAN, Buoys, CRN)

The 25 automated climate stations in the SWAN directly transmit climate observations to receiving agencies. Sampling, processing, and recording procedures vary among the automated station networks. RAWS sensors are updated frequently, with data being recorded and transmitted hourly. ASOS sensors are typically sampled continuously. Data from ASOS are recorded every minute; however, the NCDC archives quality-controlled, down sampled, hourly ASOS data. AWOS sensors are sampled frequently, often continuously. Data from AWOS stations are recorded every 20 minutes and the NCDC archives sub-hourly, quality-controlled data. SNOTEL sensors (at Nuka Glacier) are updated every five minutes, with data being recorded and transmitted hourly. CRN station sensors (except precipitation) are updated every 10 seconds, the precipitation gauges are sampled every minute. Data from CRN stations are recorded every five minutes and transmitted hourly. C-MAN station sensors are updated every two minutes and moored buoy station sensors are updated every eight minutes. Data from C-MAN stations and moored buoys are transmitted hourly.

Manual Stations (COOP and Snow Course)

Observer-based COOP stations require manual recording of climate observations on a daily basis. Daily observations are obtained by park staff by directly reading instruments (e.g. maximum & minimum thermometers) and by manual measurements (e.g. using a snow stick to measure snow depth). Procedures for the calibration and maintenance of equipment, for reading instrumentation, and recording manual observations are provided in the NWS Observing Handbook No. 2 - July 1989 (National Weather Service 1989) that is available online. Daily observations are recorded on a paper form NWS Form B91. The monthly summary of daily measures is sent to the Anchorage office of the NWS. B91 forms are either mailed or can be uploaded in WXCODER by the third day of the following month (the WXCODER system is not currently used at NPS COOP stations). The NCDC eventually receives all monthly reports, transcribes the data from paper copies to electronic data bases, archives the data, and distributes quality-controlled daily values to cooperating agencies.

Snow Courses are monitored monthly when a seasonal snow pack exists. At a minimum, observations are made December – April with observations taking place on the first day of the following month (± two days). Snow depth and snow-water equivalent are measured manually using a U.S. Federal Snow Sampler. Procedures, equipment lists, and example data sheets for snow course measurements are included in the Snow Survey Sampling Guide (Soil Conservation Service 1973) that is available online. Data sheets are sent to the Anchorage office of the NRCS soon after observations are made. The data are archived by the NRCS (available electronically) and published in the monthly Alaska Snow Survey Report.

Data Management and Reporting

Data Acquisition

The six climate monitoring programs in the SWAN maintain the official repositories for climate data from all stations monitored by the SWAN. Because accessing historical data can be tedious (climate data is available in a range of formats, units, and observational frequencies), data from these stations will also be archived on the SWAN server and uploaded to the I&M enterprise climate database. Local storage of climate data should increase data access and facilitate their use in the analyses of other vital signs. A detailed discussion of data management is provided in SOP #9.

Procedures have been developed to access and automatically process data from 33 climate stations located across the SWAN (Snow Courses data will be processed manually because of the nature of the monthly observations). A simplified data model is shown in Figure 5. RAWS data are acquired from the WRCC, which is the official repository for historical RAWS data. Procedures for accessing RAWS data are described in SOP #10. The National Climatic Data Center is the official repository for historical COOP, ASOS and AWOS, and CRN data. Procedures for accessing these data are described in SOP #11 (COOP data), SOP #12 (ASOS and AWOS data), and SOP # 16 (CRN data). Historical Snow Course and SNOTEL data are archived by the NRCS. Procedures for accessing these data from the NRCS website are described in SOP #13 (Snow Course data) and SOP #14 (SNOTEL data). The National Data Buoy Center is the official repository for historical C-MAN and moored buoy data. Procedures for accessing these data are described in SOP #15. Procedures are based on current access pathways and restrictions and will be subject to revision.

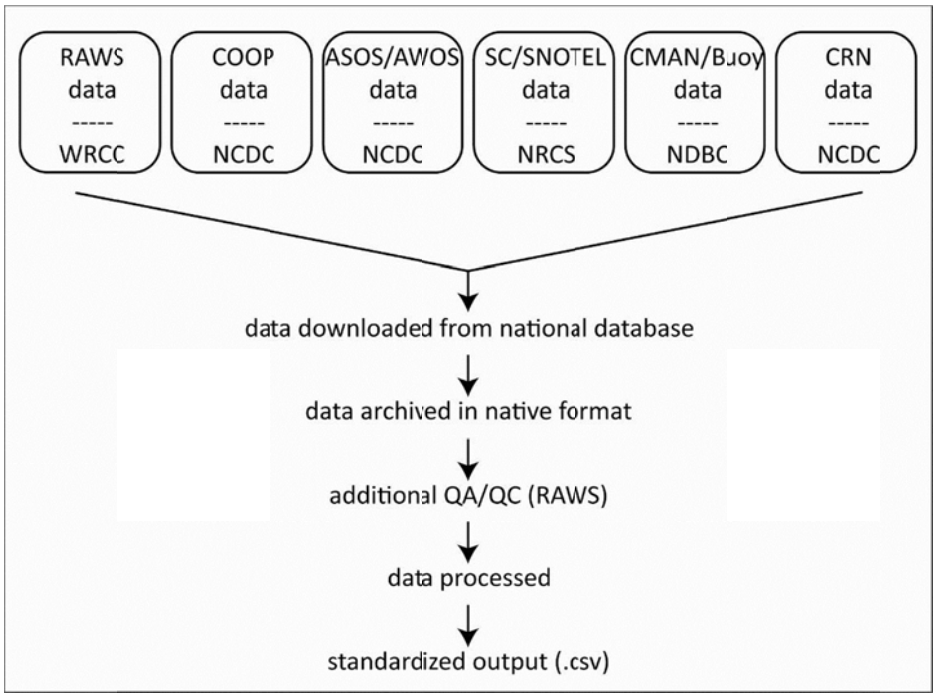


Figure 5. Data flow from national climate databases to final SWAN format.

Climate data are stored in their native format and, with the exception of Snow Course data, subsequently processed using routines that convert data to a standardized format in both metric and U.S. customary units. Climatic elements in these sources are summarized (down sampled) to hourly (when necessary), daily, monthly, and yearly (hydrologic year) measures. Customized programs (Python scripts) are used to summarize climate data. Procedures for running these programs are described in SOPs #10-16. Minimum, maximum, and arithmetic means are derived for temperature. Arithmetic means are derived for relative humidity and snow depth and, when applicable, for barometric pressure, wave height, wave period, ground surface temperature, and soil temperature. Cumulative values are derived for precipitation and solar radiation. Scalar and unit vector averaging are used to derive average wind speed and wind direction, respectively. For all derived measures, the percentage of valid observations within the observational period (hourly, daily, monthly, yearly) is reported as a measure of the reliability of the derived, mean and cumulative values.

Data Quality Control

The conversion of climate data in native format to the SWAN standardized data format employs checks for invalid date and time values, and non-numeric values when numeric are required. Errors are automatically corrected by supplying date and time values within valid ranges, and by entering a value of -9999 when missing or invalid data is identified or when a non-numeric character is found. Data flags associated with the native data format are checked and, when present, corresponding data are automatically marked by entering a value of -9999.

RAWS data from the WRCC in native format are quality checked by employing domain checks, which follow MesoWest data quality guidelines, and by referencing the SWAN station maintenance and performance tracking documents (refer to SOP #7). Missing or suspect data are marked with data quality flags. Data flags associated with the native data format are checked during subsequent conversion to the SWAN standardized output and, when present, corresponding data are automatically marked -9999. Procedures for data quality checking RAWS data are described in SOP #10. A Memorandum of Understanding between the NPS and WRCC will be developed that will result in more stringent data quality control for RAWS data collected by SWAN stations that are hosted by the WRCC.

Metadata Procedures

Metadata will be maintained at several levels. Station sensor specifications for the six climate monitoring programs in the SWAN are described in Appendices A-F. Documentation of sensor performance and station maintenance for the 10 RAWS administered by the SWAN is documented in SOPs #6 and 7. GIS data pertaining to, or created from climate data, will have FGDC-compliant metadata. Processed climate data hosted on the SWAN server should not be used or distributed without metadata documentation. The complete protocol (narrative and SOPs) is an integral component of the metadata for this vital sign. Version numbers of the narrative and SOPs in effect at the time data are collected, accessed, and processed will be recorded in the master version table (SOP #19).

Data Archiving Procedures

Data obtained from RAWS, COOP, ASOS and AWOS, Snow Course and SNOTEL, C-MAN and moored buoy, and CRN stations will be archived in their native format before any manipulation. These data and derived products will be stored on a secure SWAN server that is regularly backed-up. Data storage requirements for the original data and derivative products are approximately 25 and 75 MB respectively, per year. Processed climate data in the SWAN standardized data format (Python script output) will be uploaded to the I&M enterprise climate database following the procedures outlined in SOP #18.

Analysis and Reporting

Annual Reporting

An annual report on the climatic conditions of the most recent hydrologic year (October – September) will be distributed at the end of the calendar year. Reporting is based on the hydrologic year because it allows for more data completeness (considerable data are not transmitted from network RAWS during winter months because of antenna icing, however all data are retrieved during summer maintenance trips). The hydrologic year also maintains seasons better than the calendar year, which splits winters over two calendar years. Furthermore, 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. It is important to note that agency reporting of climate data (e.g. by NOAA, NWS) is generally based on the calendar year and that reporting of snow data (e.g. NRCS) is typically based on the hydrologic year. Although the SWAN annual summaries may differ in the reporting interval, the monthly data summaries contained in the annual reports will be directly comparable to those found in other reports.

The purpose of these annual reports is to summarize observations from local weather stations for the recent hydrologic year and to provide a regional and historical context for these observations. There are three components to the annual report: 1) a regional overview of climate and significant weather events across the network; 2) climate assessments in the context of historical trends and extremes; and 3) individual station summaries for all stations monitored by the SWAN. Reporting requirements state the need for an annual report every year and comprehensive analysis and trend reporting every five years (Bennett et al. 2006). These reports should be useful to other vital signs monitoring efforts, park managers, researchers, and also be of interest to the general public.

Report Format

Annual reports will include the following information for each climate station that is monitored:

- Brief description of climate stations, including the associated climate-monitoring program, location of station, station overview, period of record, and any equipment or data problems and issues that occurred during the recent hydrologic year.

- Annual summaries with monthly measures for the common climatic parameters (temperature, precipitation, snow depth, wind, and solar radiation).

- A brief narrative summarizing significant weather events, the degree and magnitude of climatic extremes, and departure from climate normal or period of record averages.

Reports will also include network-wide summaries that will include the following information

- Graphical comparisons, tables, and a narrative that summarizes and interprets network-wide patterns for temperature and precipitation.

Climate Station Summaries

Procedures for analyses and reporting are provided in SOP #17. Summary graphs and reports the most consistently measured climate variables from all weather stations monitored by the SWAN are included in the annual reports and are organized by park, climate monitoring program, and station name. Daily measures are used for generating plots (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 plots. An example plot is shown in Figure 6.

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 1981-2000 period and period of record (POR) values from the WRCC are included for stations with a long enough observational record. An example station summary is provided in Table 6.

Summary reports are derived (with minimal formatting) from the standard output files created by customized programs (Python scripts) that are used to summarize climate data. Plots are derived from the standard output files using graph templates (SigmaPlot).

All summary data is available in both U.S. Customary (e.g. °F, in, mph) and metric (e.g. °C, mm, m/s) units. In the interest of brevity and reader familiarity, annual reports will only present U.S. Customary units. These units are directly comparable to those found in other reports (e.g. NOAA, NWS, and NRCS).

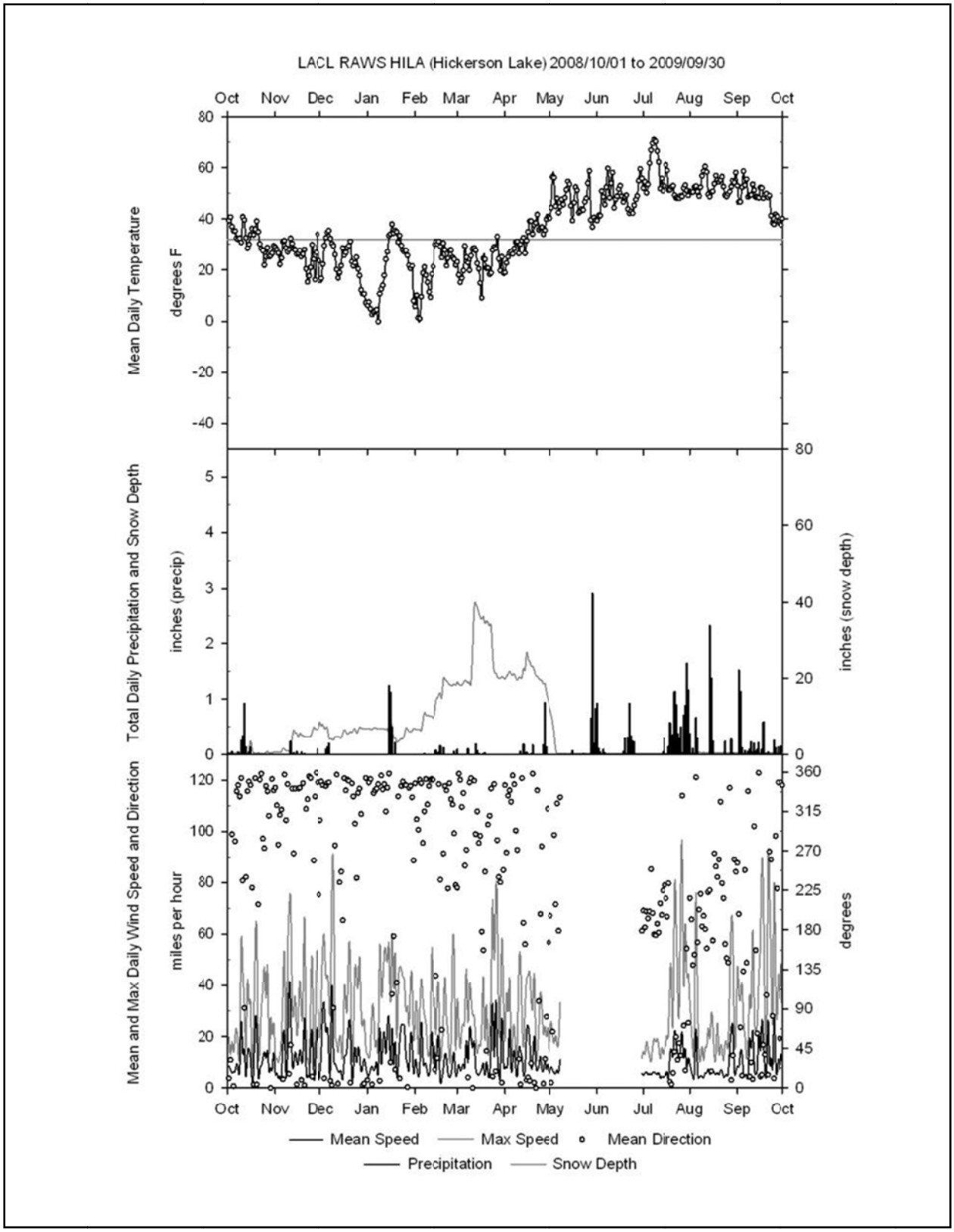


Figure 6. Example of a summary plot from an annual report.

Table 6. Example of a station summary from an annual report.

2009 Hydrologic Year – LACL RAWS HILA (Hickerson Lake)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year
Minimum air temperature (°F)													
Min.	18.5	10.6	2.8	-6.5	-6.5	3.2	15.4	31.3	37.9	43.2	41.5	32.2	-6.5
Max.	36.5	30.4	34.3	34.2	29.3	28	36.7	49.6	49.8	63.3	52.9	49.3	63.3
Mean	27.9	21.5	19.4	15.3	15.6	16.5	28.5	39.7	42.2	49.3	47.3	43.1	30.6
# days < 32 °F	23	30	28	28	28	31	20	1	0	0	0	0	189
% valid obs	100	100	100	100	100	100	100	100	98.5	99.7	99.7	100	99.8
Maximum air temperature (°F)													
Min.	28.2	21	11.3	6.3	8.1	16	28.8	38.7	45	49.6	49.8	39.6	6.3
Max.	49.8	36.9	36.9	44.2	39.6	45.1	54.7	72.1	73.6	80.6	69.3	66.6	80.6
Mean	38.2	30.5	27.2	25.3	27.5	29.3	40.5	54.6	57.1	61.8	60.3	52.4	42.1
# days < 32 °F	3	18	23	20	18	22	2	0	0	0	0	0	106
% valid obs	100	100	100	100	100	100	100	100	98.5	99.7	99.7	100	99.8
Mean air temperature (°F)													
Observed	32.2	25.7	23.1	20.1	21	22.5	33.4	46.8	49.1	55.3	53.1	47.2	35.9
% valid obs	100	100	100	100	100	100	100	100	98.5	99.7	99.7	100	99.8
POR mean 1971-2000													
Precipitation (in)													
Total[2]	1.93	0.53	0.45	3.13	0.61	0.47	1.73	5.62	2.67	9.69	5.57	5.51	37.91
% valid obs	100	100	100	100	100	100	100	100	98.3	99.7	99.9	100	99.8
POR mean 1971-2000													
Snow depth (in)													
Average	0.5	4.2	5.9	6.2	13.6	26.4	20.3	1	0.2	0.2	0.4	0.4	
% valid obs	98.9	99.6	100	92.9	100	98.5	99.4	98.3	97.6	84.7	96	93.9	
POR mean													
Wind (mph, degrees)													
Mean speed	10.6	12.9	13.9	14	9.9	12.4	11.2	7.2	5.3	9.3	7.8	12.4	
% valid obs	100	100	100	100	100	100	100	21.9	4.4	99.7	99.7	100	
Max speed	60.2	72.3	84.8	60.2	54.8	75.4	50.1	33.3	14.3	93.3	75.8	88.8	93.3
Max direction	3	1	10	60	336	14	0	6	186	0	5	9	0
Solar radiation (KWh/m^2)													
Total	45.7	13.5	7.1	11.9	32.2	76.4	118.4	161.2	151.3	133.2	119.6	63.9	934.2
% valid obs	100	100	100	100	100	100	100	100	98.5	99.7	99.9	100	99.8

[2]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.

Network-wide Comparison

Key climatic elements (e.g. observed departures in temperature and precipitation from the climate normal or period of record average) will be displayed geographically in order to identify any spatial patterns. Point-based station observations for the recent hydrologic year will be superimposed on maps derived from the Parameter-elevation Regressions on Independent Slopes Model (PRSIM, e.g. Figure 7). The PRISM model combines point weather observations and known climate patterns with elevation, slope, and aspect information in order to produce a spatial climate model (Daly et al, 1994). This geographic approach will allow for rapid identification of any spatial patterns of climate variability in the context of long-term climatic normals. This somewhat rudimentary method for network-wide comparison will be further developed in the future. This depiction of regional climatic conditions will likely be of interest to park managers and may provide important insight into reasons for observed spatial and/or temporal trends in other monitored vital signs.

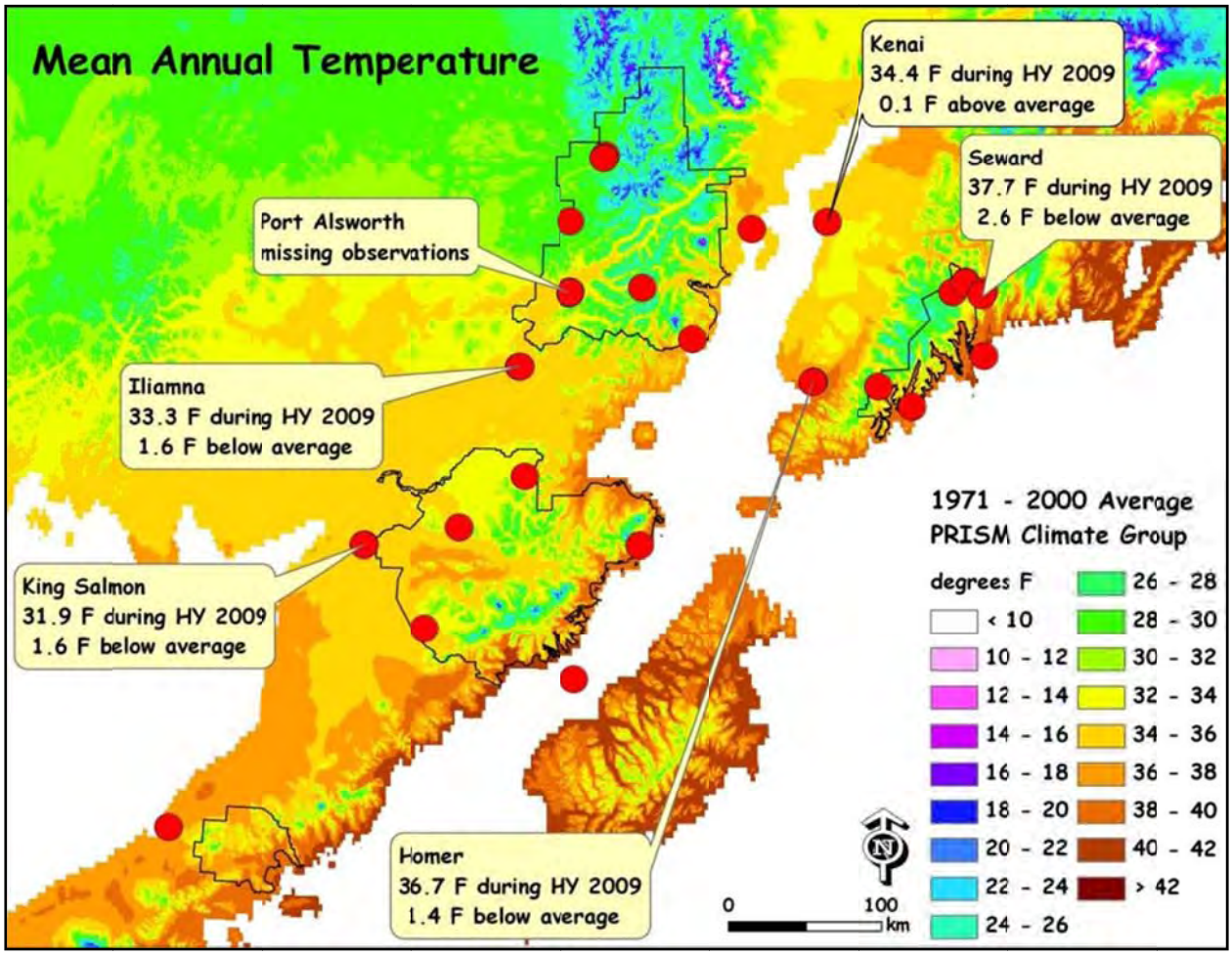


Figure 7. Mean annual temperature observations from long-term stations for the recent hydrologic year superimposed on PRISM model output (Daly 2009). Maps like these provide a spatial frame of reference for identifying departure from normal climatic conditions.

Personnel Requirements and Training

Roles and Responsibilities

The principle investigator (PI) for the SWAN climate monitoring vital sign is responsible for implementing these methods for monitoring climate in SWAN parks. The PI is responsible for appropriate site selection and placement of any new climate stations, station maintenance, assuring that appropriate weather station standards are being maintained, tracking station maintenance and sensor performance, acquisition and management of climate data, completion of annual reports, and the synthesis and analysis of climate data. The PI will also provide technical and field assistance to network parks in support of park climate monitoring efforts. Responsibilities for taking station observations and conducting maintenance are discussed above in the Field Methods section.

Training

Climate Station Observations

Recording and reporting observations from climate stations is either automated (SWAN RAWS) or the role of park staff (COOP and Snow Course). The NWS Observing Handbook No. 2 (National Weather Service 1989) describes procedures for recording and reporting COOP observations. A brief narrative of the NWS instructions for filing the NWS Form B-91 is also included in the Handbook. The Snow Survey Sampling Guide (Soil Conservation Service 1973) describes procedures for conducting monthly Snow Course observations. Typically, a park staff member with experience in COOP station operation or Snow Survey instructs new observers on these procedures.

RAWS Maintenance

Instructions for the completion of key preparatory work is necessary before maintenance of network RAWS are outlined in SOPs #1 - 3 and SOPs #6 and 7. Procedures for the field maintenance of RAWS are explained in SOPs #4, 5, and 8. Useful contacts are also provided (SOP #1) to help resolve questions or problems that may develop.

Training

Currency in the following training is required for SWAN staff responsible for the field maintenance of network RAWS:

- RAWS Technician (FTS Inc. or National Interagency Fire Center)
- Interagency Helicopter Manager
- Interagency Basic Aviation Safety
- Non-Law Enforcement Firearms Training Course for NPS employees
- Bear Safety for NPS employees
- Wilderness First Aid

Data Acquisition, Processing, and Archiving

Instructions and procedures for downloading and archiving climate station data are described in SOPs # 10 – 16. Procedures are largely automated and require good general computer and digital data management skills. SOPs will be reviewed prior to data acquisition, processing, and archiving.

Partnerships

The magnitude, cost and complexity of successful climate monitoring in the SWAN region requires that strong working relationships be maintained with various partners. The SWAN has relied on many experts in all aspects of establishing a climate monitoring program (weather station site selection, equipment selection, station maintenance, data quality control, and data archiving) and will continue to rely on the wealth of knowledge and guidance available from these experts. The SWAN will continue to support agencies and educational institutions through both funded and unfunded partnerships to facilitate climate monitoring efforts.

Operational Requirements

Annual Workload and Field Schedule

The expected annual time commitment for implementing these methods for monitoring climate in SWAN parks is approximately six months (0.5 FTE) and a generalized schedule is depicted in Figure 8. Data acquisition, processing, analysis, and reporting require about six weeks during the fall, after the conclusion of the hydrologic year. The finalized annual report should be distributed by the end of the calendar year. Maintenance agreements with the RAWS Depot should be established early in the fiscal year. Logistical preparations typically start in February or March and should include any sensor orders for stations that will be maintained before June. Snowpits on the Harding Icefield are dug in late April – this information is used to compliment precipitation values from the Harding Icefield RAWS in KEFJ. Typically, the SWAN provides technical and field assistance to KEFJ in support of this park glacier- and climate-monitoring effort and therefore it is practical to also maintain the Harding Icefield RAWS at this time. Logistical preparations for the bulk of the RAWS maintenance takes about 3 weeks and should be completed at least one month prior to the bulk of the field work. Most RAWS are maintained in June in order to make use of usually good weather conditions for aviation. The seasonal snowpack has usually melted by this time. Remaining and any unscheduled RAWS maintenance typically occur in the late summer. Sensors should be returned to the RAWS Depot as soon as all maintenance is finished. Station metadata is updated in WFMI and a maintenance report is completed in September.

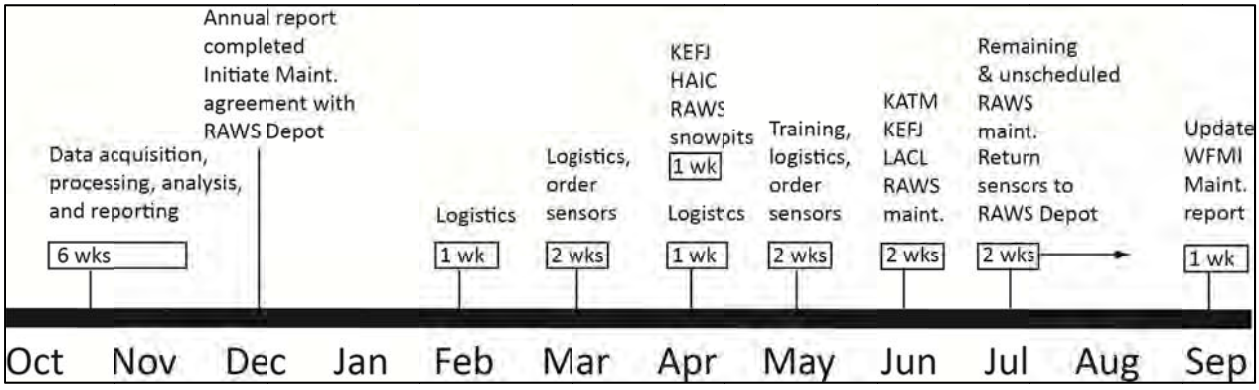


Figure 8. Generalized schedule for implementing methods for monitoring climate in SWAN parks. The calendar is organized by hydrologic (and also fiscal) year. Station name acronyms are defined in Table 4.

Climate Station Observations

The SWAN will not be directly involved with taking observations at climate stations. Park staff are primarily responsible for recording daily observations of COOP stations (KEFJ and LACL) and conducting monthly Snow Course observations (KEFJ and LACL). Network staff will provide technical and field assistance to parks in support of park climate monitoring efforts.

Startup Costs and Budget Considerations

Startup costs included all costs associated with identifying potential climate monitoring station locations; conducting on-the-ground site surveys; analysis, evaluation and priority ranking of potential deployment sites; preparation of an Environmental Assessment (for station installations); acquisition of weather stations and deployment of climate monitoring stations. All costs incurred after weather station deployment are considered operational costs. Startup costs for SWAN climate monitoring included:

- Site identification, site surveys and site evaluation/priority ranking process: $15,000
- Preparation of an environmental assessment for weather station deployments: $30,000
- Acquisition of weather stations (nine stations @ $18,000 each): $162,000
- Deployment of weather stations (aviation expenses, travel): $50,000

The total start-up cost for the installation of nine* additional climate monitoring stations in three network parks was $257,000. The Pedersen Lagoon RAWS was purchased with park funds from KEFJ.

Annual budget considerations for the operation and annual maintenance of nine RAWS in network parks include salary, the costs of annual sensor recalibration and replacement, travel, as well as unscheduled operational costs like sensor and or station damage due tower breakage and/or damage caused by animals (bears, moose, and rodents). Annual operational and maintenance costs for SWAN climate monitoring include:

- Salary (0.5 FTE GS 1301-09): $38,000
- Aviation (through DOI Aviation Management): $21,000
- Travel: $2,000
- Sensor replacement and recalibration (RAWS Depot): $9,000
- New sensors and other equipment: $15,000

The annual budget for the operation and maintenance of nine RAWS in network parks is $85,000, approximately 5% of the annual operating budget of the SWAN (based on FY2012).

Procedures for Making Changes to and Archiving Previous Versions of the Protocol

Revisions to these methods for monitoring climate in SWAN parks are inevitable. Clear documentation of these changes is critical for maintaining climate station standards and for proper acquisition, processing, interpretation, and analysis of climate data. Procedures for changing the protocol narrative and related SOPs are documented in SOP #19. The narrative and all SOPs are labeled with version numbers and each contains a Revision History Log. Updated version numbers will be recorded in the Climate Master Version Table (SOP #19) and communicated to the network Data Manager. Previous versions of the protocol narrative and SOPs will be archived.

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Appendix A-1. Attributes of RAWS monitored by the SWAN.

Station				***Available observations***																							
Park/ Station name/ NESDIS ID	**Location Lat Lon NAD83**	**Elev. ft (m)**	**Period of record**	***Air temp. (avg)***	***Air temp. (max)***	***Air temp. (min)***	***Wind speed (avg)***	***Wind speed (max)***	***Wind dir. (avg)***	***Wind dir. (max)***	***Rel. humidity (avg)***	***Atmos. Pressure***	***Sea Level Pressure***	***Visibility***	***Solar radiation***	***Precip. (liquid only)***	***Precip. (year-round)***	***Snowfall***	***Snow depth***	***Water temp. (avg)***	***Wave height (avg)***	***Wave period (avg)***	***Wave energy (avg)***	***Wave dir. (avg)***	***Tide (avg)***	***Surface temp. (avg)***	***Soil temp. (avg)***
LACL Chigmit Mountains FA6544FC	60.2249 -153.4675	4658 (1420)	7/2009 - present	✔	✔	✔	✔	✔	✔	✔	✔				✔	✔			✔								
KATM Contact Creek 32803738	58.2076 -155.9225	657 (200)	6/2008 - present	✔	✔	✔	✔	✔	✔	✔	✔				✔	✔			✔								
KATM Coville 3280B12C	58.8025 -155.5629	1567 (478)	6/2008 - present	✔	✔	✔	✔	✔	✔	✔	✔				✔	✔			✔								
KATM Fourpeaked 328135C2	58.7057 -153.5179	327 (100)	6/2009 - present	✔	✔	✔	✔	✔	✔	✔	✔				✔	✔											
KEFJ Harding Icefield FA656210	60.1325 -149.7820	4335 (1321)	7/2004 - present	✔	✔	✔	✔	✔	✔	✔	✔				✔		✔		✔								
LACL Hickerson Lake 3280C7BC	59.9148 -152.8925	1048 (319)	6/2008 - present	✔	✔	✔	✔	✔	✔	✔	✔				✔	✔			✔								

Appendix A-1 continued. Attributes of RAWS monitored by the SWAN.

Station				Available observations																							
Park/ Station name/ NESDIS ID	**Location Lat Lon NAD83**	**Elev. ft (m)**	**Period of record**	**Air temp. (avg)**	**Air temp. (max)**	**Air temp. (min)**	**Wind speed (avg)**	**Wind speed (max)**	**Wind dir. (avg)**	**Wind dir. (max)**	**Rel. humidity (avg)**	**Atmos. Pressure**	**Sea Level Pressure**	**Visibility**	**Solar radiation**	**Precip. (liquid only)**	**Precip. (year-round)**	**Snowfall**	**Snow depth**	**Water temp. (avg)**	**Wave height (avg)**	**Wave period (avg)**	**Wave energy (avg)**	**Wave dir. (avg)**	**Tide (avg)**	**Surface temp. (avg)**	**Soil temp. (avg)**
KEFJ McArthur Pass 3280244E	59.4726 -150.3337	1266 (386)	6/2008 - present	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓											
KEFJ Pedersen Lagoon 326AD012	59.8944 -149.7308	624 (190)	8/2011 - present	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓			✓								
KATM Pfaff Mine FA65578A	59.1109 -154.8367	2018 (615)	6/2008 - present	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓			✓								✓
LACL Port Alsworth FA6102CC	60.1958 -154.3200	321 (98)	6/1992 - present	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓											
LACL Snipe Lake 328041A8	60.6103 -154.3199	2315 (706)	6/2008 - present	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓			✓								✓
LACL Stoney FA600036	61.008 -153.8958	1250 (381)	6/1992 - present	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓											

Appendix A-2. RAWS instrumentation standards.

Sensor specifications are for the sensors currently in use on SWAN RAWS. They meet (or exceed) the NWCG Interagency Wildland Fire Weather Station Standards and Guidelines.

Parameter	Accuracy	Range	Resolution
Air temperature (°F)	--	--	--
Air temperature[1] (°C)	± 0.1 (-40 to + 60) ± 0.2 (at -40)	-40 to + 60	0.1
Wind speed[2] (mph)	± 2 %	0 to 150 mph	--
Wind speed[2] (m/s)	--	--	0.1
Wind direction[3] (°)	± 10	0 to 360°	1°
Relative humidity[4] (%)	± 2 % (at 0 to 60 °C)	0-100%	1%
Pressure (inHg)	--	--	--
Pressure (hPa = mbar)	--	--	--
Visibility (mi)	--	--	--
Visibility (km)	--	--	--
Solar radiation (Ly)	--	--	--
Solar radiation[5] (W/m^2)	± 5 %	0 to 1800	0.1
Precipitation (in)	--	--	--
Precipitation (mm) [6]	± 2 % of total (at 0 to 60 °C)	0 to 60 °C	0.2
Snowfall (in)	--	--	--
Snowfall (mm)	--	--	--
Snow depth (in)	--	--	--
Snow depth[7] (mm)	± 10 mm or 0.4 %	500 to 10,000 mm	0.25 mm
Water temperature (°F)	--	--	--
Water temperature (°C)	--	--	--
Wave height (ft)	--	--	--
Wave height (m)	--	--	--
Wave period (sec)	--	--	--
Wave energy (sec)	--	--	--
Wave direction (°)	--	--	--
Tide(ft)	--	--	--
Tide(m)	--	--	--
Surface temperature (°F)	--	--	--
Surface temperature (°C)	--	--	--
Soil temperature[3] (°F)	--	--	--
Soil temperature[3] (°C)	--	--	--

[1,4]FTS THS-3 Temperature/Humidity Sensor (T: encapsulated thermistor, RH: capacitive sensor)
[2]Met One Instruments 013 Wind Speed Sensor
[3]Met One Instruments 023 Wind Direction Sensor
[5]FTS SDI-SR-Pyranometer
[6]FTS RG-T-1 Rain Gauge Sensor (203 mm gauge diameter)
[7]Cambell Scientific SR50A Sonic Ranging Sensor (range cited is for distance to target)

Appendix B-1. Attributes of NWS COOP stations monitored by SWAN.

Station				Available observations																							
Park/ Station name/ COOP Stn. #	**Location: Lat Lon NAD83**	**Elev. ft (m)**	**Period of record**	**Air temp. (avg)**	**Air temp. (max)**	**Air temp. (min)**	**Wind speed (avg)**	**Wind speed (max)**	**Wind dir. (avg)**	**Wind dir. (max)**	**Rel. humidity (avg)**	**Atmos. Pressure**	**Sea Level Pressure**	**Visibility**	**Solar radiation**	**Precip. (liquid only)**	**Precip. (year-round)**	**Snowfall**	**Snow depth**	**Water temp. (avg)**	**Wave height (avg)**	**Wave period (avg)**	**Wave energy (avg)**	**Wave dir. (avg)**	**Tide (avg)**	**Surface temp. (avg)**	**Soil temp. (avg)**
Homer Airport 503665	59.6428 -151.4872	64 (20)	2/1939 - present		✓	✓											✓	✓	✓								
Iliamna Airport 503905	59.7539 -154.9069	183 (56)	1/1931 - present		✓	✓											✓	✓	✓								
Kenai Airport 504546	60.5797 -151.2391	91 (28)	3/1939- Present		✓	✓											✓	✓	✓								
King Salmon Airport 504766	58.6829 -156.6563	47 (14)	1/1942 - present		✓	✓											✓	✓	✓								
Port Alsworth 507570	60.2033 -154.3164	260 (79)	6/1960 - present		✓	✓											✓	✓	✓								
Seward 508371	60.1039 -149.4439	110 (34)	01/1931 - present		✓	✓											✓	✓	✓								
KEFJ Seward 8NW 508375	60.183 -149.633	410 (125)	6/1983 - present		✓	✓											✓	✓	✓								
LACL Telaquana Lake* # T.B.D.	60.984 -153.924	1250 (381)	6/1997 - present		✓	✓											✓	✓	✓								

*Station is currently being converted to NWS COOP station.

Appendix B-2. COOP instrumentation standards.

(http://www.nws.noaa.gov/directives/sym/pd01013002curr.pdf)

Parameter	Accuracy	Range	Resolution
Air temperature (°F)	± 2.0 °F (-62 to -50°F) ± 1.0 °F (-50 to +122°F) ± 2.0 °F (+122 to +134°F)	-62 to -50°F -50 to +122°F +122 to +134°F	1°F 1°F 1°F
Air temperature (°C)	--	--	--
Wind speed (mph)	--	--	--
Wind speed (m/s)	--	--	--
Wind direction (°)	--	--	--
Relative humidity (%)	--	--	--
Pressure (inHg)	--	--	--
Pressure (hPa = mbar)	--	--	--
Visibility (mi)	--	--	--
Visibility (km)	--	--	--
Solar radiation (Ly)	--	--	--
Solar radiation (W/m^2)	--	--	--
Precipitation (in)	± 0.02 in or 4% of hourly amount (the greater)	0-10 in / hour	0.01 in
Precipitation (mm)	--	--	--
Snowfall (in)	≥ 0.01 in	0 to 40 in	0.01 in
Snowfall (mm)	--	--	--
Snow depth[1,2] (in)	± 0.5 in (0 to 5 in) ± 1.0 in (>5 to 99 in)	0 to 99 in	1 in
Snow depth[1,2] (mm)	--	--	--
Water temperature (°F)	--	--	--
Water temperature (°C)	--	--	--
Wave height (ft)	--	--	--
Wave height (m)	--	--	--
Wave period (sec)	--	--	--
Wave energy (sec)	--	--	--
Wave direction (°)	--	--	--
Tide(ft)	--	--	--
Tide(m)	--	--	--
Surface temperature (°F)	--	--	--
Surface temperature (°C)	--	--	--
Soil temperature (°F)	--	--	--
Soil temperature (°C)	--	--	--

Appendix C-1. Attributes of ASOS and AWOS monitored by the SWAN.

Station				Available observations																						
Station name/ WBAN ID	**Location: Lat Lon**	**Elev. ft (m)**	**Period of record**	**Air temp. (avg)**	**Air temp. (max)**	**Air temp. (min)**	**Wind speed (avg)**	**Wind speed (max)**	**Wind dir. (avg)**	**Wind dir. (max)**	**Rel. humidity (avg)**	**Atmos. Pressure**	**Sea Level Pressure**	**Visibility**	**Solar radiation**	**Precip. (liquid only)**	**Precip. (year-round)**	**Snowfall**	**Snow depth**	**Water temp. (avg)**	**Wave height (avg)**	**Wave period (avg)**	**Wave energy (avg)**	**Wave dir. (avg)**	**Tide (avg)**	**Surface temp. (avg)**	**Soil temp. (avg)**
Homer Airport 25507	59.6428 -151.4872	64 (20)	12/1997 - current	✓			✓		✓		✓	✓	✓	✓			✓										
Iliamna Airport 25506	59.7539 -154.9069	183 (56)	12/1997 - current	✓			✓		✓		✓	✓	✓	✓			✓										
Kenai Airport 26523	60.5797 -151.2391	91 (28)	3/1939- present	✓			✓		✓		✓	✓	✓	✓			✓										
King Salmon Airport 25503	58.6829 -156.6563	47 (14)	06/1998 - present	✓			✓		✓		✓	✓	✓	✓			✓										
Port Heiden Airport 25508	56.9500 -158.6167	95 (25)	10/2007 - present	✓			✓		✓			✓															
Seward Airport 26438	60.1283 -149.4167	22 (7)	04/1997 - present	✓			✓		✓		✓	✓	✓	✓			✓										

Appendix C-2. ASOS and AWOS instrumentation standards.

(http://www.nws.noaa.gov/asos/pdfs/aum-toc.pdf)

Parameter	Accuracy	Range	Resolution
Air temperature (°F)	± 3.6°F (-80 to -58°F) ± 1.8°F (-58 to +122°F) ± 3.6°F (+122 to +130°F)	-80 to -58°F -58 to +122°F +122 to +130°F	0.1°F 0.1°F 0.1°F
Air temperature (°C)	--	--	--
Wind speed[1] (knots)	± 2 kts or 5% (the greater)	0 to 125 kts	1 kt
Wind speed (m/s)	--	--	--
Wind direction (°)	± 5° at ≥ 5 kts	0 to 359°	1°
Relative humidity[2] (%)	not specified	0 to 100%	1%
Pressure (inHg)	± 0.02 inHg	16.9 to 31.5 inHg	0.003 inHg (meas.) 0.005 inHg (report)
Pressure (hPa = mbar)	--	--	--
Visibility[3] (mi)	≤ 1 mi	0 to 10 mi	1 mi
Visibility (km)	--	--	--
Solar radiation (Ly)	--	--	--
Solar radiation (W/m^2)	--	--	--
Precipitation (in)	± 0.02 in or 4% of hourly amount (the greater)	0-10 in / hour	0.01 in
Precipitation (mm)	--	--	--
Snowfall (in)	--	--	--
Snowfall (mm)	--	--	--
Snow depth[1,2] (in)	--	--	--
Snow depth[1,2] (mm)	--	--	--
Water temperature (°F)	--	--	--
Water temperature (°C)	--	--	--
Wave height (ft)	--	--	--
Wave height (m)	--	--	--
Wave period (sec)	--	--	--
Wave energy (sec)	--	--	--
Wave direction (°)	--	--	--
Tide(ft)	--	--	--
Tide(m)	--	--	--
Surface temperature (°F)	--	--	--
Surface temperature (°C)	--	--	--
Soil temperature (°F)	--	--	--
Soil temperature (°C)	--	--	--

[1]Accuracy, range, and resolution for wind speed are reported in knots. The NCDC converts wind speed to mph in the quality controlled local climatological data archive.
[2]Relative humidity is calculated using average ambient (dry-bulb) temperature and dew point temperature. Refer to the dew point temperature algorithm in the ASOS User's Guide for more information.
[3]Refer to the ASOS User's Guide for more information on the accuracy of the ASOS visibility sensor.

Appendix D-1. Attributes of Snow Courses and SNOTEL stations monitored by the SWAN.

Station				Available observations																							
Park/ Station name/ Station type/ NRCS ID#	**Location: Lat Lon**	**Elev. ft (m)**	**Period of record**	**Air temp. (avg)**	**Air temp. (max)**	**Air temp. (min)**	**Wind speed (avg)**	**Wind speed (max)**	**Wind dir. (avg)**	**Wind dir. (max)**	**Rel. humidity* (avg)**	**Atmos. Pressure**	**Sea Level Pressure**	**Visibility**	**Solar radiation**	**Precip. (liquid only)**	**Precip. (year-round)**	**Snowfall**	**Snow depth****	**Water temp. (avg)**	**Wave height (avg)**	**Wave period (avg)**	**Wave energy (avg)**	**Wave dir. (avg)**	**Tide (avg)**	**Surface temp. (avg)**	**Soil temp. (avg)**
KATM Brooks Camp Aerial Marker 55J01	58.533 -155.767	150 (45)	1995																✓								
KATM Three Forks Aerial Marker 55J02	58.367 -155.383	900 (274)	1955																✓								
KEFJ Exit Glacier Snow Course 49L18	60.1903 -149.6212	400 (122)	09/1988																✓								
KEFJ Exit Glacier SNOTEL 49L18	60.1903 -149.6212	400 (122)	07/2011	✓	✓	✓	✓	✓	✓		✓				✓	✓	✓		✓								✓
KEFJ Nuka Glacier SNOTEL 50K06S	59.6943 -150.7110	1250 (381)	10/1990	✓	✓	✓					✓				✓		✓		✓								✓

*Only relative humidity sampled at midnight is available from the Nuka Glacier SNOTEL. **Snowpack density and snow water equivalent are calculated at Snow Courses, but not at aerial markers (Brooks Camp and Three Forks).

Appendix D-1 continued. Attributes of Snow Courses and SNOTEL stations monitored by the SWAN.

Station				Available observations																						
Park/ Station name/ Station type/ NRCS ID#	**Location: Lat Lon**	**Elev. ft (m)**	**Period of record**	**Air temp. (avg)**	**Air temp. (max)**	**Air temp. (min)**	**Wind speed (avg)**	**Wind speed (max)**	**Wind dir. (avg)**	**Wind dir. (max)**	**Rel. humidity* (avg)**	**Atmos. Pressure**	**Sea Level Pressure**	**Visibility**	**Solar radiation**	**Precip. (liquid only)**	**Precip. (year-round)**	**Snowfall**	**Snow depth****	**Water temp. (avg)**	**Wave height (avg)**	**Wave period (avg)**	**Wave energy (avg)**	**Wave dir. (avg)**	**Tide (avg)**	**Surface temp. (avg)**	**Soil temp. (avg)**
LACL Fishtrap Lake Snow Course 54L02	60.4913 -154.3296	1800 (549)	8/1991																✓								
LACL Upper Twin Lakes Snow Course 53L02	60.650 -153.800	2000 (610)	8/1991																✓								
LACL Port Alsworth Snow Course 54L01	60.1921 -154.3272	270 (83)	10/1991																✓								
LACL Telaquana Lake Snow Course 53L01	60.983 -153.917	1550 (472)	08/1991																✓								

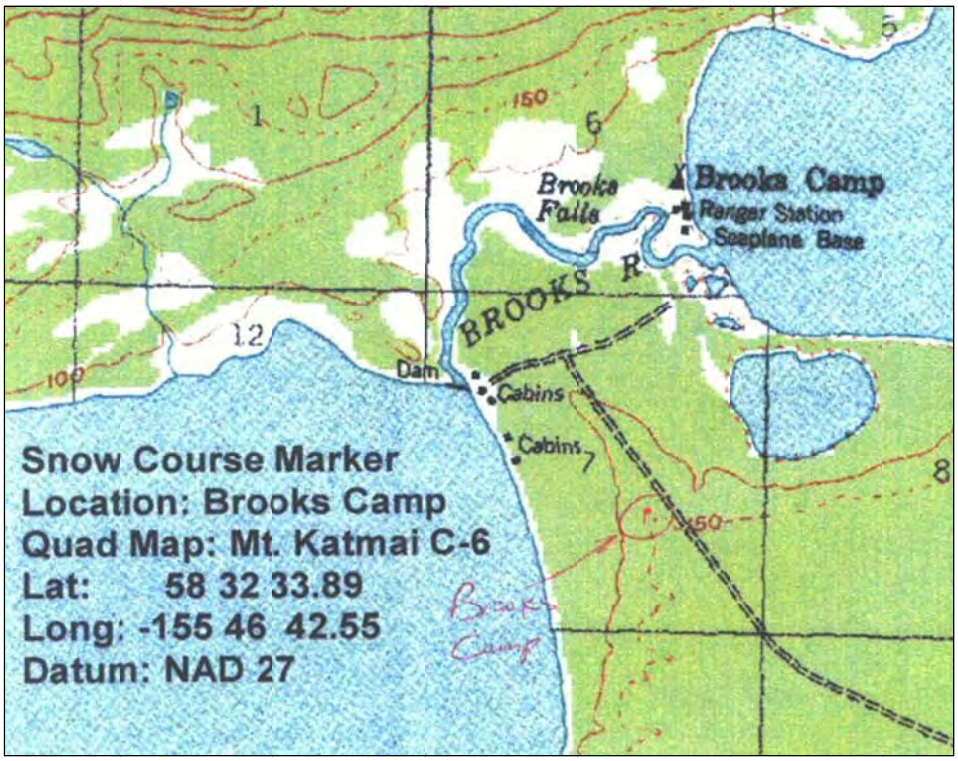
*Snowpack density and snow water equivalent are calculated at Snow Courses. **Snowpack density and snow water equivalent are calculated at Snow Courses, but not at aerial markers (Brooks Camp and Three Forks).

Appendix D-2. Snow Course measurement and SNOTEL instrumentation standards.

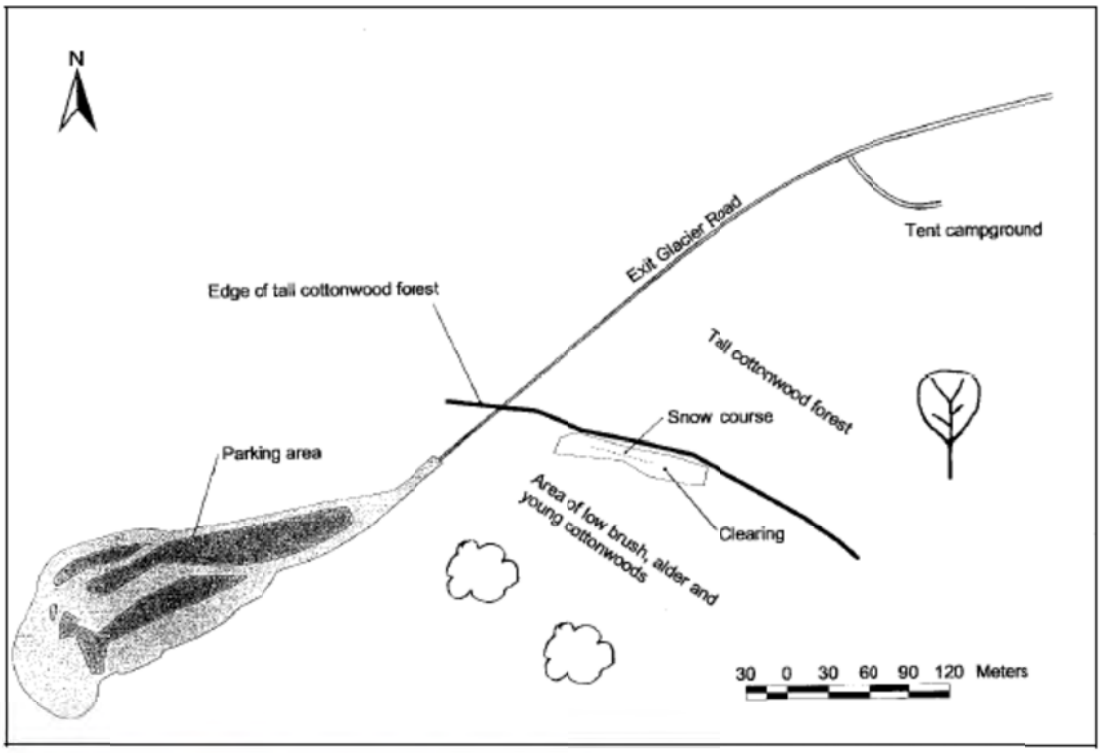
Parameter	Accuracy	Range	Resolution
Air temperature[1] (°F)	± 1°F	-40 to +140°F	0.1°F
Air temperature (°C)	--	--	--
Wind speed (mi)	--	--	--
Wind speed (m/s)	--	--	--
Wind direction (°)	--	--	--
Relative humidity[1] (%)	± 3 %	10 to 100%	1%
Pressure (inHg)	--	--	--
Pressure (hPa = mbar)	--	--	--
Visibility (mi)	--	--	--
Visibility (km)	--	--	--
Solar radiation (Ly)	--	--	--
Solar radiation[1] (W/m^2)	± 5%	0 to 1500 W/m^2	0.1 W/m^2
Precipitation[1] (in)	± 4%	not specified	0.1 in
Precipitation (mm)	--	--	--
Snowfall (in)	--	--	--
Snowfall (mm)	--	--	--
Snow depth (in)	± 4% (SNOTEL) not specified (Snow Course)	not specified	0.5 in (SNOTEL) 0.5 in (Snow Course)
Snow depth (mm)			
Snow water equivalence (in)	≤ 3% (Snow Course)	not specified	0.5 in (Snow Course)
Water temperature (°F)	--	--	--
Water temperature (°C)	--	--	--
Wave height (ft)	--	--	--
Wave height (m)	--	--	--
Wave period (sec)	--	--	--
Wave energy (sec)	--	--	--
Wave direction (°)	--	--	--
Tide(ft)	--	--	--
Tide(m)	--	--	--
Surface temperature (°F)	NA	NA	NA
Surface temperature (°C)	NA	NA	NA
Soil temperature (°F)	--	--	--
Soil temperature (°C)	--	--	--

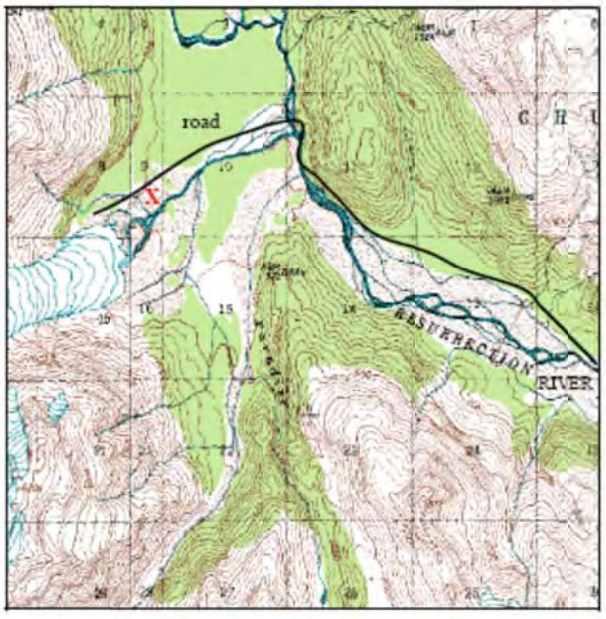
[1]SNOTEL only. Soil temperature data are available from depths of 2”, 8”, and 20” at the Nuka Glacier SNOTEL.

Appendix D-3. Maps of active Snow Course transects located in SWAN park units.



Appendix D-3 continued. Maps of active Snow Course transects located in SWAN park units.





COOPERATIVE SNOW SURVEYS, ALASKA

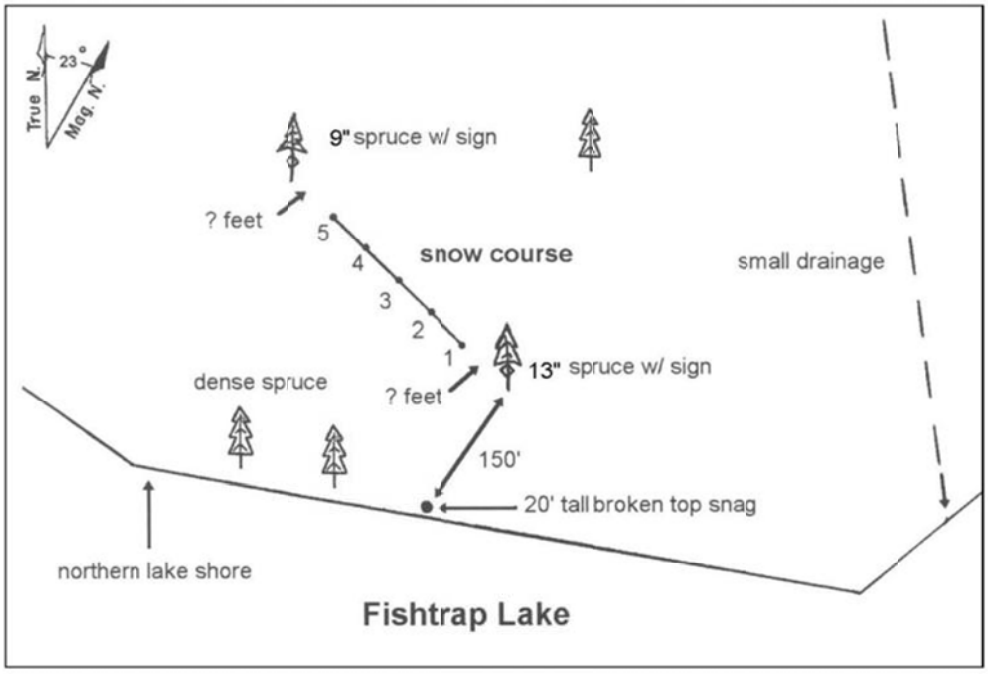
NAME: **EXIT GLACIER**

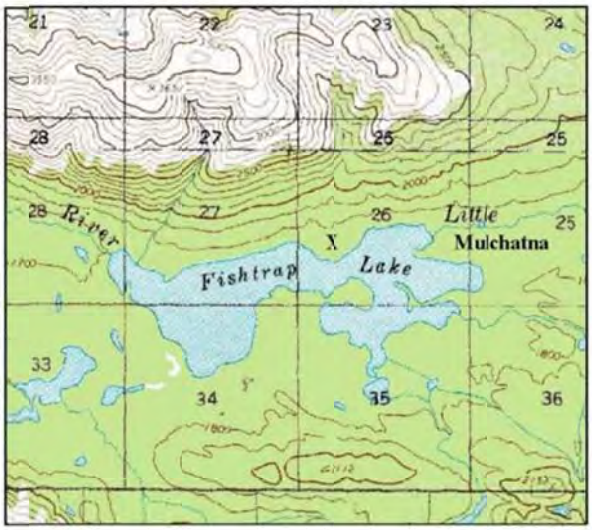
COURSE NO. **49L18** ELEVATION - 400'
SAMPLES - 5 INTERVAL - 15'
N-LAT. 60° 11.42' W-LONG. 149° 37.27'
RESURRECTION DRAINAGE
WESTERN GULF BASIN
MAP: SEWARD A-7

Ownership: National Park Service
Estab. 9/88 by G. Clagett & B. Rice

DESCRIPTION: Five station snow course located approximately mid-way between the Exit Glacier parking area and the tent campground. From the parking area, walk toward the campground on the road. Turn right (east) and leave the road just before the significant vegetation change from low shrub and alder to tall cottonwoods. The course is located in the long, narrow clearing about 160' off the road. At the NW end is a small cottonwood tree w/ a yellow sign. It is 20' from this tree to the first station and then 15' between stations.

Appendix D-3 continued. Maps of active Snow Course transects located in SWAN park units.





COOPERATIVE SNOW SURVEYS, ALASKA

NAME: **FISHTRAP LAKE**

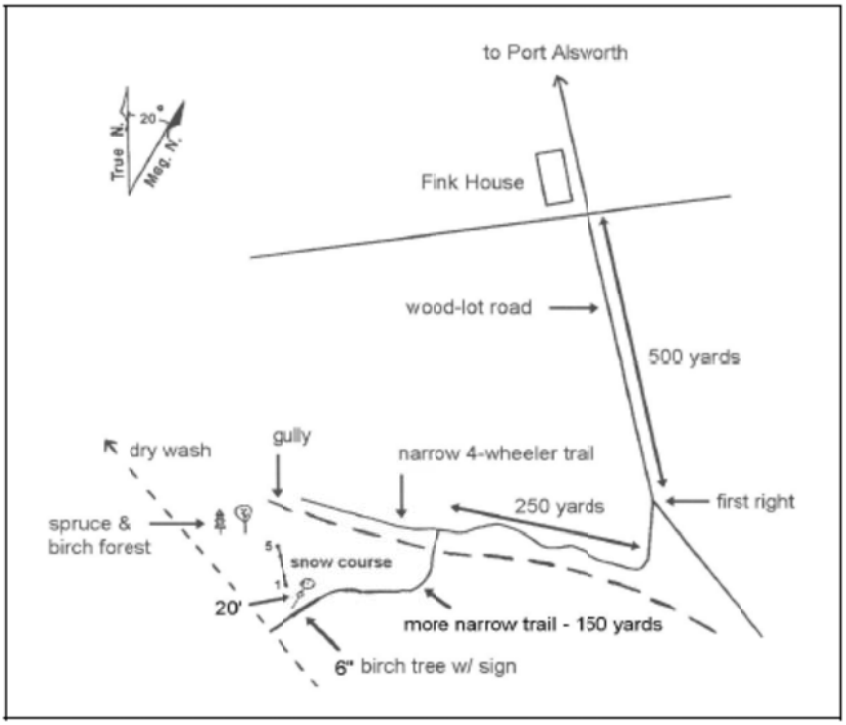
COURSE # **54L02** ELEVATION - 1800'
SAMPLES - 5 INTERVAL – Variable, 14'-16'
N-LAT. 60° 29.48' W-LONG. 154° 19.78'
MULCHATNA RIVER DRAINAGE
BRISTOL BAY HYDROLOGIC BASIN
MAP: LAKE CLARK B-4

Ownership: National Park Service
Estab. 8/91 by George Clagett & Leon Alsworth

DESCRIPTION: Five station snow course. The key land mark along the north shore of Fishtrap Lake is a 20' broken snag. This is near the tip of the rounded peninsula and just west of where a small drainage enters the lake. From the snag, the snow course is 150' to the NE. The course runs NW/SE and both ends are marked by 50' spruce with yellow signs.

Questions for the Surveyor: Is the sample interval 14-16 feet?
How far is it from the two spruce with signs to the closest sample station? Again, to nearest whole foot.

Appendix D-3 continued. Maps of active Snow Course transects located in SWAN park units.





COOPERATIVE SNOW SURVEYS, ALASKA

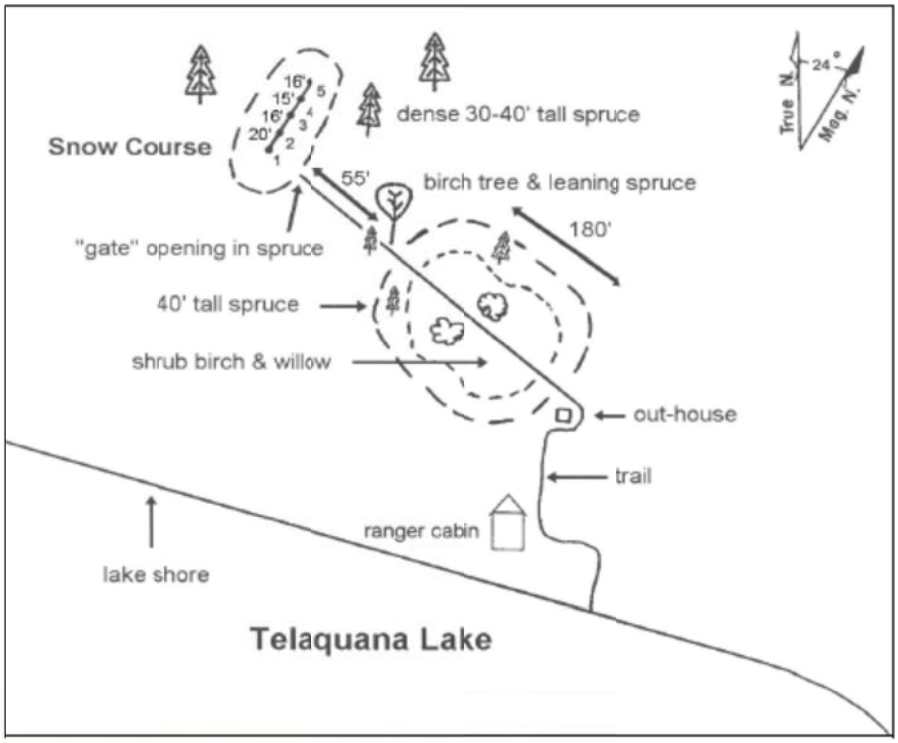
NAME: **PORT ALSWORTH**

COURSE # **54L01** ELEVATION - 270'
SAMPLES - 5 INTERVAL – Variable, 10'-16'
N-LAT. 60° 11.526' W-LONG. 154° 19.631'
LAKE CLARK DRAINAGE
BRISTOL BAY HYDROLOGIC BASIN
MAP: LAKE CLARK A-4

Ownership: National Park Service
Estab. 10/91 by Rick McClure & Leon Alsworth

DESCRIPTION: Five station snow course. To reach the course, start at the Fink's house south of the airstrip. Follow the "wood lot road" south for 500 yards, then take the first right onto the 4-wheeler trail. Go west along the north side of the gully for 250 yards. Turn left (south) onto narrow trail and cross gully. Follow this trail for 150 yards and snow course is on the right (north) side just before dry wash. Look for the snow course sign on 6" birch. There is also a birch with arrow 8' from point #1. Sample intervals are: #1 to #2 = 14', #2 to #3 & #4 to #5 = 16', and #3 to #4 = 10'.

Appendix D-3 continued. Maps of active Snow Course transects located in SWAN park units.





COOPERATIVE SNOW SURVEYS, ALASKA

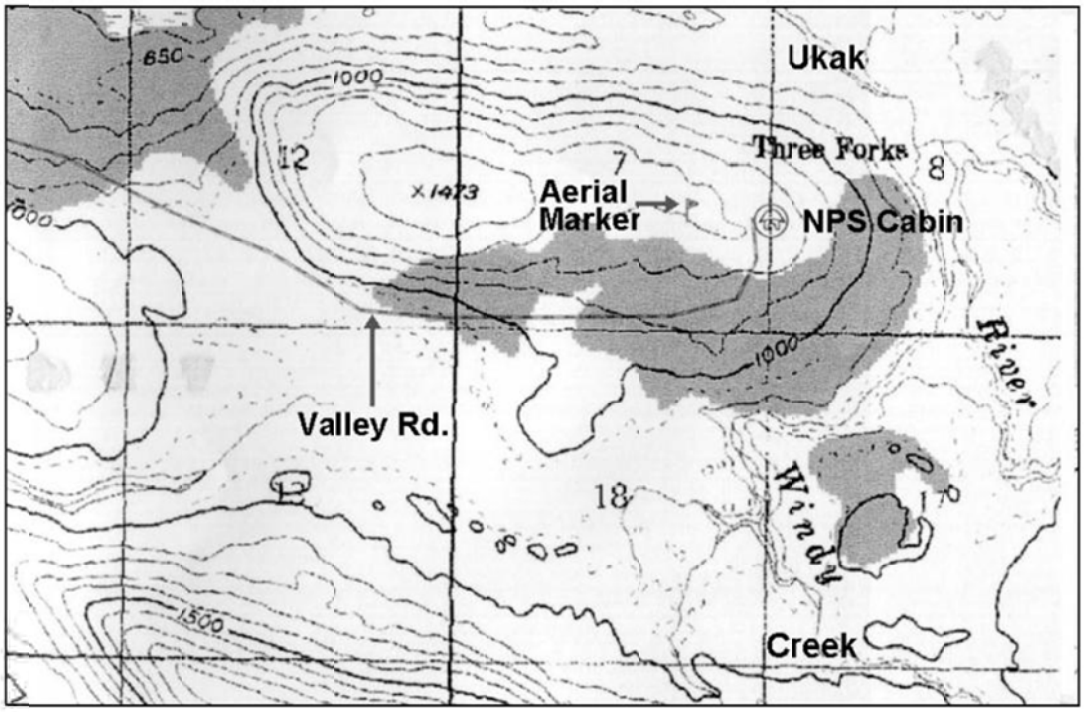
NAME: **TELAQUANA LAKE**

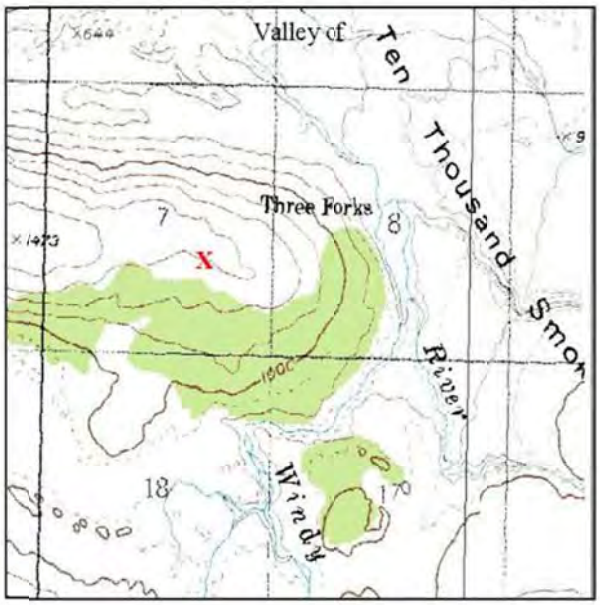
COURSE # **53L01** ELEVATION - 1550'
SAMPLES - 5 INTERVAL – Variable, 15' - 20'
N-LAT. 60° 59' W-LONG. 153° 55'
MULCHATNA DRAINAGE ?
LOWER YUKON-KUSKOKWIM BASIN
MAP: LAKE CLARK D-3

Ownership: National Park Service
Estab. 8'91 by George Clagett & Leon Alsworth

DESCRIPTION: Five station snow course. To reach the snow course, first locate the ranger cabin on the north shore of Telaquana Lake. From the ranger cabin, follow the trail north and after passing the out-house, turn NW. Go 180' through an area of dwarf birch/willow surrounded by spruce, then look for a birch tree on the right and a spruce on the left that leans over the trail. Continue NW and look for the "gate" in the wall of dense spruce. The snow course is in a small clearing inside the spruce stand.

Appendix D-3 continued. Maps of active Snow Course transects located in SWAN park units.





COOPERATIVE SNOW SURVEYS, ALASKA

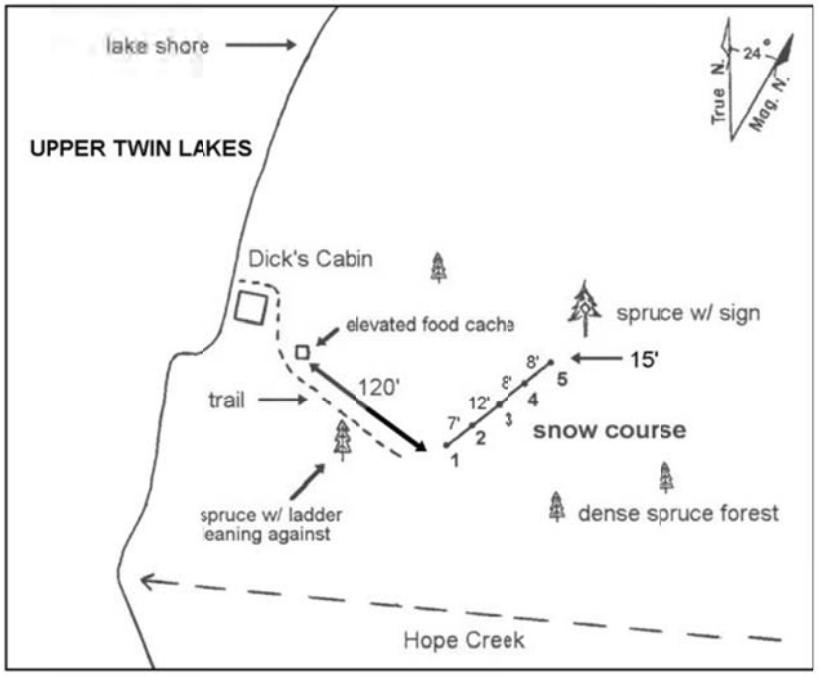
NAME: **THREE FORKS**

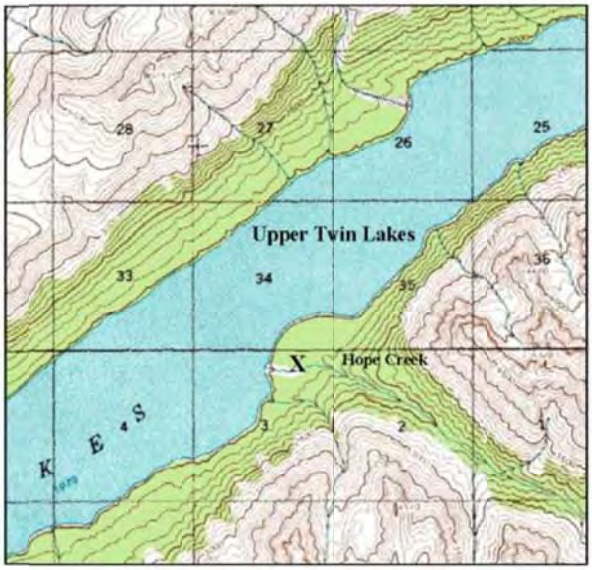
COURSE # **55J02** ELEVATION - 1300'
N-LAT. 58° 22.18' W-LONG. 155° 23.24'
BRISTOL BAY HYDROLOGIC BASIN
MAP: MT. KATMAI B-5

Ownership: National Park Service
Estab. 8/14/93 by G. Clagett

DESCRIPTION: 10' Aerial Marker located on the south side of a small ridge and just west (about 1000') of the NPS cabin at the end of "Valley of Ten Thousand Smokes" Road.

Appendix D-3 continued. Maps of active Snow Course transects located in SWAN park units.





COOPERATIVE SNOW SURVEYS, ALASKA

NAME: **UPPER TWIN LAKES**

COURSE # **53L02** ELEVATION - 2000'
SAMPLES - 5 INTERVAL – Variable, 7'-12'
N-LAT. 60° 39' W-LONG. 153° 48'
MULCHATNA RIVER DRAINAGE
BRISTOL BAY HYDROLOGIC BASIN
MAP: LAKE CLARK C-3

Ownership: Nation Park Service
Estab. 8/91 by George Clagett & Leon Alsworth
Moved on 12/98 by Leon Alsworth – original lost

DESCRIPTION: Five station snow course. To locate the snow course, first locate "Dick's Cabin" which is just north of Hope Creek on the south shore of Upper Twin Lakes. Behind Dick's cabin is an elevated food cache. From the cache, go SE 120' and look for a 60' spruce tree with a yellow snow course sign. The snow course is just east of this spruce tree.

Appendix E-1. Attributes of CMAN stations and moored buoys monitored by the SWAN.

Station				Available observations																					
Station name/ NDBC #	**Location: Lat Lon**	**Elev. ft (m)**	**Period of record**	**Air temp. (avg)**	**Air temp. (max)**	**Air temp. (min)**	**Wind speed (avg)**	**Wind speed (max)**	**Wind dir. (avg)**	**Wind dir. (max)**	**Rel. humidity (avg)**	**Atmos. Pressure**	**Sea Level Pressure**	**Visibility**	**Solar radiation**	**Precip. (liquid only)**	**Precip. year-round)**	**Snowfall**	**Snow depth**	**Water temp. (avg)**	**Wave height (avg)**	**Wave period (avg)**	**Wave energy (avg)**	**Wave dir. (avg)**	**Tide (avg)**	**Surface temp. (avg)**	**Soil temp. (avg)**
Drift River Terminal DRFA2	60.5533 -152.1367	53 (16)	9/1999 - present	✓			✓	✓	✓		✓		✓														
Pilot Rock PILA2	59.7417 -149.4700	79 (24)	12/1999 - present	✓			✓	✓	✓		✓		✓														
Shelikof Strait 46077	57.9200 -154.2542	0 (0)	10/2005 - present	✓			✓	✓	✓		✓		✓							✓	✓	✓	✓				

Appendix E-2. CMAN (MARS payload) instrumentation standards.

(http://www.ndbc.noaa.gov/rsa.shtml)

Parameter	Accuracy	Range	Resolution
Air temperature (°F)	--	--	--
Air temperature (°C)	± 1°C	-40 to +50°C	0.1°C
Wind speed (mph)	--	--	--
Wind speed (m/s)	± 1 m/s	0 to 62 m/s	0.1 m/s
Wind direction (°)	± 10°	0 to 359°	1°
Relative humidity (%)	± 6%	0 to 100%	0.1%
Pressure (inHg)	--	--	--
Pressure (hPa = mbar)	± 1 hPa	800 to 1100 hPa	0.1 hPa
Visibility (mi)	--	--	--
Visibility (km)	--	--	--
Solar radiation (Ly)	--	--	--
Solar radiation (W/m^2)	--	--	--
Precipitation (in)	--	--	--
Precipitation (mm)	--	--	--
Snowfall (in)	--	--	--
Snowfall (mm)	--	--	--
Snow depth (in)	--	--	--
Snow depth (mm)	--	--	--
Water temperature (°F)	--	--	--
Water temperature (°C)	--	--	--
Wave height (ft)	--	--	--
Wave height (m)	--	--	--
Wave period (sec)	--	--	--
Wave energy (sec)	--	--	--
Wave direction (°)	--	--	--
Tide(ft)	--	--	--
Tide(m)	--	--	--
Surface temperature (°F)	--	--	--
Surface temperature (°C)	--	--	--
Soil temperature (°F)	--	--	--
Soil temperature (°C)	--	--	--

Appendix E-3. Moored buoy (ARES payload) instrumentation standards.

(http://www.ndbc.noaa.gov/rsa.shtml)

Parameter	Accuracy	Range	Resolution
Air temperature (°F)	--	--	--
Air temperature (°C)	± 1°C	-40 to +60°C	0.1°C
Wind speed (mph)	--	--	--
Wind speed (m/s)	± 1 m/s or 10% (greater)	0 to 62 m/s	0.1 m/s
Wind direction (°)	± 10°	0 to 359°	1°
Relative humidity (%)	± 3%	0 to 100%	0.1%
Pressure (inHg)	--	--	--
Pressure (hPa = mbar)	± 1 hPa	800 to 1100 hPa	0.1 hPa
Visibility (mi)	--	--	--
Visibility (km)	--	--	--
Solar radiation (Ly)	--	--	--
Solar radiation (W/m^2)	--	--	--
Precipitation (in)	--	--	--
Precipitation (mm)	--	--	--
Snowfall (in)	--	--	--
Snowfall (mm)	--	--	--
Snow depth (in)	--	--	--
Snow depth (mm)	--	--	--
Water temperature (°F)	--	--	--
Water temperature (°C)	± 1°C	-5 to +40°C	0.1°C
Wave height (ft)	--	--	--
Wave height (m)	± 0.2 m	0 to 35 m	0.1 m
Wave period (sec)	± 1 sec	0 to 30 sec	1.0 sec
Wave energy (sec)	± 1 sec	0 to 30 sec	1.0 sec
Wave direction (°)	--	--	--
Tide(ft)	--	--	--
Tide(m)	--	--	--
Surface temperature (°F)	--	--	--
Surface temperature (°C)	--	--	--
Soil temperature (°F)	--	--	--
Soil temperature (°C)	--	--	--

Appendix F-1. Attributes of CRN stations monitored by the SWAN.

Station				Available observations																						
Station name/	**Location: Lat Lon**	**Elev. ft (m)**	**Period of record**	**Air temp. (avg)**	**Air temp. (max)**	**Air temp. (min)**	**Wind speed (avg)**	**Wind speed (max)**	**Wind dir. (avg)**	**Wind dir. (max)**	**Rel. humidity (avg)**	**Atmos. Pressure**	**Sea Level Pressure**	**Visibility**	**Solar radiation**	**Precip. (liquid only)**	**Precip. (year-round)**	**Snowfall**	**Snow depth**	**Water temp. (avg)**	**Wave height (avg)**	**Wave period (avg)**	**Wave energy (avg)**	**Wave dir. (avg)**	**Tide (avg)**	**Surface temp. (avg)**	**Soil temp. (avg)**
KATM King Salmon 42 SE	58.2077 -155.9225	657 (200)	8/2012 – present	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓									✓	
LACL Port Alsworth 1 SW	60.1958 -154.3198	315 (96)	09/2009 – present	✓	✓	✓	✓				✓				✓		✓									✓	

Appendix F-2. CRN instrumentation standards.

(http://www.ncdc.noaa.gov/crn/instrdoc#SENSORS)
(http://www1.ncdc.noaa.gov/pub/data/uscrn/documentation/program/X040_d0.pdf)

Parameter	Accuracy	Range	Resolution
Air temperature (°F)	--	--	--
Air temperature (°C)	± 0.3°C (-50 to +50°C) ± 0.6°C (-60 to -50°C) ± 0.6°C (+50 to +60°C)	-60 to +60°C	0.1°C (reported)
Wind speed (mph)	--	--	--
Wind speed (m/s)	± 1m/s or 2%	0 to 50 m/s	0.1 m/s
Wind direction (°)	--	--	--
Relative humidity (%)	--	--	--
Pressure (inHg)	--	--	--
Pressure (hPa = mbar)	--	--	--
Visibility (mi)	--	--	--
Visibility (km)	--	--	--
Solar radiation (Ly)	--	--	--
Solar radiation (W/m^2)	± 70 W/m^2	0 to 1400 W/m^2	10 W/m^2
Precipitation (in)	--	--	--
Precipitation (mm)	± 0.25 mm or ± 2%	0 to 600 mm	0.25 mm
Snowfall (in)	--	--	--
Snowfall (mm)	--	--	--
Snow depth (in)	--	--	--
Snow depth (mm)	--	--	--
Water temperature (°F)	--	--	--
Water temperature (°C)	--	--	--
Wave height (ft)	--	--	--
Wave height (m)	--	--	--
Wave period (sec)	--	--	--
Wave energy (sec)	--	--	--
Wave direction (°)	--	--	--
Tide(ft)	--	--	--
Tide(m)	--	--	--
Surface temperature (°F)	--	--	--
Surface temperature (°C)	± 0.5°C	-50 to +80°C	0.1°C
Soil temperature (°F)	--	--	--
Soil temperature (°C)	--	--	--

SOP #1: Logistics and Safety
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) establishes standards for safely accessing and maintaining weather stations in Southwest Alaska Network (SWAN) parks. It describes, month-by-month, the logistical planning necessary for annual maintenance of SWAN Remote Automated Weather Stations (RAWS). This SOP also contains access maps, a list of useful contacts, and Job Hazard Analyses.

Introduction

The purpose of this SOP is to establish standards for safely accessing and maintaining weather stations in Southwest Alaska Network (SWAN) parks. This SOP describes, month-by-month, the logistical planning necessary for the successful annual maintenance of network Remote Automated Weather Stations (RAWS), including: 1) making logistical arrangements; 2) scheduling park and vendor aircraft; and 3) preparing Field Travel and Communication Plans (FTCPs). Access maps, a comprehensive contact list, and Job Hazard Analyses (JHAs) are also included in this SOP.

Personnel Requirements

A minimum of two people are required for safety when accessing or maintaining a RAWS (one of these people can be a pilot if the aircraft stays on site).

Logistics Schedule

Acronyms used for network parks and weather stations are described in Table 1-1. A generalized schedule documenting the steps necessary to prepare for annual network RAWS maintenance is presented in Table 1-2. Individual tasks are described in more detail below.

Table 1-1. Acronyms for Remote Automated Weather Station (RAWS) operated and maintained by the SWAN.

RAWS name	RAWS acronym	Park	Park acronym
Chigmit Mountains	CHMO	Lake Clark NP&P	LACL
Contact Creek	COCR	Katmai NP&P	KATM
Coville	COVI	Katmai NP&P	KATM
Fourpeaked	FOUR	Katmai NP&P	KATM
Harding Icefield	HAIC	Kenai Fjords NP	KEFJ
Hickerson Lake	HILA	Lake Clark NP&P	LACL
McArthur Pass	MCPA	Kenai Fjords NP	KEFJ
Pedersen Lagoon	PELA	Kenai Fjords NP	KEFJ
Pfaff Mine	PFMI	Katmai NP&P	KATM
Snipe Lake	SNLA	Lake Clark NP&P	LACL

Table 1-2. Logistics schedule for maintaining network RAWS. “Maint.” refers to conducting annual station maintenance; “h” denotes that helicopter access is typically required; “FTCP” refers to preparing a Field Travel and Communication Plan; “unsched.” denotes unscheduled; and “Admin” denotes administrative. Other acronyms are described in Table 1-1 or pages xv-xvi.

Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
		Logistics: determine what sensors will be needed from RAWS Depot **Purchase:** sensors from FTS	**Order:** sensors for HAIC from RAWS Depot **Purchase:** and prepare antifreeze solution for HAIC **Logistics:** charter helicopter for HAIC maint [Apr option] **Training:** wilderness first aid	**Order:** sensors for CHMO COCR COVI FOUR HILA MCPA PELA PFMI SNLA from RAWS Depot **Logistics:** park aircraft and lodging: KATM LACL FTCP for HAIC maint [Apr option] **Training:** glacier travel and crevasse rescue [optional] **Maint:** HAIC (h) [Apr option]	**Training:** bear safety, firearms safety, helicopter manager, basic aviation safety **Ship:** sensors and supplies to KATM and LACL **Logistics:** travel arrangements to/from KATM and LACL complete FTCP(s) for upcoming maint. charter helicopter for Jun maint.	**Maint:** CHMO (h) COCR COVI FOUR (h) HAIC (h) [Jun option] HILA MCPA (h) PFMI SNLA **Logistics:** park boat: KEFJ park or vendor aircraft for unscheduled repairs	**Maint:** PELA (boat access) **Maint:** unsched. repairs **Ship:** sensors to RAWS Depot	**Maint:** unsched. repairs **Purchase:** sensors from FTS with end of year funds	**Admin.** update WFMI entries for all station maint. send data to WRCC complete maint. report.	**Admin.** renew RAWS Depot maint. agreement for the new fiscal year	

February

Logistics and purchasing

The sensor replacement schedule (refer to SOP # 6) describes sensors that are regularly scheduled for replacement. Check the performance of SWAN RAWS (following the methods described in SOP #7) to identify any additional unplanned maintenance issues and sensors that will be needed for repairs. Use this information to complete an annual RAWS maintenance plan (described in SOP #6). Purchase any sensors that cannot be acquired from the RAWS Depot under maintenance contract (e.g. snow depth, soil temperature) directly from FTS, Campbell Scientific, or Judd Communications.

March

Ordering sensors, logistics, and training

Order the necessary sensors for the Harding Icefield RAWS from the RAWS Depot using the WFMI website (refer to SOP #6). Sensors should be ordered about 45 days before scheduled maintenance. Contact the KEFJ natural resource program manager and determine if the Harding Icefield RAWS will be maintained in April in conjunction with KEFJ glacier monitoring field work. Contract a helicopter through DOI Office of Aircraft Services (OAS) for April maintenance of the Harding Icefield weather station. Purchase propylene glycol and ethanol and prepare the solution for the Harding Icefield displacement precipitation gauge (refer to SOP #8). Determine if certification or recertification is needed in Wilderness First Aid training. This training course is often available in late March (see below for more information).

April

Ordering sensors, logistics, training, and station maintenance

Order the necessary sensors for the remaining weather station maintenance from the RAWS Depot using the WFMI website (refer to SOP #6). Sensors should be ordered about 45 days before scheduled maintenance. Make arrangements for using park aircraft and staying in park housing with KATM and LACL for upcoming maintenance in June. Determine if certification or recertification is needed in glacier travel and crevasse rescue. This optional training is required if the Harding Icefield RAWS will be maintained in April in conjunction with KEFJ glacier monitoring field work. This training course is often available in April (see below for more information). The Harding Icefield RAWS is usually maintained during the last two weeks of April.

May

Shipping sensors and logistics

Ship sensors to KATM and LACL for upcoming weather station maintenance in June. Shipment of sensors and supplies must be carefully packaged to prevent damage to sensitive components. Park contacts identified below can receive packages and make sure sensors and supplies are placed in a secure and dry storage facility. Complete Field Travel and Communications (FTCP) plans for upcoming weather station maintenance in June (see below for more information). Contract any necessary helicopter support through OAS for upcoming weather station maintenance. Make travel arrangements for getting to KATM and LACL. Tickets from Anchorage to King Salmon can be acquired through GovTrip.com or by calling Carlson Wagonlit (907-565-4400). A travel authorization needs to be in place.

Training

A variety of training is usually available March-May. Personnel involved with RAWS maintenance need to maintain currency in the following training:

- Bear safety for NPS employees (refresher every year)
- Non-law enforcement firearms training course for NPS employees (refresher every year)
- Wilderness first aid (refresher every two-three years, depending on certifying program)
- Basic aviation safety (refresher every three years)
- Helicopter manager (refresher every three years, PI only)
- Glacier travel and crevasse rescue (refresher every two years, only needed for optional spring RAWS maintenance)

Bear safety and non-law enforcement firearms training courses are typically offered in Anchorage and network parks during May. Initial training in wilderness first aid and refresher course are typically held March-May in Anchorage, Seward, and Talkeetna. Organizations offering this training include the American Red Cross, Wilderness Medical Associates, and the Wilderness Medicine Institute. Initial training in Basic Aviation Safety is often offered by network parks and at Aviation Centered Education classes held in Anchorage. More info can be found at www.iat.gov. Helicopter manager training and is offered by the Alaska Fire Service (http://fire.ak.blm.gov/afs/afs.php). Recertification is often available at Aviation Centered Education classes. Personnel involved with optional spring RAWS maintenance should be current in glacier travel and crevasse rescue training. Initial training classes are periodically held at KEFJ and are also available from private organizations (e.g. Alaska Mountaineering School). Shorter refresher trainings are held at KEFJ before park glacier monitoring field work starts in April.

June

Station maintenance and logistics

June is the best time to conduct the bulk of annual RAWS maintenance because the snow pack has usually melted and good weather conditions generally prevail. It is usually most practical and cost effective to maintain all the RAWS in KATM and LACL during one field campaign followed by maintenance of RAWS in KEFJ. Detailed logistics and weather prescriptions necessary for safety are described below. Job Hazard Analyses (JHAs) for weather station maintenance are included below. Detailed procedures for maintaining network RAWS are provided in SOP #8. Logistical arrangements should be made to access the Pedersen Lagoon weather station (during July). Contact the KEFJ resource management logistics coordinator to make these arrangements.

July

Station maintenance and unscheduled repairs

The Pedersen Lagoon Weather Station is usually maintained in July with access by boat and foot. This typically requires a two-day trip from Seward with an overnight stay at the Aialik Bay Ranger Station or onboard the M/V Serac. Unscheduled weather station maintenance may be necessary in July and/or August. After all maintenance has been completed, inventory and return sensors to the RAWS Depot.

August

Unscheduled repairs, end of year purchasing

Unscheduled weather station maintenance may also be necessary in August. If the budget allows, purchase additional sensors and equipment that will be needed for the following year with end-of-year funds.

September

Update WFMI system and WRCC archive

Complete post-trip updates for all station maintenance using the WFMI system (refer to SOP #8). After all network RAWS maintenance is completed and data has been acquired, conduct a cursory review of network RAWS data (refer to SOP #8). Send these data to the Western Regional Climate Center (WRCC) by email or FTP. Contacts at the WRCC are identified below in Table 1-7.

October

Renew RAWS Depot maintenance agreement

Complete a Direct Charge Authorization Form (located at: \SWAN\Vital_Signs\Climate\Administrative\Logistics\Budget\) and send it to: NIFC_NPS_Administration@nps.gov. More information on the RAWS Depot is provided in SOP# 6.

Logistics for RAWS Maintenance

RAWS Locations and Access

Access to RAWS that are operated and maintained by the SWAN is by fixed-wing aircraft, helicopter, and boat. Locations of these stations and mode of access, by park, are listed in Tables 1-3 (KATM), 1-4 (KEFJ), and 1-5 (LACL) and are shown in Figures 1-1 (KATM), 1-2 (KEFJ), and 1-3 (LACL). Acronyms used for network parks and weather stations are listed in Table 1-1.

Table 1-3. RAWS operated and maintained by SWAN in Katmai National Park and Preserve (KATM).

Location	Latitude (DD)	Longitude (DD)	Latitude (DMS)	Longitude (DMS)	Elevation ft (m)	Access
COCR RAWS	58.20762°	-155.92247°	58° 12’ 27.4”	-155° 55’ 20.8”	657 (200)	Wheel or float plane
COVI RAWS	58.80248°	-155.56289°	58° 48’ 08.9”	-155° 33’ 46.4”	1567 (478)	Float plane
FOUR RAWS	58.70572°	-153.51792°	58° 42’ 20.5”	-153° 31’ 04.5”	1074 (327)	Wheel plane or helicopter
PFMI RAWS	59.11090°	-154.83666°	59° 06’ 39.2”	-154° 50’ 11.9”	2018 (615)	Wheel plane

Table 1-4. RAWS operated and maintained by SWAN in Kenai Fjords National Park and Preserve (KEFJ).

Location	Latitude (DD)	Longitude (DD)	Latitude (DMS)	Longitude (DMS)	Elevation ft (m)	Access
HAIC RAWS	60.13247°	-149.78204°	60° 07’ 56.8”	-149° 46’ 55.3”	4300 (1311)	Helicopter or skiplane
MCPA RAWS	59.47263°	-150.33371°	59° 28’ 21.4”	-150° 20’ 01.3”	1266 (386)	Boat or helicopter
PELA RAWS	59.8944°	-149.7308°	59° 53’ 39.8	-149° 43’ 50.9”	624 (190)	Boat or helicopter

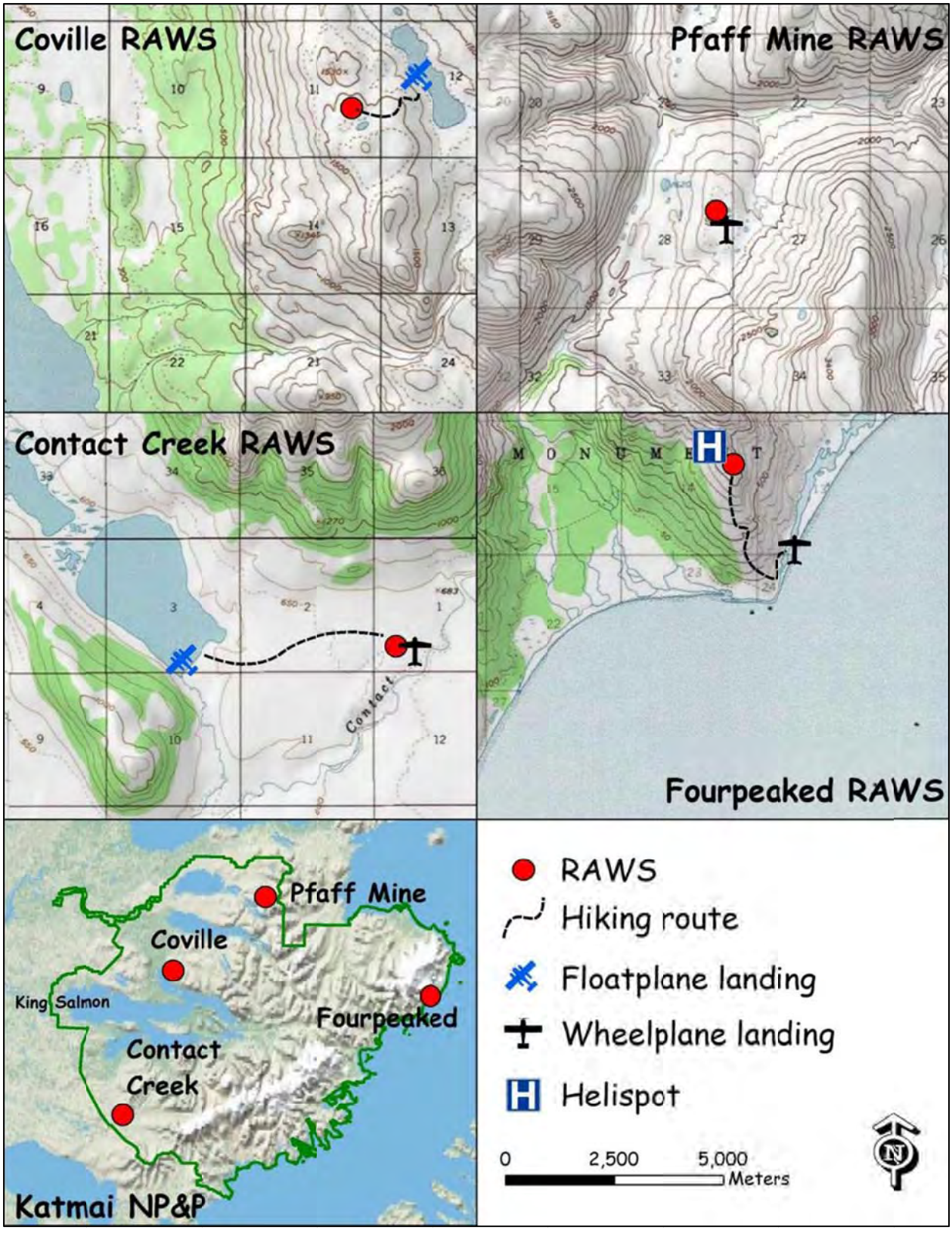


Figure 1-1. Locations and access of SWAN operated and maintained RAWS in Katmai National Park and Preserve (KATM).

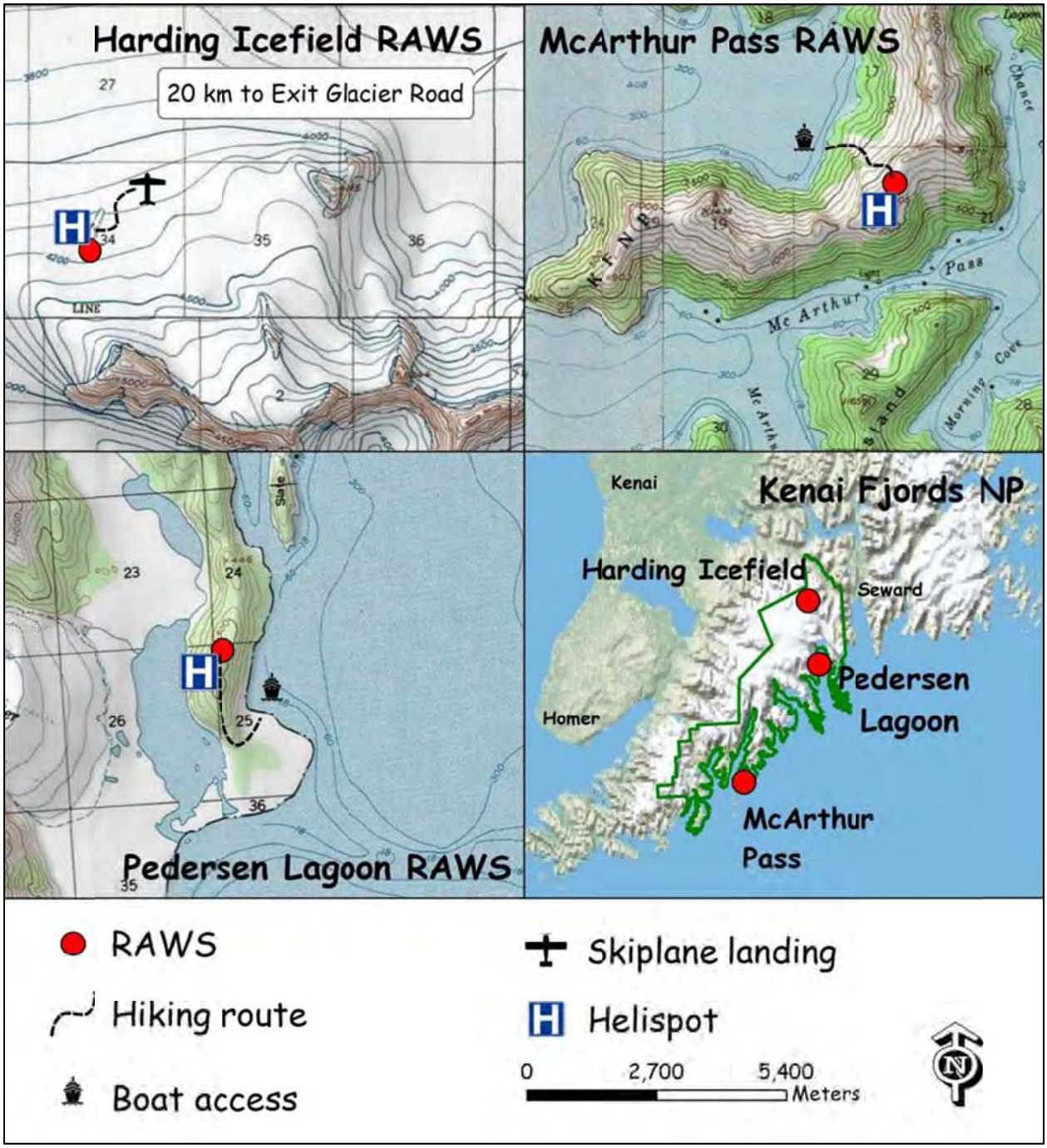


Figure 1-2. Locations and access of SWAN operated and maintained RAWS in Kenai Fjords National Park (KEFJ).

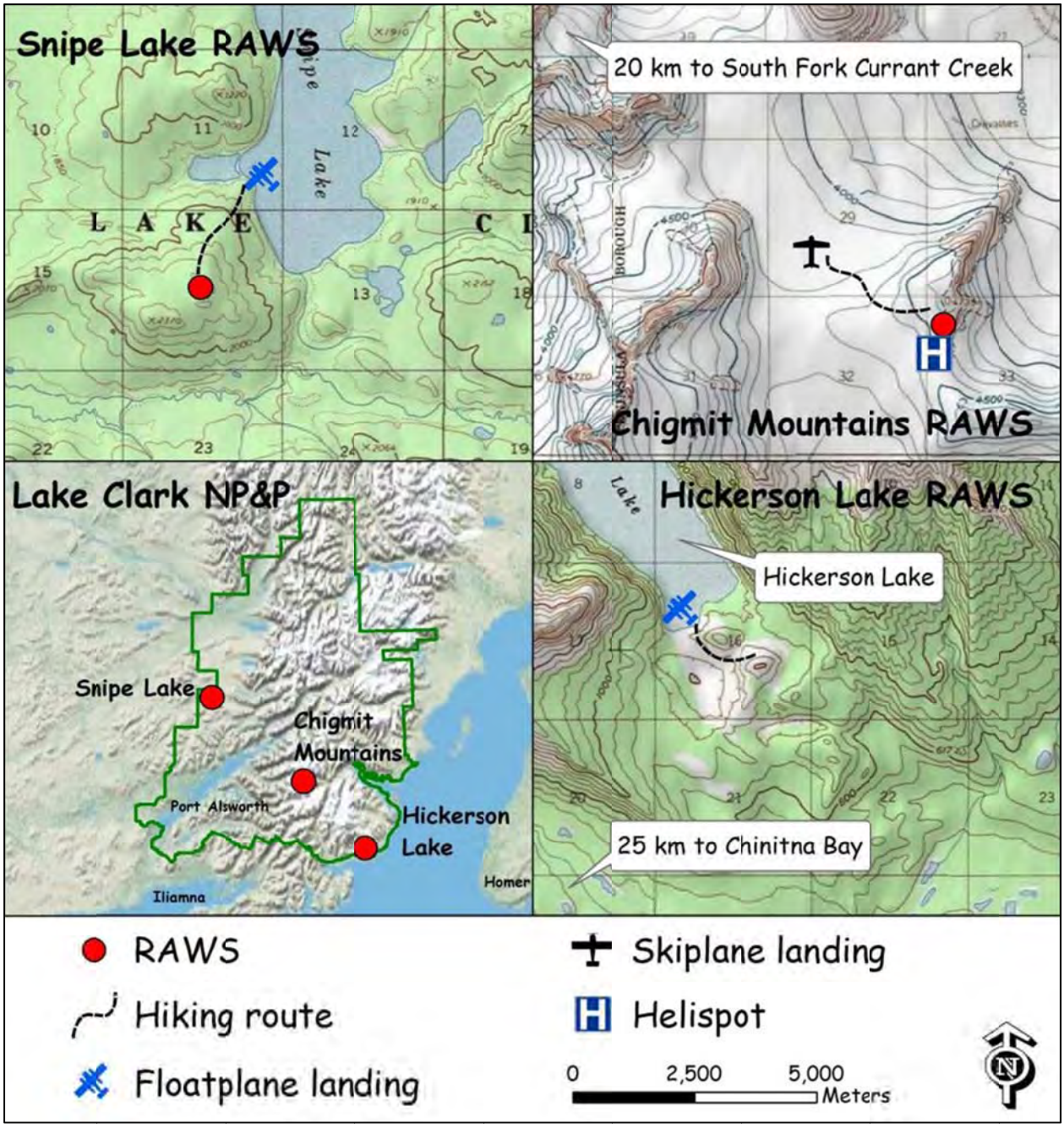


Figure 1-3. Locations and access of SWAN operated and maintained RAWS in Lake Clark National Park and Preserve (LACL).

Table 1-5. RAWS operated and maintained by SWAN in Lake Clark National Park and Preserve (LACL).

Location	Latitude (DD)	Longitude (DD)	Latitude (DMS)	Longitude (DMS)	Elevation ft (m)	Access
CHMO RAWS	60.22490°	-153.46752°	60° 13’ 29.6”	-153° 28’ 3.0”	4675 (1425)	Helicopter or skiplane
HILA RAWS	59.91480°	-152.89251°	59° 54’ 53.2”	-152° 53’ 33.0”	1048 (319)	Float plane
SNLA RAWS	60.6103°	-154.31994°	60° 36’ 37.1”	-154° 19’ 11.8”	2315 (705)	Float plane

Weather Prescription for RAWS Maintenance

The weather conditions listed in Table 1-6 must be forecast during RAWS maintenance.

Table 1-6. Weather conditions required during RAWS maintenance.

Location	Clear days forecast (#)	Min. Temp (F)	Max. Wind Speed (mph)
Spring maintenance			
CHMO RAWS	2	>15	<10
HAIC RAWS	2	>15	<10
Summer maintenance			
CHMO RAWS	1	--	<20
COCR RAWS	--	--	<20
COVI RAWS	--	--	<20
FOUR RAWS	--	--	<20
HAIC RAWS	1	--	<20
HILA RAWS	--	---	<20
MCPA RAWS	--	--	<20
PFMI RAWS	--	--	<20
SNLA RAWS	--	--	<20

Several websites are useful in reviewing the weather and weather forecasts including:

- http://www.arh.noaa.gov/
- http://aawu.arh.noaa.gov/longtermsigwx.php
- http://akweathercams.faa.gov/sitelist.php
- http://graphical.weather.gov/sectors/aktrimmed.php

Current conditions can be accessed by selecting the desired RAWS name (refer to Table 1-1) at: http://www.wrcc.dri.edu/wraws/akF.html.

Logistics for Optional Spring RAWS Maintenance

The timeframe for optional spring maintenance of the Harding Icefield (HAIC) RAWS is late April. Ski plane or helicopter access will only be attempted during clear weather conditions because the landscape at these locations at this time of year is completely snow-covered and white. Current weather forecasts should indicate that clear conditions will persist for two full days (from the beginning of field maintenance), preferable more. These weather requirements dictate that all parties involved in the maintenance need to remain flexible and also be able to mobilize quickly (within one day) if appropriate weather conditions develop.

The following logistical preparations need to be completed before spring maintenance:

- Required sensors, tools, and field/safety gear are packed.
- All involved personnel are scheduled and committed to the trip.
- Travel authorizations are completed.
- Make lodging arrangements with KEFJ in Seward.
- Coordinate aircraft needs with KEFJ glacier monitoring efforts. LACL may be able to provide a skiplane to support this work. Acquire vendor aircraft through the OAS. Park aviation managers, the Alaska Region aviation manager, or the OAS (http://amd.nbc.gov/akro/) can provide up to date information on how to acquire vendor aircraft. Specify that the mission is weather dependent and that flexibility is important.
- Prepare a Field Travel and Communication Plan (FTCP) and distribute it appropriately before departing for field work. Blank forms and guidance on distribution are located at \SWAN\Vital_Signs\Climate\Administrative\Logistics\Templates.
- File a flight plan with the Alaska Region Communication Center (DENA_CommCenter@nps.gov). A blank form is located in the same location as the FTCP form described above.

The tools and equipment necessary for maintaining a RAWS are listed in SOP #8. April maintenance of the Harding Icefield RAWS takes place at relatively high elevations during Alaskan springtime. Therefore, personnel must be prepared for winter survival. A Job Hazard Analyses for springtime maintenance of the Harding Icefield weather station is included at the end of this SOP. In addition to the equipment necessary for maintenance of the weather station, the following field and safety gear is needed:

- Handheld VHF-FM radio with park frequencies and extra AA clamshell with additional batteries
- Satellite telephone with two spare batteries, and at least 200 service minutes
- Personal locator beacon (PLB)
- Automated Flight Following (AFF) equipment on board aircraft
- Handheld GPS receiver with topographic maps
- Topographic map and compass
- Sufficient food for 48 hours and water (extra water can be melted)
- Camp stove, fuel, and pot for melting snow
- Two ways to start a fire (matches, lighter)
- Headlamp
- Duct tape, Leatherman tool, wire

- Winter sleeping bags and sleeping pads for each person
- Four-season tent(s) large enough to accommodate everyone
- First aid kit
- Mountaineering shovel
- Skis (or snowshoes), skins, poles, ski boots, gators
- Group glacier travel equipment: climbing rope, 12 wands (with flagging), and a collapsible probe pole
- Personal glacier travel equipment: climbing harness, ice axe, long + short prusik loops, two pulleys, snow picket, ice screw, long and short runners, two cordelettes, belay device, 7 carabiners (2 locking)
- Sleds with harness system
- Windproof outerwear and insulating clothing made of synthetic materials or wool
- Hat (2 each), over mittens, gloves, goggles, balaclava

Logistics for Summer RAWS Maintenance

The timeframe for summer RAWS maintenance is June-July. It is usually most practical and cost effective to maintain all the RAWS in KATM and LACL during one field campaign followed by RAWS maintenance in KEFJ. The field work in KATM and LACL involves travel by commercial air carrier to King Salmon, accessing three or four RAWS using park aircraft, travelling by charter or park aircraft to Port Alsworth, accessing two RAWS using park aircraft, accessing one RAWS by helicopter, and returning to Anchorage by commercial air carrier. RAWS maintenance in KEFJ (June-July) involves accessing one RAWS by helicopter and two RAWS by boat (the park-preferred method of access) or helicopter if necessary.

The following logistical preparations need to be completed before summer maintenance:

- Required sensors, tools, and field/safety gear are packed and shipped to parks.
- All involved personnel are scheduled and committed to the trip.
- Travel authorizations are completed.
- Make reservations with commercial air carrier from Anchorage to King Salmon (one-way).
- Make lodging arrangements in King Salmon. Park housing may be available. Contact KATM and submit a Temporary Housing Request form.
- Schedule park aircraft and pilot in KATM. Contact KATM Dispatch. Submit a Flight Request form.
- Make tentative arrangements for air travel between King Salmon and Port Alsworth. Charter or park aircraft may be used.
- Make lodging arrangements in Port Alsworth by submitting a LACL Housing Request form.
- Schedule park aircraft in LACL. By submitting a LACL Flight Request form.
- Make reservations with commercial air carriers from Port Alsworth to Anchorage. There are two choices: Lake Clark Air and Lake and Penn Air. Get their flight schedules and indicate to them that the trip is weather dependant. It may also be possible to travel from Port Alsworth to Anchorage with park aircraft.

- Acquire vendor aircraft through the DOI Aviation Management Directorate. Park aviation managers, the Alaska Region aviation manager, or the Alaska Regional Office for the OAS (http://amd.nbc.gov/akro/) can provide up to date information on how to acquire vendor aircraft. Specify that the mission is weather dependent and that flexibility is important.
- Prepare a Field Travel and Communication Plan (FTCP) and distribute it appropriately before departing for field work. Blank forms and guidance on distribution are located at \SWAN\Vital_Signs\Climate\Administrative\Logistics\Templates.
- File a flight plan with the Alaska Region Communication Center (DENA_CommCenter@nps.gov). A blank form is located in the same location as the FTCP form described above.
- Make arrangements with KEFJ for accessing the McArthur Pass RAWS by boat including: departure date and time, trip schedule, and collateral duties (assisting other park or network field work).
- Blank forms and guidance on distribution are located at \SWAN\Vital_Signs\Climate\Administrative\Logistics\Templates.

Tools and equipment specific to maintaining a RAWS is listed in SOP #8. Weather, terrain and wildlife can present unexpected challenges during summer RAWS maintenance. Personnel must be prepared for wilderness survival. A Job Hazard Analyses for springtime maintenance of the Harding Icefield weather station is included at the end of this SOP. In addition to the equipment necessary for maintenance of the weather station, the following field and safety gear are required:

- Handheld VHF-FM radio with park frequencies and extra AA clamshell with additional batteries
- Satellite telephone with two spare batteries and at least 300 service minutes
- Personal Locator Beacon (PLB)
- Automated Flight Following (AFF) equipment on board aircraft
- Rain gear
- Insulating clothing made of synthetic materials or wool
- Hat and gloves
- Handheld GPS receiver with topographic maps
- Topographic map and compass
- Sufficient food for 48 hours and water (if airplane is not staying onsite)
- Two ways to start a fire (matches, lighter)
- Duct tape, Leatherman tool, wire
- Tent large enough to accommodate everyone (if airplane is not staying onsite)
- First aid kit
- Shotgun and slugs (10) – Park may be able to supply these
- Bear spray (one per person) – Park may be able to supply these

Field Travel and Communication Plan

Distribution List

A brief, but detailed, Field Travel and Communication Plan (FTCP) will be distributed electronically to all personnel involved with aviation-supported RAWS maintenance. This plan will be distributed at least one day before flying occurs. Pilot and personnel will carry a copy of the FTCP while flight/work occurs. This form will be distributed to:

- Park dispatch
- Park Chief Ranger
- Helicopter or charter aircraft company (if used)
- Network coordinator and/or supervisor
- Denali Communication Center (DENA_CommCenter@nps.gov)
- Network server (\SWAN_Program_Management\Field_Operations\Emergency_Plans)

Blank FTCP forms and guidance on distribution are located at \SWAN\Vital_Signs\Climate\Administrative\Logistics\Templates.

If you will not be flight following with the park (flying after hours or in KEFJ), you will also need to file a flight plan with the Alaska Region Communication Center (DENA_CommCenter@nps.gov). A blank form is located in the same location as the FTCP form described above.

Useful Contacts

Table 1-7. Contacts useful for monitoring climate in SWAN parks – list is current as of September 2012.

Contact	Affiliation	Role, contact for	Phone	Email
RAWS Depot, National Interagency Fire Center (NIFC)				
Herb Arnold	BLM - NIFC Fire and Aviation	RAWS Help	208 387-5363	Herb_Arnold@ nifc.blm.gov
Mark Fitch	NPS - NIFC Fire and Aviation	NPS fire weather program Annual RAWS Depot Agreement/Contract and Account authorization	208 387-5212	Mark_Fitch @nps.gov
Michelle Fox	NPS - NIFC Fire and Aviation	RAWS Depot Annual Sensor Maintence Needs Questions/coordination	208 387-5476	Michelle_Fox@nifc.blm.gov
Robbie Swofford	BLM - NIFC Fire and Aviation	RAWS Depot Annual Sensor Maintence Needs Questions/coordination. NESID Channel Assignments	208 387-5362	Robbie_Swofford@nifc.blm.gov
RAWS Help Desk	BLM - NIFC Fire and Aviation	All things RAWS, provide annual maintenance report for each RAWS maintained	208 387-5475	rawshelp@blm.gov
Sheila Williams	BLM – NIFC and NPS	RAWS maintenance contracts	208 387-5203	Sheila_Williams@nps.gov
Alaska Fire Service, Bureau of Land Management				
Kent Gale	BLM - Alaska Fire Service	Annual Sensor Order: Coordinate annual sensor order/needs with Kent Gale and Tom Gillett	907 356-5800	Kent_Gale@blm.gov
Radio shop, National Park Service				
Tom Gillett	NPS - Alaska Region Radio Shop	RAWS maint. collaboration	907 644-3721	Tom_Gillett@nps.gov
Doug Peratrovich	NPS - Alaska Region Radio Shop	RAWS maintenance, telemetry issues, maint. collaboration, spare parts	907 644-3722	Doug_peratrovich@nps.gov
Fire weather station coordination				
Sharon Alden	BLM Alaska Fire Service	Alaska RAWS Program Contact. Fire Weather Forecaster	907 356-5691	Sharon_Alden@blm.gov
Heidi Strader	BLM Alaska Fire Service	Alaska RAWS Program Contact. Fire Weather Forecaster	907 356-5691	Heidi_Strader@BLM.gov
Dan Warthin	NPS - AKRO	Regional FMO	907 644-3409	Dan_Warthin@nps.gov

Table 1-7 continued. Contacts useful for monitoring climate in SWAN parks – list is current as of September 2012.

Contact	Affiliation	Role, contact for	Phone	Email
Aircraft contracting, Aviation Management				
Jan Bennett	DOI - NBC	On-Call helicopter contracts	907-271-3935	Jan_Bennett@nbc.gov
Lark Wuerth	DOI - NBC	Aircraft rental agreement	907 271-6032	Lark_Wuerth@nbc.gov
Helicopter companies				
Bob Fell	Maritime Helicopters, Homer	Chief of operations	907 235-7771	info@maritimehelicopters.com
Mike Fell	Pathfinder Helicopters, Homer	Owner, pilot	907 226-2800	pathfinderaviation@alaska.net
Melissa Elerick	Pathfinder Avation	Office manager	907-226-2800	melissa@pathfinderaviation.com
Park contacts, National Park Service				
Allen Gilliland	NPS - KATM	Park pilot, flight operations and logistics	907 246-3305	Allen_Gilliland@nps.gov
Vera Gilliland	NPS - KATM	Dispatch, park aircraft scheduling, park housing, PASP	907 246-2103	Vera_Gilliland@nps.gov
Neal Labrie	NPS - KATM	Chief Ranger, aviation	907 246-2127	Neal_Labrie@nps.gov
Claudette Moore	NPS - SWAN	Ecologist, logistics and field assistance	907 246-2149	Claudette_Moore@nps.gov
Mark Kansteiner	NPS - KEFJ	Logistics coordinator	907 422-0545	Mark_Kansteiner@nps.gov
Deb Kurtz	NPS - KEFJ	Natural Resource Program Manager	907 422-0546	Deborah_Kurtz@nps.gov
Mark Thompson	NPS - KEFJ	Chief Ranger, aviation	907 422-0522	Mark_Thompson@nps.gov
Rich Richotte	NPS - LACL	Park Pilot, flight operations and logistics	907 781-2102	Rich_Richotte@nps.gov
Lee Fink	NPS - LACL	Chief Ranger, aviation	907 644-3646 781-2102	Lee_Fink@nps.gov
Ginger_Irvine	NPS - LACL	Dispatch, park aircraft scheduling, park housing, PASP	907 781-2218	Ginger_Irvine@nps.gov
Climate monitoring, National Park Service				
Bruce Giffen	NPS - AKRO	Geologist	907 644-3752	Bruce_Giffen@nps.gov
Ken Hill	NPS - ARCN	Physical Scientist, climate monitoring	907 455-5752	Ken_Hill@nps.gov
Chuck Lindsay	NPS - SWAN	Physical Scientist, climate monitoring	907 235-7892	Chuck_Lindsay@nps.gov
Jessica Wilbarger	NPS-KLGO	Physical Science technician, climate	907 983-9240	Jessica_Wilbarger@nps.gov
Pam Sousanes	NPS - CAKN	Physical Scientist, climate monitoring	907-455-0677	Pam_Sousanes@nps.gov

Table 1-7 continued. Contacts useful for monitoring climate in SWAN parks – list is current as of September 2012.

Contact	Affiliation	Role, contact for	Phone	Email
Western Regional Climate Center				
Greg McCurdy	WRCC	Climate applications programmer, send RAWS data	775 674-7010	Greg.McCurdy@dri.edu
Kelley Redmond	WRCC	Deputy Director, Regional Climatologist, climate monitoring	775 674-7010	Kelly.Redmond@dri.edu
National Weather Service – Alaska Regional Headquarters				
Gary Hufford	NWS - ARH	Regional Climatologist, expert guidance on climate monitoring	907 271-5093	gary.hufford@noaa.gov
Angel Corona	NWS - ARH	Chief Data Acquisition, expert guidance on climate monitoring	907 271-5119	angel.corona@noaa.gov
Dan Peterson	NWS - ARH	COOP manager, station metadata and expert guidance on climate monitoring	907 266-5121	dan.c.peterson@noaa.gov
Bob Hopkins	NWS - ARH	Supervisory Meterologist, station testing at ARH	907 266-5120	bob.hopkins@noaa.gov
John Papineau	NWS – ARH	Hydrologist, expert guidance on Alaska climatology	907 266-5165	john.papineau@noaa.gov
Alaska Snow Survey Program – Natural Resources Conservation Service				
Rick McClure	NRCS	Program manager for Alaska Snow Course and SNOTEL	907 271-2424 x 113	richard.mcclure@ak.usda.gov
Daniel Fischer	NRCS	Hydrologist	907 271-2424 X 117	daniel.fisher@ak.usda.gov
Dan Kenney	NRCS	Hydrological Technician, Alaska Snow Course and SNOTEL	907 271-2424 x 112	dan.kenney@ak.usda.gov
State Climatologist, University of Alaska Anchorage				
Peter Olsson	UAA	State Climatologist, expert guidance in climate monitoring	907 786-7234	peter.olsson@uaa.alaska.edu
Climate Reference Network, National Oceanic and Atmospheric Agency				
Mark Hall	NCDC	Supervisory Engineer	865 576-0366	Mark.E.Hall@noaa.gov
Forest Technology Systems, Inc. (FTS)				
Tyler Smith	FTS	Sales Representative, RAWS parts and replacement sensors	800 548-4264	tsmith@ftsinc.com
Chelsea Varney	FTS	RAWS data logger program and sensors	800 548-4264	cvarney@ftsinc.com
Rick White	FTS	RAWS data logger program and sensors	800 548-4264	rwhite@ftsinc.com

Job Hazard Analyses

JOB HAZARD ANALYSIS

JOB HAZARD ANALYSIS		**Date:** **7 May 2012**	
Park Unit: Southwest Alaska Network (SWAN) Inventory and Monitoring Program			
Job Title: Weather station maintenance in summer with access by aircraft and/or foot		**JHA Number**	**Page** 1 **of** 3
Job performed by: Chuck Lindsay	**Analysis by:** Chuck Lindsay	**Work Supervisor:** Michael Shephard	**Approved by:** M. Shephard **Date: 5/16/2012**
Required Standards/Notes	Refer to SWAN climate monitoring protocol SOP#1 – "Logistics and Safety"		
Required Personal Protective Equipment:	Warm clothing, emergency food, water, shelter for two days. Aviation PPE appropriate for flight type. Bear spray, shotgun and ammunition. Rubber rain gear, rubber gloves, and eye protection for working with alcohol-antifreeze solution at Harding Icefield weather station. Bear spray, shotgun and ammunition.		
Tools and Equipment:	Refer to SWAN climate monitoring protocol SOP#8 – "RAWS maintenance"		
Sequence of Job Steps	**Potential Hazards/Injury Sources**	**Safe Procedure or Mitigation**	
Identify appropriate weather	Stranding at remote site, aircraft accident, hypothermia	Review weather forecast information carefully and discuss it with someone who is familiar with local conditions. For the Harding Icefield and Chigmit Mountains weather stations, a forecast for two days of mostly sunny sky conditions and wind speeds <20 mph are necessary. For the remaining weather stations a forecast for ceilings >500 ft AGL and winds <20 mph are necessary. Refer to http://graphical.weather.gov/sectors/aksouthcoast.php#tabs for planning. Carry warm clothing, emergency shelter, food & water for 2 days. Maintain situational awareness regarding changing weather conditions when working on weather station.	
Aviation – loading/unloading aircraft	Injury or damage to property	Do not engage in loading, unloading, moving, or fueling of aircraft without specific direction from pilot or flight manager. Exercise proper lifting methods (lift with legs – not back) if you are directed to assist with these activities. Notify pilot if transporting hazardous materials (i.e. alcohol-antifreeze solution).	

JOB HAZARD ANALYSIS

Sequence of Job Steps	Potential Hazards/Injury Sources	Safe Procedure or Mitigation
Aviation – general	Weather, terrain, aircraft malfunction, pilot error Injury or death	Complete and maintain currency in aviation training (B3 - combination helicopter/airplane safety). A park aviation manager must approve your flight and you must receive a pre-flight safety briefing. Understand weather minimums for flying (fixed-wing: > 500 ft ceiling, > 2 miles visibility, winds < 35 knots; helicopters: > 500 ft ceiling, and > ½ mile visibility, winds < 30 knots. Make sure that flight-following is in place. Wear required PPE (minimum PPE is flight vest with survival equipment in pockets – an inflatable PFD is required overwater). You can turn down any flight if you do not feel safe.
Backcountry travel	Bear encounter	Make your presence known. Give bears plenty of room. Give bears opportunity to avoid you. Carry pepper spray and firearm (if warranted). Maintain current training with these tools and be comfortable with their use. If you do encounter a bear: remain calm and don't run; move away slowly but don't turn you back. If a bear charges: don't run, stand your ground; use pepper spray when bear is within 30 feet. If a bear makes contact: fight back if you are attacked by a black bear; surrender, fall to the ground and play dead if you are attacked by a brown bear. If the bear continues biting you long after you assume a defensive posture, fight back. Do not leave any belongings or equipment unattended.
Backcountry travel	Environment – terrain, vegetation	Do not travel alone. Carry the "ten-essentials" and a way to communicate with others. Plan your route carefully considering terrain and vegetation. Know your physical limitations and those of your companion(s). Carry an emergency overnight shelter like a large trash compactor bag, which you can also use in your pack to keep gear dry.
Weather station maintenance - general	Trips, falls, cuts	Wear gloves when working on weather station. Thin gloves with a rubber coating (e.g. Atlas Thermafit gloves) work well to protect your hands and maintain a good grip. Carry and use disposable heat packs for gloves to keep fingers warm. Watch your footing when moving about to avoid tripping on uneven terrain or weather station components. When climbing on the weather station, avoid standing any higher than the lowest rail (4 ft) of the weather station frame.

JOB HAZARD ANALYSIS

Sequence of Job Steps	Potential Hazards/Injury Sources	Safe Procedure or Mitigation
Weather station maintenance – all season precipitation gauge	Chemical exposure	Wear appropriate PPE when servicing the all season precipitation gauge at the Harding Icefield weather station. Appropriate PPE includes rain pants, rain coat, rubber gloves, and eye protection. The potential chemical exposure is to a mixture of 45% ethyl alcohol, 45% propylene glycol, 10% water, and a small amount of motor oil. Avoid contact with eyes, skin, or by ingestion. This solution is classified as a flammable liquid. Notify pilot that you are transporting hazardous materials before flight.

JOB HAZARD ANALYSIS

JOB HAZARD ANALYSIS		**Date:** **7 March 2012**	
Park Unit: Southwest Alaska Network (SWAN) Inventory and Monitoring Program			
Job Title: Weather station maintenance in winter with access by ski plane and/or foot		**JHA Number**	**Page** 1 **of** 2
Job performed by: Chuck Lindsay	**Analysis by:** Chuck Lindsay	**Work Supervisor:** Michael Shephard	**Approved by:** M. Shephard **Date: 5/16/2012**
Required Standards/Notes	Refer to SWAN climate monitoring protocol SOP#1 – "Logistics and Safety"		
Required Personal Protective Equipment:	Warm clothing, emergency food, water, shelter for two days. Aviation PPE appropriate for flight type. Rubber rain gear, rubber gloves, and eye protection for working with alcohol-antifreeze solution at Harding Icefield weather station. Crevasse rescue equipment for any travel on glacier ice. Disposable heat packs for gloves.		
Tools and Equipment:	Refer to SWAN climate monitoring protocol SOP#8 – "RAWS maintenance"		
Sequence of Job Steps	**Potential Hazards/Injury Sources**	**Safe Procedure or Mitigation**	
Identify appropriate weather	Stranding at remote site, aircraft accident, hypothermia	Review weather forecast information carefully and discuss it with someone who is familiar with local conditions. A forecast for two days of mostly sunny sky conditions with temperatures >15 F and wind speeds <10 mph are necessary. Refer to http://graphical.weather.gov/sectors/aksouthcoast.php#tabs for planning. Carry warm clothing, emergency shelter, food & water for 2 days. Carry and use disposable heat packs for gloves/boots to keep fingers/toes warm. Maintain situational awareness regarding changing weather conditions when working on weather station.	
Aviation – loading/unloading aircraft	Injury or damage to property	Do not engage in loading, unloading, moving, or fueling of aircraft without specific direction from pilot or flight manager. Exercise proper lifting methods (lift with legs – not back) if you are directed to assist with these activities. Notify pilot if transporting hazardous materials (i.e. alcohol-antifreeze solution).	

JOB HAZARD ANALYSIS

Sequence of Job Steps	Potential Hazards/Injury Sources	Safe Procedure or Mitigation
Aviation – general	Weather, terrain, aircraft malfunction, pilot error Injury or death	Complete and maintain currency in aviation training (B3 - combination helicopter/airplane safety). A park aviation manager must approve your flight and you must receive a pre-flight safety briefing. Understand weather minimums for flying (fixed-wing: > 500 ft ceiling, > 2 miles visibility, winds < 35 knots; helicopters: > 500 ft ceiling, and > ½ mile visibility, winds < 30 knots. Make sure that flight-following is in place. Wear required PPE (minimum PPE is flight vest with survival equipment in pockets – an inflatable PFD is required overwater). You can turn down any flight if you do not feel safe.
Glacier travel	Crevasse fall, getting lost	The terrain between aircraft landing sites and weather stations is glaciated. A deep snowpack usually completely covers any crevasses in mid-winter or early spring; however, there is a possibility of falling into a crevasse. Be knowledgeable about safe travel on glaciers and techniques for self-rescue. Seek training (www.climbalaska.org). Do not travel alone. Travel as a rope team carrying appropriate equipment for glacier travel and crevasse rescue. Consider using a helicopter to access sites in order to avoid travel on glacier ice. Carry a GPS with waypoints for the landing site and weather station to avoid getting lost should weather conditions deteriorate.
Weather station maintenance - general	Trips, falls, cuts	Wear gloves when working on weather station. Thin gloves with a rubber coating (e.g. Atlas Thermafit gloves) work well to protect your hands and maintain a good grip. Carry and use disposable heat packs for gloves to keep fingers warm. Watch your footing when moving about to avoid tripping on uneven terrain or weather station components. When climbing on the weather station, avoid standing any higher than the lowest rail (4 ft) of the weather station frame.
Weather station maintenance – all season precipitation gauge	Chemical exposure	Wear appropriate PPE when servicing the all season precipitation gauge at the Harding Icefield weather station. Appropriate PPE includes rain pants, rain coat, rubber gloves, and eye protection. The potential chemical exposure is to a mixture of 45% ethyl alcohol, 45% propylene glycol, 10% water, and a small amount of motor oil. Avoid contact with eyes, skin, or by ingestion. This solution is classified as a flammable liquid. Notify pilot that you are transporting hazardous materials before flight.

SOP #2: Research Permits and Investigator's Annual Report
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for maintaining the required permits for conducting research in network parks and for completing the Investigator's Annual Report (IAR).

Introduction

In 2004, an Environmental Analysis (EA) and Finding of No Significant Impact (FONSI) were prepared for the installation of one RAWS at KEFJ. The Harding Icefield RAWS was subsequently installed in 2004. In 2007-2008, an EA and FONSI were prepared for RAWS installations and maintenance within three network parks. Eight RAWS were subsequently installed during 2008-2009. A total of 13 sites were evaluated and approved for RAWS deployment in the network parks. However, any additional RAWS installations beyond those evaluated and approved in the EA would require further National Environmental Policy Act (NEPA) compliance documentation (i.e. a new EA). In 2011, an additional RAWS was installed in KEFJ. Because this station was set up on Port Graham Native Corporation Land – located within the administrative boundary of KEFJ – an EA was not required. The network's climate monitoring is now operational – with maintenance trips to each of the network RAWS occurring each year.

The purpose of this SOP is to outline the steps necessary to comply with the NPS requirements for conducting research in park units. Research permits and an Investigator's Annual Report (IAR) are required. Research permits for maintaining seven RAWS are currently in-place for two network parks (KATM and KEFJ). A special use permit (at the park's request) is in-place for maintenance of three RAWS in LACL. As a condition of the research permits, an Investigator's Annual Report (IAR) must be completed prior to March 31 each year. The IAR reports on the work accomplished during the preceding field season.

Current Research and Special Use Permits

Current research permits related to network climate monitoring include:

Study#: KATM-00062
Permit #: KATM-2012-SCI-0005
Name of Principal Investigator: Chuck Lindsay
Project Title: Southwest Alaska Network (SWAN) Inventory and Monitoring Program – Climate Monitoring

Study#: KEFJ-00042
Permit #: KEFJ-2012-SCI-0004
Name of Principal Investigator: Chuck Lindsay
Project Title: Southwest Alaska Network (SWAN) Inventory and Monitoring Program – Climate Monitoring

Name of Use: NPS Weather Station Maintenance
Permit #: ARO-LACL-9500-2012-49
Name of Permittee: Chuck Lindsay

Research and special use permits are located on the network server at:
\SWAN\Vital_Signs\Climate\Administrative\Research_Permits\.

Investigator's Annual Report (IAR)

A request for an Investigator's Annual Report (IAR) will be sent by email to the Principle Investigator. This email request is generated by the NPS Research and Reporting System. This email will contain detailed instructions on how to file the Investigator's Annual Report (IAR). Included in this email will be a link to the IAR website and a unique user name and password to be used to access the website. Further guidance on filing the IAR is available on the IAR website: https://science.nature.nps.gov/research.

- Log onto the site using the username and password provided in the email. A web page will appear that has a link to each IAR that you need to file.

- For the SWAN Climate Monitoring Program, there will be two IARs that need to be filed annually, one each for two parks with RAWS (KATM and KEFJ). Select one of the two highlighted links to an IAR and complete the report following the guidance provided.

- No reporting is required for the Special Use Permit in LACL.

Research Permit Contacts

Katmai National Park and Preserve

Whitney Rapp: Whitney_Rapp@nps.gov (907-246-2145)

Kenai Fjords National Park

Laura Phillips: Laura_Phillips@nps.gov (907-422-0540)

Special Use Permit Contacts

Lake Clark National Park and Preserve

Jeff Shearer: Jeff_Shearer@nps.gov (907-644-3629)

SOP #3: Field Laptop Setup
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for setting up a ruggedized field laptop computer used for direct communication with the FWS-12S data loggers used by nine network RAWS.

Introduction

This SOP explains the procedures for setting up a ruggedized field laptop computer used for direct communication with the FWS-12S data loggers used by nine network RAWS (the Pedersen Lagoon RAWS uses a F6 data logger and a laptop computer isn't needed for communicating with the data logger). A laptop with good batteries, a serial (RS232) port, and/or USB port is necessary. Ruggedized laptops are recommended – the Panasonic Toughbook is currently being used. Forest Technology Systems, Inc. (FTS) "FTS Toolbox" software must be loaded on the laptop.

Procedures

The following procedures are necessary to properly set up the field laptop computer:

1. Install FTS Toolbox software onto the laptop that is going to be used during the annual maintenance trip. A copy of this software can be obtained from FTS at: http//ftsinc.com/ or by calling FTS (800-548-4262). The current version is v. 2.22.0.0.

2. Launch the FTS Toolbox program.

3. Customize FTS Toobox by adding station metadata for each network RAWS. Click on the "Station" menu and select "Add" from the drop down menu (Figure 3-1).



Figure 3-1. Adding a new station using FTS Toolbox.

4. Enter the name of one of the stations listed in Table 3-1 and click "OK".

Table 3-1. Locations of Network RAWS.

Station Name	Latitude	Longitude	Elevation ft
Chigmit Mountains	60.22490	-153.46752	4675
Contact Creek	58.20762	-155.92247	657
Coville	58.80248	-155.56289	1567
Fourpeaked	58.70572	-153.51792	1074
Harding Icefield	60.13247	-149.78204	4300
Hickerson Lake	59.91480	-152.89251	1048
McArthur Pass	59.47267	-150.33369	1266
Pedersen Lagoon*	59.89442	-149.73076	624
Pfaff Mine	59.11090	-154.83666	2018
Snipe Lake	60.61026	-154.31994	2315

*FTS Toolbox isn't used for communications with this RAWS.

5. The "Station Setup" screen will open (Figure 3-2). Verify that the name of the station is correctly entered, that the communication type is set to FTS (Direct Connection), and that the

logger type is set to FWS12S. Station latitude, longitude, and elevation (Table 3-1) can be entered if desired.

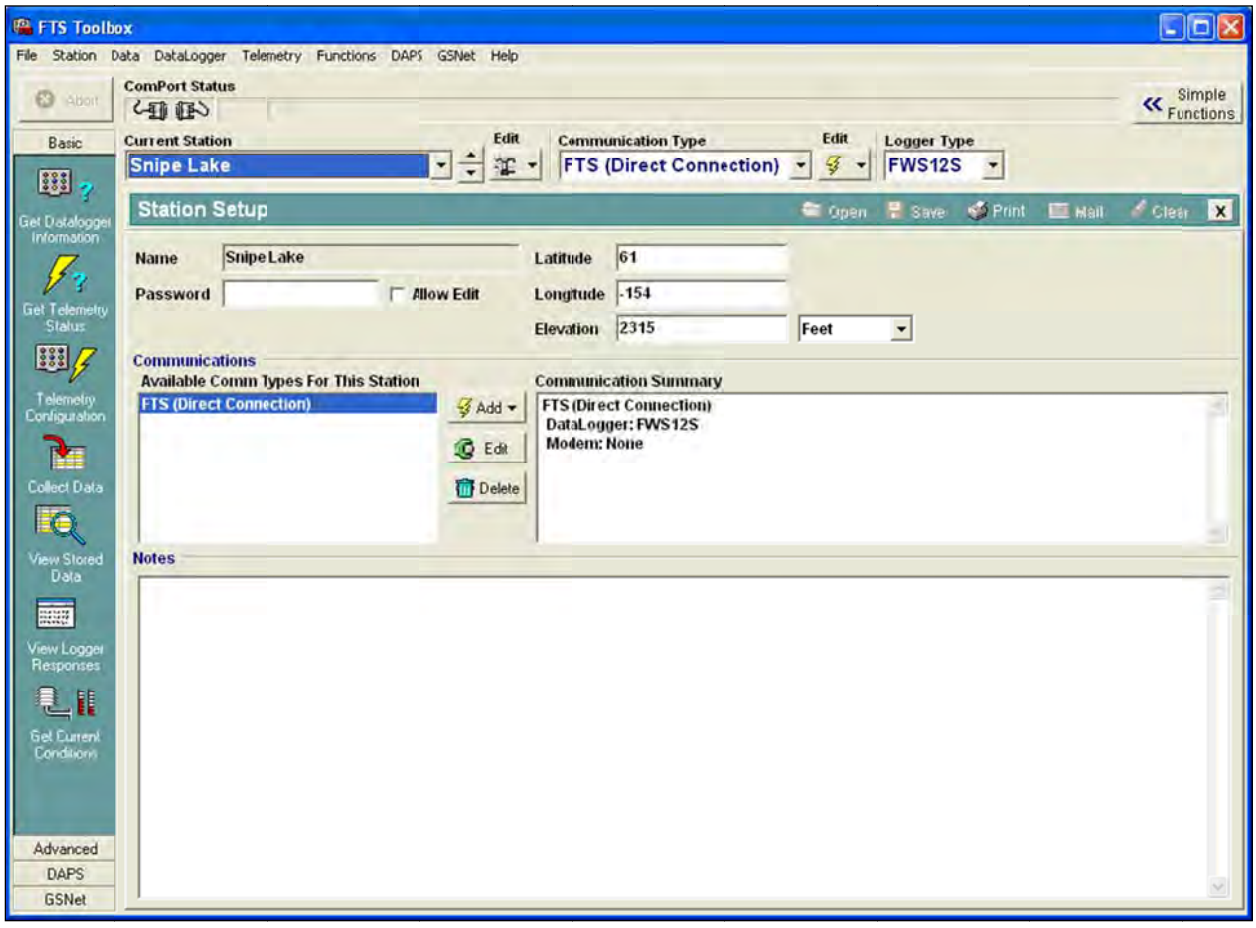


Figure 3-2. FTS Toolbox station setup window.

6. Repeat procedures 3 to 5 in order to add all network RAWS.

7. Close FTS Toolbox.

8. Make sure that the current version of these Methods for Monitoring Climate in Southwest Alaska Network Parks (protocol narrative and SOPs) are stored on the field laptop computer.

9. Make sure that the information in Table 3-2 is stored on the field laptop computer.

Table 3-2. NESDIS ID assignments for network RAWS.

Station Name	NESDIS ID	Acronym	Channel	Transmit time (hh:mm:ss)
Chigmit Mountains	FA6544FC	CHMO	160	00:43:10
Contact Creek	32803738	COCR	166	00:04:20
Coville	3280B12C	COVI	166	00:04:40
Fourpeaked	328135C2	FOUR	80	00:17:00
Harding Icefield	FA656210	HAIC	160	00:43:30
Hickerson Lake	3280C7BC	HILA	166	00:04:50
McArthur Pass	3280244E	MCPA	166	00:04:10
Pedersen Lagoon	326AD012	PELA	158	00:28:50
Pfaff Mine	FA65578A	PFMI	160	00:43:20
Snipe Lake	328041A8	SNLA	166	00:04:30

10. Copy the data logger programs (DLP) for each network RAWS onto the field laptop computer. The DLPS are located on the SWAN server at:

\SWAN\Vital_Signs\Climate\Stations\RAWS_Station_Name\Data_Logger_Program\

Two different types of data logger programs are used on the FWS-12S data logger. This is because each of the network RAWS has a snow depth sensor and there are two different snow depth sensor models (SDI SR50 and SDI SR50A) currently being used – each of which requires a specific DLP.

The following file naming structure is used for DLPs:

[NAME]_[DLP]_[SRXXX]_[filedate].prg

Where:

[NAME] is the four-letter acronym for the network RAWS (Table 3-2).
[DLP] refers to “Data Logger Program”
[SRXXX] is the snow depth sensor model (= SR50 or SR50A)
[filedate] is the date the program was uploaded to the RAWS
.prg is the file extension required by the RAWS data logger (these are text files)

Example: CHMO_DLP_SR50A_20090630.prg

11. Copy all current DLPs from the network server on to the field laptop. DLPs should be stored on the field laptop computer in the following directory:

C:\FTS\Toolbox\Programs\SWAN_DLP_SR50\
C:\FTS\Toolbox\Programs\SWAN_DLP_SR50A\

Note that there are other subtle differences in the DLPs making them unique to each station, including the snow depth offset and the transmit time. When uploading a DPL to a network RAWS, double-check the pertinent lines of the DLP prior to uploading the DLP to the RAWS data logger to make sure it is the correct DLP. This is more thoroughly addressed in SOP #5

SOP #4: RAWS GOES Transmitter Configuration

Version 1.0

Change History:

Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for programming the Forest Technology Systems, Inc. (FTS) G5 Geostationary Operational Environmental Satellite (GOES) transmitter. The G5 GOES transmitter is used by network RAWS to transmit hourly data.

Introduction

The Forest Technology Systems, Inc. (FTS) G5 Geostationary Operational Environmental Satellite (GOES) transmitter is used by network RAWS to transmit data. The GOES transmitter is a separate component on stations equipped with FWS12-S data loggers but it is part of the F6 data logger. The FTS G5 GOES transmitter must be properly configured so that network RAWS transmit data at the assigned time and interval. Proper data transmission requires also require correct orientation of the GOES antenna and installation of a GPS antenna. This SOP applies only to GOES transmitter configuration for RAWS equipped with FWS-12S data loggers.

Procedures

1. Make sure that the FTS FSW12S data logger is powered-up. In the field, power is supplied by the photovoltaic system and the FTS power manager. In the office, power can be supplied using an AC power adapter (available from FTS)

2. Connect the field laptop computer (refer to SOP #3) to the FW12S data logger using the supplied serial cable (FTS P/N CBL-FWS-LDS-PC).

3. Execute the FTS Toolbox program. The “Simple Functions” window should open. If the “DataLogger Responses” window opens, click on the “Simple Functions” button in the upper-right-hand corner of the window (Figure 4-1) to access the “Simple Functions” window (Figure 4-2).

4. Click on “Get or Set the DataLogger Telemetry Configurations” button (Figure 4-2) and select “Set to GOES/GPS Telemetry” (Figure 4-3).

5. The current GOES transmitter configurations for the RAWS will be displayed (Figure 4-4).

6. Enter or edit the following information:

- NESDIS ID: Enter the RAWS NESDIS ID (refer to Table 4-1).
- Transmitter: Select “G4/G5 HDR”
- Transmission type: Select “BLM”
- Enable Self-Timed Transmit by checking that box
- Channel: Enter the RAWS assigned channel number (refer to Table 4-1)
- Interval: Enter “01:00:00”
- Days: Enter “0”
- First Tx Time: Enter the RAWS transmit time (refer to Table 4-1)
- Tx Window Length: Enter 10s
- Preamble: Select “Short”
- Bit Rate: Select “300”
- Interleaver: Select “None”
- Do not enable “Random Transmit” (leave box unchecked)
- GOES Satellite: Select “WEST” and accept the default latitude and longitude
- Double check entries and click “Send Configuration”

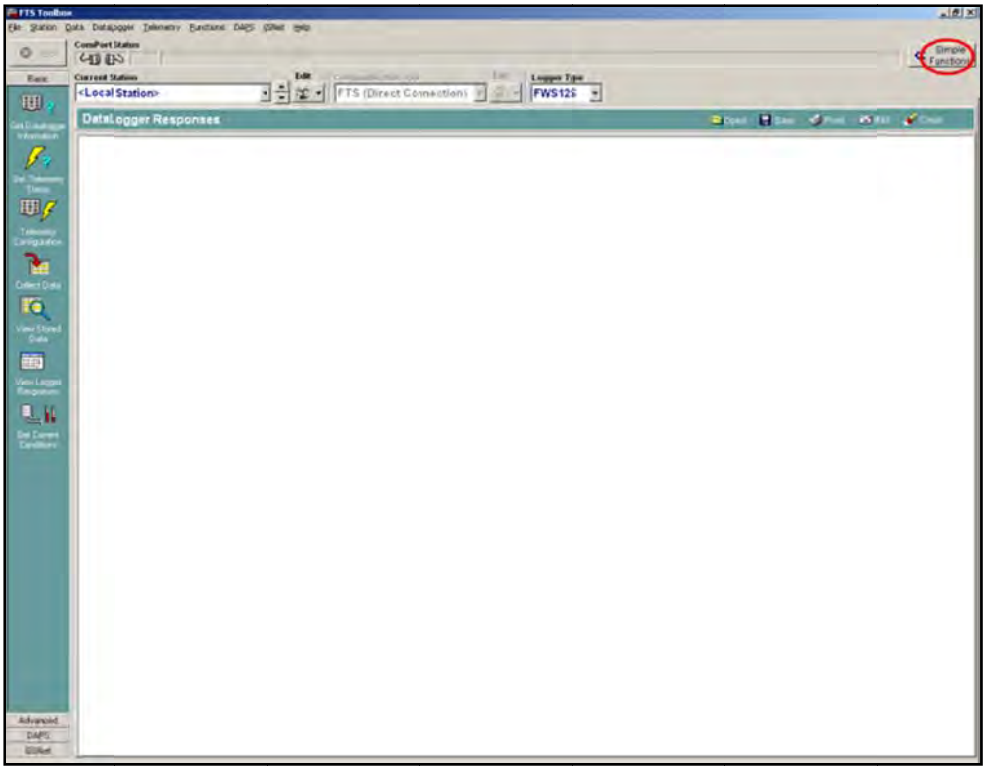


Figure 4-1. FTS Toolbox “DataLogger Responses” window. Clicking on the “Simple Functions” button in the upper-right-hand corner of the window will access the “Simple Functions” window.

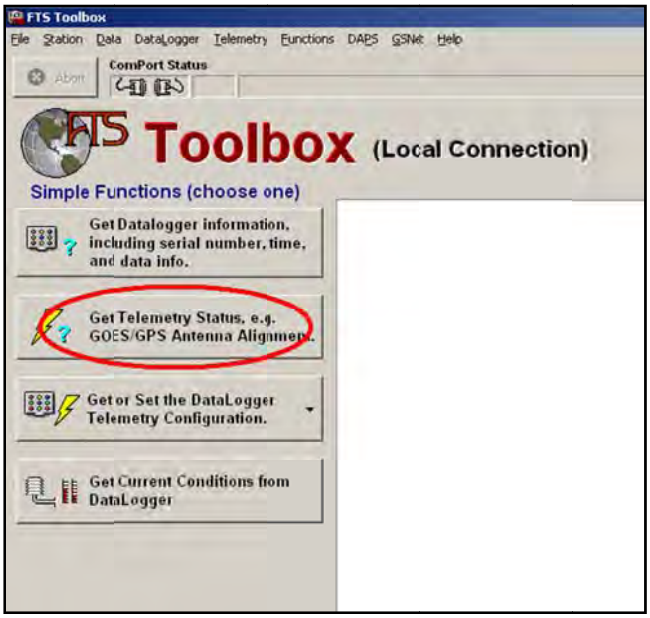


Figure 4-2. FTS Toolbox “Simple Functions” window.

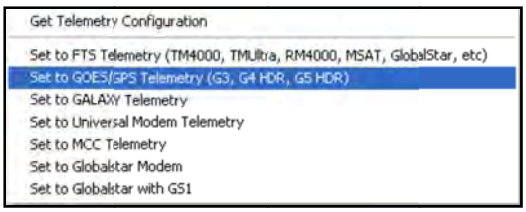


Figure 4-3. FTS Toolbox "Get/Set Telemetry Configuration" menu.

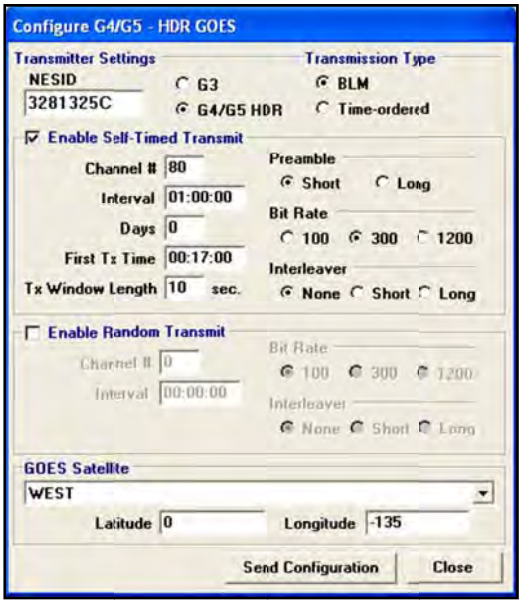


Figure 4-4. FTS Toolbox GOES transmitter configuration menu.

Table 4-1. NESDIS ID assignments and other GOES parameters for network RAWS.

Station Name	Acronym	NESDIS ID	Channel	Transmit time (hh:mm:ss)	Offset time (s)
Chigmit Mountains	CHMO	FA6544FC	160	00:43:10	2470
Contact Creek	COCR	32803738	166	00:04:20	140
Coville	COVI	3280B12C	166	00:04:40	160
Fourpeaked	FOUR	328135C2	80	00:17:00	900
Harding Icefield	HAIC	FA656210	160	00:43:30	2490
Hickerson Lake	HILA	3280C7BC	166	00:04:50	170
McArthur Pass	MCPA	3280244E	166	00:04:10	130
Pedersen Lagoon	PELA	326AD012	158	00:28:50	1610
Pfaff Mine	PFMI	FA65578A	160	00:43:20	2480
Snipe Lake	SNLA	328041A8	166	00:04:30	150

SOP #5: RAWS Data Logger Programs and Configurations
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) documents the procedures for communicating with Forest Technology Systems, Inc. (FTS) FWS-12S and F6 data loggers, modifying the data logger programs (DLPs) and configuration files, and calibrating the different snow depth sensors that are used by network RAWS.

Introduction

Forest Technology Systems, Inc. (FTS) FWS-12S and F6 data loggers are used by network RAWS. They support a variety of sensors and telemetry options. Customized data logger programs (DLPs) direct the data logger to sample a suite of sensors at specified time intervals, to store and down sample sensor data, and to summarize and transmit hourly weather observations using Geostationary Environmental Satellite (GOES) telemetry. The data transmissions are processed by the National Interagency Fire Center in Boise, Idaho and then transmitted to the Western Regional Climate Center (WRCC). This SOP describes what elements the data logger is recording and transmitting. It also outlines the steps necessary to modify DLPs and how to upload DLPs onto FTS data loggers. This SOP is split into two sections; the first section is focused on the FWS-12S data logger, the second section is focused on the F6 data logger. An example of each of the two two general types of DLPs used for network RAWS are included for reference at the end of this SOP

Data Transmission Standards

Required Elements: Rainfall, Wind Speed and Direction, Air Temperature, Relative Humidity, and Battery Voltage

Network RAWS meet the minimum standards established in the Interagency Wildland Fire Weather Station Standards & Guidelines. These standards and guidelines require that data be transmitted in a specific order and format (Table 5-1).

Table 5-1. Network RAWS data transmission standards for the six required elements.

Transmission order	Element	Format (unit)
1	Rainfall	Continuous, cumulative measurement (in)
2	Wind speed	10-minute average, calculated from no less than 120 samples (mph)
3	Wind direction	10-minute average, calculated from no less than 120 samples (° from true North)
4	Air temperature	Instantaneous (°F)
5	Relative humidity	10-minute average, calculated from no less than 120 samples (%)
6	Battery voltage	Instantaneous (V)

Additional Elements: Peak Wind Speed and Direction, Solar Radiation, Snow Depth, Average Air Temperature, Average Relative Humidity, Average Wind Speed and Direction, Maximum and Minimum Air Temperature

Network RAWS also transmit several elements in addition to the six required elements. The DLPs used by network RAWS are modified and direct the data logger to sample sensors and store and down sample sensor data in order to transmit the additional elements listed in Table 5-2.

Table 5-2. Network RAWS data transmission standards for additional elements.

Transmission order	Element	Format (unit)
7	Peak wind direction	Corresponding wind direction for the peak wind speed documented during 60 minute sampling interval (° from true North)
8	Peak wind speed	Maximum (instantaneous) wind speed documented during 60 minute sampling interval (mph)
9	Solar radiation	Average, calculated from 60 minute sampling interval (W/m^2)
10	Snow depth	Instantaneous (in)
11	Air temperature	Average, calculated from 60 minute sampling interval (°F)
12	Relative humidity	Average, calculated from 60 minute sampling interval (%)
13	Wind speed	Average, calculated from 60 minute sampling interval (mph)
14	Wind direction	Average, calculated from 60 minute sampling interval (° from true North)
15	Air temperature	Maximum, documented during 60 minute sampling interval (°F)
16	Air temperature	Minimum, documented during 60 minute sampling interval (°F)

FWS-12S Data Logger

Data Logger Programs

FTS provided the network with customized DLPs in order to collect and transmit the elements shown in Tables 5-1 and 5-2. These DLPs are text files and can be edited using a text editor if the DLP file extension is changed to ".txt". The FWS-12S data logger will only recognize these DLPs if the file extension is ".prg". The syntax used in these DLPs roughly follows the C programming language. Because changes to the DLPs used by network RAWS are inevitable, version numbers are used in the file naming structure, which correspond to dates when a revised DLP was uploaded on to a RAWS datalogger.

There are two basic DLPs used by network RAWS. The only difference in these DLPs is which snow depth sensor they support – Campbell Scientific SR50 (now discontinued) or SR50A. The file naming structure used for DLPs for network RAWS indicates which snow depth sensor the DLP is compatible with:

The following file naming structure is used for DLPs:

[NAME]_[DLP]_[SRXXX]_[filedate].prg

Where:

[NAME] is the four-letter acronym for the network RAWS (Table 5-3).
[DLP] refers to "Data Logger Program"
[SRXXX] is the snow depth sensor model (= SR50 or SR50A)
[filedate] is the date the program was uploaded to the RAWS
.prg is the file extension required by the RAWS data logger (they are text files)

Example: CHMO_DLP_SR50A_20090630.prg
DLPs for network RAWS are located on the network server at:

\SWAN\Vital_Signs\Climate\Stations\RAWS_Station_Name\Data_Logger_Program\

Where: "Station_Name" is that shown in Table 5-3.

Table 5-3. NESID assignments, transmit times, off-set, and acronyms used for network RAWS.

Station Name	NESDIS ID	Acronym [NAME]	Channel	Data logger	Transmit time (hh:mm:ss)	Transmit Time Off-set (s)
Chigmit Mountains	FA6544FC	CHMO	160	FWS-12S	00:43:10	2470
Contact Creek	32803738	COCR	166	FWS-12S	00:04:20	140
Coville	3280B12C	COVI	166	FWS-12S	00:04:40	160
Fourpeaked	328135C2	FOUR	80	FWS-12S	00:17:00	900
Harding Icefield	FA656210	HAIC	160	FWS-12S	00:43:30	2490
Hickerson Lake	3280C7BC	HILA	166	FWS-12S	00:04:50	170
McArthur Pass	3280244E	MCPA	166	FWS-12S	00:04:10	130
Pedersen Lagoon	326AD012	PELA	158	F6	00:28:50	1610
Pfaff Mine	FA65578A	PFMI	160	FWS-12S	00:43:20	2480
Snipe Lake	328041A8	SNLA	166	FWS-12S	00:04:30	150

The DLPs are also stored on the field laptop (refer to SOP #3). DLPs are located in the following directories on the field laptop:

C:\FTS\Toolbox\Programs\SWAN_DLP_SR50\

and

C:\FTS\Toolbox\Programs\SWAN_DLP_SR50A\

The basic DLPs used by network RAWS are included at the end of this SOP.

Modifying and Loading Data Logger Programs

There are two lines in the DLPs that will require modification in the field. One of these lines sets the snow depth sensor off-set distance and the other sets the time of satellite transmission.

Snow Depth Off-Set (SR50 and SR50A)

The snow depth will typically need to be calibrated during RAWS maintenance; this procedure involves editing the DLP. The procedure varies slightly if the sensor type is being changed (e.g. SR50 is replaced with SR50A) because the DLP will need to be replaced. The following steps are conducted on-site during a maintenance visit.

Procedures

Note: All data in the FWS-12S datalogger will be lost when a DLP is uploaded. It is extremely important that all data is retrieved (downloaded) and saved before modifying DLPs. Refer to SOP #8 for the procedures for downloading station data.

1. The datalogger must be powered up. The snow depth sensor must be installed and plugged into the SDI Expansion port. The SDI Expansion Port cable must be attached to the SDI port on the FWS12S data logger.

2. Connect the field laptop to the FSW12S datalogger. Use the port labeled “Display”. Use the FTS serial cable (FTS P/N CBL-FWS-LDS-PC). A USB to RS232 converter can be used.

3. Launch the FTS Toolbox program. Access the “DataLogger Responses” window (Figure 5-1). If the “Simple Functions” window is not displayed, click on the “All Functions” button in the upper-right-hand corner of the window to access the “DataLogger Responses” window.

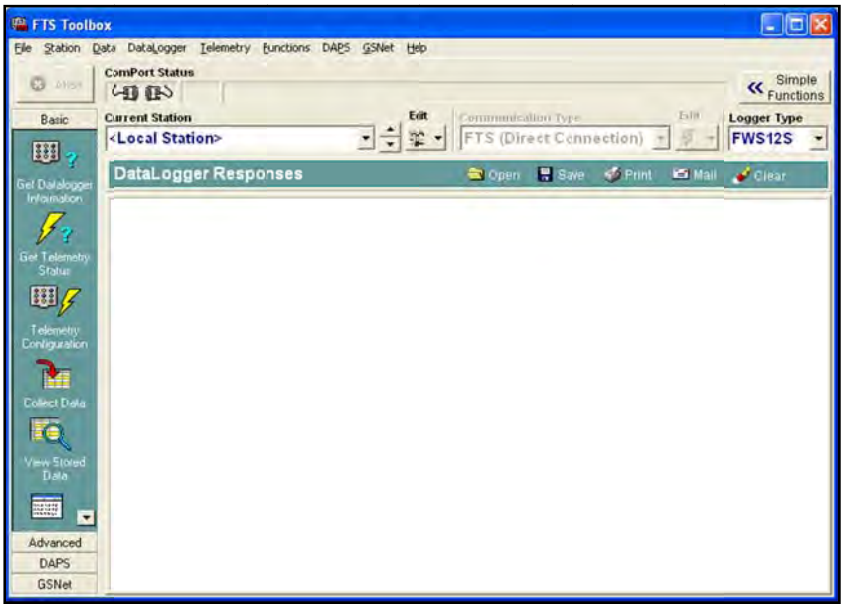


Figure 5-1. FTS Toolbox “DataLogger Responses” window.

4. Select the appropriate station name (refer to Table 5-3) under the “Current Station” pull-down menu. Then click on the “Advanced” button in the lower-left-hand corner of the window (Figure 5-2).

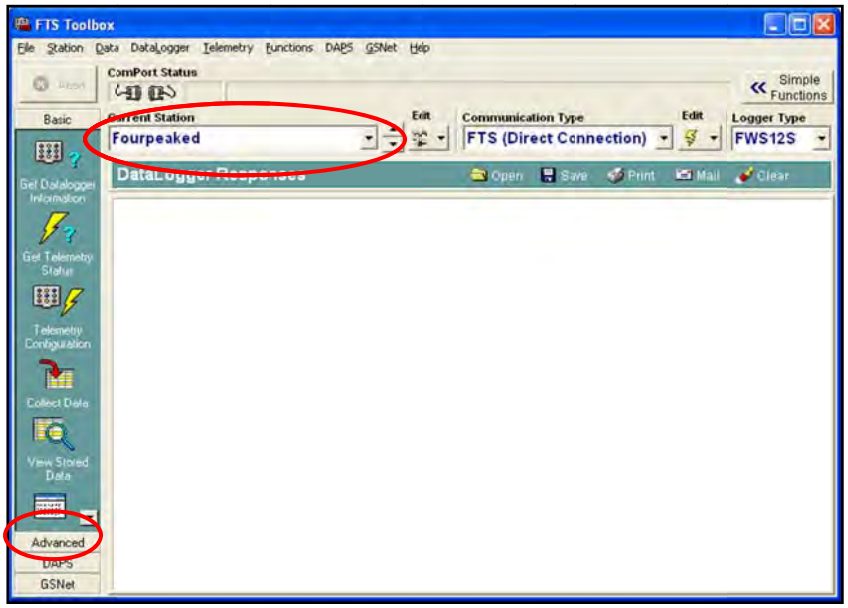


Figure 5-2. FTS Toolbox “DataLogger Responses” window.

5. Are you changing the snow depth sensor type? If so, change the DLP. Refer to the procedures in the section below titled “Loading a new DLP”. If you’re not changing the snow depth sensor type, select “DataLogger Program” from the options in the column on the left-hand side of the screen and click on the “Get Program” button (Figure 5-3).

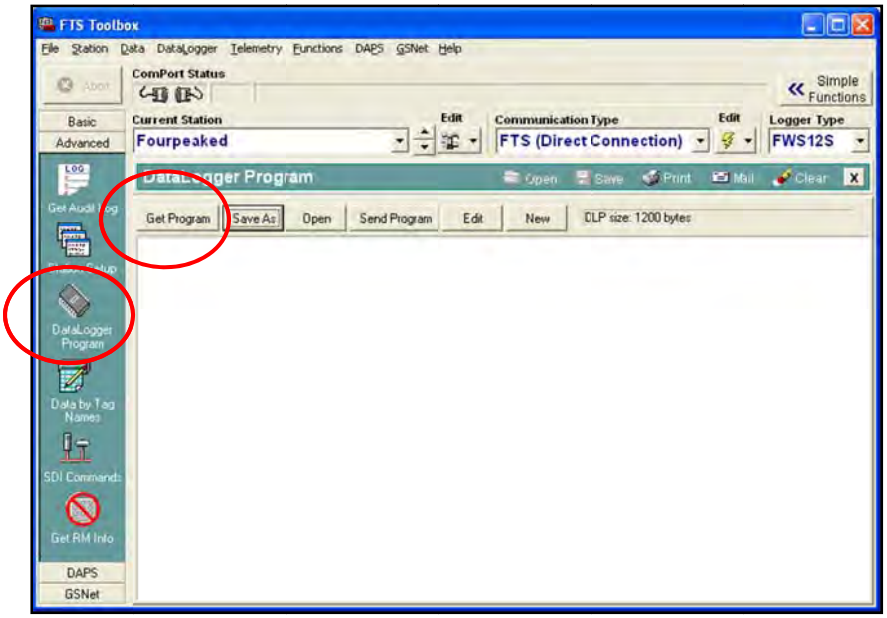


Figure 5-3. FTS Toolbox “DataLogger Program” window.

6. The laptop will connect to the FWS-12S data logger to retrieve the DLP that is currently running. A portion of this DLP will display in the “DataLogger Program” window (Figure 5-4).

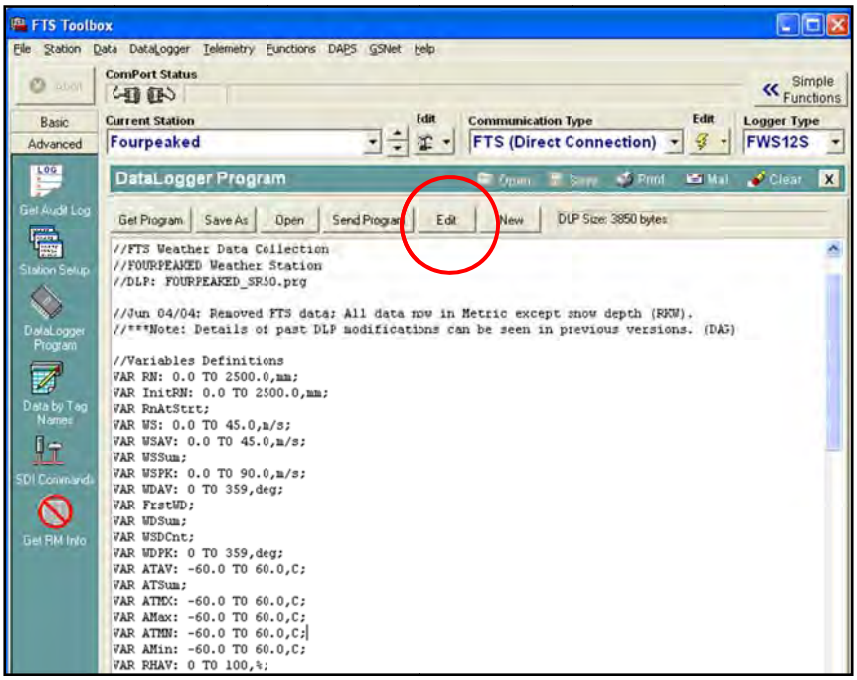


Figure 5-4. FTS Toolbox "DataLogger Program" window showing the DLP that is currently running.

7. Click on the "Edit" button. The DLP will open using a text editor (e.g. Notepad). The process used to calibrating snow depth is identical for both the SR50 and SR50A sensor with the exception of the units that are used. The DLP for the SR50 expects that the offset is entered using decimal feet. The DLP for the SR50A expects that the offset is currently entered using decimal inches.

8. Scroll down the DLP until you see either of the following lines:

DPL Program Lines for Snow Depth Sensor Off-Set for SDI-SR50

```
//SR50 Sensor-to-Ground Distance (in feet):
 GDist = 5.114; //* CAUTION: modify NUMBERS ONLY - Range: 0.000 to 32.810
```

DPL Program Lines for Snow Depth Sensor Off-Set for SDI-SR50A

```
//SR50 Sensor-to-Ground Distance (***in Inches***):
GDist = 0.000; //* CAUTION: modify NUMBERS ONLY - Range: 0.000 to 393.72 inches
```

9. The following example snow depth off-set calibration is specific to the SR50 sensor. The measured offset (sensor base to ground surface) was set at 5.1114 ft (Figure 5-5) – this is equivalent to 5 ft 1-5/16 in or 1.558 m. Edit the DLP and set "GDist = 0.000".

```
//SDI Definitions
SDI SR: 0.0 TO 2000.0,w/m^2,1M!,2; //Solar Radiation, Pyranometer
SDI SDist: 0.000 TO 32.810,ft,3M4!,1; //Sonic Distance, CSI SR50, non-temp compensated

//Initialization Section
{
 //Initial Accumulating Rainfall Offset (in millimeters):
 InitRN = 0.0; //* CAUTION: modify NUMBERS ONLY - Range: 0 to 2500.0

 //SR50 Sensor-to-Ground Distance (in feet):
 GDist = 5.114; //* CAUTION: modify NUMBERS ONLY - Range: 0.000 to 32.810
```

Figure 5-5. Calibrating the snow depth off-set in the DLP using a text editor (e.g. Notepad).

10. Click on the text editor's "File" menu and select "Save As". Accept the default file name "Temp.prg". The file should be saved at: C:\FTS\Toolbox\Programs\ .

11. The procedures outlined in steps 7-10 are the same if a DLP for a SDI-SR50A snow depth sensor is used, except the off-set is entered in decimal inches.

12. Return to the FTS Toolbox program and the "DataLoggerProgram" window. Select "Open" and browse to the directory where the "Temp.prg" file was saved and click "Open" (Figure 5-6).

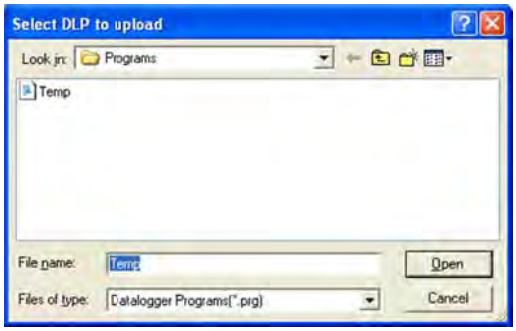


Figure 5-6. Opening the recently-edited DLP with FTS Toolbox.

13. A portion of this DLP will display in the "DataLogger Program" window. Scroll through the program lines to verify the following items before uploading the DLP to the FWS-12S data logger:

- Verify that the station name shown in the 2nd and 3rd lines of the DLP is correct for the station you are connected to
- Verify that the snow depth off-set is set to zero
- Verify that the transmit time and off-set time are correct for the station you are connected to (refer to Table 5-3)

These lines shouldn't have changed – this step just ensures that you are loading the correct DLP!

14. Click "Send Program" to upload the DLP to the FWS-12S data logger (Figure 5-7).

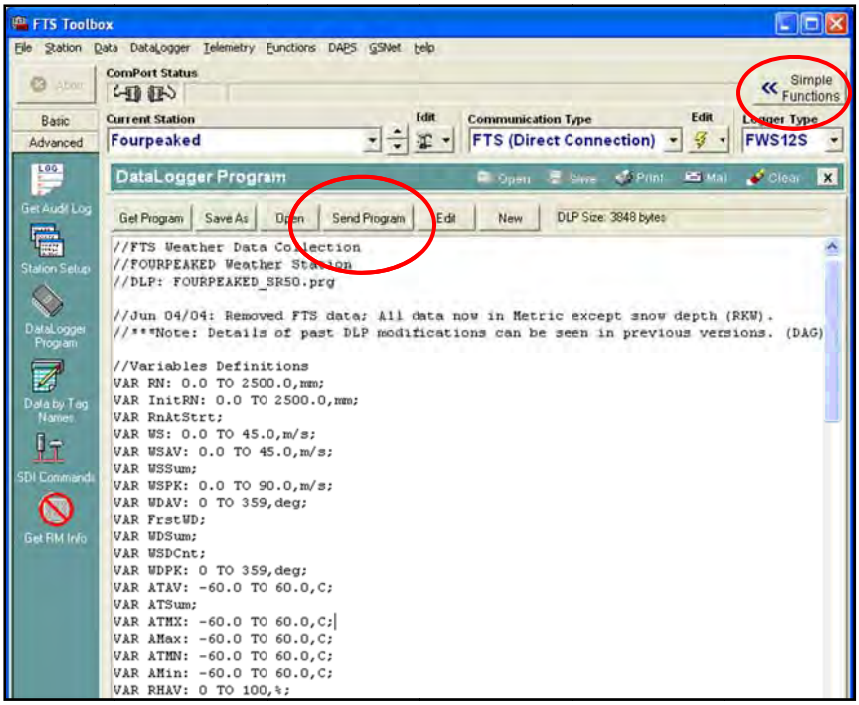


Figure 5-7. Uploading the recently-edited DLP to the data logger using FTS Toolbox.

15. Sample the station sensors to get the current conditions. Click on the “Simple Functions” button in the upper-right-hand corner of the window (Figure 5-7).

16. Click on “Get Current Conditions from DataLogger” (Figure 5-8).

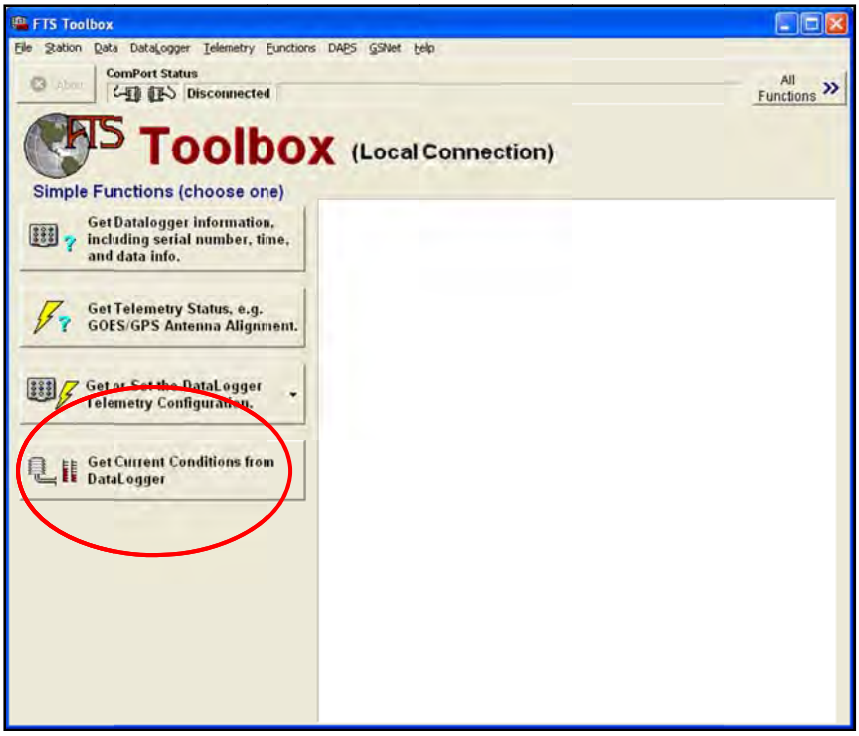


Figure 5-8. Sampling station sensors for current conditions.

17. Current conditions will be displayed. Snow depth is identified by “SDepth” (Figure 5-9).

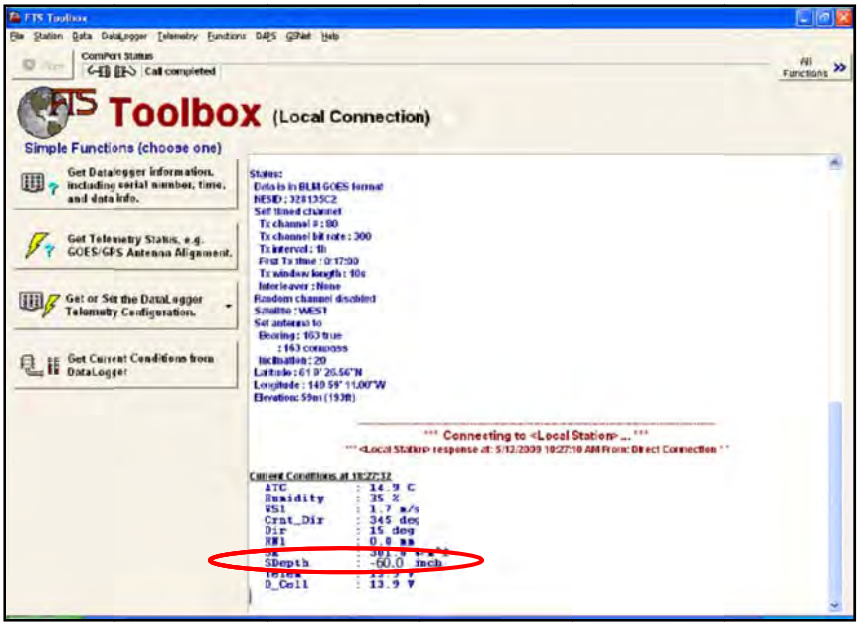


Figure 5-9. Current conditions reported by station sensors.

18. The snow depth sensor is quite sensitive and the station sensors may have to be sampled several times (repeat Step 16) until the snow depth value levels and is consistent. The snow depth value shown in Figure 5-9 is -60.0 inches.

19. Record the current snow depth (average several observations). If necessary, convert the units to decimal feet or decimal inches (depending on sensor model). This snow depth value will be used when editing the DLP (again) to calibrate (i.e. tare) the snow depth.

20. Repeat steps 5-10. Edit the DLP, setting "GDist" equal to the average snow depth that you recorded in step 19. Remember, that the SDI-SR50 requires that the units used for "GDist" be decimal feet. In the above example 60.0 inches = 5.000 feet, so the DLP would be modified so that "GDist = 5.000". The polarity (sign) of the value should be reversed.

21. Repeat steps 12-19 and step 20 (if necessary) until the reported snow depth value levels off at, or very close to, zero. Reported snow depths between +0.5 and -0.5 inches are acceptable.

<u>Loading a new DLP</u>

If you replacing a snow depth sensor with a different model (e.g. swapping a SDI-SR50 for a SDI-SR50A or vice versa) the DLP will need to be changed. Complete the following procedures after completing steps 1-4 in the section titled "Snow Depth Off-Set (SR50 and SR50A)".

Procedures

1. Select "DataLogger Program" from the options in the column on the left-hand side of the screen and click on the "Open" button.

2. Browse to C:\FTS\Toolbox\Programs\ and select the corresponding folder containing the DLPs for the snow depth sensor model that was just installed. Select the DLP for the correct

station and click on “Open”. Figure 5-10 shows the selection of the appropriate DLP for a SR50A snow depth sensor model installed at the Fourpeaked RAWS.

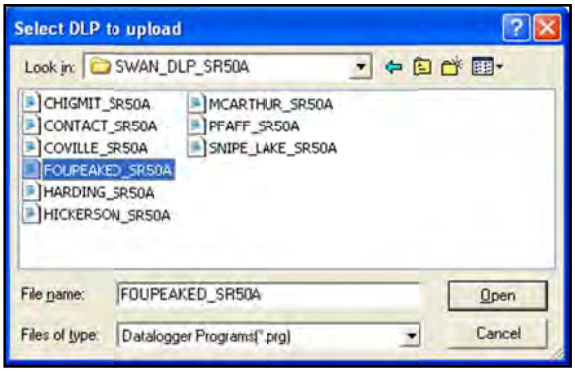


Figure 5-10. Selecting a DLP for uploading.

3. A portion of the selected DLP will display in the “DataLogger Program” window in FTS Toolbox. Scroll through the program lines to verify the following items before uploading the DLP to the FWS-12S data logger:

- Verify that the station name shown in the 2nd and 3rd lines of the DLP is correct for the station you are connected to
- Verify that the snow depth off-set is set to zero
- Verify that the transmit time and off-set time are correct for the station you are connected to (refer to Table 5-3)

This step ensures that you are loading the correct DLP!

4. Click “Send Program” to upload the DLP to the FWS-12S data logger. This will take a minute and a response on the screen will indicate that the program is running normally.

5. Continue with step 15 in the section above titled “Snow Depth Off-Set (SR50 and SR50A)”.

Changing DLP Transmit and Off-Set Time

The following procedures to adjust DLP transmit time and transmit time off-set are not usually performed. They are presented here to build familiarity with the DLPs and to help resolve any problems with DLPs (should they develop) in the field.

Each of the network RAWS is assigned a specific identification number – the National Environmental Satellite Data and Information Service Identifier (NESDIS ID) – and a specific transmit time. All of the network RAWS have a 10 second transmit window. Configuring the FTS G5 Transmitter was covered in SOP #4. The FTS G5 transmitter should already be configured specific to the station NESDIS ID and the assigned transmit time. Table 5-3 lists the transmit time and transmit off-set time for each of the network RAWS. As indicated, the transmit times are assigned, the off-set times are the transmit time expressed in seconds minus 2 minutes (120 seconds). For example, the Fourpeaked RAWS has a transmit time of 00:17:00. This means that the Fourpeaked RAWS transmits at 17 minutes past the hour every hour. The off-set time is calculated as {(17 minutes x 60 sec/minute) + 0 seconds} – 120 seconds = 900 seconds. The

following procedures describe through the process of modifying the transmit time and transmit off-set time in the DLP.

Note: Because most of the following procedures are very similar to those described above, figures are not provided.

Procedures

1. Modifying the DLP transmit and transmit off-set time can be accomplished without communicating with a data logger. However, the modified DLP will eventually need to be uploaded to a data logger as described above.

2. Launch the FTS Toolbox program. Access the “DataLogger Responses” window. If the “Simple Functions” window is not displayed, click on the “All Functions” button in the upper-right-hand corner of the window to access the “DataLogger Responses” window.

4. Select the appropriate station name under the “Current Station” pull-down menu. Then click on the “Advanced” button in the lower-left-hand corner of the window.

5. Select “DataLogger Program” from the options in the column on the left-hand side of the screen and click on the “Open” button.

6. Browse to C:\FTS\Toolbox\Programs\ (on the field laptop computer) and select the corresponding folder containing the DLPs for the snow depth sensor model that was just installed. Select the DLP for the correct station and click on “Open”.

7. A portion of the selected DLP will display in the “DataLogger Program” window in FTS Toolbox. Click on “Edit” to edit the DLP using a text editor (e.g. Notepad).

8. Scroll down the end of the DLP and identify the following program lines:

```
//1-Hr Readings & GOES Transmission with Tx time offset
EVERY 3600 AT 900 //Tx time is 00:17:00
```

9. In the example DLP lines above (DLP is for the Fourpeaked RAWS), “900” represents the off-set time and “00:17:00” represents the transmit time.

10. If the transmit time or off-set time are not correct in the DLP for the corresponding RAWS, edit these values (referring to Table 5-3).

11. After modifying transmit time and off-set (if needed) click on the text editor’s “File” menu and select “Save As”. Accept the default file name “Temp.prg”. The file should be saved at: C:\FTS\Toolbox\Programs\ .

12. Return to the FTS Toolbox program and the “DataLoggerProgram” window. Select “Open” and browse to the directory where the “Temp.prg” file was just saved and click “Open”.

13. A portion of the selected DLP will display in the "DataLogger Program" window in FTS Toolbox. Scroll through the program lines to verify the following items before uploading the DLP to the FWS-12S data logger:

- Verify that the station name shown in the 2nd and 3rd lines of the DLP is correct for the station you are connected to
- Verify that the snow depth off-set is set to zero
- Verify that the transmit time and off-set time are correct for the station you are connected to (refer to Table 5-3)

This step ensures that you are in fact loading the correct DLP!

14. Click "Send Program" to upload the DLP to the FWS-12S data logger.

15. Sample the station sensors to get the current conditions. Click on the "Simple Functions" button in the upper-right-hand corner of the window.

16. Click on "Get Current Conditions from DataLogger". Verify that the DLP is functioning properly by checking that all sensors are returning reasonable data.

Saving the DLP

The following procedure is used any time there has been a change to the DLP and that modified DLP has been sent to a FWS-12S datalogger. This ensures that there is a record of the currently operating DLP for all network RAWS.

Procedures

After you are satisfied that the DLP operating normally and as expected, complete the following steps to save a copy of the DLP to your laptop. These steps assume that you are communicating with the data logger using FTS Toolbox.

1. Select "DataLogger Program" from the options in the column on the left-hand side of the screen and click on the "Get Program" button (Figure 5-11).

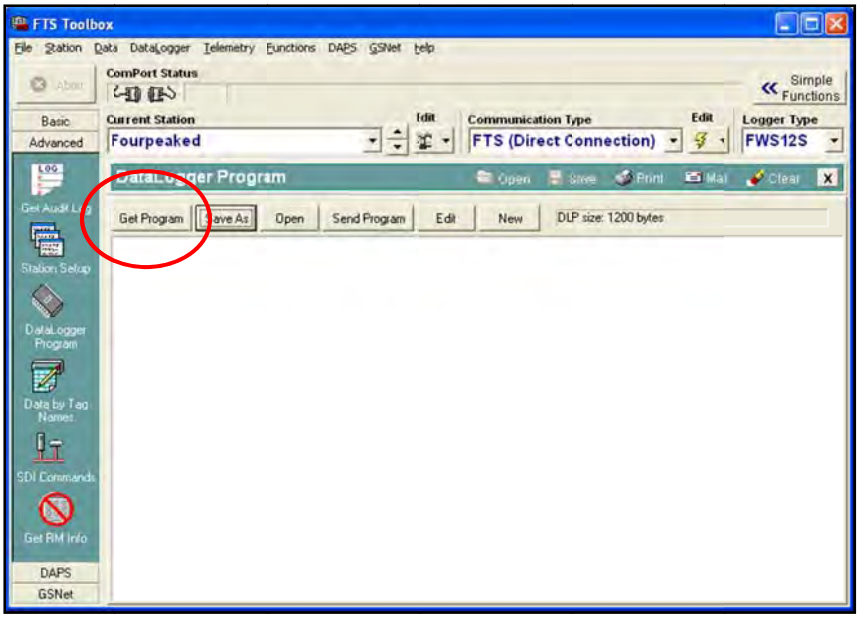


Figure 5-11. FTS Toolbox "DataLogger Program" window.

2. The laptop will connect to the FWS-12S data logger to retrieve the DLP that is currently running. A portion of this DLP will display in the "DataLogger Program" window (Figure 5-12).

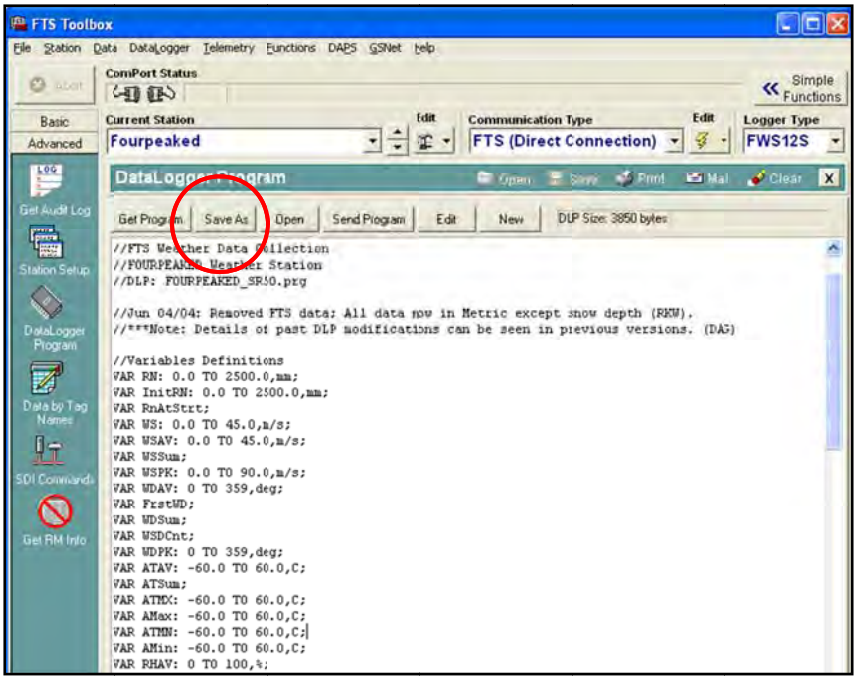


Figure 5-12. FTS Toolbox "DataLogger Program" window showing the DLP that is currently running.

3. Click on the "Save As" button (Figure 5-12) and save the program to the field laptop and archive it on the SWAN server back at the office. Use the file naming structure outlined above in the section titled "Data Logger Programs".

Example FWS-12S Data Logger Programs Used by Network RAWS

The following generic (i.e. not station specific) DLP is used by network RAWS with FWS-12S data loggers. There are two versions of this DLP, one for use with the SR-50 snow depth sensor and one for use with the SR50A snow depth sensor. As described above, there are a few lines in each of the DLPs that require editing. The header lines in each of the programs also need to be modified to identify the network RAWS. Program lines highlighted with yellow in the generic DLP below require editing before use or are specific to snow depth sensor type.

FWS-12S DLP for SWAN RAWS (w/ SR50 snow depth sensor)
v. CHMO_DLP_SR50_20090630.prg

```
//FTS Weather Data Collection
//Chigmit Mtns Weather Station
//DLP: CHIGMIT.prg

//Old file name: Chigmit_20090630_SR50 2009/06/30

//Jun 04/04: Removed FTS data; All data now in Metric except snow depth (RKW).
//***Note: Details of past DLP modifications can be seen in previous versions. (DAG)

//Variables Definitions
VAR RN: 0.0 TO 2500.0,mm;
VAR InitRN: 0.0 TO 2500.0,mm;
VAR RnAtStrt;
VAR WS: 0.0 TO 45.0,m/s;
VAR WSAV: 0.0 TO 45.0,m/s;
VAR WSSum;
VAR WSPK: 0.0 TO 90.0,m/s;
VAR WDAV: 0 TO 359,deg;
VAR FrstWD;
VAR WDSum;
VAR WSDCnt;
VAR WDPK: 0 TO 359,deg;
VAR ATAV: -60.0 TO 60.0,C;
VAR ATSum;
VAR ATMX: -60.0 TO 60.0,C;
VAR AMax: -60.0 TO 60.0,C;
VAR ATMN: -60.0 TO 60.0,C;
VAR AMin: -60.0 TO 60.0,C;
VAR RHAV: 0 TO 100,%;
VAR RHSum;
VAR TOHCnt; //Top-of-hr Counter
VAR SRAV: 0.0 TO 2000.0,W/m^2;
VAR SRSum;
VAR SRCnt;
VAR SD: -393.7 TO 393.7,in;
VAR SDepth: -393.7 TO 393.7,in; //spot
VAR SDepthft: -32.810 TO 32.810,ft; //spot
VAR GDist: 0.000 TO 32.810,ft;
VAR A;
VAR B;
VAR TCF; //Temp compensation factor for SR50

//SDI Definitions
SDI SR: 0.0 TO 2000.0,W/m^2,1M!,2; //Solar Radiation, Pyranometer
SDI SDist: 0.000 TO 32.810,ft,3M4!,1; //Sonic Distance, CSI SR50, non-temp compensated

//Initialization Section
{
```

```
 //Initial Accumulating Rainfall Offset (in millimeters):
 InitRN = 0.0; //* CAUTION: modify NUMBERS ONLY - Range: 0 to 2500.0

 //SR50 Sensor-to-Ground Distance (in feet):
 GDist = 5.485; //* CAUTION: modify NUMBERS ONLY - Range: 0.000 to 32.810

 RN=InitRN;
 RnAtStrt=RnCnt;
 WS=0;
 WSAV=0;
 WSSum=0;
 WSPK=0;
 WDAV=0;
 WDPK=0;
 FrstWD=0;
 WDSum=0;
 WSDCnt=0;
 ATAV=0;
 ATSum=0;
 ATMX=-60;
 AMax=-60;
 ATMN=60;
 AMin=60;
 RHAV=0;
 RHSum=0;
 TOHCnt=0;
 SRAV=0;
 SRSum=0;
 SRCnt=0;
 SD=0;
 SDepth=0;
 SDepthft=0;
 A=0;
 B=0;
 TCF=0;

 //Current Conditions
 IF(0==1)
 {
  LOG(ATC,Rh,WS,Crnt_Dir,Dir,RN,SR,SDepth,SDepthft,Telem,D_Cell);
 }
}

//1-Minute Readings
EVERY 60
{
 //Calc Accumulated Rain since Logger power-up
 RN=RnCnt-RnAtStrt;
 IF(RN<0)
 {
  RN=RN+65536;
 }

 RN=(0.254*RN)+InitRN;

 IF(RN>2500)
 {
  InitRN=RN-2500; //init a new offset
  RN=InitRN; //reset Acc Rain
  RnAtStrt=RnCnt;
 }
```

```
 WS=WSK*0.278;

 SRSum=SRSum+SR;
 SRCnt=SRCnt+1;

 //temperature compensation for SR50
 A=(ATC+273.15)/273.15;
 TCF=A/2;
 B=A/TCF;
 TCF=(B+TCF)/2;
 B=A/TCF;
 TCF=(B+TCF)/2;
 B=A/TCF;
 TCF=(B+TCF)/2;
 SDepth=(GDist-(SDist*TCF))*12; //temp comp'd reading in inches
 SDepthft=(GDist-(SDist*TCF)); //temp comp'd reading in feet

 ATSum=ATSum+ATC;
 RHSum=RHSum+Rh;
 TOHCnt=TOHCnt+1;
 AMax=MAX(ATC,AMax);
 AMin=MIN(ATC,AMin);
}

//10-Minute Readings
EVERY 600
{
 WSSum=WSSum+WS;

 IF(WSDCnt==0)
 {
  FrstWD=Dir;
 }
 //calculate Wind direction sum
 IF((FrstWD-Dir>180) || (FrstWD-Dir<-180))
 {
  WDSum=WDSum + Dir + 360;
 }
 ELSE
 {
  WDSum=WDSum + Dir;
 }

 WSDCnt=WSDCnt+1;
}

//1-Hr Readings - top of hour
EVERY 3600
{
 WDPK=WSMDir;
 WSPK=WSMK*0.278;
 SD=SDepth;

 //Calc Avg AT & RH
 IF(TOHCnt==0)
 {
  ATAV=ATC;
  RHAV=Rh;
 }
 ELSE
 {
  ATAV=ATSum/TOHCnt;
```

```
 RHAV=RHSum/TOHCnt;
}

//Calc Avg WS
IF(WSDCnt==0)
{
 WSAV=WSK*0.278;
}
ELSE
{
 WSAV=WSSum/WSDCnt;
}

//Calc Avg WD
WDAV=WDSum/WSDCnt;

IF(WDAV>=360)
{
 WDAV=WDAV-360;
}

ATMX=AMax;
ATMN=AMin;

//reset for next hr
ATSum=0;
RHSum=0;
WSSum=0;
WDSum=0;
TOHCnt=0;
WSDCnt=0;
AMax=-60;
AMin=60;
}

//1-Hr Readings & GOES Transmission with Tx time offset
EVERY 3600 AT 2470 //Tx time is 00:43:10
{
 //Calc Avg SR
 IF(SRCnt==0)
 {
  SRAV=SR;
 }
 ELSE
 {
  SRAV=SRSum/SRCnt;
 }

 LOG(RN,WS,Dir,ATC,Rh,Telem,WDPK,WSPK,SRAV,SD,ATAV,RHAV,WSAV,WDAV,ATMX,ATMN);
 TX(RN,WS,Dir,ATC,Rh,Telem,WDPK,WSPK,SRAV,SD,ATAV,RHAV,WSAV,WDAV,ATMX,ATMN);

//reset for next hr
SRSum=0;
SRCnt=0;
}
```

F6 Data Logger

Configuration files

FTS provided the network with a configuration file for use on the F6 data logger, which is currently only in use at the Pedersen Lagoon RAWS. This configuration file encompasses all data logger details including site and telemetry parameters as well as the general data collection and processing algorithms. This configuration file collects and transmits the elements shown in Tables 5-1 and 5-2.

The default file naming structure used by the F6 data logger when saving configuration files to a memory stick is:

StationName/Config/Configuration-YYYY-MM-DD-hh-mm.xml

However, the user can specify a filename during the save configuration process.

The following file naming structure should be used for F6 configuration files:

[NAME]_[F6config]_[XXXXX]_[filedate].prg

Where:

[NAME] is the four-letter acronym for the network RAWS (Table 5-3).
[F6config] refers to a F6 configuration file
[XXXXX] is the snow depth sensor model (e.g. SR50A or Judd)
[filedate] is the date (YYYYMMDD) the configuration was saved
.xml is the file extension required by the F6 data logger

Example: PELA_F6config_Judd_20120725.xml

DLPs for network RAWS are located on the SWAN server at:

\SWAN\Vital_Signs\Climate\Stations\RAWS_Station_Name\Data_Logger_Program\

Where: “Station_Name” is that shown in Table 5-3.

The configuration file is also saved on a USB memory stick necessary for communication with the F6 data logger. Configuration files are located in the following directory on the USB memory stick:

\F6 Data Logger\Station Name\Config\

Where: “Station_Name” is that shown in Table 5-3.

The basic configuration file used by network RAWS equipped with F6 data loggers is included for reference below.

Loading a New Configuration File

If you are replacing a snow depth sensor with a different model (e.g. swapping a Campbell Scientific SR-50A for a Judd Communications sensor, the configuration file will have to be changed. Complete the following steps:

Procedures

1. Use the stylus on the F6 data logger touch screen Graphic User Interface (GUI) and select the "Station Set-up" icon.

2. The ability to save and load a configuration file is provided in the "Set-up" tab.

3. The "Load Configuration" button on the "Set-up" screen allows the user to load a configuration file stored on the data logger or from a USB memory stick.

4. The "Load from USB Station Folder" option (default) automatically looks in the station's \Config folder on the USB memory stick. The File Selection Box will list the configuration files available – select the configuration to upload and press OK. Typically, the station's \Config folder on the USB memory stick will contain configuration files previously saved from the data logger.

Modifying Configuration Files

The configuration file will need to be modified when adjusting (zeroing) the snow depth during annual maintenance. This is done through the touchscreen GUI. Complete the following steps:

Procedures

1. Use the stylus on the F6 data logger touch screen Graphic User Interface (GUI) and select the "Processing" icon.

2. Select the "GDist" icon and then the "Set" icon.

3. Enter the distance between the snow depth sensor and the ground (Figure 5-13) in inches and select "OK"

4. Select the "Setup" icon and then the "Edit" icon.

5. Click on the box beside the "Default Power Up Value" (zero is the default) and enter the same value used for GDist in step 3 above and then select "OK" twice, and then select "Home".

6. From the "Home" menu, select "Current Condition". Scroll to the bottom and verify the SDepth value. This value refreshes every minute. The value should be slightly negative (0 to -0.5 inches) when there is no snow on the ground.

7. Repeat steps 1-6 above until the SDepth value has stabilized to a slightly negative (0 to -0.5 inches) value.

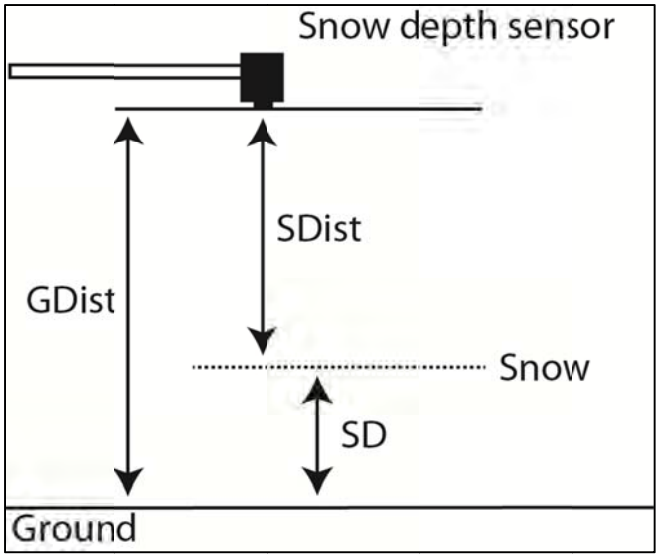


Figure 5-13. Variables used by the F6 data logger to calculate snow depth. GDist (inches) is distance between sensor and ground surface, SDist (inches) is the distance between the sensor and the snow surface, and SD is the calculated value (SD=Gdist-[SDist*temperature compensation]) that is transmitted. The relative humidity – air temperature sensor must be installed for this process to work.

Saving Configuration Files

After making any modifications to the data logger configuration, save the configuration file. Complete the following steps:

Procedures

1. Use the stylus on the F6 data logger touch screen Graphic User Interface (GUI) and select the "Station Set-up" icon.

2. The ability to save and load a configuration file is provided in the "Set-up" tab.

3. The "Save Configuration" button on the "Set-up" screen allows the user to save the data logger's active configuration to a USB memory stick.

4. The "Save to USB Station Folder" option (default) automatically stores to the station's \Config folder on a the USB memory stick. The station folder on the USB memory stick will automatically have the same name as the data logger if there is not already a folder with that station name present.

5. Enter a file name in the "Save File Name" box using the file naming structure described above and select "OK".

Example F6 Data Logger Configuration File Used by Network RAWS

The following configuration file DLP is used by the Pedersen Lagoon RAWS. Modifying the site and telemetry parameters would allow it to be used as a template for other stations using F6 data loggers.

F6 Configuration File for the Pedersen Lagoon RAWS (w/ Judd Communications snow depth sensor)

PELA_F6config_Judd_20120725.xml

```
<?xml version="1.0" encoding="utf-8"?>
<XMLRoot>
  <StationSetup StationName="Pedersen Lagoon" StationDescription="2012-May-8  rev2.0&#xD;&#xA; - add Judd sensor on
SDI-AM&#xD;&#xA; - Judd jumpered for 2.5V range&#xD;&#xA; - remove SR50A0&#xD;&#xA;&#xD;&#xA;2011-Jan-5
rev1.0&#xD;&#xA; - based on MCARTHUR2.prg" StationLatitude="" StationLongitude="" StationElevation=""
StationElevationUnits="ft" VCutOff="6.5" VResume="11" />
  <TimeZoneInfo Bias="0">
    <StandardTime Name="Coordinated Universal Time" Year="0" Month="0" DayOfWeek="0" Day="0" Hour="0" Minute="0"
Second="0" Millisecond="0" Bias="0" />
    <DaylightTime Name="Coordinated Universal Time" Year="0" Month="0" DayOfWeek="0" Day="0" Hour="0" Minute="0"
Second="0" Millisecond="0" Bias="0" />
  </TimeZoneInfo>
  <SaveData DateFormat="yyyy/MM/dd HH:mm:ss" />
  <Sensors>
    <SolarPanel SensorType="SolarSensor" SensorOn="Y" BvName="VSolar" BiName="ISolar" />
    <Battery SensorType="BatterySensor" SensorOn="Y" BvName="Telem" BiName="IBatt" BtName="TBatt" BtUnits="C"
BDvName="" />
    <RN1 SensorType="RainSensor" SensorOn="Y" VariableName="RN1" Units="mm" AutoResetEnabled="N"
AutoResetDate="01/01/2007 00:00:00" TipInc="0.254" ZeroAtPowerUp="N" RolloverEnabled="N" RolloverValue="0" />
    <THS SensorType="AirSensor" SensorOn="Y" AtName="ATC" AtUnits="C" AhName="Rhspot" AhClip="Y" />
    <WindSpot SensorType="WindSensor" SensorOn="Y" WsName="Crnt_Wspd" WsUnits="m/s" WsPrecision="1"
WdPrecision="0" WdName="Crnt_Dir" />
    <PYRSR SensorType="SDISensor" SensorOn="Y" Address="1" HardwareID="">
      <Cmd0 CmdName="M" CmdInterval="60" CmdOffset="50">
        <SR FieldUnits="W/m^2" FieldPrecision="1" FieldFactor="1" FieldOffset="0" FieldNum="2" />
      </Cmd0>
    </PYRSR>
    <SDI_AM SensorType="AMSensor" SensorOn="Y" Address="3" HardwareID="FTS----- SDI-AM 50897 "
Analog1Name="Vjudd" Analog2Name="" Analog3Name="" Analog4Name="" Analog1Mode="Differential"
Analog2Mode="Off" Analog3Mode="Off" Analog4Mode="Off" Analog1Range="" Analog2Range="" Analog3Range=""
Analog4Range="" Power1Mode="Warm-up" Power2Mode="Enabled" Power1WarmUp="4" Power2WarmUp="1"
Power1CycleEvery="1" Power2CycleEvery="1" Power1CycleFor="1" Power2CycleFor="1" Ex1Mode="Disabled"
Ex2Mode="Disabled" Ex1WarmUp="0" Ex2WarmUp="0" Ex1Volts="0" Ex2Volts="0" InputCount="" PeriodicCount=""
SwitchState="" SwitchStateUnits1="On" SwitchStateUnits0="Off" PeriodicReset="N">
      <Cmd0 CmdName="CC" CmdInterval="60" CmdOffset="50">
        <Vjudd FieldUnits="mV" FieldPrecision="3" FieldFactor="1" FieldOffset="0" FieldNum="1" />
      </Cmd0>
      <Cmd1 CmdName="RC1" CmdInterval="60" CmdOffset="50" />
    </SDI_AM>
  </Sensors>
  <Processes>
    <SDist ProcessType="FuncProcess" Units="inch" Equation="0.19685*Vjudd" Precision="2" />
    <GDist ProcessType="UserVarProcess" Units="inch" Precision="2" DefaultValue="0" />
    <SDepth ProcessType="FuncProcess" Units="inch" Equation="GDist-SDist" Precision="2" />
    <Rh ProcessType="FuncProcess" Units="%" Equation="Rhspot" Precision="0" />
    <WSM ProcessType="AvgProcess" MeaName="WS1" MedName="" SdName="" MaxName="" MinName=""
Input="Crnt_Wspd" Interval="5" FilterLen="120" />
    <WDD ProcessType="AvgProcess" MeaName="Dir" MedName="" SdName="" MaxName="" MinName=""
Input="Crnt_Dir" Interval="5" FilterLen="120" />
    <wSMP ProcessType="PeakProcess" PeakSpeedName="WSMP" PeakDirectionName="WDDP" SpeedInput="Crnt_Wspd"
DirectionInput="Crnt_Dir" Interval="5" ResetInterval="3600" ResetOffset="" LogInline="False" />
```

```
   <AvgWS ProcessType="AvgProcess" MeaName="WSavg" MedName="" SdName="" MaxName="" MinName=""
Input="WS1" Interval="600" FilterLen="10" />
   <AvgWD ProcessType="AvgProcess" MeaName="WDavg" MedName="" SdName="" MaxName="" MinName=""
Input="Dir" Interval="600" FilterLen="10" />
   <AvgSR ProcessType="AvgProcess" MeaName="SRAV" MedName="" SdName="" MaxName="" MinName="" Input="SR"
Interval="60" FilterLen="60" />
   <AvgAT ProcessType="AvgProcess" MeaName="ATavg" MedName="" SdName="" MaxName="" MinName=""
Input="ATC" Interval="60" FilterLen="60" />
   <AvgRH ProcessType="AvgProcess" MeaName="RHavg" MedName="" SdName="" MaxName="" MinName=""
Input="Rh" Interval="60" FilterLen="60" />
   <ATAV ProcessType="UserVarProcess" Units="C" Precision="1" DefaultValue="0" />
   <ATMX ProcessType="UserVarProcess" Units="C" Precision="1" DefaultValue="0" />
   <ATMN ProcessType="UserVarProcess" Units="C" Precision="1" DefaultValue="0" />
   <RHAV ProcessType="UserVarProcess" Units="%" Precision="0" DefaultValue="0" />
   <WSAV ProcessType="UserVarProcess" Units="m/s" Precision="1" DefaultValue="0" />
   <WSPK ProcessType="UserVarProcess" Units="m/s" Precision="1" DefaultValue="0" />
   <WDAV ProcessType="UserVarProcess" Units="deg" Precision="0" DefaultValue="0" />
   <WDPK ProcessType="UserVarProcess" Units="deg" Precision="0" DefaultValue="0" />
   <SD1 ProcessType="UserVarProcess" Units="inch" Precision="2" DefaultValue="0" />
   <ATMXMN ProcessType="MaxMinProcess" MaxName="AMax" MinName="AMin" Input="ATC" Interval="60"
ResetInterval="3600" ResetOffset="0" LogMaxInline="False" LogMinInline="False" LogOutputs="False"
UseOccurrenceTimestamp="False" />
   <TOH_Script ProcessType="ScriptProcess" Script="// top of hour
script&#xD;&#xA;SD1\equalSDepth;&#xD;&#xA;ATAV\equalATavg;&#xD;&#xA;RHAV\equalRHavg;&#xD;&#xA;WSPK\
equalWSMP;&#xD;&#xA;WDPK\equalWDDP;&#xD;&#xA;WSAV\equalWSavg;&#xD;&#xA;WDAV\equalWDavg;&#xD;&
#xA;ATMX\equalAMax;&#xD;&#xA;ATMN\equalAMin;&#xD;&#xA;" Interval="3600" Offset="0" />
  </Processes>
  <Loggers>
   <Logger0 LoggerName="LOG(RN1 WS1 Dir ATC Rh Telem WDPK WSPK SRAV SD1 ATAV RHAV WSAV WDAV
ATMX ATMN)" LoggerInterval="3600" LoggerOffset="1610" LoggerCondEnabled="False" LoggerCondConst="0"
LoggerCondOperator="&gt;" LoggerCondType="Value" LoggerCondVariable="">
     <RN1 DpEnabled="Y" />
     <WS1 DpEnabled="Y" />
     <Dir DpEnabled="Y" />
     <ATC DpEnabled="Y" />
     <Rh DpEnabled="Y" />
     <Telem DpEnabled="Y" />
     <WDPK DpEnabled="Y" />
     <WSPK DpEnabled="Y" />
     <SRAV DpEnabled="Y" />
     <SD1 DpEnabled="Y" />
     <ATAV DpEnabled="Y" />
     <RHAV DpEnabled="Y" />
     <WSAV DpEnabled="Y" />
     <WDAV DpEnabled="Y" />
     <ATMX DpEnabled="Y" />
     <ATMN DpEnabled="Y" />
   </Logger0>
  </Loggers>
  <Telems>
   <Telem0 TelemType="G5">
    <G5 NesID="326AD012" Satellite="WEST" MsgFormat="BLM" SelfTimedEnabled="Y" SelfTimedInterval="3600"
SelfTimed1stTrans="1730" SelfTimedBitrate="300" SelfTimedWin="10" SelfTimedChannel="158" SelfTimedEmpMsg="N"
SelfTimedTxDataFormat="A" SelfTimedMsgCenter="N" RandomEnabled="N" RandomBitrate="300" RandomChannel=" "
RandomRepeatCount="0" TxEnabled="Y" FwrPwr="YF" RflPwr="YR" SWR="SWR" VLoad="YB"
ManTimeMeasurement="Y">
     <SelfTimed>
      <BLM Interval="3600" Offset="1610">
       <RN1 Format="0000.0" />
       <WS1 Format="00.0" />
       <Dir Format="000" />
       <ATC Format="00.0" />
```

```
          <Rh Format="000" />
          <Telem Format="00.0" />
          <WDPK Format="000" />
          <WSPK Format="00.0" />
          <SRAV Format="0000.0" />
          <SD1 Format="0000.00" />
          <ATAV Format="00.0" />
          <RHAV Format="000" />
          <WSAV Format="00.0" />
          <WDAV Format="000" />
          <ATMX Format="00.0" />
          <ATMN Format="00.0" />
        </BLM>
      </SelfTimed>
    </G5>
  </Telem0>
  <Telem1 TelemType="FTS" />
 </Telems>
 <CurrentCond>
  <ATC />
  <Rh />
  <WS1 />
  <Crnt_Dir />
  <Dir />
  <RN1 />
  <SR />
  <SDepth />
  <Telem />
 </CurrentCond>
</XMLRoot>
```

SOP #6: RAWS Annual Sensor Order and Maintenance Work Plan

Version 1.0

Change History

Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for identifying sensor replacement needs for network RAWS and how to order these sensors using the Wildland Fire Management Information system (WFMI). Scheduled sensor replacement is necessary to ensure quality data collection and to satisfy the requirements established by the National Wildfire Coordinating Group for Interagency Wildland Fire Weather Stations.

Introduction

Annual maintenance of network RAWS is required to ensure that the stations remain in good repair and that the stations are making accurate hourly weather observations, recording and transmitting those observations. This SOP documents the procedures necessary to place the annual sensor order required for maintenance with the RAWS Depot. In the course of preparing the annual sensor order, a network RAWS Maintenance Plan is prepared for the upcoming field season.

The RAWS Depot is part of the National Interagency Fire Center (NIFC) located in Boise, Idaho. The RAWS Depot performs repair, refurbishment and calibration of RAWS sensors and other station components. The RAWS Depot offers a maintenance contract to agencies (e.g. BLM, NPS, and USFS) for the purpose of maintaining their RAWS. Currently, the RAWS Depot provides refurbished and recalibrated sensors and other station components for $900 per year (2012). Historically, the RAWS Depot maintenance contract was only provided to the RAWS associated with fire management. However, in 2009, the RAWS Depot maintenance contract was expanded to include "resource" or non-fire RAWS. The SWAN is currently participating, with all 10 network RAWS enrolled in the RAWS Depot weather station maintenance contract.

RAWS Depot Maintenance Agreements

At the beginning of each fiscal year (October), submit a Direct Charge Authorization (DCA) form to the National Interagency Fire Center (NIFC). This form is authorizes the NPS Fire Management Program Center to electronically transfer funds from the SWAN account.

1. The DCA form can be submitted electronically by sending it to:

Mark_Fitch@nps.gov and Sheila_Williams@nps.gov

2. The current (FY2012) charge for the 10 network RAWS is $9,000 ($900/station).

3. A template DCA form is located on the SWAN server at:

\SWAN\Vital_Signs\Climate\Administrative\Logistics\Templates\

The template is named: SWAN_FMPCYYYYDirectChargeAuthorization.doc

Completed DCA forms are stored at:

\SWAN\Vital_Signs\Climate\Administrative\Budget\

Sensor Replacement Schedule

Acronyms used for network RAWS are listed in Table 6-1. The sensor replacement schedule for network RAWS is listed in Table 6-2. Wind speed and direction sensors on network RAWS that experience extreme wind conditions (Chigmit Mountains, Fourpeaked, Harding Icefield, McArthur Pass, and Pedersen Lagoon) are replaced more frequently than the other network RAWS.

Table 6-1. Acronyms used for network RAWS.

Station Name	Acronym [NAME]
Chigmit Mountains	CHMO
Contact Creek	COCR
Coville	COVI
Fourpeaked	FOUR
Harding Icefield	HAIC
Hickerson Lake	HILA
McArthur Pass	MCPA
Pedersen Lagoon	PELA
Pfaff Mine	PFMI
Snipe Lake	SNLA

Table 6-2. Sensor replacement schedule for network RAWS.

Sensor or component	Replacement schedule frequency, by station	
	COCR, COVI, HILA, PFMI, SNLA	CHMO, FOUR, HAIC, MCPA, PELA
Air temperature / relative humidity	1 yr	1 yr
Wind speed	2 yr	1 yr
Wind direction	2 yr	1 yr
Tipping bucket (precipitation)	3 yr	3 yr
Solar radiation	3 yr	3 yr
Snow depth	3 yr	3 yr
Snow depth transducers	1 yr	1 yr
Batteries	3-5 yr	3-5 yr

Station and Sensor Tracking Spreadsheets

Spreadsheets for tracking station maintenance and each station's sensor replacement schedule are located on the SWAN server at:

\SWAN\Vital_Signs\Climate\Stations\RAWS_StationName\Maintenance\

Where: "StationName" is that listed in Table 6-1.

The \Maintenance\ sub-directory for each network RAWS contains an Excel spreadsheet. These spreadsheets are named:

[NAME]_Sensor_Tracking.xls

Where: [NAME] is the four-letter acronym listed in Table 6-1.

Each spreadsheet in turn contains several worksheets, described below.

Sensor Deployment Worksheet

This worksheet includes the station's original installation date, sensor models and serial numbers, and sensor heights (Figure 6-1)

Sensor Replacement Schedule Worksheet
This worksheet includes a multi-year calendar identifying when sensors should need to be replaced (Figure 6-2).

Sensor Tracking Worksheet
This worksheet includes a detailed sensor replacement history identifying which sensors were replaced, when they were replaced, and corresponding sensor serial numbers (Figure 6-3).

Station Name	Snipe Lake		
Station Deployment Date	07-Jun-08		
Sensor	**Model**	**FTS Serial Number**	**Sensor Hieght - ft-inches**
Wind Speed	WS-013-30	18383	20 ft
Wind Direction	WD-023-30	18387	20 ft
Rain Guage/Tipping Bucket	RG-T-TR	17198	7 ft 5 inches
Temperature/Relative Humidity	THS-3-1	29849	7 ft 1 inches
Solar Radiation	SDI-SR-PYR	13970	7 ft 3 inches
Snow Depth	SDI-SR50A	28267	6 ft 10.9 inches
GOES Transmitter	G5	18304	
SDI Expansion Port	SDI-EXP-KW-3	18272	
Power Manager	POWER-MANAGER	17032	
Datalogger	FWS12S-DATA-KW	13521	
Cabinet	WP-ENCL-KW1	18336	
Battery	BATTERY-12V-SE	28273	
Battery	BATTERY-12V-SE	28277	
GPS Antenna	GPS-ANTENNA-ICE	18321	
GOES Antenna	Yagi	14033	
Solar Panel	SPS-50W-PM	14262	

Figure 6-1. Sensor deployment worksheet. Sensor model, serial numbers, and heights are listed.

Station Name	Snipe Lake							
Station Deployment Date	07-Jun-08							
Annual Maintenance								
		Minimum Replcaement Schedule (yrs)	Deployment Year	Mairtenance Year	Maintenance Year	Maintenance Year	Maintenance Year	Maintena Year
Sensor	Model		2008	2009	2010	2011	2012	2013
Wind Speed	WS-013-30	2	✓		✓		✓	
Wind Direction	WD-023-30	2	✓		✓		✓	
Rain Guage/Tipping Bucket	RG-T-TR	3	✓			✓		
Temperature/Relative Humidity	THS-3-1	1	✓	✓	✓	✓	✓	✓
Solar Radiation	SDI-SR-PYR	3	✓			✓		
Snow Depth	SDI-SR50A	3	✓			✓		
GOES Transmitter	G5	as needed						
SDI Expansion Port	SDI-EXP-KW-3	as needed						
Power Manager	POWER-MANAGER	as needed						
Datalogger	FWS12S-DATA-KW	as needed						
Cabinet	WP-ENCL-KW1	as needed						
Battery	BATTERY-12V-SE	3	✓			✓		
Battery	BATTERY-12V-SE	3	✓			✓		
GPS Antenna	GPS-ANTENNA-ICE	as needed						
GOES Antenna	Yagi	as needed						
Solar Panel	SPS-50W-PM	as needed						

Figure 6-2. Sensor replacement schedule worksheet. Checkmarks indicate which sensors are to be replaced for each calendar year.

Station Name	Snipe Lake							
Station Deployment Date	07-Jun-08							
Annual Maintenance			Deployment Date (mm/dd/yy)	Date of Maintenance (mm/dd/yy)	Date of Maintenance (mm/dd/yy)	Date of Maintenance (mm/dd/yy)	Date of Maintenance (mm/dd/yy)	Date Mainter (mm/d
		Minimum Replcaement Schedule (yrs)	2008/06/07	05/27/09				
Sensor	Model		2008	2009	2010	2011	2012	201
Wind Speed	WS-013-30	2	18383					
Wind Direction	WD-023-30	2	18387					
Rain Guage/Tipping Bucket	RG-T-TR	3	17198					
Temperature/Relative Humidity	THS-3-1	1	29849	32358				
Solar Radiation	SDI-SR-PYR	3	13970					
Snow Depth	SDI-SR50A	3	28267					
GOES Transmitter	G5	as needed	18304					
SDI Expansion Port	SDI-EXP-KW-3	as needed	18272					
Power Manager	POWER-MANAGER	as needed	17032					
Datalogger	FWS12S-DATA-KW	as needed	13521					
Cabinet	WP-ENCL-KW1	as needed	18336					
Battery	BATTERY-12V-SE	3	28273					
Battery	BATTERY-12V-SE	3	28277					
GPS Antenna	GPS-ANTENNA-ICE	as needed	18321					
GOES Anterna	Yagi	as needed	14033					
Solar Panel	SPS-50W-PM	as needed	14262					

Figure 6-3. Sensor tracking worksheet. Highlighted cells indicate upcoming sensor replacement. Sensor serial numbers are used to indicate that sensor was replaced.

Annual RAWS Maintenance Plan

The information contained in the Station and Sensor Tracking Spreadsheet for each network RAWS is compiled and used to create an annual RAWS maintenance plan for the upcoming field season. This maintenance plan serves as a quick reference for planned sensor replacement and maintenance needs at each SWAN RAWS.

A template for this annual maintenance plan is located on the SWAN server at:

\SWAN\Vital_Signs\Climate\Administrative\Logistics\Templates

The template is named: SWAN_RAWSYYYYAnnualMaintenancePlan.xls.

Completed annual maintenance plans for the upcoming field year are stored at:

\SWAN\Vital_Signs\Climate\Administrative\Logistics\YYYY\

Where: “YYYY” is the calendar year.

An example annual maintenance plan is shown in Figure 6-4.

SWAN RAWS

Annual Maintenance Plan Year: 2010

Station Name	Wind Speed	Wind Direction	Rain Guage/Tipping Bucket	Temperature /Relative Humidity	Solar Radiation	Snow Depth	GOES Transmitter	SI Expar Po
Chigmit Mountains	X	X		X				
Contact Creek	X	X		X				
Coville	X	X		X				
Fourpeaked	X	X		X				
Harding Icefield	X	X	X	X				
Hickerson Lake	X	X		X				
McAthur Pass	X	X		X				
Pfaff mine	X	X		X				
Snipe Lake	X	X		X				

Place a check mark indicating a sensor swap for the indicated RAWS

SWAN RAWS NESID and Channel Assignments

Station Name	NESID	Channel	Transmit Time (hr:mm:sec)	Transmit Window
Chigmit Mtns	FA6544FC	160	00:43:10	10 secord window
Contact Creek	32803738	166	00:04:20	10 secord window
Coville	3280B12C	166	00:04:40	10 secord window
Fourpeaked	328135C2	80	00:17:00	10 secord window
Harding Icefield	FA656210	160	00:43:30	10 secord window
Hickerson Lake	3280C7BC	166	00:04:50	10 secord window
McArthur Pass	3280244E	166	00:04:10	10 secord window
Pfaff Mine	FA65578A	160	00:43:20	10 secord window
Snipe Lake	328041A8	166	00:04:30	10 secord window

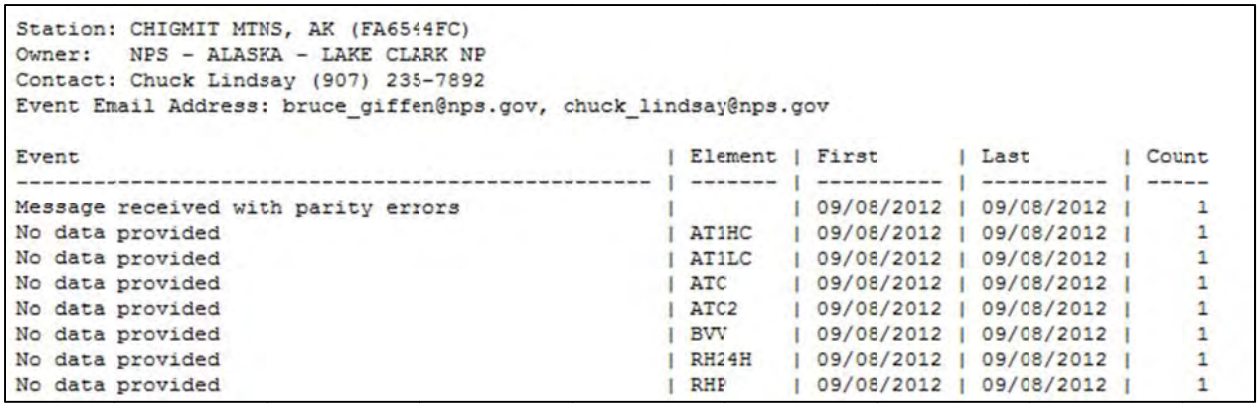
SWAN RAWS - Date of Last Data Download

Station Name	Date	Date
Chigmit Mtns	2009/06/30	
Contact Creek	6/23/2009	
Coville	6/22/2009	
Fourpeaked	2009/06/09	
Harding Icefield	2009/06/03	
Hickerson Lake	6-29-2009	

Figure 6-4. Annual RAWS maintenance plan for the 2010 field season.

Station Event Reports

Station event reports are distributed weekly by the Wildland Fire Management Information (WFMI) system. These reports are sent by email to recipients listed as "Station Event Recipients" for RAWS in WFMI. Some events are only informational and others may indicate a problem with a particular RAWS. Information contained in these Station Event Reports should be used to update both the Performance Tracking Worksheet (refer to SOP #7) and the Annual RAWS Maintenance Plan. An example of a Station Event Report is shown in Figure 6-5.



```
Station: CHIGMIT MTNS, AK (FA6544FC)
Owner:   NPS - ALASKA - LAKE CLARK NP
Contact: Chuck Lindsay (907) 235-7892
Event Email Address: bruce_giffen@nps.gov, chuck_lindsay@nps.gov

Event                                              | Element | First      | Last       | Count
-------------------------------------------------- | ------- | ---------- | ---------- | -----
Message received with parity errors                |         | 09/08/2012 | 09/08/2012 |     1
No data provided                                   | AT1HC   | 09/08/2012 | 09/08/2012 |     1
No data provided                                   | AT1LC   | 09/08/2012 | 09/08/2012 |     1
No data provided                                   | ATC     | 09/08/2012 | 09/08/2012 |     1
No data provided                                   | ATC2    | 09/08/2012 | 09/08/2012 |     1
No data provided                                   | BVV     | 09/08/2012 | 09/08/2012 |     1
No data provided                                   | RH24H   | 09/08/2012 | 09/08/2012 |     1
No data provided                                   | RHP     | 09/08/2012 | 09/08/2012 |     1
```

Figure 6-5. Part of a Station Event Report sent automatically by the WFMI system.

Annual Sensor Order

The information compiled in the annual RAWS maintenance plan is used to order sensors from the RAWS Depot using the WFMI system. Sensors should be ordered about 45 days before the scheduled annual maintenance date, which is documented in WFMI. If sensors for multiple stations are ordered at the same time they will be shipped together at a cost savings to the government. After determining what sensors are needed for each station, complete the following steps:

1. If you don't have access to WFMI, complete a user access request form. The form is available at: https://www.nifc.blm.gov/weather/WfmiWeatherMaintUserAccessForm.pdf. Make sure to specify that you need "edit" access.

2. Go to: http://www.nifc.blm.gov/

3. Click "Proceed to Wildland Fire Management Information home page", click "Logon" and then "I agree".

4. Enter your username and password. Click "Logon" and "Continue".

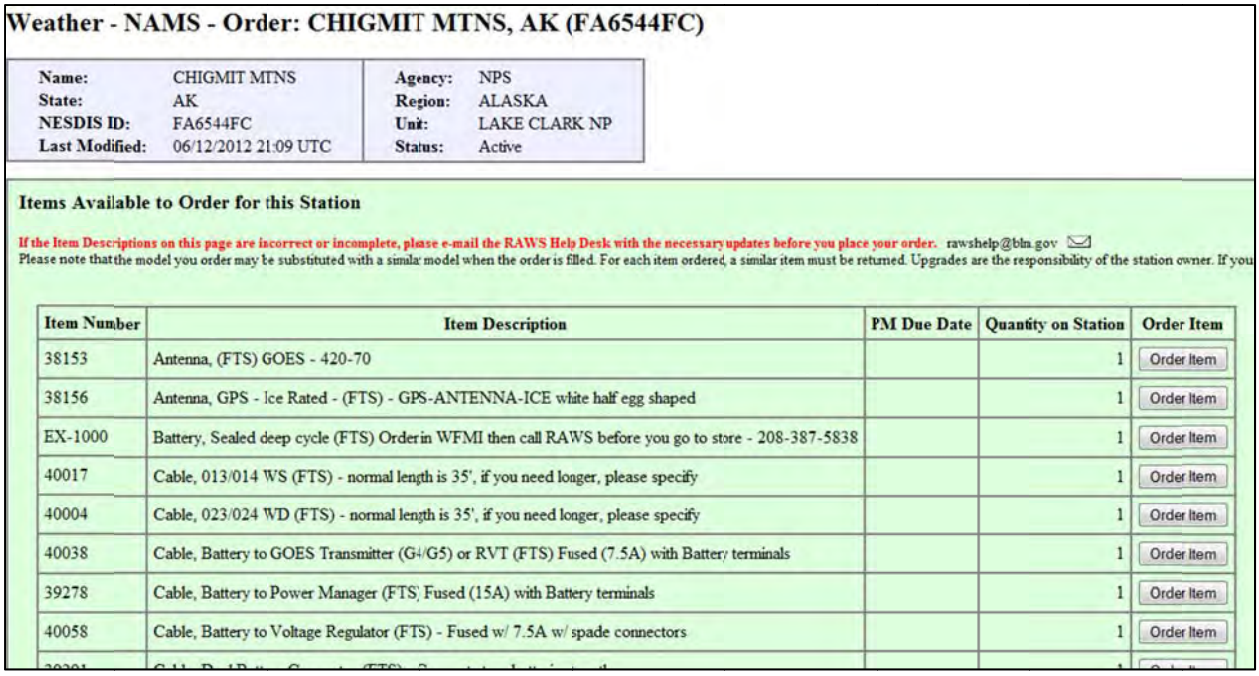
5. Select the "Weather" button and then click the "Select Station" button.

6. Scroll down and click on the desired station name (Table 6-1) from the list.

7. Click the "NAMS – Place an Order" button.

8. Select the sensors needed for the order by pressing the "Order Item" button next to each sensor that is listed for the station (Figure 6-6). If you order an item that is not scheduled for replacement (PM Due Date), you will have to complete a justification.

9. Identify a shipping address. Be sure to use the same shipping address for each station and to order the sensors needed for multiple stations on the same day. This way all items will be shipped together.



Weather - NAMS - Order: CHIGMIT MTNS, AK (FA6544FC)

Name:	CHIGMIT MTNS	Agency:	NPS
State:	AK	Region:	ALASKA
NESDIS ID:	FA6544FC	Unit:	LAKE CLARK NP
Last Modified:	06/12/2012 21:09 UTC	Status:	Active

Items Available to Order for this Station

If the Item Descriptions on this page are incorrect or incomplete, please e-mail the RAWS Help Desk with the necessary updates before you place your order. rawshelp@blm.gov
Please note that the model you order may be substituted with a simila model when the order is filled. For each item ordered, a similar item must be returned. Upgrades are the responsibility of the station owner. If you

Item Number	Item Description	PM Due Date	Quantity on Station	Order Item
38153	Antenna, (FTS) GOES - 420-70		1	Order Item
38156	Antenna, GPS - Ice Rated - (FTS) - GPS-ANTENNA-ICE white half egg shaped		1	Order Item
EX-1000	Battery, Sealed deep cycle (FTS) Order in WFMI then call RAWS before you go to store - 208-387-5838		1	Order Item
40017	Cable, 013/014 WS (FTS) - normal length is 35', if you need longer, please specify		1	Order Item
40004	Cable, 023/024 WD (FTS) - normal length is 35', if you need longer, please specify		1	Order Item
40038	Cable, Battery to GOES Transmitter (G4/G5) or RVT (FTS) Fused (7.5A) with Battery terminals		1	Order Item
39278	Cable, Battery to Power Manager (FTS) Fused (15A) with Battery terminals		1	Order Item
40058	Cable, Battery to Voltage Regulator (FTS) - Fused w/ 7.5A w/ spade connectors		1	Order Item

Figure 6-6. Sensor ordering page in the WFMI system.

Ordering Additional Sensors

If additional sensors are needed beyond those included in the annual sensor order or available from the RAWS Depot, contact the NPS Radio Shop to see if they have spare sensors that may be available. Snow depth sensors and other additional sensors, including replacements for those which are destroyed or repairable, are purchased from FTS:

FTS, Inc. sales and technical support
800-548-4264
250-478-5561
800-905-7004 (Fax)

Email:
sales@ftsinc.com
service@ftsinc.com

Mailing address:
Forest Technology Systems, Inc.
1065 Henry Eng Place
Victoria, BC, Canada
V9B 6B2

SOP #7: RAWS Routine Performance Tracking
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures used to routinely track the performance of network RAWS and maintain a running log of issues affecting performance.

Introduction

The purpose of this SOP is to remotely track the performance of network RAWS. Identifying and documenting issues that may develop that affect station sensors, power supply, or other components will make both scheduled and unscheduled maintenance visits more effective with resulting cost benefits. Routinely documenting station performance will also help to identify and flag suspect data during subsequent quality control, analysis, and reporting.

A combination of tools is used to track station performance. Recent weather observations are examined for anomalous or missing values on the Western Regional Climate Center (WRCC) website and the Wildland Fire Management Information (WFMI) system. Station Event Reports (Refer to SOP #6) are distributed by email by the WFMI system every week.

Station Performance Tracking Worksheets

Spreadsheets for tracking station performance are located on the SWAN server at:

\SWAN\Vital_Signs\Climate\Stations\RAWS_Station_Performance_Tracking

This directory is organized by hydrologic year (Oct 1 to Sep 30). Each subdirectory contains an Excel spreadsheet named:

RAWS_Station_Performance_Tracking_HYyyyy.xlsx

Where: “yyyy” is the hydrologic year.

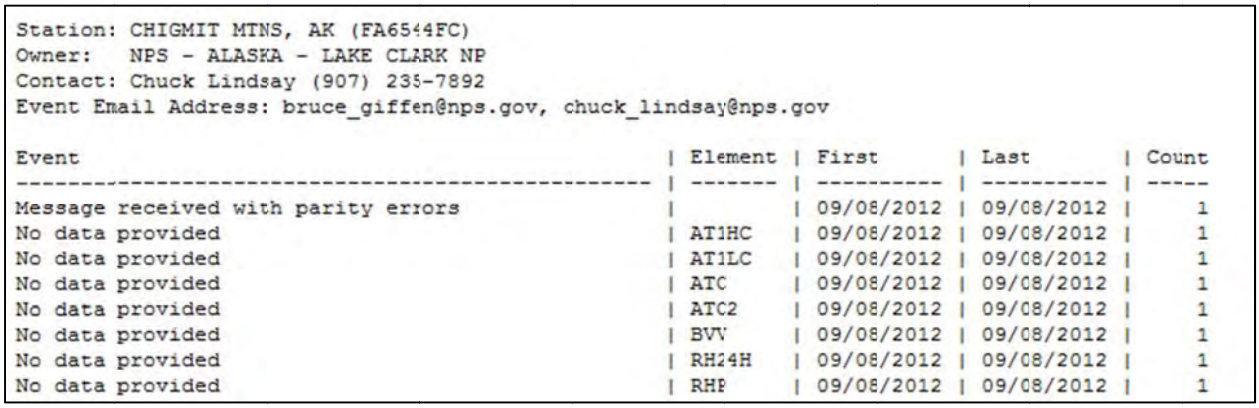
This spreadsheet contains several worksheets; each is named for one of the network RAWS with the acronyms listed in Table 7-1.

Table 7-1. Acronyms and NESDIS IDs for network RAWS.

Station Name	Acronym	NESDIS ID
Chigmit Mountains	CHMO	FA6544FC
Contact Creek	COCR	32803738
Coville	COVI	3280B12C
Fourpeaked	FOUR	328135C2
Harding Icefield	HAIC	FA656210
Hickerson Lake	HILA	3280C7BC
McArthur Pass	MCPA	3280244E
Pedersen Lagoon	PELA	326AD012
Pfaff Mine	PFMI	FA65578A
Snipe Lake	SNLA	328041A8

WFMI Station Event Reports

Station event reports are distributed weekly by the Wildland Fire Management Information (WFMI) system. These reports are sent by email to recipients listed as "Station Event Recipients" for RAWS in WFMI. Some events are only informational and others may indicate a problem with a particular RAWS. Information contained in these Station Event Reports should be used to update both the Performance Tracking Worksheet and the Annual RAWS Maintenance Plan. An example of a Station Event Report is shown in Figure 7-1.



Station: CHIGMIT MTNS, AK (FA6544FC)
Owner: NPS - ALASKA - LAKE CLARK NP
Contact: Chuck Lindsay (907) 235-7892
Event Email Address: bruce_giffen@nps.gov, chuck_lindsay@nps.gov

Event	Element	First	Last	Count
Message received with parity errors		09/08/2012	09/08/2012	1
No data provided	AT1HC	09/08/2012	09/08/2012	1
No data provided	AT1LC	09/08/2012	09/08/2012	1
No data provided	ATC	09/08/2012	09/08/2012	1
No data provided	ATC2	09/08/2012	09/08/2012	1
No data provided	BVV	09/08/2012	09/08/2012	1
No data provided	RH24H	09/08/2012	09/08/2012	1
No data provided	RHP	09/08/2012	09/08/2012	1

Figure 7-1. Part of a Station Event Report sent automatically by the WFMI system.

Station Event Reports should be archived. Save each report as a PDF using the following naming convention:

WFMI Weather_Station Event Rep_YYYYMMDD.pdf

Where:

> [WFMI Weather_Station Event Rep] is the subject line of the email that is sent
> [YYYYMMDD] is the date the report was sent
> .pdf is the file extension

These reports should be archived in the same directory described above (\RAWS_Station_Performance_Tracking\) in the \WFMI_Station_Event_Reports folder.

Performance Tracking Worksheet

This worksheet is a running log of sensor malfunctions and/or any data quality issues. Station performance is tracked by documenting whether or not individual sensors are operating normally. This is determined by referring to WFMI Station Event Reports and examining recent weather observations online using two websites, one hosted by the WRCC and the other by WFMI. Performance can be tracked over any length of time, although the subtleties of individual sensor performance may be lost if the tracking interval is too long. Tracking over a one or two week period seems to provide the optimal resolution. After examining recent weather observations and telemetry strength, each sensor is flagged in the worksheet to denote normal or suspect operation. Detailed notes can also be made. An example of the performance tracking worksheet is shown in Figure 7-2.

SWAN RAWS Performance Tracking														
RAWS:	SNLA													
Date Check Start	Date Check End	Date/Time Checked	User Initials	Wind Speed (WS)	Wind Direction (WD)	Rain Gauge/Tipping Bucket (RG)	Air Temperature (AT)	Relative Humidity (RH)	Solar Radiation (SR)	Snow Depth (SD)	GOES Transmission (GT)	Battery Voltage (BV)	Soil Temperature (ST)	Notes: Sensor flags (Y = normal, N = Suspect). Why was the sensor flagged? Any significant weather events?
2010/01/18	2010/01/22	2010/01/22 08:00	CRL	Y	Y	N	Y	Y	Y	Y	N	N	N	RG: AT < 0° / GT: X flag (bad modulation index) signal strength = 43 dBM / BV: 12.0V / ST: -265.6
2010/01/19	2010/01/25	2010/01/25 14:00	BAG	Y	Y	N	Y	Y	Y	Y	Y	N	N	RG: AT < 0° / G / BV: 12.0V / ST: no data

Figure 7-2. Performance tracking worksheet for the Snipe Lake RAWS. Normal sensor operation is flagged "Y" and suspect sensor operation is flagged with "N" in order to answer the logical question: "is the sensor operating normally?"

The following procedures are repeated for each of the 10 network RAWS.

Procedures

1. Open the performance tracking worksheet (PTW) for a network RAWS.

2. Record the date and time when performance was tracked and enter your initials into the PTW.

3. Log on to the WRCC RAWS website at: http://www.raws.dri.edu/wraws/akF.html

4. Select a network RAWS by clicking on the station name (refer to Table 7-1) on the left-hand-side (LHS) of the screen (Figure 7-3).

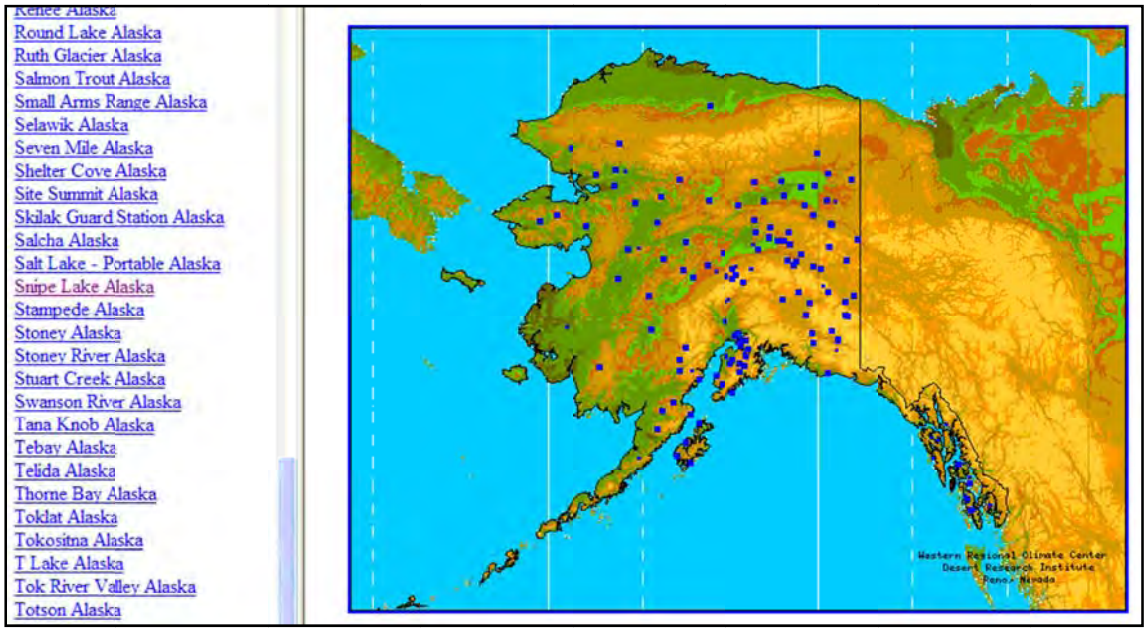


Figure 7-3. RAWS station list on WRCC website.

5. Click on "Time Series Graph" in the menu on the LHS of the screen. This will open the time series graph options window (Figure 7-4).

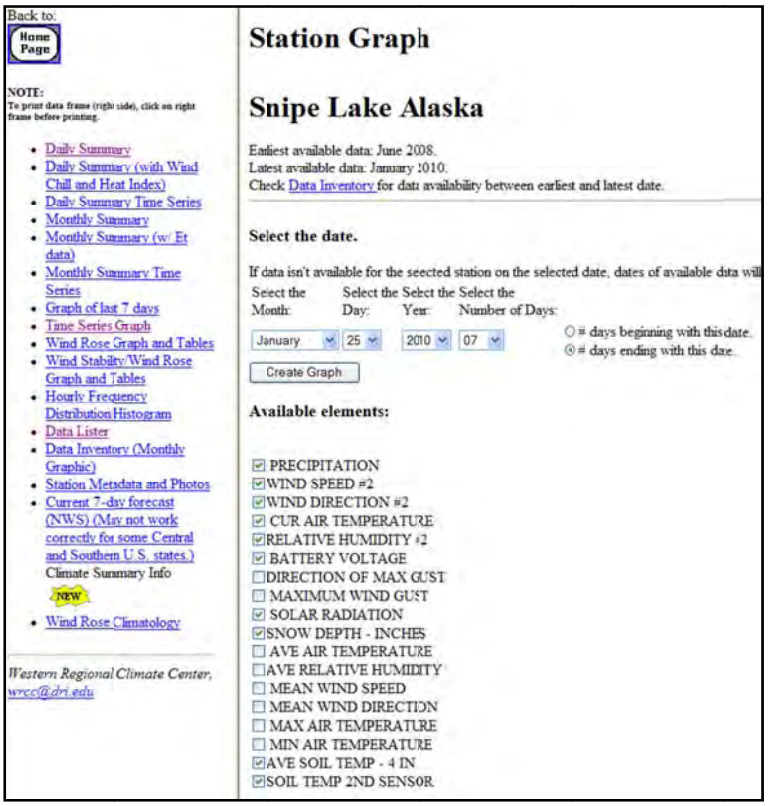


Figure 7-4. Time series graph options for selected RAWS station.

6. Select the time interval for station tracking. Enter the start month, date, and year and the number of days in the tracking time interval (e.g. 7 or 14 days). Record this time interval in the performance tracking worksheet (PTW) using a date/time format recognized by Excel.

7. Select elements for performance tracking that represent each sensor and the batteries:

- Precipitation
- Wind speed
- Wind direction
- Relative humidity
- Air temperature
- Battery voltage
- Solar radiation
- Snow depth

Note that multiple elements may be available that are derived from the same sensor. Refer to SOP #5 for more information on data transmissions from network RAWS.

8. Click on “Create Graph” (Figure 7-4).

9. One graph will be created for each selected element. Examples are shown in Figures 7-5 through Figure 7-12. Each of the example elements shows normal sensor operation with the exception of precipitation (Figure 7-5), and battery voltage (Figure 7-10).

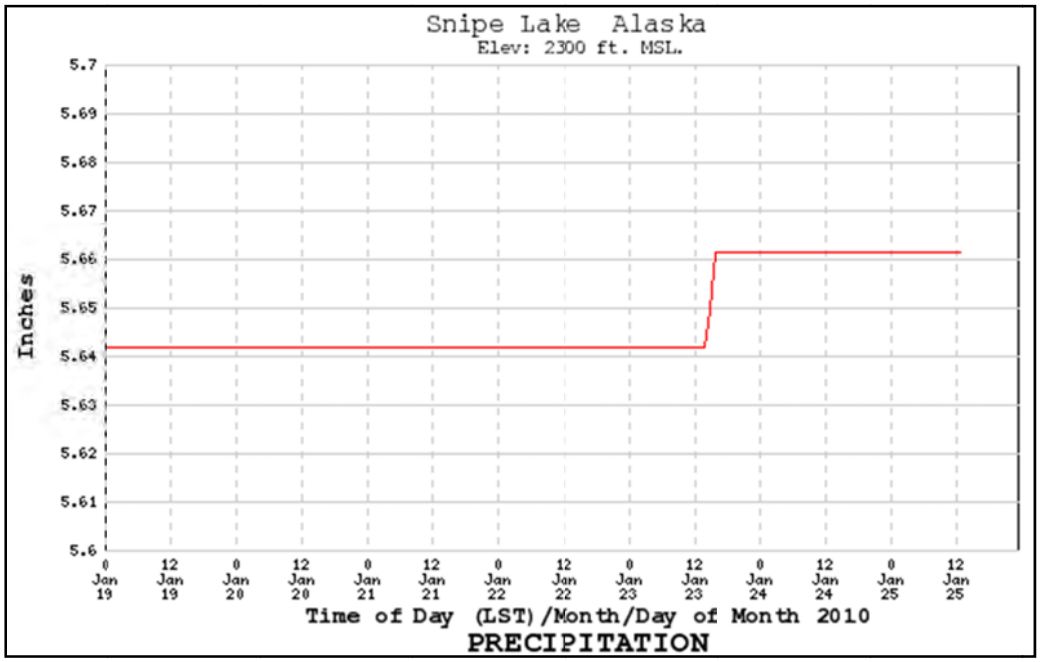


Figure 7-5. Precipitation – sensor operation suspect (liquid passing through tipping bucket is unlikely when temperatures are below freezing). This observation is supported by temperature data.

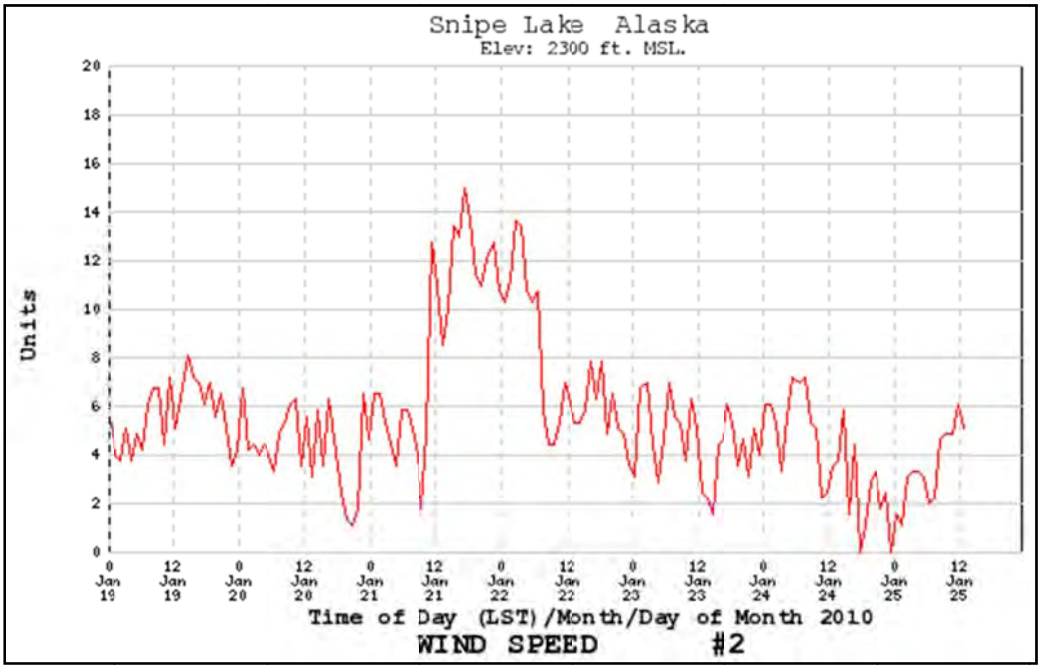


Figure 7-6. Wind speed – sensor operation normal. Units are mph.

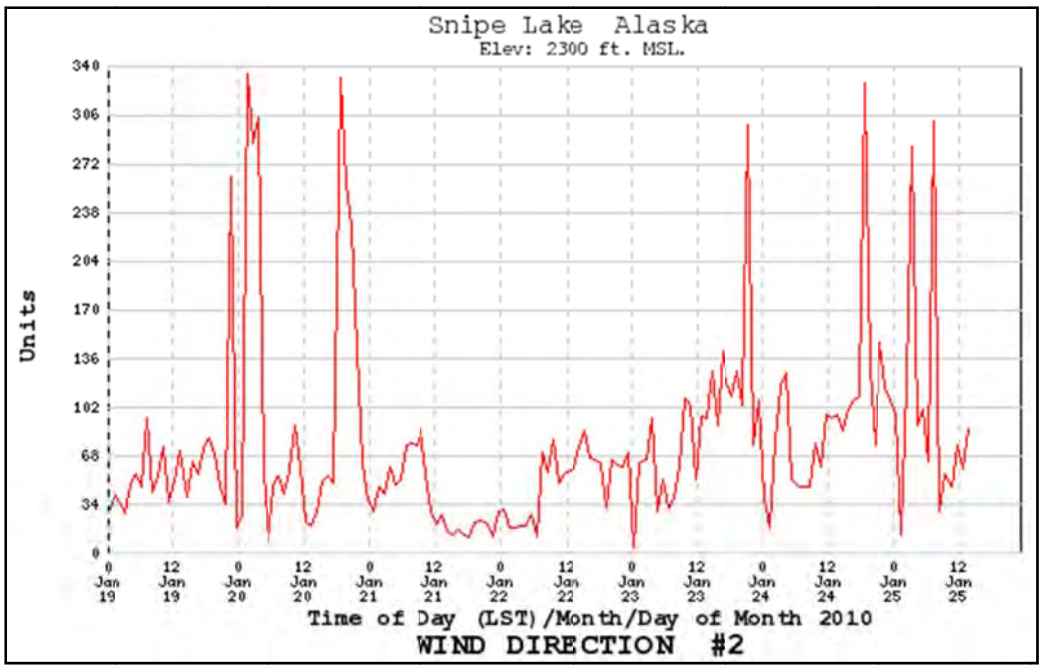


Figure 7-7. Wind direction - sensor operation normal. Units are degrees.

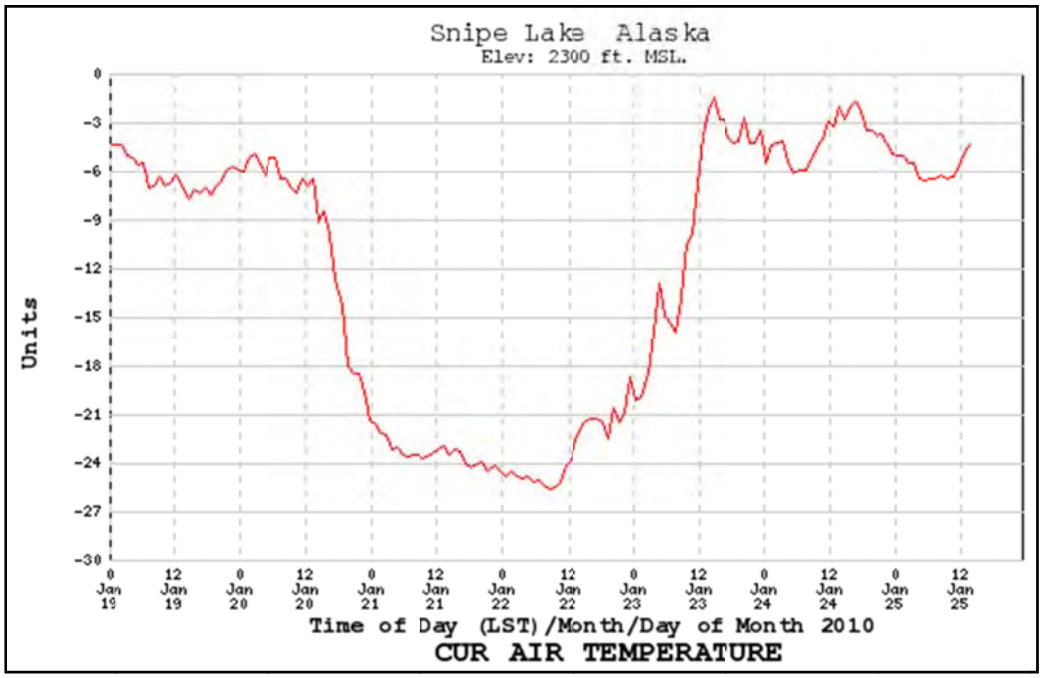


Figure 7-8. Air temperature - sensor operation normal. Units are °F.

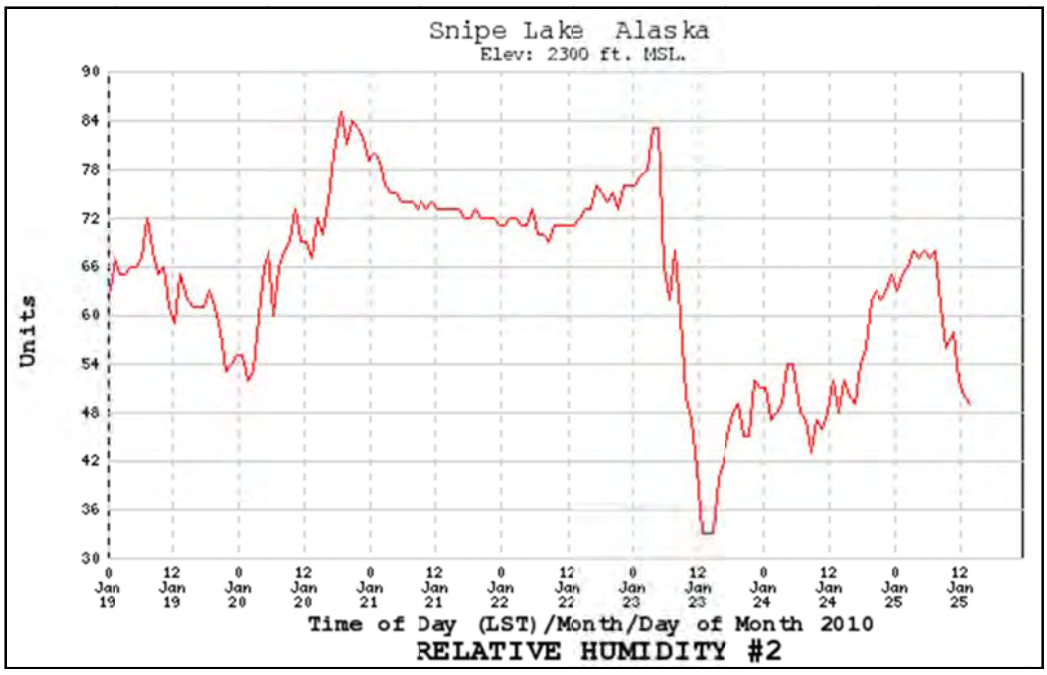


Figure 7-9. Relative humidity - sensor operation normal. Units are %.

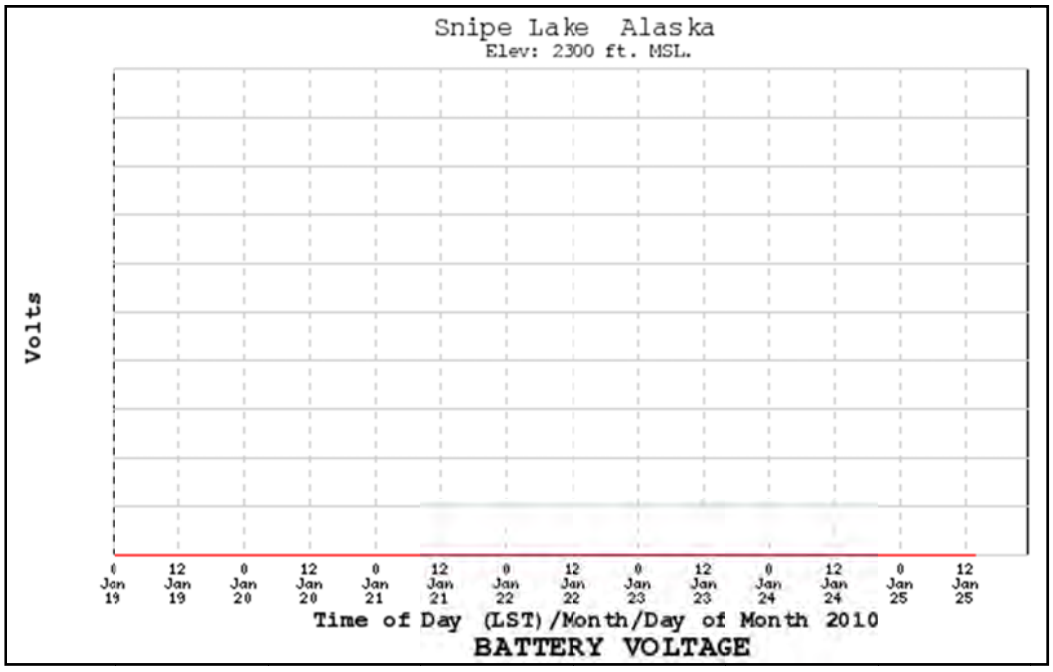


Figure 7-10. Battery voltage (voltage is flat at 11.8 V although scale was cropped) - operation suspect based on absence of diurnal charge/discharge cycles and low voltage.

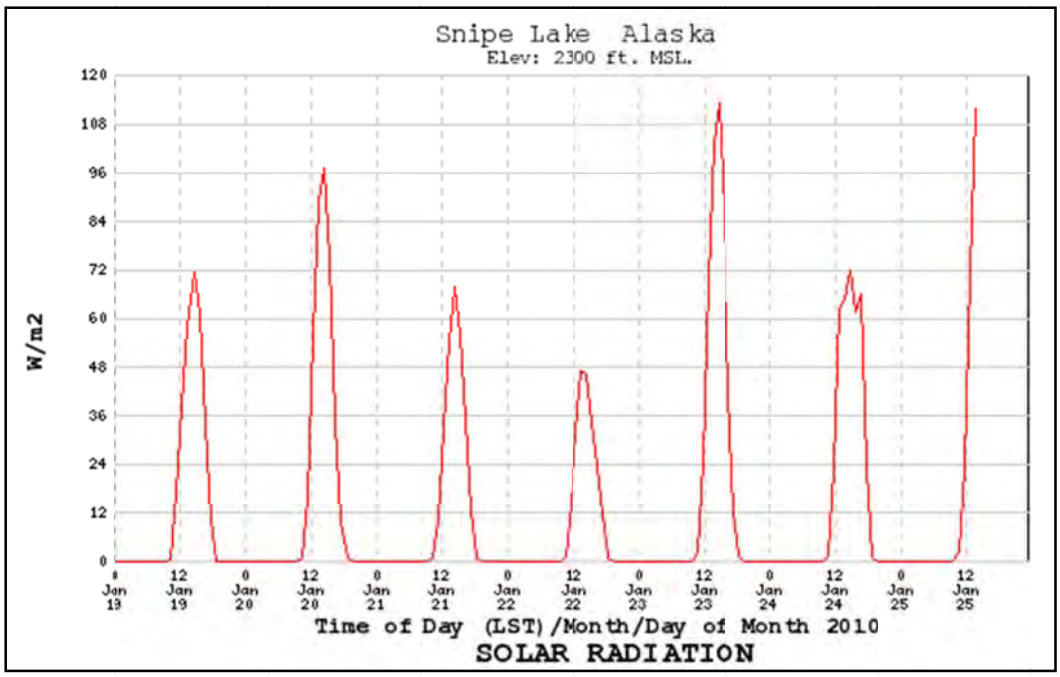


Figure 7-11. Solar radiation - sensor operation normal.

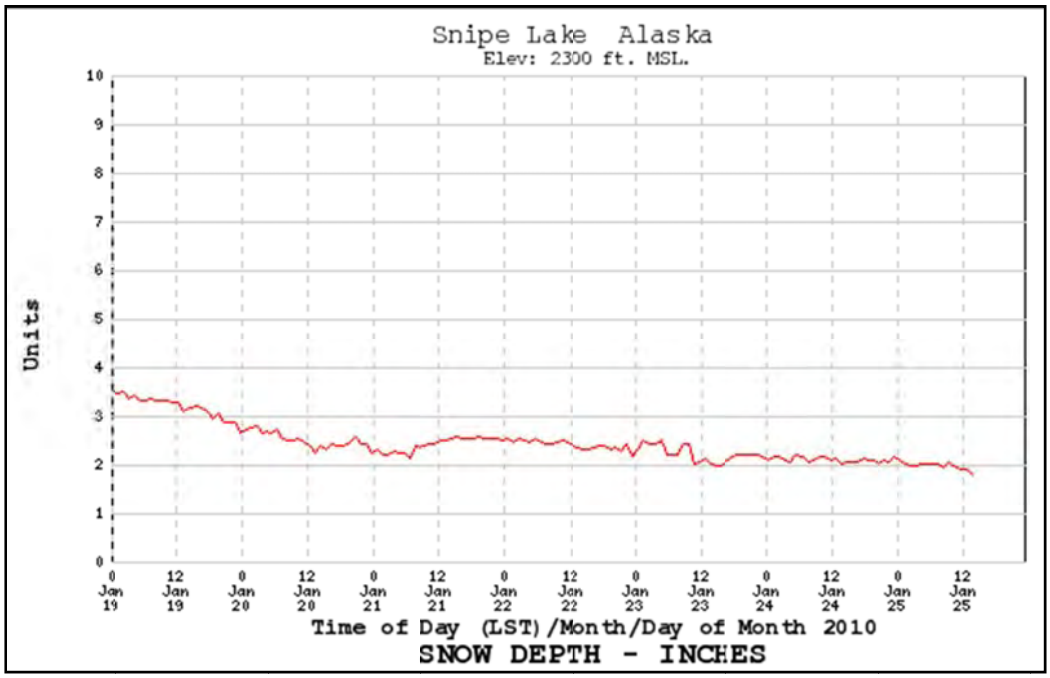


Figure 7-12. Snow depth - sensor operation normal.

Notes on example graphs:

- The Precipitation Graph (Figure 7-5) shows a precipitation event on January 23. Examination of the temperature graph (Figure 7-8) shows the temperature never exceeded 0˚ F on January 23, thus liquid water passing through the tipping bucket mechanism (rain gauge) would not be likely. All precipitation documented by tipping

bucket sensors (all network RAWS excepting the Harding Icefield RAWS) should be flagged as suspect if air temperature is significantly below freezing.

- The Battery Voltage graph (Figure 7-10) indicates that the power system is not charging the batteries. This issue is indicative of one or more problems. Any scheduled or unscheduled maintenance would include the inspection and likely replacement of each of the following components: power manager, solar panel, or the cable from solar panel to power manager failure. Battery health would need to be assessed and possibly replaced.

10. Document sensor performance in the PTW.

11. If data transmissions are missing, check the Geostationary Operational Environmental Satellite (GOES) telemetry performance for the RAWS station. Logon to the WFMI web site at: http://www.nifc.blm.gov). Requests for login/password can also be submitted from this URL.

12. Select the Weather Module and click on "Select Station". A list of RAWS will populate in a new window. Select the desired network RAWS by scrolling to and clicking on the station name and associated NESDIS ID (refer to Table 7-1 for NESDIS IDs).

13. Useful station metadata will be displayed for the selected station (Figure 7-13).

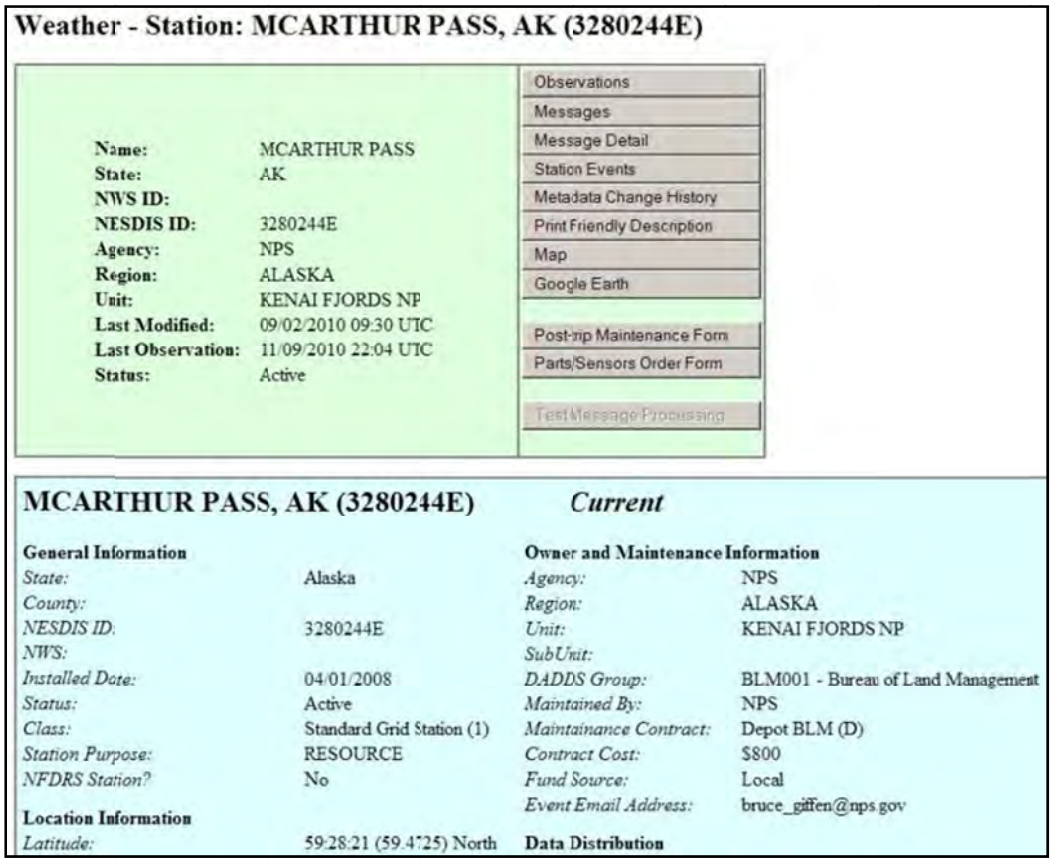
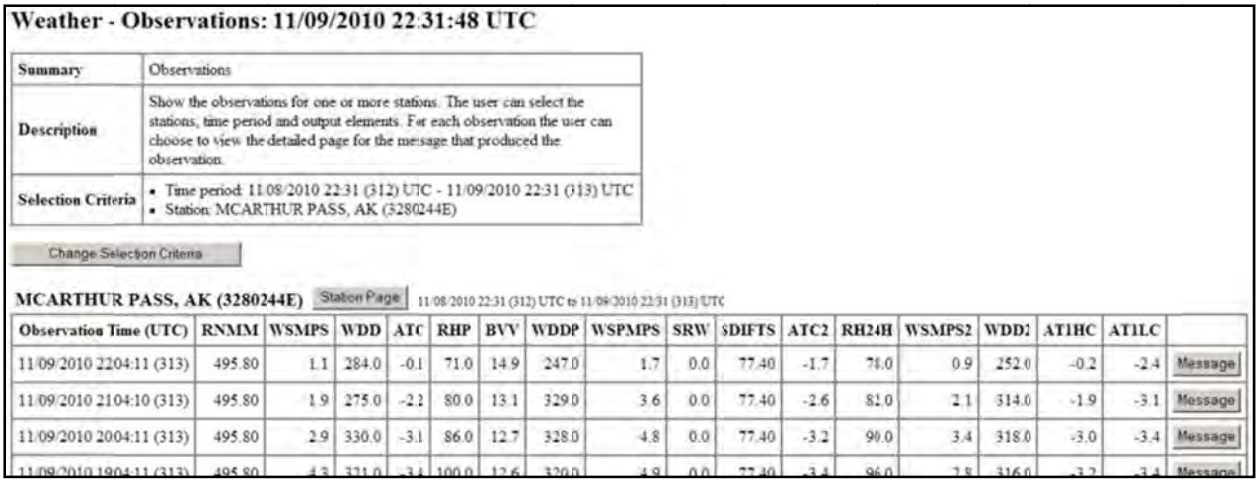


Figure 7-13. Station metadata accessed from the Weather Module on WFMI website.

14. Click on “Observations” to view recent data transmissions. Recent data transmissions will be displayed (Figure 7-14). The observational time frame can be changed by varying the selection criteria. Individual transmission details can be viewed by clicking the “Message” button. Acronyms for meteorological elements are listed in Table 7-2.



Weather - Observations: 11/09/2010 22:31:48 UTC

Summary	Observations
Description	Show the observations for one or more stations. The user can select the stations, time period and output elements. For each observation the user can choose to view the detailed page for the message that produced the observation.
Selection Criteria	• Time period: 11/08/2010 22:31 (312) UTC - 11/09/2010 22:31 (313) UTC • Station: MCARTHUR PASS, AK (3280244E)

Change Selection Criteria

MCARTHUR PASS, AK (3280244E) Station Page 11/08/2010 22:31 (312) UTC to 11/09/2010 22:31 (313) UTC

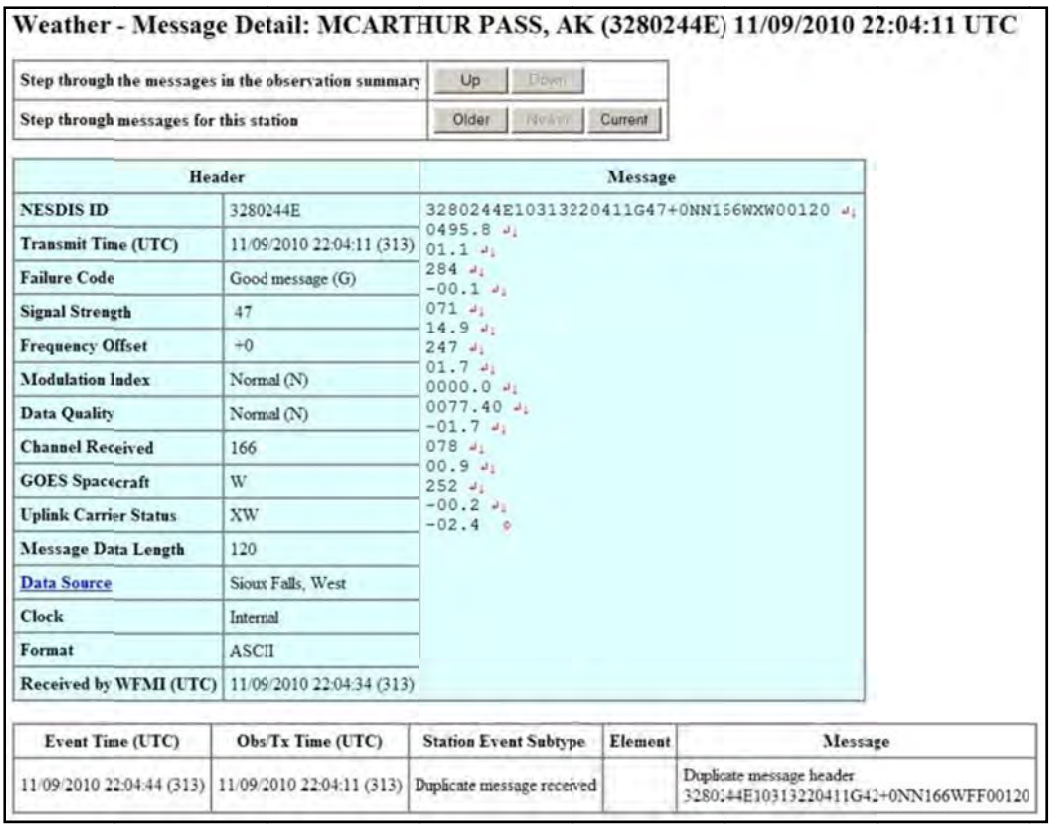
Observation Time (UTC)	RNMM	WSMPS	WDD	ATC	RHP	BVV	WDDP	WSPMPS	SRW	SDIFTS	ATC2	RH24H	WSMPS2	WDD2	AT1HC	AT1LC	
11/09/2010 2204:11 (313)	495.80	1.1	284.0	-0.1	71.0	14.9	247.0	1.7	0.0	77.40	-1.7	78.0	0.9	252.0	-0.2	-2.4	Message
11/09/2010 2104:10 (313)	495.80	1.9	275.0	-2.1	80.0	13.1	329.0	3.6	0.0	77.40	-2.6	81.0	2.1	314.0	-1.9	-3.1	Message
11/09/2010 2004:11 (313)	495.80	2.9	330.0	-3.1	86.0	12.7	328.0	4.8	0.0	77.40	-3.2	90.0	3.4	318.0	-3.0	-3.4	Message
11/09/2010 1904:11 (313)	495.80	4.3	331.0	-3.4	100.0	12.6	329.0	4.8	0.0	77.40	-3.4	96.0	3.8	316.0	-3.2	-3.4	Message

Figure 7-14. Recent weather observations accessed from the Weather Module on WFMI website.

Table 7-2. WFMI weather observation acronyms.

WFMI acronym	Definition
RNMM	Rain accumulation, cummulative (mm)
WSMPS	10-minute average wind speed (m/s)
WDD	10-minute average wind direction (°)
ATC	Current air temperature (°C)
RHP	Current relative humidity (%)
BVV	Battery voltage (v)
WDDP	Peak wind direction (°)
WSPMPS	Peak wind speed (m/s)
SRW	Solar radiation (W/m^2)
SDIFTS	Snow depth (in)
ATC2	Average air temperature (°C)
RH24H	Average relative humidity (%)
WSMPS2	Average wind speed (m/s)
WDD2	Average wind direction (°)
AT1HC	Maximum air temperature (°C)
AT1LC	Minimum air temperature (°C)

15. The message details that are displayed by clicking on the “Message” button include information on GOES transmission signal strength (Figure 7-15), data transmission quality, both raw and converted meteorological observations (Figure 7-16), and flags for missing or invalid data. GOES transmission signal strength is measured in the power ratio in decibels of the measured power referenced to one milliwatt (dBm). The typical range is 44 to 49 dBm. Higher signal strengths are not preferred by GOES; lower signal strengths are okay and are generally indicative of icing conditions on the antenna elements or broken antenna elements.



Weather - Message Detail: MCARTHUR PASS, AK (3280244E) 11/09/2010 22:04:11 UTC

Step through the messages in the observation summary	Up / Down
Step through messages for this station	Older / Newer / Current

Header		Message
NESDIS ID	3280244E	3280244E10313220411G47+0NN156WXW00120 ↵ 0495.8 ↵ 01.1 ↵ 284 ↵ -00.1 ↵ 071 ↵ 14.9 ↵ 247 ↵ 01.7 ↵ 0000.0 ↵ 0077.40 ↵ -01.7 ↵ 078 ↵ 00.9 ↵ 252 ↵ -00.2 ↵ -02.4 ♦
Transmit Time (UTC)	11/09/2010 22:04:11 (313)	
Failure Code	Good message (G)	
Signal Strength	47	
Frequency Offset	+0	
Modulation Index	Normal (N)	
Data Quality	Normal (N)	
Channel Received	166	
GOES Spacecraft	W	
Uplink Carrier Status	XW	
Message Data Length	120	
Data Source	Sioux Falls, West	
Clock	Internal	
Format	ASCII	
Received by WFMI (UTC)	11/09/2010 22:04:34 (313)	

Event Time (UTC)	Obs/Tx Time (UTC)	Station Event Subtype	Element	Message
11/09/2010 22:04:44 (313)	11/09/2010 22:04:11 (313)	Duplicate message received		Duplicate message header 3280244E10313220411G42+0NN166WFF00120

Figure 7-15. Message details accessed from Weather Module on WFMI website.

Element	Observation Pattern	Observation Number 23 11/09/2010 22:04:11 (313) UTC		
		Raw Data	Converted Value	Data Quality
Rain accumulation	All Obs	0495.8	495.80	Good
Windspeed	All Obs	01.1	1.1	Good
Wind Direction	All Obs	284	284.0	Good
Air Temperature	All Obs	-00.1	-0.1	Good
Relative Humidity	All Obs	071	71.0	Good
Battery Voltage	All Obs	14.9	14.9	Good
Wind Direction, Peak	All Obs	247	247.0	Good

Figure 7-16. Raw observations and converted values for single data transmission accessed from Weather Module on WFMI website.

15. Complete documentation in the PTW and close and save the worksheet.

Update the RAWS Maintenance Plan

Use information from the performance tracking worksheet completed for each network RAWS to update the RAWS maintenance plan prior to any maintenance. This plan and the procedures for updating it are described in SOP #6.

Reference the PTW in Annual Reporting

Include a summary of issues affecting the performance and data quality of RAWS operated and maintained by the SWAN in annual reporting (SOP #17). Base this summary off entries in the PTW. Table 7-3 represents an example summary from an annual report.

Table 7-3. Issues affecting performance and data quality of RAWS operated and maintained by the SWAN. Acronyms are as follows: relative humidity (RH), wind speed (WS), wind direction (WD), snow depth (SD), and soil temperature (ST).

Station	Date begin	Date end	Issue
Chigmit Mountains	10/01/2008	06/30/2009	Station not in operation yet
Chigmit Mountains	06/30/2008	09/30/2009	High precipitation recorded during strong wind events
Chigmit Mountains	06/30/2008	09/30/2009	Many non-natural spikes in SD data.
Chigmit Mountains	10/01/2008	09/30/2009	Only liquid (e.g. rain) precipitation recorded
Contact Creek	10/01/2008	04/01/2009	Few non-natural spikes in SD data.
Contact Creek	10/01/2008	09/30/2009	Only liquid (e.g. rain) precipitation recorded
Coville	10/01/2008	09/30/2009	Only liquid (e.g. rain) precipitation recorded
Fourpeaked	10/01/2008	06/09/2009	Station not in operation yet
Fourpeaked	06/09/2009	09/30/2009	Little precipitation recorded
Fourpeaked	08/15/2009	09/30/2009	Few non-natural spikes in SD data
Fourpeaked	10/01/2008	09/30/2009	Only liquid (e.g. rain) precipitation recorded
Harding Icefield	10/01/2008	09/30/2009	Significant precipitation undercatch
Harding Icefield	11/25/2008	02/25/2009	Batteries not fully charging
Harding Icefield	10/01/2008	09/30/2009	SD sensor not working
Harding Icefield	01/16/2009	06/03/2009	Mast broken – no WD or WS
Hickerson Lake	11/15/2008	09/30/2009	Few non-natural spikes in SD data
Hickerson Lake	05/07/2008	06/29/2009	Bear damage – no WD or WS
Hickerson Lake	10/01/2008	09/30/2009	Only liquid (e.g. rain) precipitation recorded
McArthur Pass	10/01/2008	09/30/2009	High precipitation recorded during strong wind events
McArthur Pass	10/01/2008	09/30/2009	Only liquid (e.g. rain) precipitation recorded
McArthur Pass	10/01/2008	10/31/2008	Bear damage – no WD
McArthur Pass	10/01/2008	09/30/2009	SD sensor not working
McArthur Pass	01/23/2009	06/02/2009	RH sensor not working
McArthur Pass	03/25/2009	06/02/2009	Mast broken – no WD or WS
Pfaff Mine	10/01/2008	09/30/2009	Few non-natural spikes in SD data
Pfaff Mine	07/04/2009	09/30/2009	RH sensor not working
Pfaff Mine	10/01/2008	09/30/2009	Only liquid (e.g. rain) precipitation recorded
Snipe Lake	07/16/2009	09/30/2009	Bear damage – batteries not charging and no ST
Snipe Lake	05/28/2009	06/27/2009	RH sensor not working
Snipe Lake	10/01/2008	09/30/2009	Few non-natural spikes in SD data
Snipe Lake	10/01/2008	09/30/2009	Only liquid (e.g. rain) precipitation recorded

SOP #8: RAWS Maintenance
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for both scheduled and unscheduled maintenance of network RAWS. Necessary equipment and tools are listed and procedures for completing post-maintenance tasks are explained.

Introduction

Network RAWS require regular maintenance in order to provide for continuous acquisition of quality meteorological data, complete retrieval of data, and to meet the standards issued by the National Wildfire Coordinating Group (NWCG) for fire and resource weather stations. Unscheduled maintenance of network RAWS will also be necessary in order to repair stations damaged by harsh weather or wildlife and to replace sensors that may have unexpectedly failed.

This SOP explains the procedures for both scheduled and unscheduled maintenance of network RAWS, and ensures that personnel who perform maintenance on network RAWS are properly equipped for the job. Successful maintenance of network RAWS also relies on the completion of key preparatory work. Procedures for completing most of this preparatory work are documented in other SOPs and are only briefly referenced here. This SOP focuses on: 1) preparatory work for maintaining the all-season precipitation gauge at the Harding Icefield RAWS, 2) the necessary equipment and tools for RAWS maintenance, 3) detailed procedures for maintaining RAWS, and 4) post-maintenance tasks.

Preparatory Work

Timeline and Logistics

Successful operation and maintenance of network RAWS relies on the timely completion of a number of tasks including: establishing a direct charge authorization, completing an annual sensor order, making logistical plans (including the scheduling of aircraft and boats), packing and shipping equipment, and travelling to the field. The necessary timing of these events is described in SOP #1 and is outlined in Table 1-2 (SOP #1).

Laptop Setup

A laptop computer is necessary for maintaining network RAWS. Forest Technology Systems, Inc. (FTS) “FTS Toolbox” software and all the data logger programs for network RAWS must be loaded on the laptop. Procedures for configuring a laptop computer are described in SOP #3.

Maintenance Plan

A completed RAWS maintenance plan outlines the scheduled sensor replacement and other anticipated maintenance necessary for network RAWS (Figure 6-4, SOP #6). This plan is helpful for placing the annual sensor order and for making logistical arrangements or refining the field schedule for RAWS maintenance. Procedures for completing a RAWS maintenance plan are documented in SOP #6.

Field Data Sheets

Field data sheets are used to document station maintenance. Sensor models and serial numbers are recorded along with meteorological observations taken directly before and after station maintenance. Copies of the RAWS maintenance field sheet for each station should be printed on "Rite in the Rain" all-weather writing paper.

Field maintenance sheets are located on the SWAN server at:

\SWAN\Vital_Signs\Climate\Stations\RAWS_Station_Name\Maintenance\

Where: "Station_Name" is that listed in Table 8-1.

The \Maintenance sub-directory for each network RAWS contains Excel spreadsheets. RAWS maintenance field sheets are named:

[NAME]_StationMaintenance_YYYYMMDD.xls

Where: [NAME] is the four-letter acronym listed in Table 8-1.

An example of a RAWS maintenance field data sheet is shown in Figure 8-1.

Table 8-1. NESDIS ID assignments, transmit times, transmit time off-sets, and acronyms used for network RAWS.

Station Name	NESDIS ID	Acronym [NAME]	Channel	Transmit time (hh:mm:ss)	Transmit time off-set (s)
Chigmit Mountains	FA6544FC	CHMO	160	00:43:10	2470
Contact Creek	32803738	COCR	166	00:04:20	140
Coville	3280B12C	COVI	166	00:04:40	160
Fourpeaked	328135C2	FOUR	80	00:17:00	900
Harding Icefield	FA656210	HAIC	160	00:43:30	2490
Hickerson Lake	3280C7BC	HILA	166	00:04:50	170
McArthur Pass	3280244E	MCPA	166	00:04:10	130
Pedersen Lagoon	326AD012	PELA	158	00:28:50	1610
Pfaff Mine	FA65578A	PFMI	160	00:43:20	2480
Snipe Lake	328041A8	SNLA	166	00:04:30	150

Evaluating Station Performance

Identifying and documenting issues that affect station sensors, power supply, or other components as they occur will make both regular and unscheduled maintenance visits more effective with resulting cost benefits. Station performance is tracked by documenting whether or not individual sensors are operating normally. This is determined by examining recent weather observations using the WRCC and WFMI websites. The performance of network RAWS are documented using performance tracking worksheets. Procedures for evaluating and tracking station performance are described in SOP #7.

RAWS Station Maintenance

Station Name:	Fourpeaked			Date of Maintenance:	
Property Number:	37417		Maintenance Personnel:		
Park:	Katmai National Park and Preserve				
Latitude:	58.70572	Longitude:	-153.51792	Elevation (ft)	1074
Transmit Time:	00:17:00	Channel:	80	Tx Data Rate:	300

Rehab / Repair	Sensors	New Sensor Serial #	New Asset #	Old Sensor Serial #	Old Asset #
	Relative Humidity / Air Temp				
	Wind Speed				
	Wind Dir				
	Solar RAD				
	Precip (TB)				
	Snow Depth				
	Datalogger				
	GOES Transmitter				
	Power Manager				
	SDI Expansion Port				
	GOES Antenna				
	GPS Antenna				
	Battery #1				
	Battery #2				

Last Data							
Precip:		Relative Humidity:		Solar Rad:		Wind Speed:	
Wind Speed:		Battery:		Snow Depth:		Wind Direction:	
Wind Dir:		Wind Dir - Peak		Air Temp - Average:		Air Temp - Max	
Air Temp:		Wind Speed - Peak:		Relative Humidity - Average:		Air Temp - Min:	

Forced Scan							
Precip:		Relative Humidity:		Solar Rad:		Wind Speed:	
Wind Speed:		Battery:		Snow Depth:		Wind Direction:	
Wind Dir:		Wind Dir - Peak		Air Temp - Average:		Air Temp - Max	
Air Temp:		Wind Speed - Peak:		Relative Humidity - Average:		Air Temp - Min:	

Tipping Bucket Test:		Wind Direction Test		Photos:			

Narrative Notes

Figure 8-1. Example of a RAWS maintenance field data sheet. Station metadata is specific to individual stations.

Preparing Antifreeze Solution for All-Season Precipitation Gauge

The Harding Icefield (HAIC) RAWS is currently the only network RAWS equipped with an all-season precipitation gauge, filled with an antifreeze-alcohol solution that is replaced annually. This solution must be prepared before maintaining the HAIC RAWS.

Procedures

Estimate the amount of antifreeze-alcohol solution to be removed.

1. Access the WRCC web page: http://www.wrcc.dri.edu/

2. Select "WRCC Projects" followed by "RAWS Data (Remote Automated Weather Stations)".

3. A map of the US will appear on the screen, click on "Alaska".

4. A map of RAWS stations within the state will appear along with an alphabetic list of RAWS sites, which is displayed on the left-hand side (LHS) of the screen (Figure 8-2).



Figure 8-2. Alphabetic list (partial) of RAWS sites displayed on the WRCC Web Page.

5. Select the HAIC station from the alphabetic list of RAWS on the LHS. A window will open showing the data availability list for the selected station (Figure 8-3) and station data retrieval options on the LHS (Figure 8-4).



Figure 8-3. Data availability list.



Figure 8-4. Station data retrieval options.

6. Select “Graph of last 7 days” from the LHS. Inspect the precipitation plot (Figure 8-5).

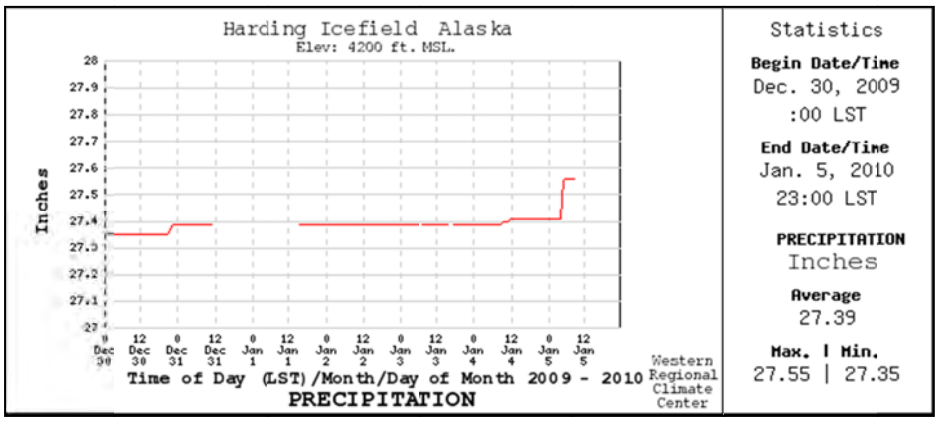


Figure 8-5. Precipitation plot for “last 7 days” for the HAIC RAWS.

7. The maximum precipitation value represents the total precipitation measured since the last time the rain count was reset, which should be the date of last maintenance. In the example, (Figure 8-5) nearly 27.6 inches of precipitation was measured.

8. The amount of antifreeze to be removed is equivalent to the volume of the standpipe (21 gallons,) plus the volume of the displaced precipitation since the date of last maintenance. Calculate the amount of antifreeze to be removed using the formula:

$$\text{Amount (gal)} = \text{StandpipeCapacity (gal)} + [\ \pi r^2 \text{ x MaxPrecipitation (in) x } 0.004329\ (\text{gall/in}^3)]$$

Where:

Amount is the amount of antifreeze to be removed in gallons
SandpipeCapacity is 21 gallons
π is 3.1415
r is 4 inches
MaxPrecipitation is reported by the RAWS on the WRCC website
0.004329 gal/in^3 is the conversion factor

9. In the example above, the total amount of antifreeze to be removed is 27 gallons. Twenty-one gallons should be in the stand pipe and six gallons should be in the Jerry cans.

Determine the Necessary Number of Empty Containers

The HAIC RAWS is accessed by either ski-plane or helicopter. If space is not an issue, bring enough empty five-gallon plastic containers to hold all the old antifreeze solution. In the example provided above, six empty five-gallon plastic containers are needed to hold and transport the old antifreeze solution.

If space is an issue, the number of empty containers can be minimized by doing a simple calculation. The four five-gallon Jerry cans (on-site) can hold a total of 20 gallons of antifreeze solution. Some antifreeze solution from the standpipe can be temporarily stored in the four five-gallon Jerry cans (the plastic containers that are used to transport the new antifreeze solution are

in turn used to transport discarded antifreeze solution once they are empty). In the example provided above, the four-five gallon Jerry cans (on-site) will be able to temporarily hold an additional 14 gallons of antifreeze solution (20 gallons – 6 gallons = 14 gallons). In this example, seven gallons of old antifreeze are left in the standpipe. Two empty five-gallon plastic containers will be needed to hold and transport this antifreeze solution. In this example, a total of six five-gallon plastic containers would be transported to the RAWS (four full of new antifreeze solution, two empty). All six five-gallon plastic containers would also be transported back (6 full or partially full).

Prepare New Antifreeze Solution

The antifreeze solution that is used is 45% propylene glycol, 45% ethyl alcohol, and 10% water (by volume). The propylene glycol and ethyl alcohol can be purchased in five-gallon containers from Garness Industrial, Inc. in Anchorage (907-562-2933). Twenty gallons of antifreeze solution are prepared (the standpipe should not be completely drained and there is a small reserve of antifreeze solution stored on-site). The solution is prepared in the same five-gallon plastic containers that are used for transport.

1. Pour 2.25 gallons propylene glycol, 2.25 gallons ethyl alcohol, and 0.5 gallons water into each of four five-gallon plastic containers. Label and store appropriately in a flammable storage cabinet.

Equipment and Tools

In addition to the general field and safety gear identified in SOP #1, the following equipment and tools are required for maintaining network RAWS:

Equipment

- Key for network RAWS (Master Lock key number 2001)
- Field laptop computer with FTS Toolbox software installed (refer to SOP #3)
- Laptop shelf for RAWS instrument enclosure (optional)
- Download cable (laptop to FWS-12S data logger) and USB to RS-232 (serial) cable
- Digital camera with spare batteries, charger, and download cable
- Brunton or other compass capable of accounting declination and measuring inclination)
- Calculator
- AC power adaptor for FWS12S data logger (in case laptop battery dies)
- DC-AC 12V inverter
- Maintenance plan spreadsheet (printed and electronic copies)
- RAWS maintenance field sheets for all stations that will be maintained
- Replacement sensors for scheduled maintenance
- Spare sensors for unexpected repairs (see below)
- Spare cables (see below)
- Strapping tape (fiberglass tape)
- Supplies specific to the HAIC precipitation gauge are listed separately below (p. 178).

Tools

- 2 long (1½-ft) socket drivers w/ 9/16 in sockets each
- Sockets: 3/8, 5/8, 7/16, 1/2, 9/16 in
- Open-end wrenches: 1/2, 7/16, 9/16 in
- Allen wrench set (metric and standard)
- Leatherman tool or similar
- 2 crescent wrenches
- Pliers
- Wire cutters
- Vise grips: medium
- Hack saw and extra blade
- Torpedo level (or Brunton compass)
- Measuring tape (metric, standard)
- Wire stripper/crimper and various electrical connectors
- Multimeter
- Flat file
- Round file
- Flat screw driver
- Small flat screw driver
- Phillips screw driver
- Lithium grease
- Lock tight
- 4 rolls electrical tape
- Rubberized bonding electric tape (mastic tape)
- Cable ties (UV resistant, cold-weather, metal-cored)
- Pencils, sharpie
- Field notebook
- Small tarp or umbrella
- Gloves
- 3 ft folding step ladder (for McArthur Pass and Pedersen Lagoon RAWS)
- Sledge hammer (3-5 lbs)
- Heavy chisel (1 in)
- Steel plate (4 x 4 in)
- Small folding saw for trimming vegetation

Extra Sensors, Components, and Hardware

- Solar radiation sensor with cable
- Tipping bucket (precipitation gauge) with cable
- GOES antenna and extra set of antenna elements
- Solar panel with cable
- GPS antenna with cable
- Snow depth sensor with new transducers and desiccant
- Spare cables:
    - 2 wind speed
    - 2 wind direction
    - 2 solar panel
    - 2 spare GOES antenna cables
    - 2 spare dual-battery to power manager cables
    - 2 spare data manager to FWS12S datalogger cables
- 90 feet ¼ in steel aircraft cable with cable clamps and thimbles
- Spare set of stainless steel bolts, nuts, flat washers, lock washers (10 each)
- Radiator clamps (2-4 in diameter).

RAWS Maintenance Procedures

Maintenance of network RAWS involves inspecting the station, downloading data, replacing sensors, resetting the rain count, verifying operation of replacement sensors and data logger program, confirming telemetry, tightening any loose bolts, and taking photographs.

Taking Field Notes

Fill out a RAWS maintenance field data sheet. Field notes should include the following items:

- Date
- Personnel
- Weather conditions at the time of the maintenance
- Condition of the station (cables, anchor pins, guy wires, bolts, and wind sensor mast and mounting arm)
- Condition of sensors (including sensor support arms and cables)
- Condition of power system (solar panel, cable from solar panel to power manager, batteries, battery cables)
- Condition of the instrument enclosure
- Condition of data logger, transmitter, power manager, and SDI expansion ports
- Identify sensors removed by model, asset and serial number
- Indentify sensors installed by model, asset and serial number
- Describe other maintenance completed
- Describe any unresolved issues that will require future attention
- Describe how photographs were collected

Routine Station Inspection

1. Inspect all guy wires and anchor points. If necessary, tighten and secure turnbuckles with cable ties or wire to prevent them from unwinding due to the vibration of guy wires in strong winds.

2. Check station for animal damage, including damaged cables and bent sensors or sensor arms.

3. The station frame, wind sensor cross arm, and other sensor cross arms should be level. Verify and adjust if needed.

4. Tighten any loose nuts, bolts, or clamps. Do not over tighten!

5. Make sure that the grounding wire is still connected to the copper grounding rod below the enclosure.

6. Verify that the solar panel is facing south and correct the orientation if needed. Clean the solar panel, inspect for cracks, and tighten the clamps that mount it to the station.

7. Check the GOES antenna for loose or broken elements. Replace any broken or missing elements. Note the number stamped into the non-threaded end of the antenna elements. The elements are mounted incrementally with the shortest elements (#1) at the tip-end of the antenna, concluding with the #5 elements closest to the mounting end of the antenna. Elements should be firmly, but only, hand-tightened.

8. Check the condition of the mastic tape where the GOES cable is attached to the GOES antenna. Replace this tape if necessary.

Downloading the FWS-12S Data Logger

1. Unlock and open the instrument enclosure (white cabinet). Locks use Master Lock key number 2001.

2. Check the local time and identify the RAWS transmit time listed in Table 8-1. Wait until after the transmit time to complete the following steps.

3. Connect the field laptop computer to the data logger using the download cable. Turn on the laptop and launch the FTS Toolbox program.

4. Select the RAWS from “Current Station” drop-down menu (Figure 8-6).

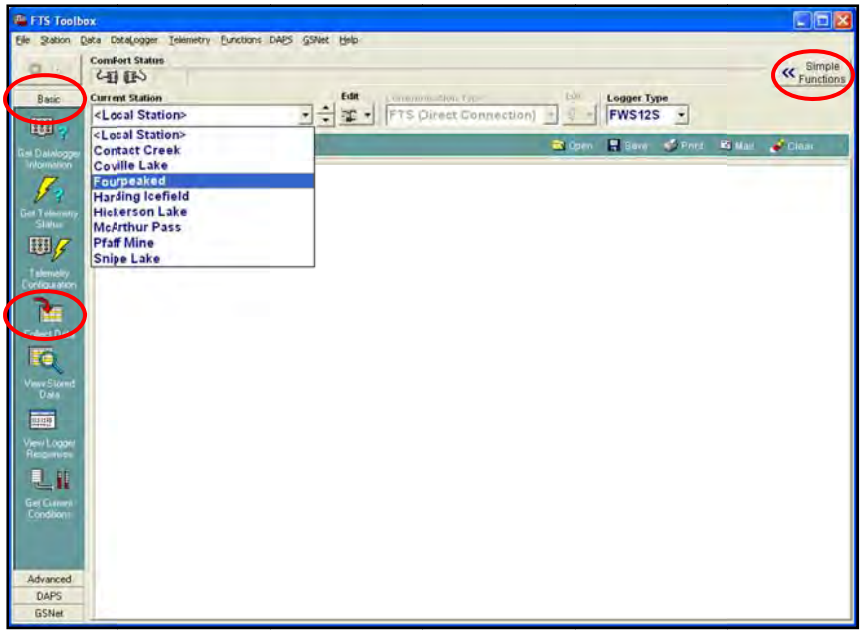


Figure 8-6. Selecting a RAWS from the FTS Toolbox "DataLogger Responses" window.

5. Verify that the communication type is set to "FTS (Direct Connection)" and that the Logger Type is "FWS12S".

6. Sample the station sensors to get the current conditions. If needed, click on the "All Functions" button in the upper-right-hand corner of the window so that "Simple Functions" is displayed and then click on the "Basic" button in the upper-left-hand corner of the window. (Figure 8-6).

7. Click on "Get Current Conditions from DataLogger" (Figure 8-7).

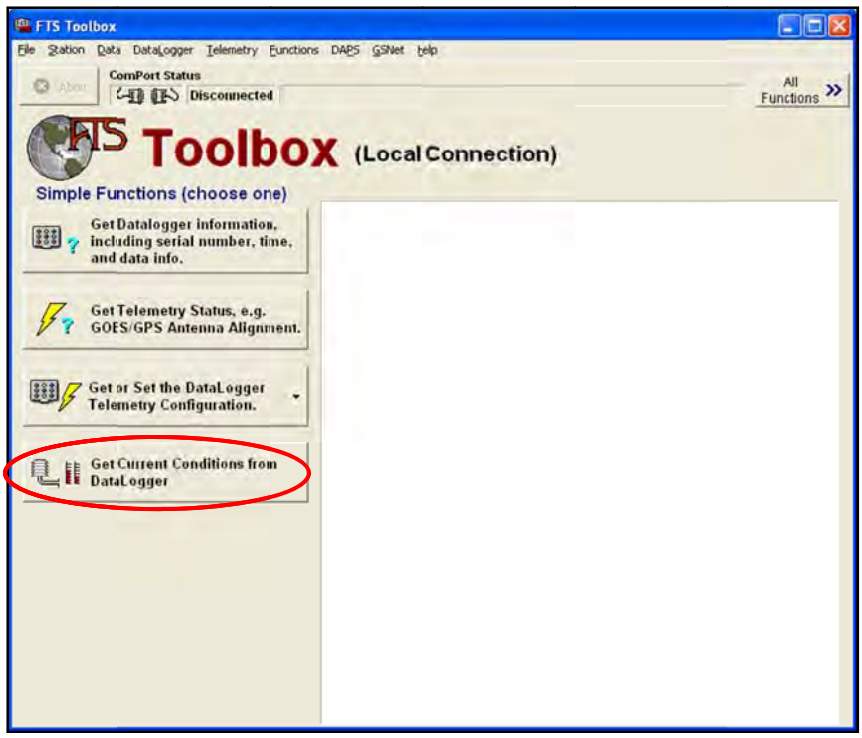


Figure 8-7. Sampling station sensors for current conditions.

8. Current conditions will be displayed (Figure 8-8).

9. Write down the current conditions on the RAWS maintenance field data sheet (under “Forced Scan”). If needed, these values could later be used to adjust for sensor drift.

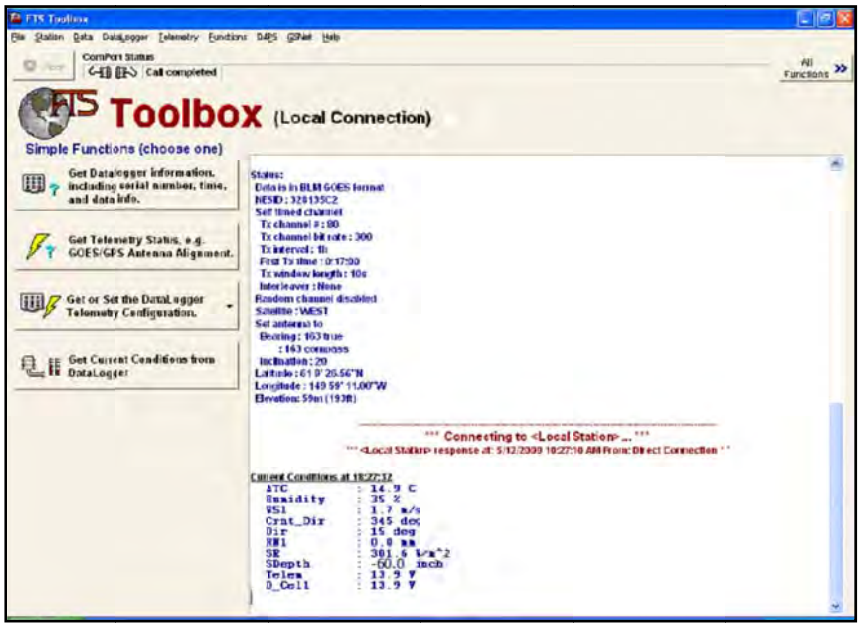


Figure 8-8. Current conditions reported by station sensors.

10. Click on the “All Functions” button in the upper-right-hand corner of the window.

11. Click on the “Collect Data” button in the left-hand column. A dialog window will open (Figure 8-9).



Figure 8-9. Collect data dialog window. Date/time is UTC.

12. Select the “Date Range” toggle. Date/Time is Coordinated Universal Time (UTC). Enter the start date/time (when the station was last downloaded, which should be documented on the RAWS maintenance work plan). Set the end date/time to current UTC (note that Toolbox defaults to the laptop’s local date/time). Click “Make Call”. Serial (RS232) communications are slow and the download may take 30-45 minutes.

13. Begin replacing sensors while the data is downloading.

14. When data transfer is complete, click on the “View Stored Data” button on the left margin. Select the “Range” toggle and enter the dates for the range of data you just downloaded. The data is displayed in tabular format (Figure 8-10). Check the box for “Show Gaps” near the top right of the page. Verify that all the data is there by scrolling through the table. Quickly scroll through the data to make sure there are no gaps. This verifies that there were no communication issues between the data logger and computer. It is possible you may need to download the data again.

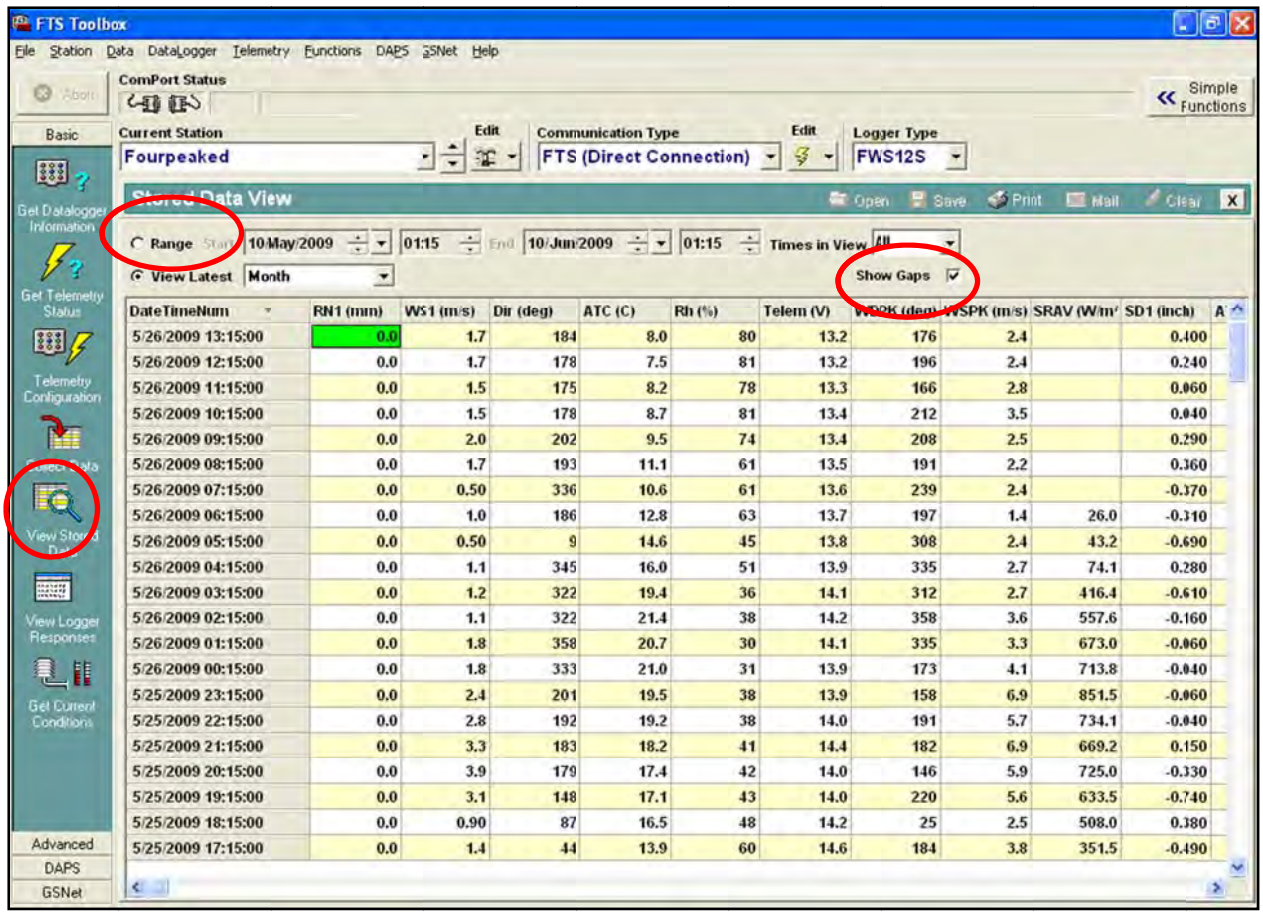


Figure 8-10. Stored data view.

15. Export the data. Select “Data” from the main menu options and click on “Export”. Verify that the correct station name is selected and that the “Copy All Data” toggle is checked. Select (check) the three options: include station names, include field names, and include field units (Figure 8-11). Select “Overwrite”, so that units are also exported (this may be necessary because of a program bug).

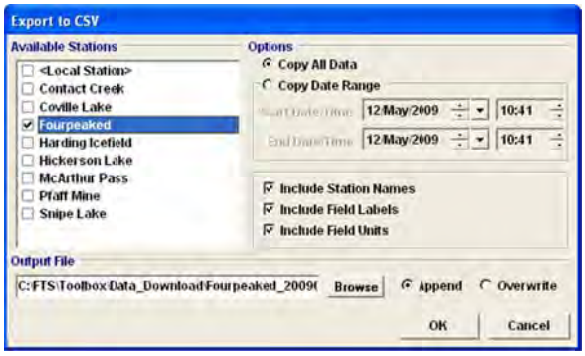


Figure 8-11. Export to CSV dialog window.

16. Click OK and save the file as a comma-delimited text (.csv) file (Figure 8-12).

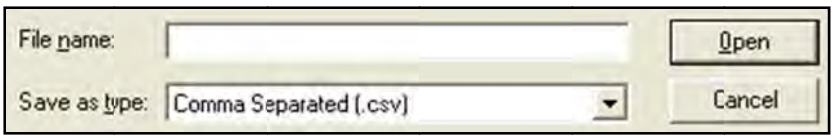


Figure 8-12. Data export dialog window.

17. Raw (downloaded) station data files are named using the following standardized format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].[ext]

Where:

[TYPE] refers to the station type (e.g. RAWS)
[NAME] is the four letter acronym for the station name (refer to Table 8-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage "raw"
[.ext] is the file type (e.g. .csv)

Example: RAWS_FOUR_20071001_20080930_20081101raw.csv

Downloading the F6 Data Logger

1. Unlock and open the instrument enclosure (white cabinet). Locks use Master Lock key number 2001.

2. Check the local time and identify the RAWS transmit time listed in Table 8-1. Wait until after the transmit time to complete the following steps.

3. Insert a USB memory stick into the "USB Host" port on the F6 data logger.

4. Select the "Data" icon from the homepage screen.

5. Select the "Download Data" icon (Figure 8-13).

6. Input the data range Select the "Date Range". Note that the date and time is Coordinated Universal Time (UTC). Enter the "From" date/time (when the station was last downloaded, which should be documented on the RAWS maintenance work plan). Set the "To" date/time to the current UTC time.

7. Output style should be "CSV".

8. The Default Date Time Format (yyyy/MM/dd HH:mm:ss) is OK.

9. Select the box for "Include Units Line".

10. Press OK

11. The data will be saved on the USB memory stick to the following location:

\F6 Data Logger\Station Name\Data\

12. At some point, rename the data file using the following standardized format that is described above for the FWS-12S data logger.

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].[ext]

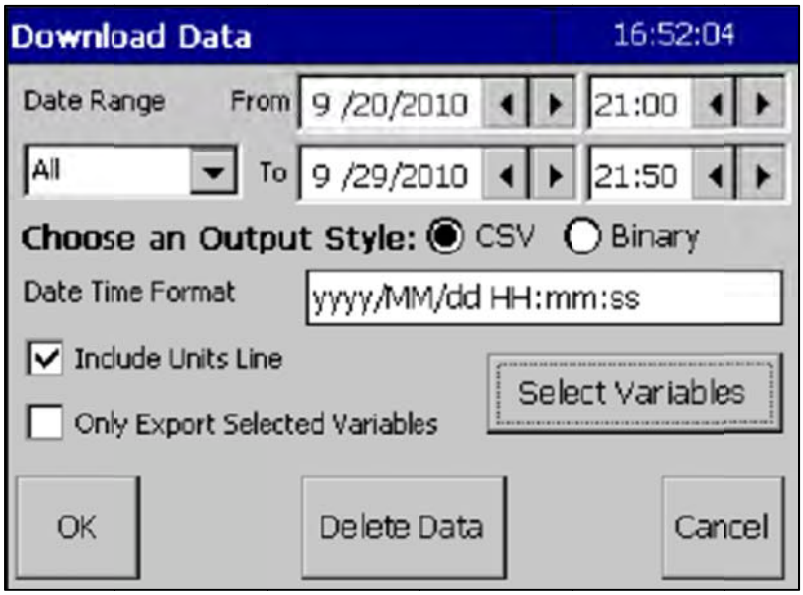


Figure 8-13. Download Data dialog window on the F6 data logger.

Replacing Sensors – General Information

Additional guidance on RAWS maintenance can be found on the RAWS Depot website under Resources (http://raws.fam.nwcg.gov/techresources.html). Procedures specific to replacing individual sensors follow the general information below.

1. Check the local time and the time of transmission (Table 8-1). Wait to begin replacing sensors until a couple minutes after data transmission. Try to plan sensor replacement so that the all sensors are reconnected at least 15 minutes before the next station transmission (after maintenance is completed). At the very least, all replacement sensor cables should be attached in this timeframe. Completion of maintenance will probably take longer, probably two to four hours.

2. Disconnect the two green cables (GOES Telemetry and Battery) from the data logger. This powers down the data logger, eliminating the possibility of artificial observations being recorded by the data logger (e.g. accidental tips of the tipping bucket) and mitigating potential damage to sensors.

3. Thread the cables that are now disconnected from the data logger out of the instrument enclosure and disconnect all cable ties and or electrical tape used in securing these cables to the station frame. The wind speed and direction cables are disconnected from the data logger; however these two cables are not replaced unless damaged. These cables can be left inside the enclosure.

4. Remove sensors from the station and replace them with the new sensors. Document the model, serial, and asset numbers for both the existing and replacement sensors on the RAWS station maintenance field sheet.

5. Make rain drip loops with each sensor cable immediately below each sensor. Use electrical tape to create the loop.

6. When attaching sensor cables to the replacement sensors make sure the fitting is snug. Use lithium grease on the threads of the military-style connectors. Thoroughly wrap connectors with electrical tape.

6. Once all replacement sensors are in place, secure the cables using cable ties. Carefully cut off the tails of the cable ties (these can build up significant amounts of heavy ice in winter).

7. Connect sensor cables to the data logger or SDI port inside the instrument enclosure.

8. Secure all turnbuckles using cable ties. This will help prevent them from loosening with time.

9. Seal the cable gland where all sensor cables enter the instrument enclosure or the extension conduit. Use the foam plug and cover this with electrical tape. It is important that this connection be well sealed so that moisture will not flow down the cables into the enclosure and freeze, potentially causing damage.

Relative Humidity and Air Temperature (RH/AT) Sensor

1. The RH/AT sensor cable is permanently attached to the sensor. Only disconnect this cable from the data logger.

2. Loosen the holding screw on the sensor arm and remove the old RH/AT sensor.

3. Install the replacement RH/AT sensor.

4. Put a drop of blue-colored (medium) lock-tight fluid on the holding screw on the sensor arm.

5. Wrap electrical tape around the sensor arm and holding screw.

Wind Direction (WD) Sensor

1. Before lowering the mast, make sure that both wind sensor cables have enough slack to accommodate lowering the mast.

2. Any reinforcement guy lines attached to the mast will have to be loosened and removed from their ground attachments. Lowering the mast is a two-person job.

3. The nut and bolt that secured the wind speed and direction mast in place is often impossible to loosen. If this is the case, break the bolt off. This is best done by two people using long ratchets, sockets, and short cheater bars. When this bolt is replaced, lubricate it with lithium grease. This will facilitate removal of the bolt during subsequent station maintenance.

4. Loosen the two screws, cutoff electrical tape, and disconnect the WD sensor cable from the WD sensor. Remove the existing WD sensor.

5. Install the replacement WD sensor. Align the “north-locating” hole in the shank of the sensor under the empty lower hole in the holder. Insert the north locating screw into the shank through the holder, and tighten down. Gently tighten the top retaining screw. Apply thread lock fluid to both screws and wrap the screws in place with electrical tape.

6. Do not attempt to put any screw into the drain hole.

7. Attach the sensor cable and wrap the connection with electrical tape. Do not cover the drain hole.

8. Remove the locking pin from the WD sensor.

9. Check that the wind direction readings are accurate by following the steps in the “Sample Sensors and Data Logger Response” section that follows. Verify that all four cardinal directions are correctly recognized by the wind direction sensor. This is a two-person task.

Wind Speed (WS) Sensor

1. Loosen the two screws, cutoff electrical tape, disconnect the WS sensor cable from the WS sensor, and remove the existing WS sensor.

2. Install the replacement WS sensor. Set the distance of the replacement WS sensor into the holder to be comparable to that of the WD sensor.

3. Tighten the two screws that hold the WS sensor in place. Apply thread lock fluid to both screws and wrap the screws in place with electrical tape.

4. There is no “locating” set screw required for the WS sensor.

5. Attach the sensor cable and wrap the connection with electrical tape. Do not cover the drain hole.

6. Raise the mast, insert, and tighten the upper bolt that fastens it to the tower. The lower bolt does not need to be very tight. Use lithium grease on all threads.

7. Reattach any reinforcement guy lines that were removed and secure the turnbuckles using cable ties to prevent unwinding due to vibration from strong winds.

Solar Radiation (SRAD) Sensor

1. Make sure that the SRAD sensor receives unobstructed sunlight throughout the day.

2. The SRAD sensor cable is permanently attached to the sensor. Only disconnect this cable from the data logger.

3. Remember to remove the plastic cup from the top of the sensor after replacing the SRAD sensor.

Snow Depth (SD) Sensor

There are two SD sensors currently in use, the SR50 and SR50A. The SR50 is being fazed out of usage and being replaced with SR50A sensors. The following procedures are specific to the SR50A and, while they can be done in the field, they are best done in the office prior to field maintenance (i.e. simply replacing the sensor unit).

Replacing Transducer and Desiccant

1. Disconnect the sensor cable from the SD sensor.

2. Remove the SD sensor from the mounting bracket by removing the two screws.

3. Remove the six screws from the bottom of the SD sensor (Figure 8-14).



Figure 8-14. SR50A snow depth sensor.

4. Remove the transducer housing (black ring), O-ring, and disconnect the wires from the sensor (Figure 8-14).

5. Insert the new desiccant packs into the replacement transducer housing assembly.

6. Carefully insert the new O-ring.

7. Reconnect the wires between the new transducer and the sensor.

8. Carefully replace the transducer housing, making sure to correctly seat the O-ring.

9. Tighten the six screws that attach the transducer housing to the bottom of the sensor.

10. Attach the SD sensor to the mounting arm. Apply thread-lock fluid to the two screws.

11. Connect the sensor cable to the SD sensor and/or data logger.

12. Wrap the sensor cable connection with electrical tape.

Resetting Snow Depth Off-Set
The snow depth will need to be calibrated after replacing the transducer plates. This requires editing the data logger program (DLP). These procedures are described in detail in SOP #5.

Rain Gauge Tipping Bucket (RGTB)
1. Disconnect the tipping bucket from the data logger.

2. If sensor is not being replaced, check that the sensor is level and adjust if necessary by tightening or loosening the horizontal and vertical adjustment screws on the sensor mounting arm. Clean the tipping bucket using a small paintbrush.

3. If the RGTB is being replaced, loosen the horizontal adjustment bolt on the sensor mounting arm and remove the entire RGTB.

4. Install the replacement RGTB.

5. Remove the rubber band used to stabilize the tipping bucket during transport. Install this rubber band on the old RGTB.

6. Level and tighten the RGTB as required by tightening or loosening the horizontal and vertical adjustment screws on the sensor mounting arm.

7. Reconnect the RGTB sensor cable to the data logger.

8. Tip the tipping bucket and count the number of tips. Sample the sensors and view the data logger responses following the procedures outlined below. Verify that “RN” or “RN1” increases by 0.254 mm (0.01 in) for each tip of tipping bucket.

9. Reset the rain count before leaving the station.

Resetting Rain Count
Resetting the rain count should be the last maintenance procedure completed.

1. Remove the power cable connecting the power manager to the data logger.

2. Remove the power cable connecting the power manager to the GOES transmitter.

3. Wait at least 30 seconds.

4. Reconnect the power cable connecting the power manager to the GOES transmitter.

5. Reconnect the power cable connecting the power manager to the data logger.

All-Season Precipitation Gauge Maintenance

The Harding Icefield RAWS is currently the only network RAWS equipped with an all-season precipitation gauge that is filled with an antifreeze solution. The following steps are necessary to maintain the all-season precipitation gauge. This precipitation gauge is filled with an antifreeze solution that is capped with a thin layer of motor oil or hydraulic fluid (to prevent evaporation). This solution is displaced as precipitation falls and exits through a spill point (located below the motor oil). The spill point is attached to a tipping bucket precipitation gauge with a hose. The displaced antifreeze solution is stored in four five-gallon Jerry cans after it passes through the tipping bucket. The antifreeze solution in the standpipe is diluted through the winter and all of it is replaced with a fresh antifreeze solution during annual maintenance.

Equipment Stored On-site

A small amount of equipment is stored on-site in a locked steel Knaack Box. The lock uses Master Lock key number 2001. Contents include:

- Torpedo level
- Bicycle pump with hose
- Tarp (6 x 8 ft)
- Barrel pump with hoses
- Funnel
- Bungee cords (3)
- Hose clamps (3)
- Wide-mouth bottle for oil disposal
- 5-gallon container of antifreeze solution (locked to the box)
- Motor oil or hydraulic fluid

Procedures

1. Disconnect the “Rain” cable from the data logger.

2. Tie back the wind baffles if it windy.

3. Check the fluid level in the standpipe. It should be level with the overflow tube (spill point). If it is significantly lower than the overflow tube, look for a leak. If the level is higher than the overflow tube, unclog the hose to the tipping bucket precipitation gauge (Step 4).

4. If the fluid level is higher than the overflow tube, disconnect the tube from the tipping bucket precipitation gauge cover. Use the bicycle pump (stored on-site in the Knaack box) to blow air into the hose in order to unclog it. Reconnect the tube.

5. Skim the oil mousse off the fluid surface in the standpipe. Use a ladle to scoop out the mousse and deposit it in a wide mouth jar. Continue scooping until most of the mousse is removed. It will be impossible to get all of it. Cap the jar and place it and the ladle in a one-gallon Ziploc bag. It will help if a small hole is drilled through the bottom of the ladle. This allows antifreeze solution to drain through the ladle, leaving the oil mousse in the ladle.

6. Insert the barrel pump into the pump holder mounted on the side of the base of the precipitation gauge tower.

7. Connect the long hose to the suction end of the barrel pump and insert the hose into the standpipe. The hose is long enough to reach to within one-foot of the bottom of the standpipe. Make sure that the hose does not extend all the way to the bottom of the standpipe. (This ensures that oily mousse will not contaminate the outlet tube leading to the tipping bucket).

8. Connect the short drain hose to outlet of the barrel pump and pump the old diluted antifreeze from standpipe into the empty five-gallon plastic containers. As flow starts, a siphon will develop, so have the empty containers open and ready to fill. Stop draining when just a small amount of solution remains in the standpipe (approximately one foot up from the bottom).

9. Remove the steel Jerry cans from the base of the precipitation tower and pour their contents into empty plastic jugs. Return the Jerry cans to their place and reconnect them. Secure the Jerry cans to the tower using cable ties.

10. Remove the steel cover from the tipping bucket mechanism and check that it is level. Adjust if necessary. If replacing the tipping bucket, remove the old tipping bucket, install, and level the replacement tipping bucket. Replace the steel cover.

11. Check to make sure that the standpipe is level and adjust, if necessary, using the adjusting clamps on the upper part of the standpipe.

12. Switch the hoses on the barrel pump connections and begin pumping the fresh antifreeze solution into the standpipe. Fill the standpipe until you hear the tipping bucket begin to tip. This indicates that the standpipe is full.

13. Pour approximately ½ cup of motor or hydraulic oil onto the surface of the fluid inside the standpipe. This helps prevent evaporative loss.

14. Check the cabling and turn-buckles that secure the precipitation gauge tower. Tighten if necessary and secure turn-buckles with cable ties.

15. Untie the wind baffles if they were secured. Make sure that they move freely and adjust them if necessary.

16. Reconnect the “Rain” cable to the data logger. Pour a small amount of water into the standpipe and make sure that the data logger is recording precipitation. Disconnect the “Rain” cable from the data logger.

17. It will take about an hour for the fluid level in the standpipe to stabilize (i.e. for bubbles to rise to the surface). Prior to leaving the station, add water to the standpipe until you hear the tipping bucket begin to tip. After the tipping stops, reconnect the “Rain” cable to the data logger.

18. Reset the rain count following the procedures outlined above.

Disposal of Antifreeze Solution

The oil mousse and any oil skimmed off the spent antifreeze solution should be taken to a hazardous waste facility for disposal. The spent antifreeze solution and oil mousse can be

disposed of at a Kenai Peninsula Borough Hazardous Waste Materials Collection Day, which is held periodically in Seward. There is a small cost for disposal at this venue.

Checking the GOES Antenna Orientation (FWS-12S Data Logger)

1. Launch the FTS Toolbox program on the field laptop computer.

2. Select RAWS from "Current Station" drop-down menu.

3. Click on the "All Functions" button in the upper-right-hand corner of the window and the "Basic" button in the upper-left-hand corner of the window.

4. Click on "Get DataLogger Information" button. (Figure 8-15).

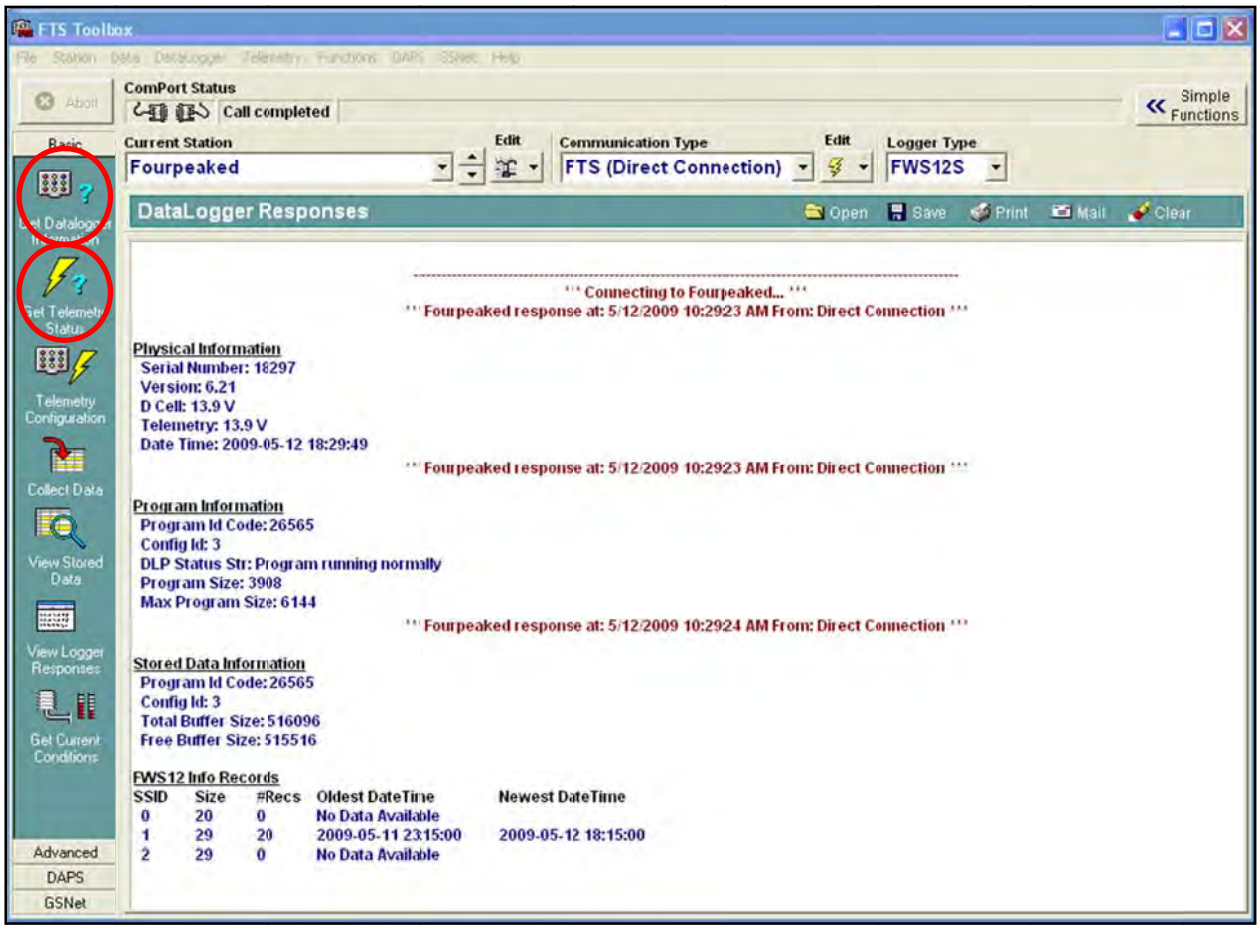


Figure 8-15. Data logger information display.

5. Click on the "Get Telemetry Status" button and confirm the GOES satellite transmission antenna orientation (Figure 8-15). Write the GOES antenna orientation in the field note book or RAWS maintenance field sheet. The values for "true" and "inclination" are used (ignore the "compass" statement). Each network RAWS has a slightly different orientation.

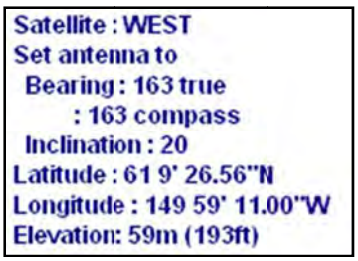


Figure 8-16. GOES antenna orientation information.

6. Use a Brunton compass to verify the GOES antenna orientation. Properly account for magnetic declination.

Sample Sensors and Data Logger Response (FWS-12S Data Logger)

1. Click on the "View Logger Responses" button in the FTS Toolbox program. Click on the "Get Current Conditions" button. The data logger will return the status of each sensor (Figure 8-17).

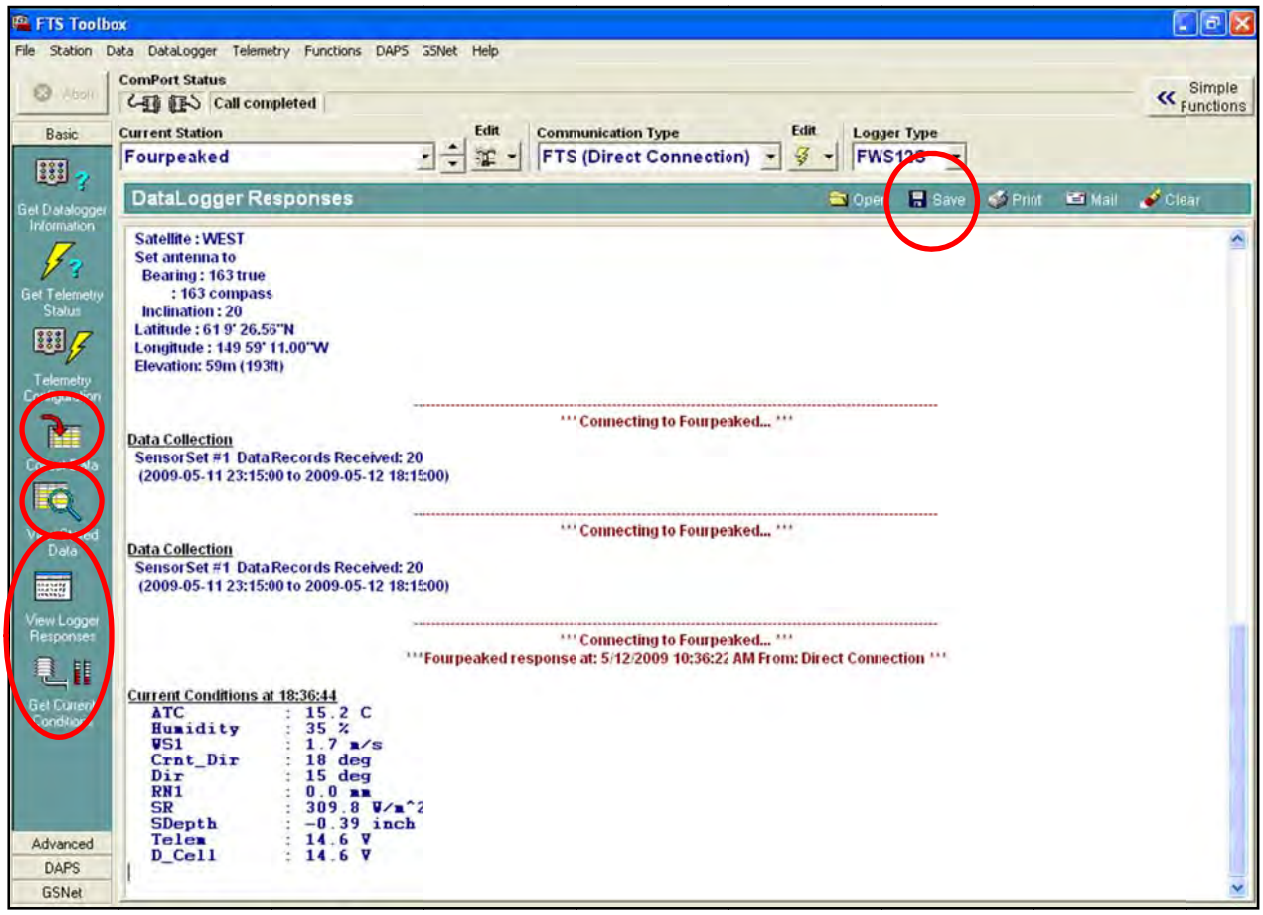


Figure 8-17. Data logger response – current conditions.

2. Check the snow depth reading. Verify that the reported snow depth is between +0.5 and -0.5 inches (if there is no snow beneath the sensor). Adjust the snow depth if needed following the procedures outlined in SOP #5.

3. Click on the “Save” button (Figure 8-17) to save all logger and telemetry responses. This stores important information about the data logger and GOES transmitter that can be used for future troubleshooting if irresolvable problems occur.

4. Click on the “Collect Data” button (Figure 8-17). The collect data dialog window will open (Figure 8-18).

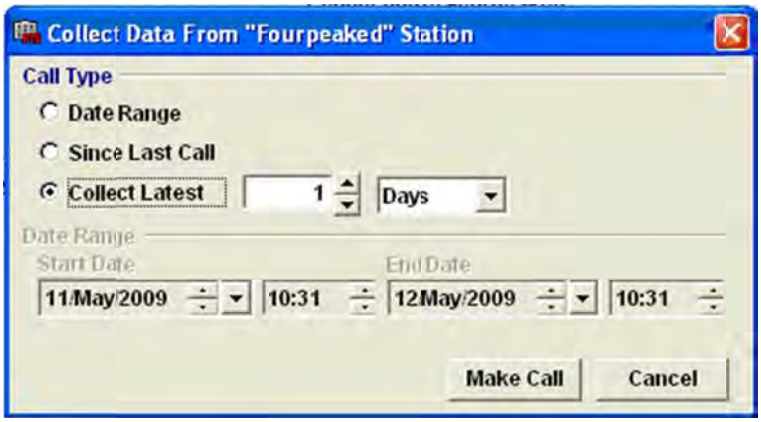
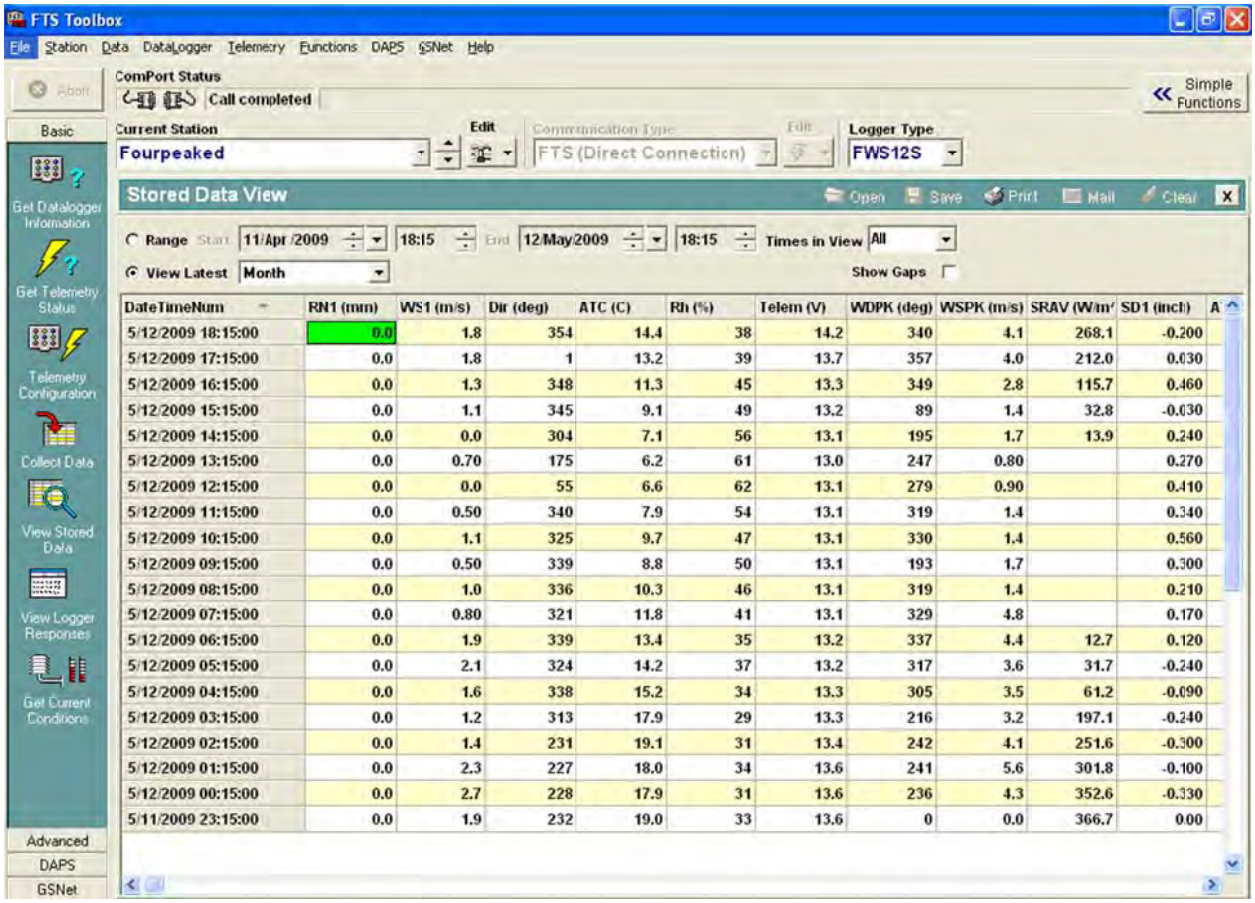


Figure 8-18. Collect data dialog window.

5. Select “Collect Latest” and select one day to retrieve a record of station performance after sensor replacement. Click “Make Call”.

6. Click on the “View Stored Data” button. This will open the stored data view (Figure 8-19).



DateTimeNum	RN1 (mm)	WS1 (m/s)	Dir (deg)	ATC (C)	Rh (%)	Telem (V)	WDPK (deg)	WSPK (m/s)	SRAV (W/m²)	SD1 (incl)
5/12/2009 18:15:00	0.0	1.8	354	14.4	38	14.2	340	4.1	268.1	-0.200
5/12/2009 17:15:00	0.0	1.8	1	13.2	39	13.7	357	4.0	212.0	0.030
5/12/2009 16:15:00	0.0	1.3	348	11.3	45	13.3	349	2.8	115.7	0.460
5/12/2009 15:15:00	0.0	1.1	345	9.1	49	13.2	89	1.4	32.8	-0.030
5/12/2009 14:15:00	0.0	0.0	304	7.1	56	13.1	195	1.7	13.9	0.240
5/12/2009 13:15:00	0.0	0.70	175	6.2	61	13.0	247	0.80		0.270
5/12/2009 12:15:00	0.0	0.0	55	6.6	62	13.1	279	0.90		0.410
5/12/2009 11:15:00	0.0	0.50	340	7.9	54	13.1	319	1.4		0.340
5/12/2009 10:15:00	0.0	1.1	325	9.7	47	13.1	330	1.4		0.560
5/12/2009 09:15:00	0.0	0.50	339	8.8	50	13.1	193	1.7		0.300
5/12/2009 08:15:00	0.0	1.0	336	10.3	46	13.1	319	1.4		0.210
5/12/2009 07:15:00	0.0	0.80	321	11.8	41	13.1	329	4.8		0.170
5/12/2009 06:15:00	0.0	1.9	339	13.4	35	13.2	337	4.4	12.7	0.120
5/12/2009 05:15:00	0.0	2.1	324	14.2	37	13.2	317	3.6	31.7	-0.240
5/12/2009 04:15:00	0.0	1.6	338	15.2	34	13.3	305	3.5	61.2	-0.090
5/12/2009 03:15:00	0.0	1.2	313	17.9	29	13.3	216	3.2	197.1	-0.240
5/12/2009 02:15:00	0.0	1.4	231	19.1	31	13.4	242	4.1	251.6	-0.300
5/12/2009 01:15:00	0.0	2.3	227	18.0	34	13.6	241	5.6	301.8	-0.100
5/12/2009 00:15:00	0.0	2.7	228	17.9	31	13.6	236	4.3	352.6	-0.330
5/11/2009 23:15:00	0.0	1.9	232	19.0	33	13.6	0	0.0	366.7	0.00

Figure 8-19. Stored data view.

7. Verify that at least one line of data has been logged after the sensors were replaced and power was restored to the station. The precipitation field (RN1**)** for the most recent observations should indicate zero because the rain gauge was reset.

Confirm Data Transmissions

Before leaving the RAWS, verify that the station is transmitting data normally. Wait until at least 10 minutes after the station transmit time (Table 8-1). Call the office contact (make these arrangements in advance) using a satellite phone. The office contact will verify that data is being transmitted by examining one or two websites. Provide the office contact with a copy of this SOP (or the WFMI cheat-sheet described below) in advance.

<u>Checking the Western Regional Climate Center Website at the Office</u>

1. Log on to the Western Regional Climate Center (WRCC) website: http://www.wrcc.dri.edu/wraws/akF.html

2. Select the RAWS by clicking on the station name (refer to Table 8-1) on the left-hand-side (LHS) of the screen (Figure 8-2).

3. Click on “Daily Summary” from the menu on the LHS of the screen (Figure 8-4).

4. Select the current date on the “Station Daily Summary” window (Figure 8-20).

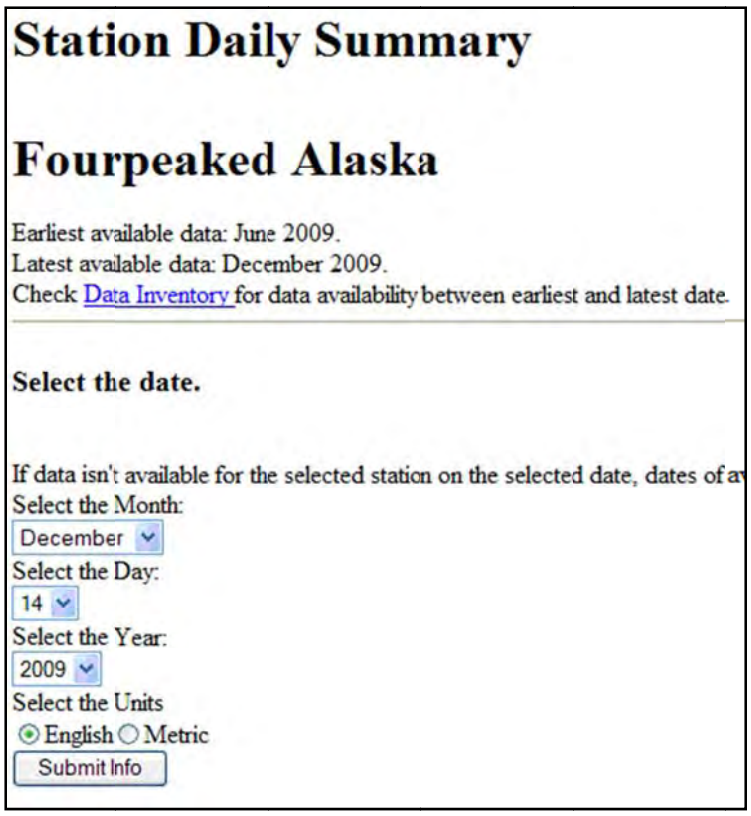


Figure 8-20. Station daily summary window.

5. Examine the current daily summary (Figure 8-21). Verify that a transmission was sent after the station was maintained and powered-up. Relay the most recent observation to the caller in the field. Verify that current observations seems reasonable (i.e. consistent with earlier observations and current weather conditions).

Hour of Day Ending at L.S.T.	Total Solar Rad. ° ly.	Wind Ave. mph	Wind V. Dir. Deg	Wind Max. mph	Air Temperature Mean Deg. F.	Air Temperature Max Deg. F.	Air Temperature Min Deg. F.
1 am	0.0	8.5	52	11.4	30.2	30.4	29.8
2 am	0.0	4.7	50	10.7	30.4	30.6	30.0
3 am	0.0	5.4	61	5.6	30.2	30.4	30.0
4 am	0.0	2.7	341	8.9	29.8	30.4	29.8
5 am	0.0	5.8	52	9.6	30.7	30.6	29.8
6 am	0.0	8.5	33	8.5	30.6	30.7	29.5
7 am	0.0	5.6	32	10.7	30.2	30.6	30.0
8 am	0.0	11.6	45	17.2	31.5	31.5	30.0
9 am	0.0	6.7	37	14.5	30.6	31.5	30.7
10 am	0.3	6.3	40	12.5	31.1	31.1	30.6
11 am	3.1	3.1	47	9.6	31.1	31.6	31.1
12 pm	4.1	7.2	12	4.9	32.2	32.4	31.1
1 pm	5.9	1.8	15	9.6	32.7	32.7	32.0
2 pm	6.8	4.3	241	4.5	30.9	32.7	31.3
3 pm							

Figure 8-21. Current observations. The most recent transmission in this example occurred at (or after) 2 pm (local time).

Checking the Wildland Fire Management Information Website at the Office

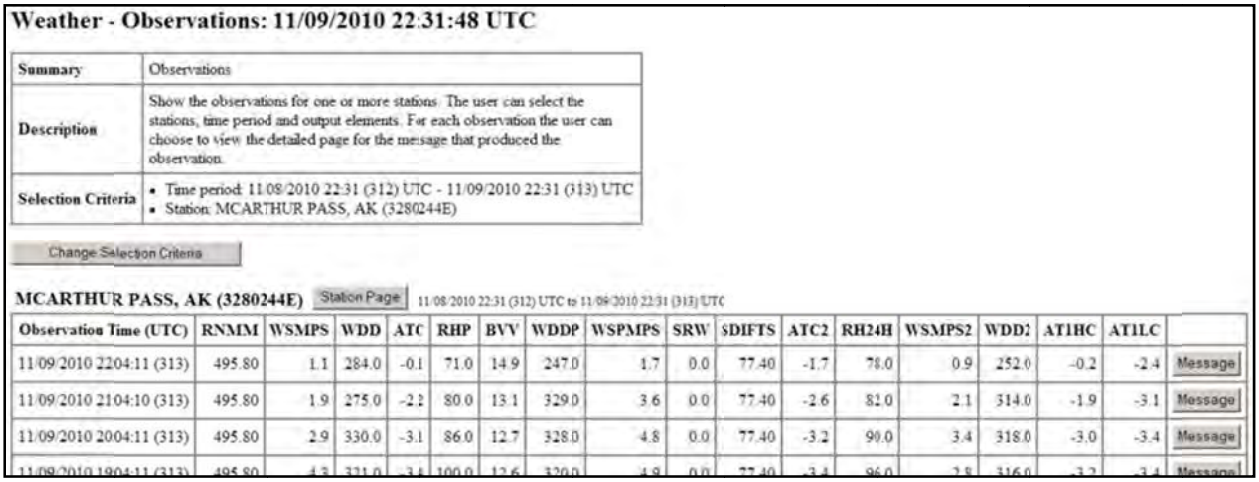
Because there is a delay in posting data to the WRCC website (and sometimes the site is down) it may be useful to check an alternate website. RAWS data is posted more quickly to the Wildland Fire Management Information (WFMI) website and some of the additional information that is available on this website may be helpful to the people doing maintenance in the field.

1. A cheat-sheet for assistants who will be checking the WFMI site is located at: J:\SWAN\Vital_Signs\Climate\Supporting_Documents\Notes

2. Log on to the WFMI website: http://www.nifc.blm.gov. A login/password is required and must be obtained in advance.

3. Select the Weather Module and click on “Select Station”. A list of RAWS will populate in a new window. Select the desired network RAWS by scrolling to and clicking on the station name (refer to Table 8-1 for NESDIS ID).

4. Some station metadata will be displayed for the selected station. Click on "Observations" to view recent data transmissions (Figure 8-22). Verify that a transmission was sent after the station was maintained and powered-up. Note that the observation time listed is Coordinated Universal Time (UTC). Local time is UTC minus eight hours during summer (AKDST) and UTC minus nine hours during winter (AKST). Relay the most recent observation to the caller in the field. Verify that current observations seem reasonable (i.e. consistent with earlier observations) and that all sensors are operating. Acronyms for the meteorological elements are listed in Table 8-2.



Weather - Observations: 11/09/2010 22:31:48 UTC

Summary	Observations
Description	Show the observations for one or more stations. The user can select the stations, time period and output elements. For each observation the user can choose to view the detailed page for the message that produced the observation.
Selection Criteria	• Time period: 11/08/2010 22:31 (312) UTC - 11/09/2010 22:31 (313) UTC • Station: MCARTHUR PASS, AK (3280244E)

Change Selection Criteria

MCARTHUR PASS, AK (3280244E) Station Page 11/08/2010 22:31 (312) UTC to 11/09/2010 22:31 (313) UTC

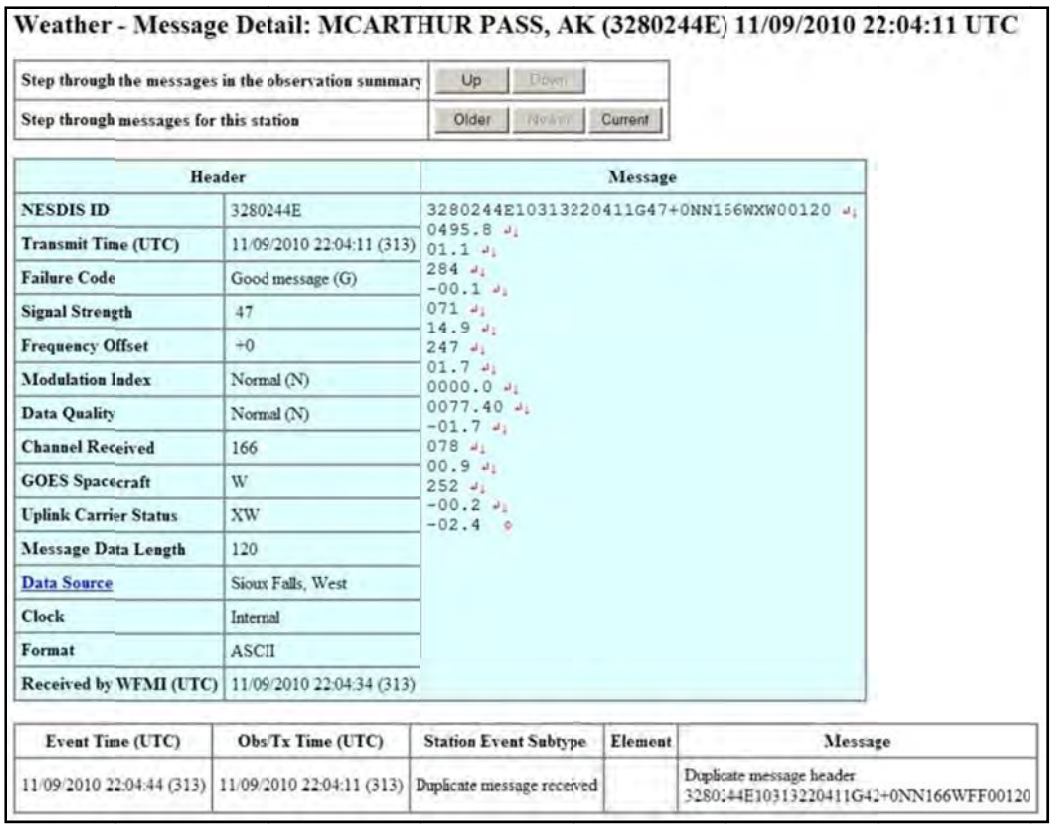
Observation Time (UTC)	RNMM	WSMPS	WDD	ATC	RHP	BVV	WDDP	WSPMPS	SRW	SDIFTS	ATC2	RH24H	WSMPS2	WDD2	AT1HC	AT1LC	
11/09/2010 2204:11 (313)	495.80	1.1	284.0	-0.1	71.0	14.9	247.0	1.7	0.0	77.40	-1.7	78.0	0.9	252.0	-0.2	-2.4	Message
11/09/2010 2104:10 (313)	495.80	1.9	275.0	-2.1	80.0	13.1	329.0	3.6	0.0	77.40	-2.6	81.0	2.1	314.0	-1.9	-3.1	Message
11/09/2010 2004:11 (313)	495.80	2.9	330.0	-3.1	86.0	12.7	328.0	4.8	0.0	77.40	-3.2	90.0	3.4	318.0	-3.0	-3.4	Message
11/09/2010 1904:11 (313)	495.80	4.3	331.0	-3.4	100.0	12.6	329.0	4.9	0.0	77.40	-3.4	96.0	3.8	316.0	-3.2	-3.4	Message

Figure 8-22. Recent weather observations accessed from the Weather Module on WFMI website.

Table 8-2. WFMI weather observation acronyms and definitions.

WFMI acronym	Definition
RNMM	Rain accumulation, cummulative (mm)
WSMPS	10-minute average wind speed (m/s)
WDD	10-minute average wind direction (°)
ATC	Current air temperature (°C)
RHP	Current relative humidity (%)
BVV	Battery voltage (v)
WDDP	Peak wind direction (°)
WSPMPS	Peak wind speed (m/s)
SRW	Solar radiation (W/m^2)
SDIFTS	Snow depth (in)
ATC2	Average air temperature (°C)
RH24H	Average relative humidity (%)
WSMPS2	Average wind speed (m/s)
WDD2	Average wind direction (°)
AT1HC	Maximum air temperature (°C)
AT1LC	Minimum air temperature (°C)

5. More detailed information on the most recent data transmission is accessed by clicking on the corresponding "Message" button. The actual GOES transmission ("Message" in Figure 8-23) and both the converted values and data quality values are displayed (Figure 8-24).



Weather - Message Detail: MCARTHUR PASS, AK (3280244E) 11/09/2010 22:04:11 UTC

Step through the messages in the observation summary	Up / Down
Step through messages for this station	Older / Newer / Current

Header		Message
NESDIS ID	3280244E	3280244E10313220411G47+0NN156WXW00120 ↵ 0495.8 ↵ 01.1 ↵ 284 ↵ -00.1 ↵ 071 ↵ 14.9 ↵ 247 ↵ 01.7 ↵ 0000.0 ↵ 0077.40 ↵ -01.7 ↵ 078 ↵ 00.9 ↵ 252 ↵ -00.2 ↵ -02.4 ↵
Transmit Time (UTC)	11/09/2010 22:04:11 (313)	
Failure Code	Good message (G)	
Signal Strength	47	
Frequency Offset	+0	
Modulation Index	Normal (N)	
Data Quality	Normal (N)	
Channel Received	166	
GOES Spacecraft	W	
Uplink Carrier Status	XW	
Message Data Length	120	
Data Source	Sioux Falls, West	
Clock	Internal	
Format	ASCII	
Received by WFMI (UTC)	11/09/2010 22:04:34 (313)	

Event Time (UTC)	Obs/Tx Time (UTC)	Station Event Subtype	Element	Message
11/09/2010 22:04:44 (313)	11/09/2010 22:04:11 (313)	Duplicate message received		Duplicate message header 3280244E10313220411G42+0NN166WFF00120

Figure 8-23. Message details accessed from Weather Module on WFMI website.

Element	Observation Pattern	Observation Number 23 11/09/2010 22:04:11 (313) UTC		
		Raw Data	Converted Value	Data Quality
Rain accumulation	All Obs	0495.8	495.80	Good
Windspeed	All Obs	01.1	1.1	Good
Wind Direction	All Obs	284	284.0	Good
Air Temperature	All Obs	-00.1	-0.1	Good
Relative Humidity	All Obs	071	71.0	Good
Battery Voltage	All Obs	14.9	14.9	Good
Wind Direction, Peak	All Obs	247	247.0	Good

Figure 8-24. Raw observations and converted values for single data transmission accessed from Weather Module on WFMI website.

Photographing the Station

Take photographs in order to document the landscape adjacent to the RAWS and to document the condition of the station. Use only one designated camera to collect photos. This helps to eliminate duplicative efforts and unnecessary images. Make sure to document the general condition of the RAWS and also any damage to the station. Take photographs of the station in the following orientations:

1. Beginning directly north of the RAWS. Step back ten meters and take one picture oriented south with the RAWS in the foreground.

2. Maintain the 10-m distance from the RAWS. Move 45˚ in a clockwise direction, to the northeast quadrant and take another photograph towards the southwest with the RAWS in the foreground. Continue moving around the RAWS until you have taken a total of eight landscape photographs with the RAWS in the foreground of each photo. These eight photographs will be looking S, SW, W, NW, N, NE, E, and SE.

3. It may be useful to take a picture of a numbered drawing of the photograph orientations in your field notebook to help keep track of photograph orientations.

Post-Maintenance Tasks

Organize and Rename Photographs

After returning to the office, copy digital photographs onto to the network server. The file naming structure for digital photographs associated with the climate monitoring vital sign is included in SOP #9.

These standards are also located on the SWAN server at:
\SWAN\Vital_Signs\Climate\Photos\Readme.pdf

Archiving Raw Data

After returning to the office archive the data that was downloaded from each network RAWS on the network server. Copy raw data to the following directory:

\SWAN\Vital_Signs\Climate\Stations\RAWS_Station_Name\Data_Archive\

Where: “Station_Name” is that shown in Table 8-1.

Raw (downloaded) station data files are named using the following standardized format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].[ext]

Where:

[TYPE] refers to the station type (e.g. RAWS)
[NAME] is the four letter acronym for the station name (refer to Table 8-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage “raw”
[.ext] is the file type (e.g. .csv)

Example: RAWS_FOUR_20071001_20080930_20081101raw.csv

Scan and Archive Field Data Sheets

Scan completed field data sheets and store them on the SWAN server at:

\SWAN\Vital_Signs\Climate\Stations\StationName\Maintenance\YYYYMMDD\

Completed field data sheets are named using the following standardized format:

[Author]_[PARK]_[name]RAWSmaintFieldSheet_[YYYYMMDD].[ext]

Where:

[Author] is the author’s last name and first initial
[PARK] is the four letter park code
[name] is the station name listed in Table 8-1
[YYYMMDD] is the year, month, and date of maintenance
[.ext] is the file type (e.g. .doc)

Example: GiffenB_KATM_snlaRAWSmaintFieldSheet_20080615.doc

Preparing Trip Reports

A trip report is written to document network RAWS maintenance. Reports should describe what occurred during the maintenance visit and what issues or problems (if any) occurred. Any suggested improvements for the next maintenance trip should also be included. An example of a trip report is included in Figure 8-25.

Annual Maintenance
Snipe Lake Weather Station

Date: June 17, 2011
Time of visit: 1100-1600
Personnel: Chuck Lindsay (SWAN), Leslie Witter (SWAN)
Mode of transport: C-185 (on floats) from King Salmon (park aircraft)

Purpose of trip: Annual maintenance

Weather: Mostly sunny, 60 F, Winds SE 12 mph gusting to 22 mph, snow 0" on ground

Sensors removed
Air temperature - relative humidity
Rain gauge tipping bucket
Solar radiation
Snow depth SR50A

Sensors installed
Air temperature - relative humidity
Rain gauge tipping bucket
Solar radiation
Snow depth SR50A
Soil temperature sensors (two)
Analog input module

Narrative
There were no indications of any problems prior to station maintenance. Sensor drift resulted in snow depth reported one inch higher than actual. Scheduled maintenance called for replacement of AT-RH, RG-TB, SR, and SD sensors. Initial inspection of the weather station showed there were no issues. All data were downloaded from the station. The AT-RH sensor was replaced. The tipping bucket was replaced, tested, and the rain count was reset to zero. The solar radiation sensor was replaced. The snow depth sensor was replaced. Snow depth was zeroed to an average reading of -0.5 inches to account for fluctuation without reporting misleading snow depth readings. Soil temperature sensors were installed at depths of 4 inches (10 cm) and 20 inches (50 cm) (Figures 1 to 3). Soil at this location is a gravelly silt loam. The organic horizon and common rooting depth extends to a depth of approximately 4 inches (10 cm). A new data logger program (DLP) capable of operating the soil temperature sensors was uploaded. The current DLP operating is SNLA_DLP_SR50A_SoilTemp_20110617.prg. All bolts were checked and tightened if loose and cables were taped and zip-tied. Station observations and GOES transmission quality were checked before departure. Observations and transmissions were verified from the WFMI website by Ginger Irvine in Port Alsworth and relayed by satellite phone. The desiccant pack and memory card were replaced in the time lapse camera. The camera was refocused at the same zoom. Before departure the station was photographed (Figure 4) from eight directions (every 45°) and the inside of the instrument enclosure (Figure 5) was also photographed.

Figure 8-25. Partial example of a maintenance trip report.

Trip reports are stored on the SWAN server in the following directory:

\SWAN\Vital_Signs\Climate\Stations\RAWS_Station_Name\Maintenance\YYYYMMDD

Where:

"Station_Name" is that shown in Table 8-1.
"YYYYMMDD" is the year month and date of the maintenance

The file naming convention for these trip reports is:

AuthorLastNameFirstInitial_PARK_BriefDescription_YYYYMMDD.ext

Where:

[AuthorLastNameFirstInitial] is self explanatory
[PARK] is the four letter acronym identifying the park unit
[BriefDescription] is self explanatory (e.g. "mcpaRAWSmaintTripReport")
[YYYYMMDD] is the year, month, and date of the trip report
[.ext] is the file extension (e.g. .doc)

Example: LindsayC_LACL_snlaRAWSmaintTripReport_20100409.doc

Annual maintenance reports have been published in the Natural Resource Publication Mangement (NRPM) Natural Resource Data Series (NRDS). These reports are simple to generate, although they need to be formatted according to the NRPM standards. This report incorporates the trip report narrative described above, photos with captions, and a table with sensor metadata (model number, serial and asset numbers, and dates of service). These reports are useful because they are the only readily accessible public record of network RAWS maintenance.

Updating Sensor Tracking Worksheet

Document station maintenance using the appropriate sensor tracking worksheet. Procedures for updating the sensor tracking worksheet are explained in SOP #7.

Enter the date of maintenance, model, and serial numbers for replacement sensors in the appropriate sensor tracking worksheet (Figure 8-26).

Station Name	Snipe Lake							
Station Deployment Date	07-Jur-08							
Annual Maintenance			Deployment Date (mm/dd/yy)	Date of Maintenance (mm/dd/yy)	Date of Maintenance (mm/dd/yy)	Date of Maintenance (mm/dd/yy)	Date of Maintenance (mm/dd/yy)	Date Mainter (mm/d
		Minimum Replcaement Schedule (yrs)	2008/06/07	05/27/09				
Sensor	Model		2008	2009	2010	2011	2012	201
Wind Speed	WS-013-30	2	18383					
Wind Direction	WD-023-30	2	18387					
Rain Guage/Tipping Bucket	RG-T-TR	3	17198					
Temperature/Relative Humidity	THS-3-1	1	29849	32358				
Solar Radiation	SDI-SR-PYR	3	13970					
Snow Depth	SDI-SR50A	3	28267					
GOES Transmitter	G5	as needed	18304					
SDI Expansion Port	SDI-EXP-KW-3	as needed	18272					
Power Manager	POWER-MANAGER	as needed	17032					
Datalogger	FWS12S-DATA-KW	as needed	13521					
Cabinet	WP-ENCL-KW1	as needed	18336					
Battery	BATTERY-12V-SE	3	28273					
Battery	BATTERY-12V-SE	3	28277					
GPS Antenna	GPS-ANTENNA-ICE	as needed	18321					
GOES Anterna	Yagi	as needed	14033					
Solar Panel	SPS-50W-PM	as needed	14262					

Figure 8-26. Sensor tracking worksheet. Highlighted cells indicate upcoming sensor replacement. The date of maintenance is recorded. Sensor serial numbers are used to indicate that a sensor was replaced.

Reporting Maintenance to the RAWS Depot

The National Interagency Fire Center (NIFC) RAWS Depot tracks sensors on all fire and resource RAWS stations throughout the nation using the Wildland Fire Management Information (WFMI) system an online shared database containing documentation of annual calibration and maintenance. Complete the following steps to update WFMI metadata for network RAWS.

1. If you don't have access to WFMI, complete a user access request form. The form is available at: https://www.nifc.blm.gov/weather/WfmiWeatherMaintUserAccessForm.pdf. Make sure to specify that you need "edit" access.

2. Go to: http://www.nifc.blm.gov/

3. Click "Proceed to Wildland Fire Management Information home page", click "Logon" and then "I agree".

4. Enter your username and password. Click "Logon" and "Continue".

5. Select the "Weather" button and then click the "Select Station" button.

6. Scroll down and click on the desired station name (Table 6-1) from the list.

7. Select the "NAMS – Post-trip Update" button.

8. Check all the asset numbers for sensors that were replaced (Figure 8-27).

9. Update the “Last Annual Maintenance Date”.

10. Update the “Last Repaired Date” if the maintenance was unscheduled.

11. Update the “Tipping Bucket Zeroed Date”.

12. Update the name of the “DCP program” to “Custom”.

13. Update the “DCP Firmware” if it has changed, which requires replacing a microchip.

14. Enter a narrative entry for the maintenance, which can be copied and pasted from the maintenance report described and shown in Figure 8-25.

15. Click the “Submit Post-trip Update” button.

If you have questions, contact the RAWS Depot Help Desk at: 208-387-5475.

For those items with New Asset Number check-boxes, select the number of the new asset that was installed on the station (by clicking the check-box). If there are multiple assets per item, do not select more assets than the quantity of the item on the station.

Item Number	Item Description	Quantity on Station	New Asset Number
38153	Antenna, (FTS) GOES - 420-70	1	
38156	Antenna, GPS - Ice Rated - (FTS) - GPS-ANTENNA-ICE white half egg shaped	1	☐ 31482
EX-1000	Battery, Sealed deep cycle (FTS) Order in WFMI then call RAWS before you go to store - 208-387-5838	1	
40017	Cable, 013/014 WS (FTS) - normal length is 35', if you need longer, please specify	1	

Figure 8-27. RAWS Service/Inventory Documentation for CMMS form.

Sending Station Data to the Western Regional Climate Center

The Western Regional Climate Center (WRCC) serves as the permanent archive for all RAWS data, including data from network RAWS. Throughout the year, some or all network RAWS miss data transmissions, largely because of ice that develops on the GOES antenna. This results in an incomplete archive record of weather observations at the WRCC. This data is not lost because it is recovered from each RAWS during maintenance and delivered to the WRCC.

Procedures

1. Do not modify the archived data; make a working copy located on the SWAN server in the following directory:

\SWAN\Vital_Signs\Climate\Stations\RAWS_Station_Name\Data_Edited\

Where: “Station_Name” is that shown in Table 8-1.

These working copies of the raw data are named using the following standardized format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].[ext]

Where:

[TYPE] refers to the station type (e.g. RAWS)
[NAME] is the four letter acronym for the station name (refer to Table 8-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was modified and the file stage “toWRCC”
[.ext] is the file type (e.g. .csv)

Example: RAWS_FOUR_20071001_20080930_20081101toWRCC.csv

2. Minor modification of the raw comma delimited data files is required before they are sent to the WRCC. An example of the data before modification is shown in Figure 8-28.

	A	B	C	D	E	F	G	H	I
1	Station	DateTime	RN	WS	Dir	ATC	Rh	Telem	WDPk
2			mm	m/s	deg	C	%	V	deg
3	McArthur Pass	2010/05/29 21:02	0	4.4	118	12	66	14.6	
4	McArthur Pass	2010/05/29 22:02	0	5.6	116	11.1	72	14.5	
5	McArthur Pass	2010/05/29 23:02	0	4.8	105	12	70	14.6	
6	McArthur Pass	2010/05/30 00:02	0	4.4	85	11.3	66	14.2	
7	McArthur Pass	2010/05/30 01:02	0	6.2	107	10.4	71	14	
8	McArthur Pass	2010/05/30 02:02	0	7.7	100	10.9	65	14.1	
9	McArthur Pass	2010/05/30 03:02	0	6.8	102	11	65	14	

Figure 8-28. Portion of a copy of the archived raw data from the Contact Creek RAWS before modification.

3. Insert a column after the “DateTime” column.

4. Parse the “DateTime” column by selecting it and converting “text to columns” using either delimited or fixed-width options.

5. Rename and convert the “Date” column into YYYY/MM/DD format.

6. Rename and convert the “Time” column into hh:mm:ss format.

7. Insert “UTC” into the units row for both Date and Time columns.

8. Save the data in a comma delimited text file using the file naming format shown above.

9. An example of the data after modification is shown in Figure 8-29.

	A	B	C	D	E	F	G	H	I	J
1	Station	Date	Time	RN	WS	Dir	ATC	Rh	Telem	WDPK
2		UTC	UTC	mm	m/s	deg	C	%	V	deg
3	McArthur Pass	2010/05/29	21:02:50	0	4.4	118	12	66	14.6	
4	McArthur Pass	2010/05/29	22:02:50	0	5.6	116	11.1	72	14.5	
5	McArthur Pass	2010/05/29	23:02:50	0	4.8	105	12	70	14.6	
6	McArthur Pass	2010/05/30	00:02:50	0	4.4	85	11.3	66	14.2	
7	McArthur Pass	2010/05/30	01:02:50	0	6.2	107	10.4	71	14	
8	McArthur Pass	2010/05/30	02:02:50	0	7.7	100	10.9	65	14.1	
9	McArthur Pass	2010/05/30	03:02:50	0	6.9	102	11	65	14	

Figure 8-29. Portion of a copy of the archived raw data from the Contact Creek RAWS after modification.

10. Send the modified data to the Western Regional Climate Center (WRCC) by email or FTP. Contact Greg McCurdy (Greg.McCurdy@dri.edu) at the WRCC.

11. In the future, data should be edited for data quality control before sending it to the WRCC. Standards for this process will need to be developed in collaboration with the WRCC.

SOP #9: Data Management
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for processing and managing data from climate monitoring stations in the SWAN and for organizing digital photographs. Climate stations are managed by six different climate monitoring programs (e.g. RAWS, COOP, etc), which are in turn administered by various federal agencies (e.g. NOAA, USDA, etc). These climate monitoring programs maintain the official repositories for climate data from stations monitored by the SWAN. Climate data is primarily hosted in national databases managed by the National Climatic Data Center (NCDC) and the Western Regional Climate Center (WRCC). Because accessing climate data can be tedious, data from these stations will also be archived on the SWAN server. Local storage of climate data in a standardized format will increase ease of data access and better facilitate their use in the analyses of other vital signs. Processed climate data will also be uploaded to the I&M enterprise climate database. Detailed procedures for downloading and processing station data from the different national climate databases are included in SOPs #10-16. Detailed procedures for uploading climate data to the I&M enterprise climate database are included in SOP #18.

Data Model

The procedures in the SOP have been developed so that climate data from multiple sources can be efficiently downloaded, archived, summarized (down sampled) when necessary, and made available for analysis (Figure 9-1). Procedures for accessing, downloading, and processing climate data from the six different sources are documented in SOPs # 10-16. Downloaded data are archived in their native format before processing.

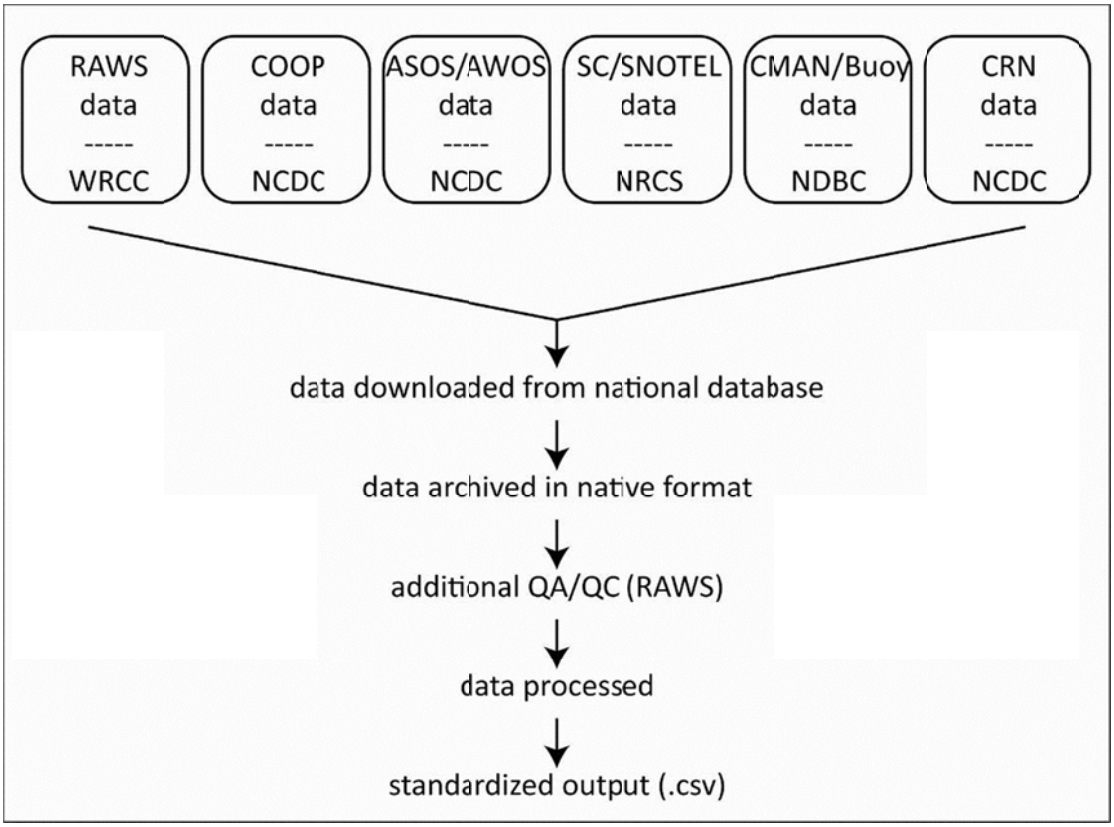


Figure 9-1. Data flow from national climate databases to final SWAN format.

National Climate Databases

Data from climate monitoring stations in the SWAN are stored in six different national climate databases. Passwords are sometimes required and can be obtained from the PI. The current access pathways are:

- RAWS: *RAWS Climate Archive* – Western Regional Climate Center (WRCC)
    - http://www.raws.dri.edu/index.html
- COOP: *Global Historical Climatology Network (GHCN-Daily)* – National Climatic Data Center (NCDC)
    - ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/all/
- ASOS/AWOS: *Quality Controlled Local Climatological Data* (QCLCD) – NCDC
    - http://cdo.ncdc.noaa.gov/qclcd/

- Snow Course and SNOTEL: *Snow Course Data and SNOTEL Data & Products* – National Water & Climate Center, Natural Resources Conservation Service (NRCS), Alaska Snow Water and Climate Service (NRCS)
    - http://www.wcc.nrcs.usda.gov/snowcourse/
    - http://www.wcc.nrcs.usda.gov/snow/
    - http://ambcs.org/dbArchive.htm
- C-MAN and moored buoy: *Standard Meterological Historical Data,* National Data Buoy Center (NDBC)
    - http://www.ndbc.noaa.gov/
- CRN: *CRN FTP Hourly02 Stream* – NCDC
    - ftp://ftp.ncdc.noaa.gov/pub/data/uscrn/products/hourly02/

Archiving Original Data

After climate data is downloaded it is first archived in native format on the SWAN server. ASOS and AWOS data are modified slightly prior to archiving – monthly data are compiled into a yearly data set. Archived data are organized by hydrologic year (e.g. October 1, 2007 to September 30, 2008 is the 2008 hydrologic year) and stored at:

\SWAN\Vital_Signs\Climate\Data\Downloads\

Files are organized using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].[ext]

Where:

[TYPE] refers to the station type (e.g. RAWS, COOP, etc.)
[NAME] identifies the climate monitoring station
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage “dwnld”
[.ext] is the file type (.csv, .txt, .dly)

Example: RAWS_HAIC_20071001_20080930_20081101dwnld.csv

The acronyms used in file naming for [TYPE] and [NAME] are described in Table 9-1.

Table 9-1. Climate stations monitored by the SWAN. The station names are those that are used by the parent climate monitoring network. The acronyms are unique and are not necessarily those used by other agencies. Data file naming uses both station type [TYPE] and acronym [NAME] (e.g. this differentiates between COOP POAL and SNCO POAL).

Station name	Station [TYPE]	Acronym [NAME]	ID no.	Lat. N	Lon. W	Elev ft.	Station start
Brooks Camp	SNCO	BRCA	55J01	58.533	155.767	150	1995
Chigmit Mountains	RAWS	CHMO	FA6544FC	60.2249	153.4675	4658	7/2009
Contact Creek	RAWS	COCR	32803738	58.2076	155.9225	657	6/2008
Coville	RAWS	COVI	3280B12C	58.8025	155.5629	1567	6/2008
Drift River Terminal	CMAN	DRRI	DRFA2	60.5533	152.1367	53	9/1999
Exit Glacier	SNCO	EXGL	49L18	60.1903	149.6212	400	9/1988
Exit Glacier	SNTE	EXGL	49L18	60.1903	149.6212	400	7/2011
Fishtrap Lake	SNCO	FILA	54L02	60.4913	154.3296	1800	8/1991
Fourpeaked	RAWS	FOUR	328135C2	58.7057	153.5179	1074	6/2009
Harding Icefield	RAWS	HAIC	FA656210	60.1325	149.7820	4335	7/2004
Hickerson Lake	RAWS	HILA	3280C7BC	59.9148	152.8925	1048	6/2008
Homer Airport	COOP	HOAI	503665	59.6428	151.4872	64	9/1949
Homer Airport	ASOS	HOAI	25507	59.6428	151.4872	64	12/1997
Iliamna Airport	COOP	ILAI	503905	59.7539	154.9069	183	9/1949
Iliamna Airport	ASOS	ILAI	25506	59.7539	154.9069	183	12/1997
Kenai Airport	COOP	KEAI	504546	60.5797	151.2391	91	9/1949
Kenai Airport	ASOS	KEAI	26523	60.5797	151.2391	91	5/1999
King Salmon Airport	COOP	KISA	504766	58.6829	156.6563	47	7/1955
King Salmon Airport	ASOS	KISA	25503	58.6829	156.6563	47	6/1998
King Salmon 42 SE	CRN	KS42	USW00025522	58.2076	155.9225	657	8/2012
McArthur Pass	RAWS	MCPA	3280244E	59.4726	150.3337	1266	6/2008
Nuka Glacier	SNTE	NUGL	50K06S	59.6943	150.7110	1250	10/1990
Pedersen Lagoon	RAWS	PELA	326AD012	59.8944	149.7308	624	8/2011
Pfaff Mine	RAWS	PFMI	FA65578A	59.1109	154.8367	2018	6/2008
Pilot Rock	CMAN	PIRO	PILA2	59.7417	149.4700	79	12/1999
Port Alsworth	COOP	POAL	507570	60.2033	154.3164	260	6/1960
Port Alsworth	SNCO	POAL	54L01	60.1921	154.3272	270	10/1991
Port Alsworth	RAWS	POAL	FA6102CC	60.1958	154.3200	321	6/1992
Port Alsworth 1 SW	CRN	P1SW	USW00026562	60.1958	154.3198	315	9/2009
Port Heiden	AWOS	POHE	25508	56.9500	158.6167	95	10/2007
Seward	COOP	SEWA	508371	60.1039	149.4439	110	9/1949
Seward Airport	ASOS	SEAI	26438	60.1283	149.4167	22	4/1997
Seward 8NW	COOP	S8NW	508375	60.1883	149.6275	410	6/1983
Shelikof Strait	BUOY	SHST	46077	57.9200	154.2542	0	10/2005
Snipe Lake	RAWS	SNLA	328041A8	60.6103	154.3199	2315	6/2008
Stoney	RAWS	STON	FA600036	61.0008	153.8958	1250	6/1992
Telaquana Lake	COOP	TELA	TBD	60.984	153.924	1250	6/1997
Telaquana Lake	SNCO	TELA	53L01	60.983	153.917	1550	8/1991
Three Forks	SNCO	THFO	55J02	58.367	155.383	900	1995
Upper Twin Lakes	SNCO	UTLA	53L02	60.650	153.800	2000	8/1991

Data Quality Control (QA/QC)

Network RAWS data from the WRCC requires additional data quality control (QA/QC). This is conducted manually in a spreadsheet program by employing domain checks, which follow MesoWest data quality guidelines, and referencing the SWAN station maintenance and performance tracking database. Any missing or suspect data are marked with data quality flags. These procedures are described in SOP# 10. All other data have passed rigorous data quality control conducted by their respective host climate monitoring programs (e.g. NOAA National Climatic Data Center). The customized data processing programs described below standardize any native data quality control that is included with the data. Any flagged data values are replaced with the common identifier "-9999".

Any data that receives additional data quality control (i.e. RAWS data) are organized by hydrologic year and stored at on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\QAQC

Files are organized using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].[ext]

Where:

[TYPE] refers to the station type (e.g. RAWS, COOP, etc.)
[NAME] identifies the climate monitoring station
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date of data quality control and the file stage "qaqc"
[.ext] is the file type (e.g. .csv, .txt, and .dly)

Example: RAWS_HAIC_20071001_20080930_20081101qaqc.csv

Data Processing

With the exception of Snow Course data, data are processed using customized data processing programs that convert data to a standardized format in both metric and U.S. customary units. To facilitate data analysis and reporting, climatic data are summarized (down sampled) to hourly (from sub-hourly, if necessary), daily, monthly, and yearly measures.

Programs

The following data processing programs are used to produce uniform hourly, daily, monthly, and yearly tables based on the varying observation rates found in RAWS, COOP, SNOTEL, ASOS & AWOS, C-MAN and Moored Buoys, and CRN (hourly summaries are not available for daily COOP data):

RAWSdata_FormatSummarizeConvert.py
COOPdata_FormatSummarizeConvert.py
SNTEdata_FormatSummarizeConvert.py
ASOSandAWOSdata_FormatSummarizeConvert.py
CMANandBUOYdata_FormatSummarizeConvert.py
CLRNdata_FormatSummarizeConvert.py

Program Requirements

A Python interpreter is necessary and Tkinter bindings are strongly recommended. Python comes standard on Mac OS X, most Unix variants, and is installed along with ESRI ArcGIS on Windows OS. Python is freely available for download from www.python.org. Tkinter is generally included by default in mainstream distributions of Python.

These programs were designed using Python 2.5, and should work on newer versions within the 2.x development branch. The Python 3.x branch represents a different language, and requires some (minor) modification of these programs in order for them to work. The 2.x branch was used for these programs because (at the time) it was better-supported, more ubiquitous as a default install, and slightly faster.

Input Format

Input formats for each of the five programs is more or less strictly defined, and is based on the formats in which corresponding data are available. Specific input format requirements are documented in SOPs # 10-16 and in each program's header – which can be viewed using a text editor or the integrated development environment for Python (IDLE).

The data processing programs are capable of automatically naming output files assuming that input files are named following the pattern:

[TYPE]_[NAME]_XXX*.[ext]

Where:

[TYPE] refers to the type of data (ASOS, CRN, etc.)
[NAME] identifies the climate monitoring station name
"XXX*" can be any numeric or character string, but should be the date range and version of the data:
[startdate]_[enddate]_[filedatestage] in the format:
YYYYMMDD_YYYYMMDD_YYYYMMDDstage
[ext] is the file extension:
".csv" used for RAWS, ASOS &AWOS, CMAN & Buoy,
".dly" used for COOP data
".txt" used for CRN data

For example, "AWOS_PTHE_20081001_20090930_20091001dwnld.csv" would fit the expected pattern. If the format of the name is incorrect, the program will still run, but the outputs will be named "unknown_[firstdate]_[lastdate].csv." If the extension is incorrect, the program will attempt to run, but be warned that the input format might be wrong.

Output Format

Output file names follow the pattern outlined below. File versioning information is automatically generated and each output file name will need to be appended with this information. Output file names are automatically appended to indicate sampling interval and units. Summaries are provided at the daily (_dy), monthly (_mo), and annual (_wyr) time scales and in both metric (_m) and U.S. customary (not appended with "_m") units. Output data are organized by hydrologic year and stored on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Ouput

Files are organized using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[sample]_[units]_[filedatestage].[ext]

Where:

[TYPE] refers to the station type (e.g. RAWS, COOP, etc.)
[NAME] identifies the climate monitoring station
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[sample] is the sampling frequency
- _hr is hourly data
- _dy is daily summary
- _mo is monthly summary
- _wyr is hydrologic year summary

[units] are the units used
- _m is metric
- not specified is U.S. customary units

[filedatestage] is the date of data processing and the file stage "fromPy"
[.ext] is the file type (.csv)

Example: RAWS_HAIC_20071001_20080930_dy_m_20081101fromPy.csv

The standard output format from the five data processing programs is described in Table 9-2. Not all climatic elements are available for all station types but the output format is identical regardless of station type.

Table 9-2. Output format used for available climatic elements from the data processing programs.

Header	Units	Units (metric)	Description
OBSV	yyyymmddhhmm		Date and time of observation
%OBSV	%	%	% valid data transmissions during sampling interval
DATE/TIME	yyyy/mm/dd hh:mm		Date and time of observation (Excel/SigmaPlot format)
ATAV	°F	°C	Mean temperature during sampling interval
%ATAV	%	%	% valid temperature observations during sampling interval
ATMX	°F	°C	Maximum temperature during sampling interval
%ATMX	%	%	% valid temperature observations during sampling interval
ATMN	°F	°C	Minimum temperature during sampling interval
%ATMN	%	%	% valid temperature observations during sampling interval
TOBS	°F	°C	Mean temperature at time of observation during sampling interval
%TOBS	%	%	% valid TOBS during sampling interval

Table 9-2 continued. Output format used for available climatic elements from the data processing programs.

Header	Units	Units (metric)	Description
WSAV	mph	m/s	Mean wind speed during sampling interval (scalar average)
%WSAV	%	%	% valid wind speed observations during sampling interval
WDAV	deg	deg	Mean wind direction during sampling interval (time-averaged using sum of unit vectors from each observation independent of wind speed)
WSPK	mph	m/s	Maximum wind speed (instantaneous) during sampling interval
%WSPK	%	%	% valid wind speed observations during sampling interval
RHAV	%	%	Mean relative humidity during sampling interval
%RHAV	%	%	% valid relative humidity observations during sampling interval
STPR	in Hg	hPa	Mean atmospheric pressure at station during sampling interval
%STPR	%	%	% valid atmospheric pressure observations during sampling interval
SLPR	in Hg	hPa	Mean atmospheric pressure at sea level during sampling interval
%SLPR	%	%	% valid SLPR observations during sampling interval
VISI	mi	km	Mean visibility during sampling interval
%VISI	%	%	% valid visibility observations during sampling interval
SRAD	Ly	Wh/m^2	Average solar radiation during hourly sampling interval, cumulative solar radiation during daily, monthly, and yearly sampling interval
%SRAD	%	%	% valid solar radiation observations during sampling interval
PRCP	in	mm	Total precipitation during sampling interval
%PRCP	%	%	% valid precipitation observations during sampling interval
PCUM	in	mm	Cumulative precipitation during period of summary (e.g. hydrologic year)
SNOW	in	mm	Total snow accumulation during sampling interval
%SNOW	%	%	% valid snow accumulation observations during sampling interval
SD	in	mm	Mean snow depth during sampling interval
%SD	%	%	% valid snow depth observations during sampling interval
WTAV	°F	°C	Mean sea water temperature during sampling interval
%WTAV	%	%	% valid sea water temperature observations during sampling interval
WVHT	ft	M	Mean wave height during sampling interval
%WVHT	%	%	% valid wave height observations during sampling interval
AWPD	sec	sec	Mean wave period during sampling interval
%AWPD	%	%	% valid wave period observations during sampling interval
DWPD	sec	sec	Mean maximum wave energy (period) during sampling interval
%DWPD	%	%	% valid DWPD observations during sampling interval
MWVD	deg	Deg	Mean wave direction (associated with DWPD) during sampling interval
%MWVD	%	%	% valid MWVD observations during sampling interval
TIDE	ft	m	Mean tide height during sampling interval
%TIDE	%	%	% valid observations during sampling interval
STAV	°F	°C	Mean ground surface (skin) temperature during sampling interval
%STAV	%	%	% valid STAV observations during sampling interval
SOT1	°F	°C	Mean soil temperature #1 during sampling interval (refer to station info.)
%SOT1	%	%	% valid SOT1 observations during sampling interval
SOT2	°F	°C	Mean soil temperature #2 during sampling interval (refer to station info.)
%SOT2	%	%	% valid SOT2 observations during sampling interval
SOT3	°F	°C	Mean soil temperature #3 during sampling interval (refer to station info.)

Table 9-2 continued. Output format used for available climatic elements from the data processing programs.

Header	Units	Units (metric)	Description
%SOT3	%	%	% valid SOT3 observations during sampling interval
SOT4	°F	°C	Mean soil temperature #4 during sampling interval (refer to station info.)
%SOT4	%	%	% valid SOT4 observations during sampling interval

Modifying Programs

These programs can be modified using a text editor (e.g. Notepad) or the IDLE. Changes should be carefully thought-out and well documented in program headers, the relevant SOPs, and the master version table (SOP# 19).

I&M Enterprise Climate Database

The I&M program, at the national level, has recently developed a SQL Server climate database for the purpose of climate monitoring – a vital sign common to each of the I&M networks. This database holds daily records for temperature and precipitation for a variety of station types including RAWS. It does not support hourly records or other weather observations like wind and solar radiation. However, this database does allow a user to upload versioned climate data that can include edited data and/or additional weather observations (e.g. wind, solar radiation). The SWAN plans to upload the data it currently processes to this database and explore its potential for reporting purposes. Detailed procedures for uploading climate data to the I&M enterprise climate database are included in SOP #18.

Digital Photo Management

Digital photos related to climate monitoring are stored on the SWAN server at:

\SWAN\Vital_Signs\Climate\Photos

using the following directory structure:

\Finished
\Originals
\Thumbnails

Finished Photos

This folder contains renamed photographs (with no changes to file size). These photographs are for use in reports or to be shared with others. Primary organization is by climate station type and name. Secondary organization is by date photograph was taken.

Folder naming structure:

YYYYMMDD where Y = year, M = month, D = day

File naming structure:

[PARK]_[TYPE]_[NAME]_[YYYYMMDD]_[Description]_[III]_[XXXX].[ext]

where:

[PARK] = Park Name (four letter park code):

SWAN	Southwest Alaska Network
ALAG	Alagnak Wild River
ANIA	Aniakchak National Monument and Preserve
KATM	Katmai National Park and Preserve
KEFJ	Kenai Fjords National Park
LACL	Lake Clark National Park and Preserve

[TYPE] = Station type (four letter code):

ASOS	Automated Surface Observing System
AWOS	Automated Weather Observing System
BUOY	Moored Buoy
CLRN	Climate Reference Network
CMAN	Coastal Marine Automated Network
SNCO	Snow Course
SNTE	SNOTEL
RAWS	Remote Automated Weather Station

[NAME] = Station name (four letter code):

SWAN RAWS:

CHMO	Chigmit Mountains
COCR	Contact Creek
COVI	Coville
FOUR	Fourpeaked
HAIC	Harding Icefield
HILA	Hickerson Lake
MCPA	McArthur Pass
PFMI	Pfaff Mine
SNLA	Snipe Lake

Other stations:

HOAI	Homer Airport
ILAI	Iliamna Airport
KEAI	Kenai Airport
KSAI	King Salmon Airport
SEAI	Seward Airport
POHE	Port Heiden
SHST	Shelikof Strait
POAL	Port Alsworth
DRTE	Drift River Terminal
PIRO	Pilot Rock
SEWA	Seward (COOP)
S8NW	Seward 8NW (Exit Glacier)
TELA	Telaquana Lake
STON	Stoney

EXGL Exit Glacier
NUGL Nuka Glacier

[YYYYMMDD] = Date photograph taken

YYYY = year (four digits)
M = month (two digits)
D = day (two digits)

[Description] = A brief (<20 character) description of photograph subject.

[III] = Photographer's initials (first, middle, last) if known

AEM Amy E Miller (SWAN)
BAG Bruce Giffen (AKRO)
CRL Chuck Lindsay (SWAN)
DP Dan Peterson (NWS)
IDM Ian Martin (KEFJ)
MES Michael Shephard (SWAN)

[XXXX] = Last four digits of camera photo naming structure

[.ext] = File extension (e.g. .jpg)

All photographs in this directory are renamed using batch file naming software (e.g. Fine Bytes: IrfanView) that does not change the date/time of photograph which is stored in the exchangeable Image File Format (EXIF). Note that , using IrfanViewer, the script [PARK]_[RAWS]_[NAME]_$E36867(%Y%m%d)_descrip_[III]_$N is used to rename files.

Original Photos

Original photographs are stored in this folder. Primary organization is by climate station type and name. Secondary organization is by date photograph was taken.

Folder naming structure:

YYYYMMDD where Y = year, M = month, D = day

File naming structure:

When possible, photographs retain the original file naming structure from the camera.

Thumbnails

Thumbnails for all photographs are contained in this folder. Thumbnails were created using a photo batch conversion/rename tool (e.g IrfanView). Settings for creating thumbnails are: 140 pixels on long axis, 72 dpi, and original date/time. File names are the identical to those found in the *Finished* folder with the exception that "_thmb" is appended to the file name. Organization is alphabetical. Primary organization is by park. Secondary organization is by station name and type. Tertiary organization is by date photograph was taken.

SOP #10:Downloading and Processing RAWS Data
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for: 1) downloading data from Remote Automated Weather Stations (RAWS) from the Western Regional Climate Center (WRCC) web site; 2) manually performing data quality control; and 3) using a customized program (Python script) that both summarizes (down samples) hourly RAWS observations (to daily, monthly, and yearly measures) and converts data to a standardized format in both metric and U.S. customary units.

Downloading RAWS Data

There are 12 RAWS monitored by the SWAN (Appendix A-1). Data from these stations will be used in conjunction with information from other climate networks to generate annual climate summaries, to identify climatic extremes, and to aid in the analysis and interpretation of trends in other monitored vital signs.

Procedures

Access the RAWS Climate Archive hosted by the Western Regional Climate Center (WRCC):

1. Access the following WRCC Web page: http://www.wrcc.dri.edu/

2. Select "RAWS Data (Remote Automated Weather Stations)"

3. A map of the US will appear on the screen. Click on "Alaska".

4. A map of RAWS stations within the state will appear along with an alphabetic list of RAWS sites, which is displayed on the left-hand side (LHS) of the screen (Figure 10-1).



Figure 10-1. Alphabetic list (partial) of RAWS sites displayed on the WRCC Web Page.

5. Select the desired station from the alphabetic list of RAWS on the LHS. A window will open showing the data availability list for the selected station (Figure 10-2) and station data retrieval options on the LHS (Figure 10-3).



Figure 10-2. Data availability list.



Figure 10-3. Station data retrieval options.

6. Click on “Data Lister” in the station data retrieval options list. The station data retrieval option window (Figure 10-4) will appear.

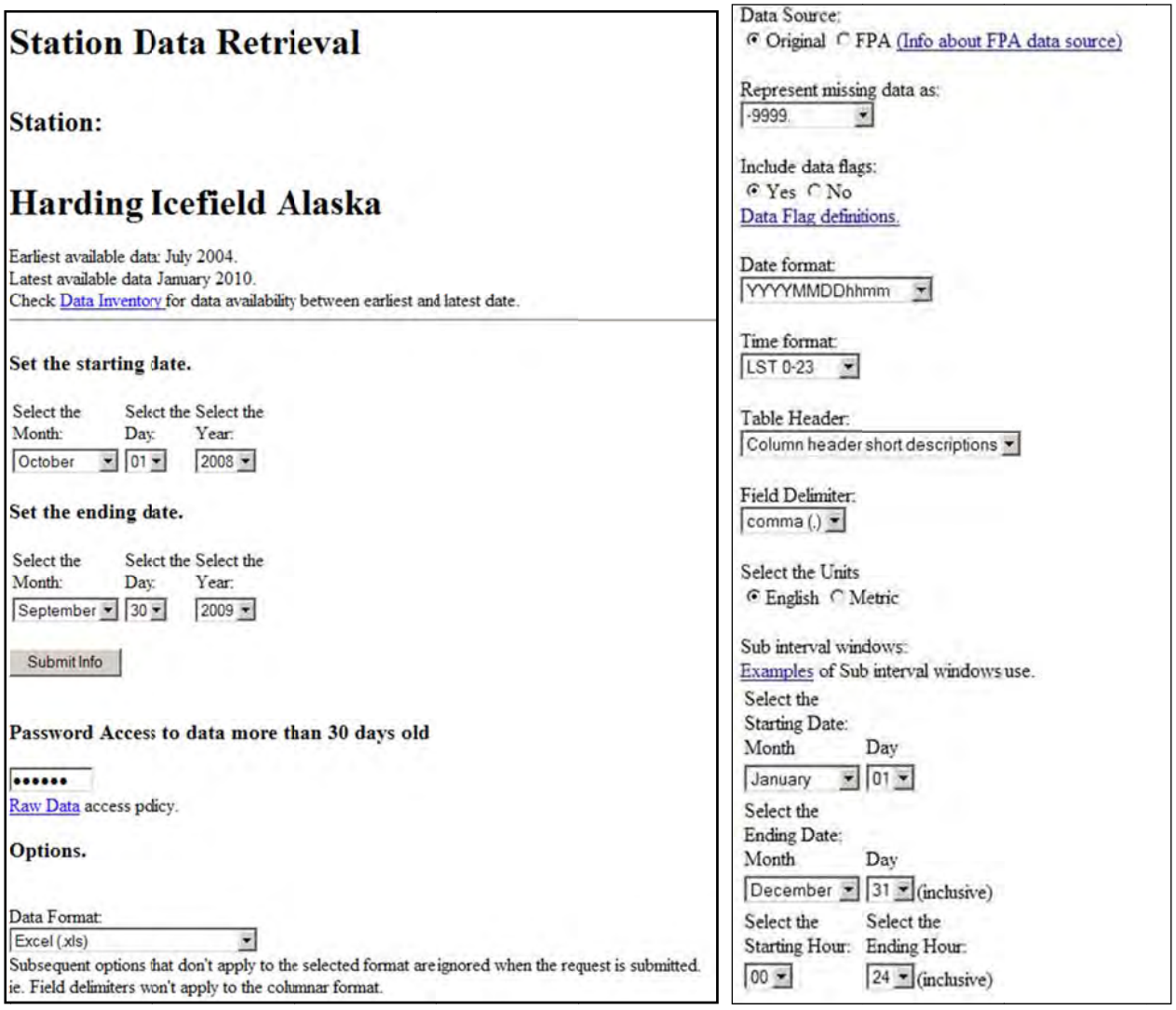


Figure 10-4. Station data retrieval option window.

7. In the station data retrieval option window, set the desired starting and ending date (these should be October 1 and September 30 of the most recent hydrologic year). Set all options to match those shown in Figure 10-4. This will result in the desired format for the data processing application described below.

8. A password is required to access data more than 30 days old. This password is provided to the SWAN by the WRCC. The password is stored on the SWAN server. Contact the principle investigator for the climate monitoring vital sign for the password.

9. After completing all required fields, click on the “Submit Info” box. Processing time will vary with the amount of requested data, but you will eventually be queued to “Open” or to “Save the Excel file”. Always elect to save the file. RAWS data from the WRCC is organized by hydrologic year and saved on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Downloads\

RAWS data files are organized using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].xls

Where:

[TYPE] refers to the station type (e.g. RAWS, refer to Table 10-1)
[NAME] is the four letter acronym for the station name (e.g. HAIC, refer to Table 10-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage "dwnld"
.xls is the file type

Example: RAWS_HAIC_20071001_20080930_20081101dwnld.xls

Table 10-1. RAWS stations monitored by the SWAN. The station names are those that are used by the parent climate monitoring network. The acronyms are unique and are not necessarily recognized by other agencies. For the purposes of digital file naming (photos, data) and table headers, stations will be identified using both station type and acronym (e.g. RAWS HAIC).

Station name	Station type [TYPE]	Acronym [NAME]
Chigmit Mountains	RAWS	CHMO
Contact Creek	RAWS	COCR
Coville	RAWS	COVI
Fourpeaked	RAWS	FOUR
Harding Icefield	RAWS	HAIC
Hickerson Lake	RAWS	HILA
McArthur Pass	RAWS	MCPA
Pedersen Lagoon	RAWS	PELA
Pfaff Mine	RAWS	PFMI
Port Alsworth	RAWS	POAL
Snipe Lake	RAWS	SNLA
Stoney	RAWS	STON

Additional Formatting and Data Quality Control (QA/QC)

Before processing RAWS data from the WRCC, additional formatting and data quality control (QA/QC) is performed. The data in the downloaded data file contains hourly measures of a suite of climate elements. The types of elements are listed in a header at the top of the file and can vary among stations and through time. Currently, quality control for data from network RAWS is limited and data acquired from the WRCC should be considered raw (a Memorandum of Understanding between the NPS and WRCC will be developed that will result in more stringent data quality control for RAWS data collected by SWAN stations that are hosted by the WRCC). Therefore, it is necessary that additional data quality control be performed on this data. Some additional formatting is necessary to accommodate custom headers that are added to identify climate elements within the data file prior to data processing.

Procedures

1. Open the tab delimited (.xls) file using Microsoft Excel.

2. Format cells for column A (Date/Time) to “Number format” with 0 decimal places (Figure 10-5). Note that this column must be formatted in this way before the file is saved as a comma delimited text file (.csv) or Date/Time information will be lost.

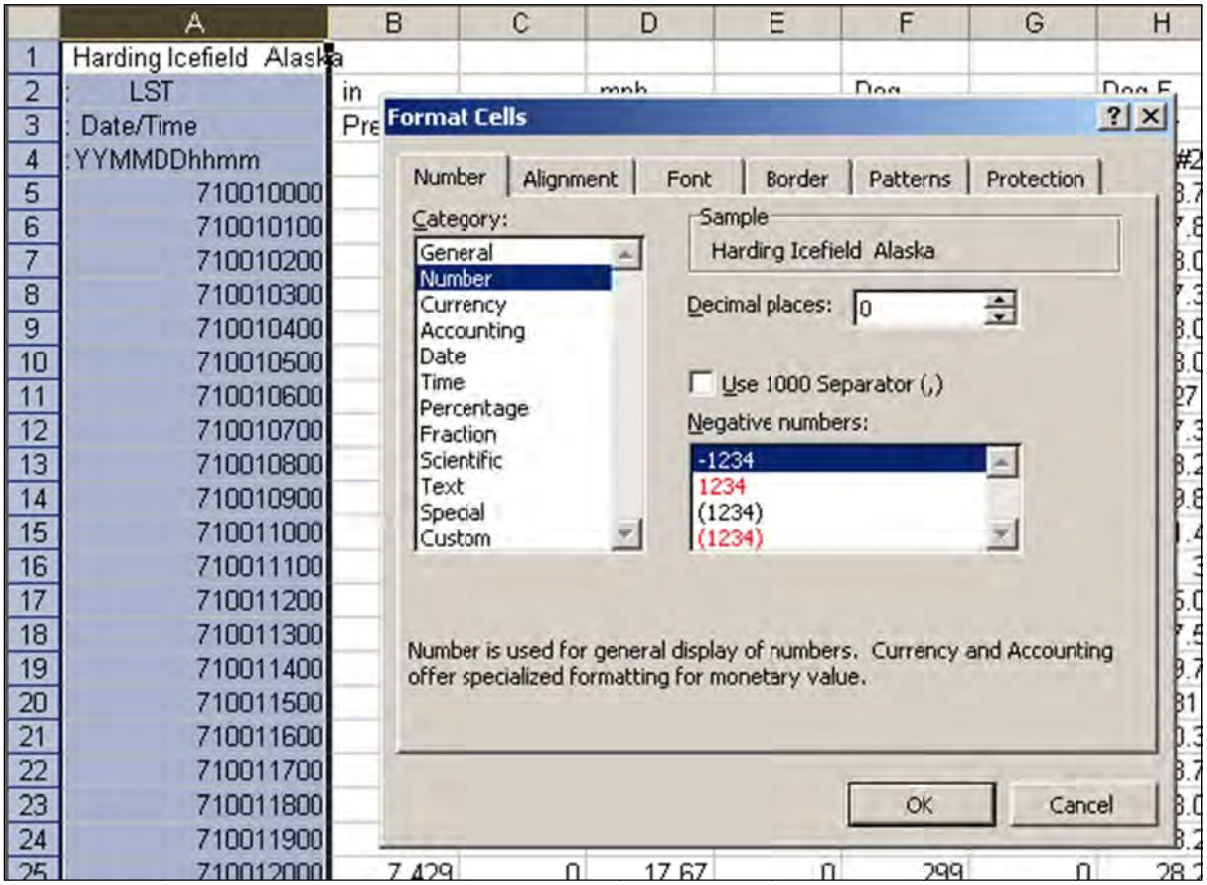
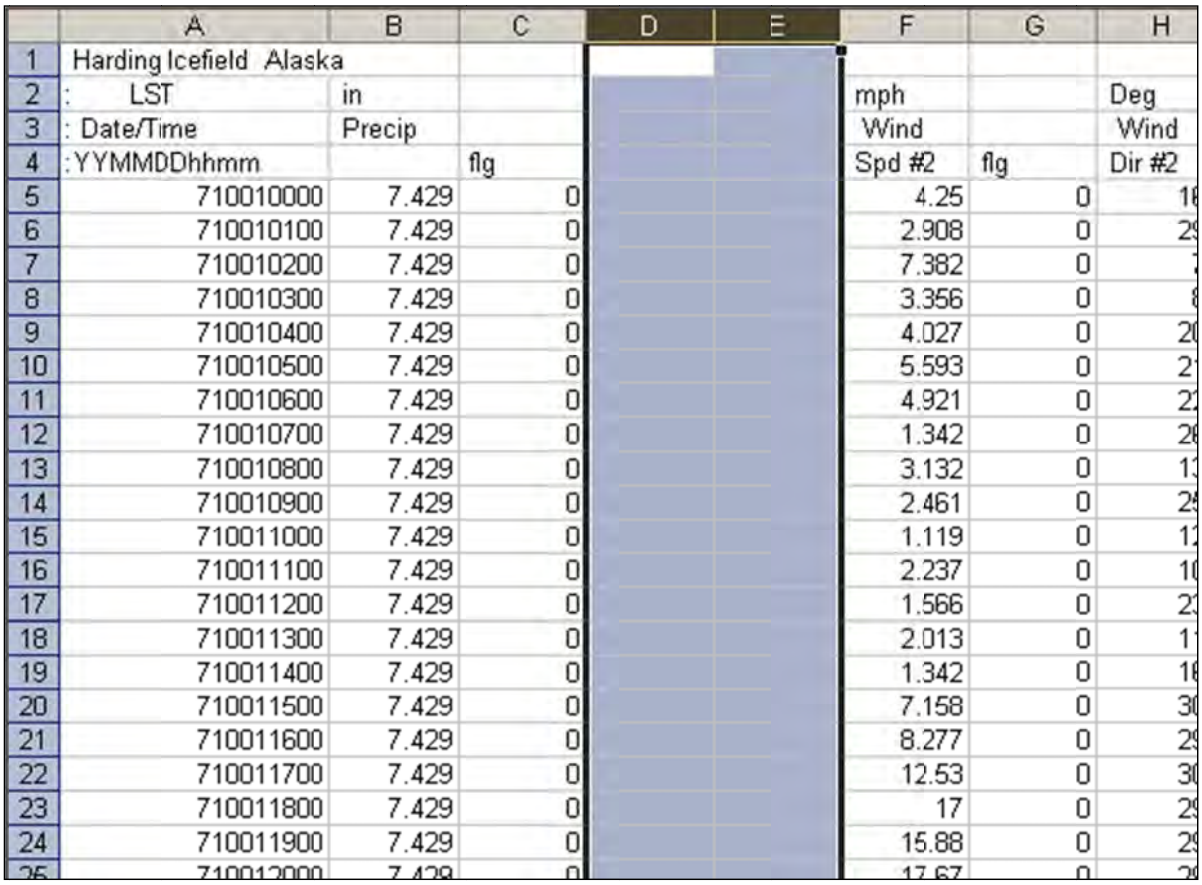


Figure 10-5. Formatting Date/Time (Step 2).

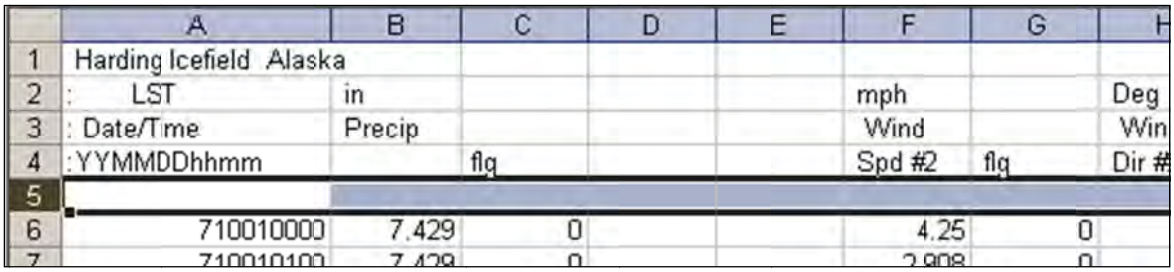
3. Insert two columns immediately after the two columns with WRCC headers labeled “in Precip and “flg” (Figure 10-6).



	A	B	C	D	E	F	G	H
1	Harding Icefield Alaska							
2	: LST	in				mph		Deg
3	: Date/Time	Precip				Wind		Wind
4	:YYMMDDhhmm		flg			Spd #2	flg	Dir #2
5	710010000	7.429	0			4.25	0	1
6	710010100	7.429	0			2.908	0	2
7	710010200	7.429	0			7.382	0	
8	710010300	7.429	0			3.356	0	
9	710010400	7.429	0			4.027	0	2
10	710010500	7.429	0			5.593	0	2
11	710010600	7.429	0			4.921	0	2
12	710010700	7.429	0			1.342	0	2
13	710010800	7.429	0			3.132	0	1
14	710010900	7.429	0			2.461	0	2
15	710011000	7.429	0			1.119	0	1
16	710011100	7.429	0			2.237	0	1
17	710011200	7.429	0			1.566	0	2
18	710011300	7.429	0			2.013	0	1
19	710011400	7.429	0			1.342	0	1
20	710011500	7.429	0			7.158	0	3
21	710011600	7.429	0			8.277	0	2
22	710011700	7.429	0			12.53	0	3
23	710011800	7.429	0			17	0	2
24	710011900	7.429	0			15.88	0	2
25	710012000	7.429	0			17.67	0	2

Figure 10-6. Inserting additional columns (Step 3).

4. Insert a row between header and data (Figure 10-7).



	A	B	C	D	E	F	G	H
1	Harding Icefield Alaska							
2	: LST	in				mph		Deg
3	: Date/Tme	Precip				Wind		Win
4	:YYMMDDhhmm		flg			Spd #2	flg	Dir #
5								
6	710010000	7.429	0			4.25	0	
7	710010100	7.429	0			2.908	0	

Figure 10-7. Inserting row for additional header information (Step 4).

5. Enter additional header information in this empty row below corresponding WRCC headers (Figure 10-8) as specified in Table 10-2. Column order does not matter and may vary between stations; the additional header information will be used to identify climate elements during processing.

	A	B	C	D	E	F	G	H
1	Harding Icefield Alaska							
2	: LST	in				mph		Deg
3	: Date/Time	Precip				Wind		Win
4	:YYMMDDhhmm		flg		flg	Spd #2	flg	Dir #
5	DATE/TIME			PRCP	PRCP_F			
6	710010000	7.429	0			4.25	0	
7	710010100	7.429	0			2.808	0	

Figure 10-8. Inserting additional header information (Step 5).

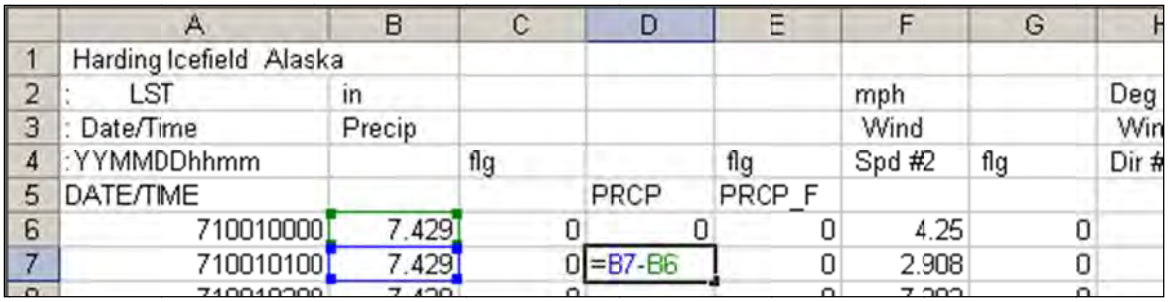
Table 10-2. Additional header information for RAWS data.

WRCC header	Description	SWAN header	Description
Date/Time	YYYYMMDDhhmm (LST)	DATE/TIME	
in precip	cumulative precipitation (in)	none	value not used
flg	data flag	none	value not used
none	value not reported	PRCP	hourly precipitation (in)
none	value not reported	PRCP_F	data flag
mph Wind Spd #2	most recent 10-min average	none	value not used
flg	data flag	none	value not used
Deg Wind Dir #2	most recent 10-min average	none	value not used
flg	data flag	none	value not used
Deg F Av. Air Temp #2	current (end of hour)	none	value not used
flg	data flag	none	value not used
% Ave Rel Humd #2	current (end of hour)	none	value not used
flg	data flag	none	value not used
volts Battery Voltage	battery voltage	none	value not used
flg	data flag	none	value not used
Deg Dir MxGust	max instantaneous wind gust direction	WDPK	max instantaneous wind gust direction
flg	data flag	WDPK_F	data flag
mph Mx Gust Speed	max instantaneous wind gust speed	WSPK	max instantaneous wind gust speed
flg	data flag	WSPK_F	data flag
ly Solar Rad.	average hourly solar radiation	SRAD	average hourly solar radiation
flg	data flag	SRAD_F	data flag
in Snow Depth	snow depth	SD	snow depth
flg	data flag	SD_F	data flag
Deg F Av Air Temp	avg air temp	ATAV	avg air temp
flg	data flag	ATAV_F	data flag
% Rel Humidty	avg relative humidity	RHAV	avg relative humidity
flg	data flag	RHAV_F	data flag
mph Wind Speed	avg (scalar) wind speed	WSAV	avg wind speed (scalar)
flg	data flag	WSAV_F	data flag
Deg Wind Direc	avg (scalar) wind dir	WDAV	avg wind dir (scalar)
flg	data flag	WDAV_F	data flag
Deg F Mx Air Temp	max air temp	ATMX	max air temp
flg	data flag	ATMX_F	data flag
Deg F Mn Air Temp	min air temp	ATMN	min air temp
flg	data flag	ATMN_F	data flag
none	soil temp (if available)	SOT1	deg F soil temp at x depth
none	data flag	SOT1_F	data flag
none	soil temp (if available)	SOT2	deg F soil temp at x depth
none	data flag	SOT2_F	data flag

6. Convert the cumulative precipitation values of column "in Precip" (Column B) to hourly precipitation for column with the new SWAN header "PRCP" (e.g. Column D, Figure 10-9).

7. Make the first entry (e.g. cell D6) equal to “0” (Figure 10-9).

8. Enter the following formula for second entry “=(cell[second entry "in Precip"]-cell[first entry "in Precip])” (e.g. D7=B7-B6; Figure 10-9).

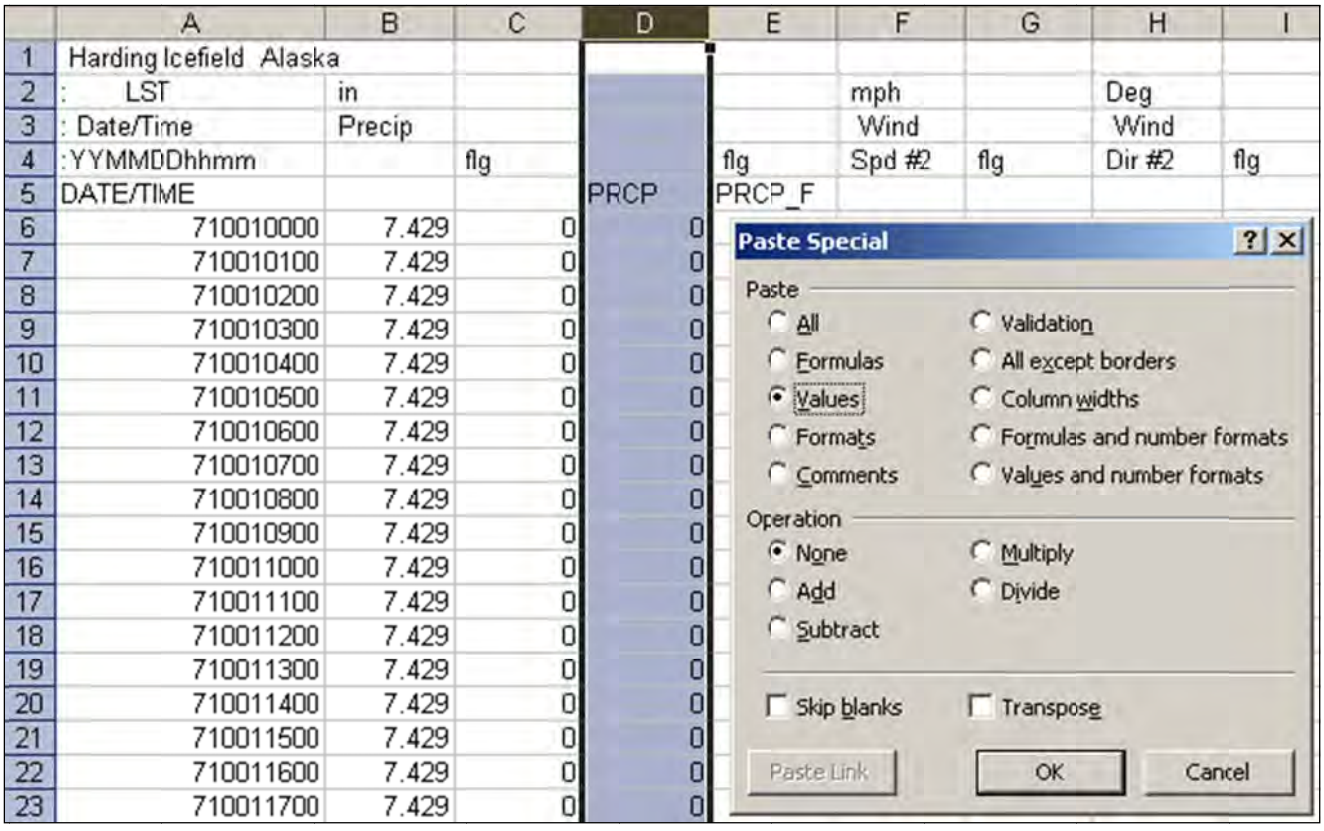


	A	B	C	D	E	F	G	H
1	Harding Icefield Alaska							
2	: LST	in				mph		Deg
3	: Date/Time	Precip				Wind		Wir
4	:YYMMDDhhmm		flg		flg	Spd #2	flg	Dir #
5	DATE/TIME			PRCP	PRCP_F			
6	710010000	7.429	0	0	0	4.25	0	
7	710010100	7.429	0	=B7-B6	0	2.908	0	

Figure 10-9. Generating hourly from cumulative precipitation values (Steps 6-8).

9. Auto-fill (copy and paste) the formula entry down column for extent of data.

10. Copy and paste special (values) to remove formula from cells (Figure 10-10). The derived PRCP values are accurate to 0.01 inch.



	A	B	C	D	E	F	G	H	I
1	Harding Icefield Alaska								
2	: LST	in				mph		Deg	
3	: Date/Time	Precip				Wind		Wind	
4	:YYMMDDhhmm		flg		flg	Spd #2	flg	Dir #2	flg
5	DATE/TIME			PRCP	PRCP_F				
6	710010000	7.429	0	0					
7	710010100	7.429	0	0					
8	710010200	7.429	0	0					
9	710010300	7.429	0	0					
10	710010400	7.429	0	0					
11	710010500	7.429	0	0					
12	710010600	7.429	0	0					
13	710010700	7.429	0	0					
14	710010800	7.429	0	0					
15	710010900	7.429	0	0					
16	710011000	7.429	0	0					
17	710011100	7.429	0	0					
18	710011200	7.429	0	0					
19	710011300	7.429	0	0					
20	710011400	7.429	0	0					
21	710011500	7.429	0	0					
22	710011600	7.429	0	0					
23	710011700	7.429	0	0					

Figure 10-10. Generating hourly from cumulative precipitation values (Step 10).

11. Perform domain checks, following MesoWest data quality guidelines (http://www.met.utah.edu/cgi-bin/database/variable_select.cgi) and the additional data quality guidelines specific to network weather stations that are specified in Table 10-3. The checks are performed by applying logical tests to the data set. Values that fail these checks are automatically flagged with the data quality flags listed in Table 10-3 and Table 10-4. A template with spreadsheet formulas for domain checks is located on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Templates\RAWS_qaqcDomainCheckTemplate_20100211.xls

Table 10-3. Domain checks for selected elements (adapted from MesoWest data quality guidelines).

SWAN header	Description	Units	Min	Max
ATAV	Air temperature (average)	°F	-75.0	135.0
ATMX	Air temperature (max)	°F	-75.0	135.0
ATMN	Air temperature (min)	°F	-75.0	135.0
RHAV	Relative humidity (average)	%	0	100.0
PRCP	Precipitation 1-hr	in	2.0	2.0
WSAV	Wind speed (average) *	mph	0	150.0
WDAV	Wind direction (average) *	deg	0	360
WSPK	Wind speed (peak)	mph	0	150.0
WDPK	Wind direction (peak)	deg	0	360
SRAD	Solar radiation	Ly	0	129
SD	Snow depth *	in	0	54.0
SOT1, SOT2	Soil temperature	°F	-75	150.0

*Maximum speeds for WSAV and WSPK are based on the specified range for the wind speed sensors used on network RAWS. These values are more conservative than those specified by MesoWest. The maximum snow depth is based on the height of the lowest snow depth sensor on network RAWS. This value is also more conservative than that specified by MesoWest.

Table 10-4. WRCC data flags for RAWS data.

WRCCdata flags	Description
0	Original measured value
E	Estimated value
M	Missing value
N	Non-measuring time interval

Table 10-5. Additional SWAN data flags for RAWS data used in manual QA/QC.

SWAN data flags	Description
S	Suspect value
F	Missing value (failed GOES transmission, value to be updated from data logger in the future)
X	Missing value (data wasn't collected and/or will not be available)

Table 10-6. Logical tests used to perform domain checks for data quality control.

SWAN header	SWAN data flag header	Logical test (Excel formula)
ATAV	ATAV_F	=IF(ATAV<-75,"S",IF(ATAV>135,"S",0))
ATMX	ATMX_F	=IF(ATMX<-75,"S",IF(ATMX>135,"S",0))
ATMN	ATMN_F	=IF(ATMN<-75,"S",IF(ATMN>135,"S",0))
RHAV	RHAV_F	=IF(RHAV<0,"S",IF(RHAV>100,"S",0))
PRCP*	PRCP_F	=IF(PRCP>2,"S",IF(ATMX<31.1,"S",IF(WSPK>=70,"S",0)))
WSAV	WSAV_F	=IF(WSAV<0,"S",IF(WSAV>150,"S",0))
WDAV	WDAV_F	=IF(WDAV<0,"S",IF(WDAV>360,"S",0))
WSPK	WSPK_F	=IF(WSPK<0,"X",IF(WSPK>150,"X",0))
WDPK	WDPK_F	=IF(WDPK<0,"X",IF(WDPK>360,"X",0))
SRAD	SRAD_F	=IF(SRAD<0,"S",IF(SRAD>129,"S",0))
SD	SD_F	=IF(SD<0,"S",IF(SD>**,"S",0))
SOT1	SOT1_F	=IF(SOT1<-75,"S",IF(SOT1>150,"S",IF(ISBLANK(SOT1),"X",0)))
SOT2	SOT2_F	=IF(SOT2<-75,"S",IF(SOT2>150,"S",IF(ISBLANK(SOT2),"X",0)))

*Used for all RAWS except the Harding Icefield.
** This value is station specific; it is the tare distance in inches used for zeroing the SD sensor.

12. Enter the logical test formula for the domain check for air temperature (ATAV) into the uppermost empty cell in the average air temperature data flag (ATAV_F) column. Replace the "ATAV" reference with the cell label for the uppermost cell in the average air temperature (ATAV) column (Figure 10-11).

Example: Cell Z6 = IF(Y6<-75,"S",IF(Y6>135,"S",0))

	T	U	V	W	X	Y	Z	AA	AB	A
1										
2		ly		in		Deg F		%		mph
3		Solar		Snow		Av Air		Rel		Wir
4	flg	Rad.	flg	Depth	flg	Temp	flg	Humidty	flg	Spe
5	WSPK_F	SRAD	SRAD_F	SD	SD_F	ATAV	ATAV_F	RHAV	RHAV_F	WSA
6	0	0.0344	0	69.8	0	41.18	=IF(Y6<-75,"S",IF(Y6>135,"S",0))			
7	0	0.0344	0	69.8	0	41	0	65	0	
8	0	0.0344	0	69.8	0	41	0	67	0	
9	0	0.0344	0	69.8	0	40.82	0	71	0	
10	0	0.0344	0	69.8	0	41	0	72	0	
11	0	0.0344	0	69.8	0	40.82	0	72	0	
12	0	0.0344	0	69.8	0	40.28	0	76	0	

Figure 10-11. Inserting a logical test formula (domain check for average air temperature; step 12).

13. Copy and paste special (formulas) down-column for the extent of data to apply the logical test to all observations (Figure 10-12).

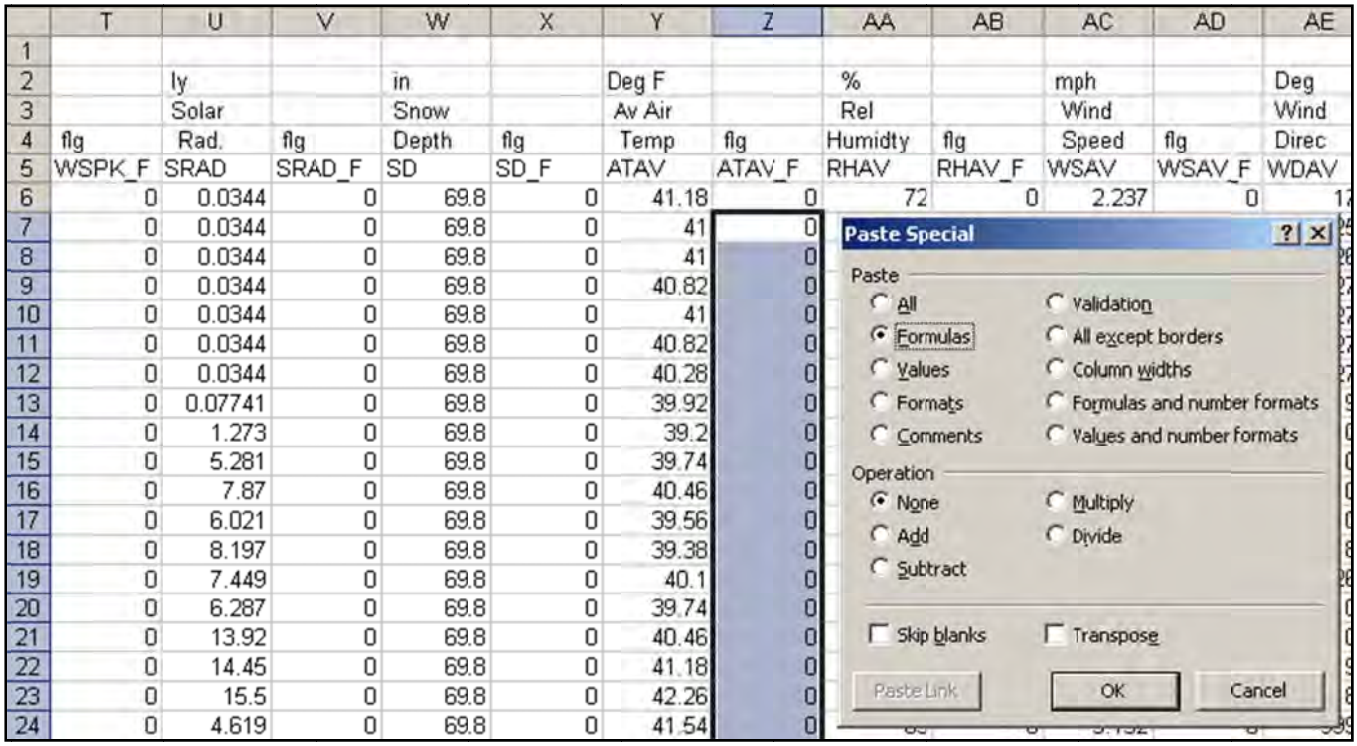


Figure 10-12. Extending the logical test formula to the entire column.

14. Copy and paste special (values) for the entire data flag column to remove formulas from cells (Figure 10-13).

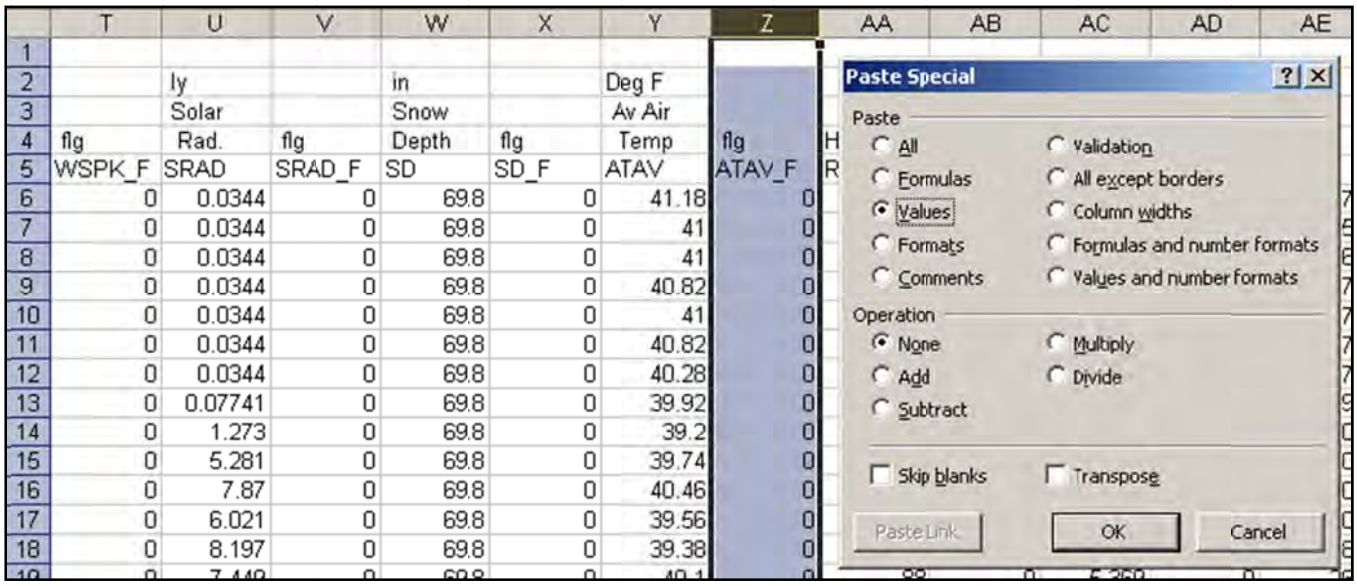


Figure 10-13. Replacing logical test formulas with values.

15. Repeat steps 12-14 for each of the domain checks listed in Table 10-6.

Note: The domain checks used for precipitation at network RAWS also employ logical tests for maximum air temperature (ATMX) and maximum wind gust speed (WSPK). This is because the tipping bucket rain gauge (TBRG) used at network RAWS can only accurately measure liquid precipitation (i.e.

rain, not snow). False precipitation is sometimes recorded during sub-freezing temperatures when ice pieces fall in the TBRG or when wind-induced vibrations trigger the TRBG. In order to account for this, the precipitation domain check partitions precipitation into solid and liquid forms as a function of surface air temperature. Any precipitation that occurs when the maximum hourly air temperature is less than 31.1 °F (-0.5 C) is assumed to be solid. This domain check flags any precipitation documented when the maximum air temperature is below 31.1 °F (-0.5 C) as suspect. This check is applied to all network RAWS except for the Harding Icefield, where an all season precipitation gauge (that measures both liquid and solid precipitation) is used. False precipitation may also be documented at network RAWS when strong winds shake the station towers. This shaking, in turn, can cause the TBRG to tip falsely, when no precipitation is occurring. In order to account for this, precipitation is flagged when wind gusts (WSPK) exceed 70 mph (31 m/s).

16. Check the hourly precipitation data (PRCP) to make sure that it is reasonable. There may be a large negative value when the precipitation gauge was reset during station maintenance. Replace this value with zero. Replace the corresponding flag with "X". Replace the corresponding flag for the first PRCP value that was changed to 0 with "X".WRCC data flags are documented in Table 10-4 and additional SWAN data flags used in manual QA/QC are documented in Table 10-5.

	A	B	C	D	E	F	G	H
1	Harding Icefield Alaska							
2	: LST	in				mph		Deg
3	: Date/Time	Precip				Wind		Win
4	:YYMMDDhhmm		flg		flg	Spd #2	flg	Dir #
5	DATE/TIME			PRCP	PRCP_F			
6617	807021100	27.55	0	0	0	13.65	0	
6618	807021200	27.55	0	0	0	13.65	0	
6619	807021300	27.55	0	0	0	7.382	0	
6620	807021400	0	0	-27.55	0	13.87	0	
6621	807021500	0	0	0	0	15.21	0	
6622	807021600	0.01969	0	0.01969	0	18.34	0	

Figure 10-14. Checking hourly precipitation values (Step 16).

17. Refer to the network RAWS performance tracking worksheets (refer to SOP #8). Insert data flags for values corresponding to any timeframe that is associated with a known station issue that may compromise data quality (e.g. sensor malfunction, low battery voltage). Use data flags specified in Table 10-5. Values that correspond to known sensor issues should be flagged with “X”.

18. Missing data because of failed GOES transmissions (no time stamp and no data - data that are typically retrievable after the next station maintenance) are automatically flagged during data processing (the data processing program identifies data gaps based on DATE/TIME).

19. Visually inspect data for climate elements of interest by examining tabular data and plotting elements (e.g. ATAV, ATMX, ATMN, RHAV, PRCP, WSAV, WDAV, WSPK, WDPK, SRAD, SD, and SOT) vs. Date/Time. This qualitative process should identify data spikes and any anomalous data. Suspect data that are identified by this process should be flagged with “S” (refer to Table 10-5). The data processing program will convert flagged data values to “-9999” in the output it generates, however, flagged data values are preserved in the QA/QC file.

20. If soil temperature data (SOT1, SOT2) is not available, and was not previously flagged using the domain checks described in steps 11-15, flag this data using data flags from table 10-5. Soil temperature data is flagged with "X" if the station does not have soil temperature sensors.

21. Make sure that worksheet is "clean" (i.e. that no plots or numeric entries in cells outside data range exist). Make sure that the DATE/TIME column is formatted as numeric with no decimals or exponential notation (Figure 10-15).

	A	B	C	D	E	F	G	H
1	Harding Icefield	Alaska						
2	: LST	in				mph		Deg
3	: Date/Time	Precip				Wind		Wir
4	:YYMMDDhhmm		flg		flg	Spd #2	flg	Dir #
5	DATE/TIME			PRCP	PRCP_F			
6	710010000	7.429	0	0	0	4.25	0	
7	710010100	7.429	0	0	0	2.908	0	
8	710010200	7.429	0	0	0	7.382	0	
9	710010300	7.429	0	0	0	3.356	0	

Figure 10-15. Proper format for DATE/TIME values (Step 18).

22. Save file as a comma delimited (.csv) text file. Edited RAWS data files are stored at:

\SWAN\Vital_Signs\Climate\Data\QAQC

RAWS data files are organized using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].xls

Where:

[TYPE] refers to the station type (e.g. RAWS, refer to Table 10-1)
[NAME] is the four letter acronym for the station name (e.g. HAIC, refer to Table 10-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was edited (QA/QC'd) and the file stage "qaqc"
.xls is the file type

Example: RAWS_HAIC_20071001_20080930_20081103qaqc.csv

Data Processing

A customized program (Python script) is used to convert RAWS data into a standardized list of climate elements and to summarize hourly data into daily, monthly, and yearly (hydrologic year) measures. Running this program also checks for invalid or missing date and time values, replaces flagged data values with a common identifier (-9999) and converts input units to both metric and U.S. customary units.

Data Processing Program

The program RAWSdata_FormatSummarizeConvert.py is used to process RAWS data. The executable program is stored on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Programs_Scripts\

The current version of the processing program is denoted by the most recent [filedatestage] (in YYYYMMDD format) appended to the program file name.

Example:

RAWSdata_FormatSummarizeConvert_20100212.py

Input Format

The expected input data set for RAWS data is a comma-delimited text (.csv) file with a five-line header. Only the fifth header is parsed. The date column must be the left-most column, otherwise column order is flexible. The expected input format is specified in Table 10-7.

Table 10-7. Input format specifications for RAWSdata_FormatSummarizeConvert.py.

Fifth-line Header label	Format	Units
DATE/TIME LST	numeric	YYYYMMDDhhmm YMMDDhhmm
PRCP	numeric	in
PRCP_F	character	
WDPK	numeric	deg
WDPK_F	character	
WSPK	numeric	mph
WSPK_F	character	
SRAD	numeric	Ly
SRAD_F	character	
SD	numeric	in
SD_F	character	
ATAV	numeric	°F
ATAV_F	character	
RHAV	numeric	%
RHAV_F	character	
WSAV	numeric	mph
WSAV_F	character	
WDAV	numeric	deg
WDAV_F	character	
ATMX	numeric	°F
ATMX_F	character	
ATMN	numeric	°F
ATMN_F	character	
SOT1	numeric	°F
SOT1_F	character	
SOT2	numeric	°F
SOT2_F	character	

Executing the Program

1. Double clicking the program will execute open it.

2. A file dialog will ask for the location of the input data (Figure 10-16). Pressing cancel will abort the operation. This program is capable of reading in multiple files at once and appending the data. This is useful to avoid calculating summaries for partial water years when using calendar year annual input data. The inputs are sorted alphabetically, so the names must be in alphabetic order by date. If the names are in the format described above with a date string following the station name, this will already be the case. The data must not overlap in time. Alternatively, data can be appended by hand using a text editor, and then fed to the program as one file.

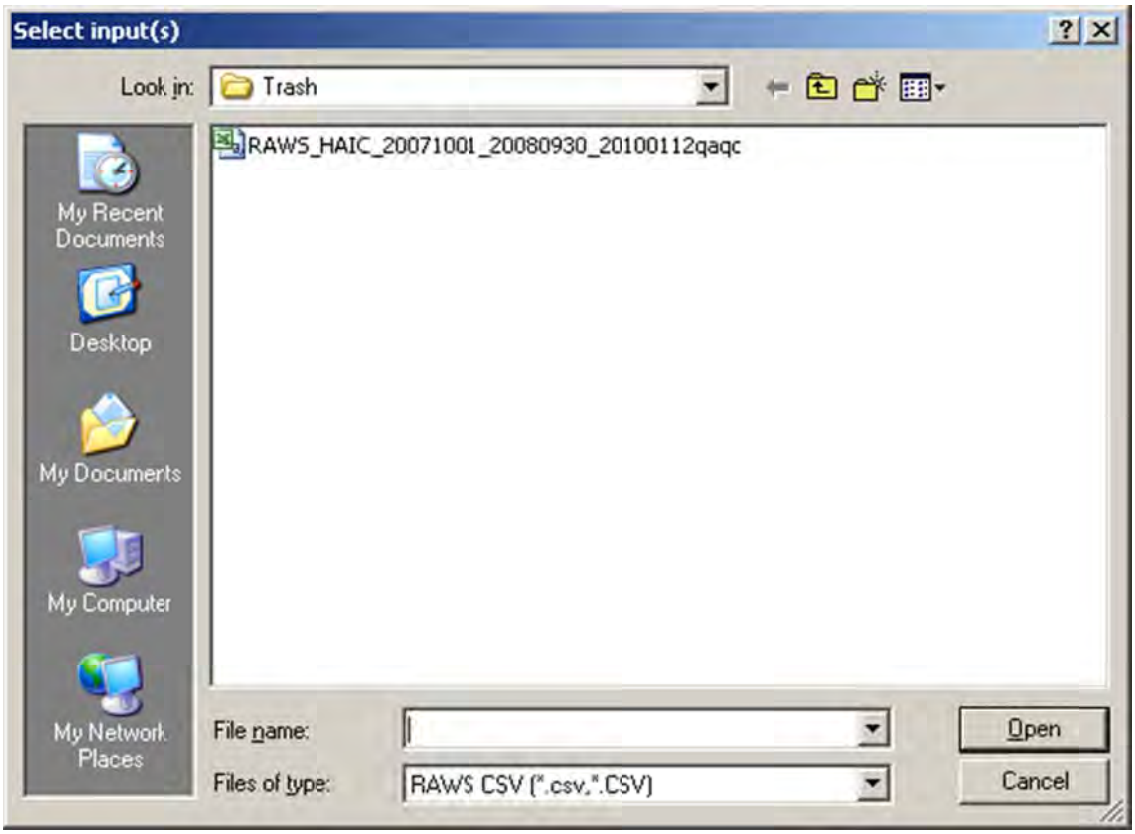


Figure 10-16. RAWSdata_FormatSummarizeConvert.py file input dialog.

3. A second dialog will ask where the data should be saved (Figure 10-17). Not specifying a location will save the data in the current directory. Pressing cancel will abort the operation.

Processed climate data (Python output) files are located on the SWAN server at:

J:\SWAN\Vital_Signs\Climate\Data\Output

and are organized by hydrologic year.

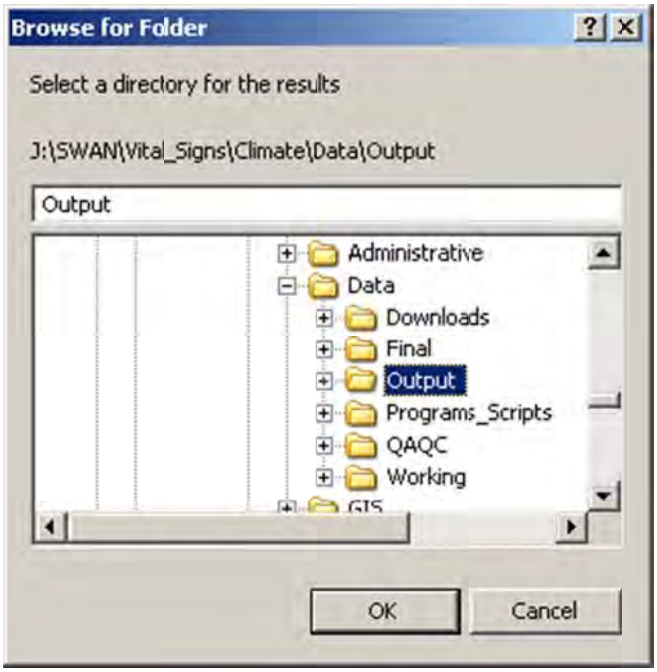


Figure 10-17. RAWSdata_FormatSummarizeConvert.py file output dialog.

4. The program will to parse, process, and write the data into multiple output products. The duration of this process will depend on the size of the input file, but for a year's worth of hourly-sampled data, the process shouldn't take more than several seconds (Figure 10-18). Should an error occur, a message should be provided that should be useful in resolving the problem.

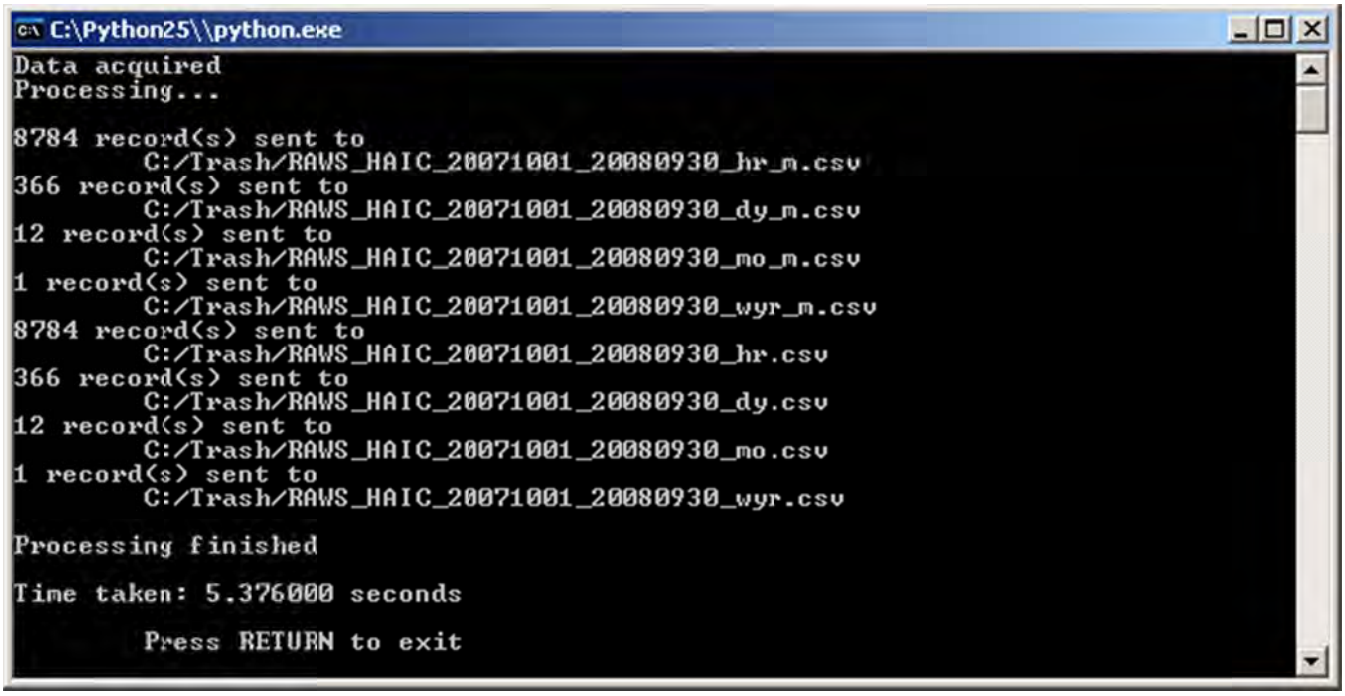


Figure 10-18. RAWSdata_FormatSummarizeConvert.py file processing dialog after successful completion.

5. Note each output file name is appended (e.g. _hr_m) in order to indicate sampling interval and units. Summaries are provided at the hourly (_hr), daily (_dy), monthly (_mo), and annual (_wyr) rates and in

both metric (_m) and U.S. customary (not appended) units. Output file names are appended with [filedatestage] (in format YYYMMDDfromPy) to be consistent with SWAN file naming conventions.

e.g. RAWS_HAIC_20071001_20080930_hr_m_20081103fromPy.csv

Output Format

Table 10-8. Output format and elements availability for RAWSdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
OBSV	yyyymmddhhmm		Date and time of observation	Y
%OBSV	%	%	% valid data transmissions during sampling interval	Y
DATE/TIME	yyyy/mm/dd hh:mm		Date and time of observation (Excel/SigmaPlot format)	Y
ATAV	°F	°C	Mean temperature during sampling interval	Y
%ATAV	%	%	% valid temperature observations during sampling interval	Y
ATMX	°F	°C	Maximum temperature during sampling interval	Y
%ATMX	%	%	% valid temperature observations during sampling interval	Y
ATMN	°F	°C	Minimum temperature during sampling interval	Y
%ATMN	%	%	% valid temperature observations during sampling interval	Y
TOBS	°F	°C	Mean temperature at time of observation during sampling interval	N
%TOBS	%	%	% valid TOBS during sampling interval	N
WSAV	mph	m/s	Mean wind speed during sampling interval (scalar average)	Y
%WSAV	%	%	% valid wind speed observations during sampling interval	Y
WDAV	deg	deg	Mean wind direction during sampling interval (time-averaged using sum of unit vectors from each observation independent of wind speed)	Y
WSPK	mph	m/s	Maximum wind speed (instantaneous) during sampling interval	Y
%WSPK	%	%	% valid wind speed observations during sampling interval	Y
WDPK	deg	deg	Corresponding wind direction for WSPK	Y
RHAV	%	%	Mean relative humidity during sampling interval	Y
%RHAV	%	%	% valid relative humidity observations during sampling interval	Y
STPR	in Hg	hPa	Mean atmospheric pressure at station during sampling interval	N
%STPR	%	%	% valid atmospheric pressure observations during sampling interval	N
SLPR	in Hg	hPa	Mean atmospheric pressure at sea level during sampling interval	N
%SLPR	%	%	% valid SLPR observations during sampling interval	N
VISI	mi	km	Mean visibility during sampling interval	N
%VISI	%	%	% valid visibility observations during sampling interval	N
SRAD	Ly	Wh/m^2	Average solar radiation during hourly sampling interval, cumulative solar radiation during daily, monthly, and yearly sampling interval	Y
%SRAD	%	%	% valid solar radiation observations during sampling interval	Y
PRCP	in	mm	Total precipitation during sampling interval	Y
%PRCP	%	%	% valid precipitation observations during sampling interval	Y
PCUM	in	mm	Cumulative precipitation during period of summary (e.g. hydrologic year)	Y
SNOW	in	mm	Total snow accumulation during sampling interval	N
%SNOW	%	%	% valid snow accumulation observations during sampling interval	N
SD	in	mm	Mean snow depth during sampling interval	Y

Table 10-8 continued. Output format and elements availability for RAWSdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
%SD	%	%	% valid snow depth observations during sampling interval	Y
WTAV	°F	°C	Mean sea water temperature during sampling interval	N
%WTAV	%	%	% valid sea water temperature observations during sampling interval	N
WVHT	ft	M	Mean wave height during sampling interval	N
%WVHT	%	%	% valid wave height observations during sampling interval	N
AWPD	sec	sec	Mean wave period during sampling interval	N
%AWPD	%	%	% valid wave period observations during sampling interval	N
DWPD	sec	sec	Mean maximum wave energy (period) during sampling interval	N
%DWPD	%	%	% valid DWPD observations during sampling interval	N
MWVD	deg	Deg	Mean wave direction (associated with DWPD) during sampling interval	N
%MWVD	%	%	% valid MWVD observations during sampling interval	N
TIDE	ft	m	Mean tide height during sampling interval	N
%TIDE	%	%	% valid observations during sampling interval	N
STAV	°F	°C	Mean ground surface (skin) temperature during sampling interval	N
%STAV	%	%	% valid STAV observations during sampling interval	N
SOT1	°F	°C	Mean soil temperature #1 during sampling interval (refer to station info.)	N
%SOT1	%	%	% valid SOT1 observations during sampling interval	N
SOT2	°F	°C	Mean soil temperature #2 during sampling interval (refer to station info.)	N
%SOT2	%	%	% valid SOT2 observations during sampling interval	N
SOT3	°F	°C	Mean soil temperature #3 during sampling interval (refer to station info.)	N
%SOT3	%	%	% valid SOT3 observations during sampling interval	N
SOT4	°F	°C	Mean soil temperature #4 during sampling interval (refer to station info.)	N
%SOT4	%	%	% valid SOT4 observations during sampling interval	N

SOP #11: Downloading and Processing COOP Data
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for downloading data from Cooperative Observing Program (COOP) stations from the National Climatic Data Center (NCDC) ftp site and using a customized program (Python script) that both summarizes (down samples) daily COOP observations to monthly and yearly measures and converts data to a standardized format in both metric and U.S. customary units.

Downloading COOP Data

There are eight COOP stations monitored by the SWAN (Appendix B-1). Data from these stations will be used in conjunction with information from other climate networks to generate annual climate summaries, to identify climatic extremes, and to aid in the analysis and interpretation of trends in other monitored vital signs.

Procedures

Access the Global Historical Climatology Network (GHCN) database managed by the National Climatic Data Center. This database is the official archive for daily data from the surface network and is particularly well suited for monitoring and assessment.

1. Access the NCDC ftp site: ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/all/[NCDC No.]

where the [NCDC No.] is shown in Table 11-1.

2. Each ".dly" file contains data for one station. Select the desired COOP station from the list by clicking on the GHCN station ID code (Table 11-1) to access the period of record data for this station.

Table 11-1. COOP stations monitored by the SWAN.

Station name	Station type [TYPE]	Acronym [NAME]	NWS COOP Stn. #	NCDC No. GHCN Stn. ID #
Homer Airport	COOP	HOAI	503665	USW00025507
Iliamna Airport	COOP	ILAI	503905	USW00025506
Kenai Airport	COOP	KEAI	504546	USW00026523
King Salmon Airport	COOP	KISA	504766	USW00025503
Port Alsworth	COOP	POAL	507570	USC00507570
Seward	COOP	SEWA	508371	USW00026438
Seward 8NW (or “Seward 9NW”)	COOP	S8NW	508375	USC00508375
Telaquana Lake*	COOP	TELA	T.B.D.	T.B.D.

*Telaquana Lake data will not be accessible via GHCN until it is formally a COOP station.

3. When prompted by the server (Figure 11-1), save the file.

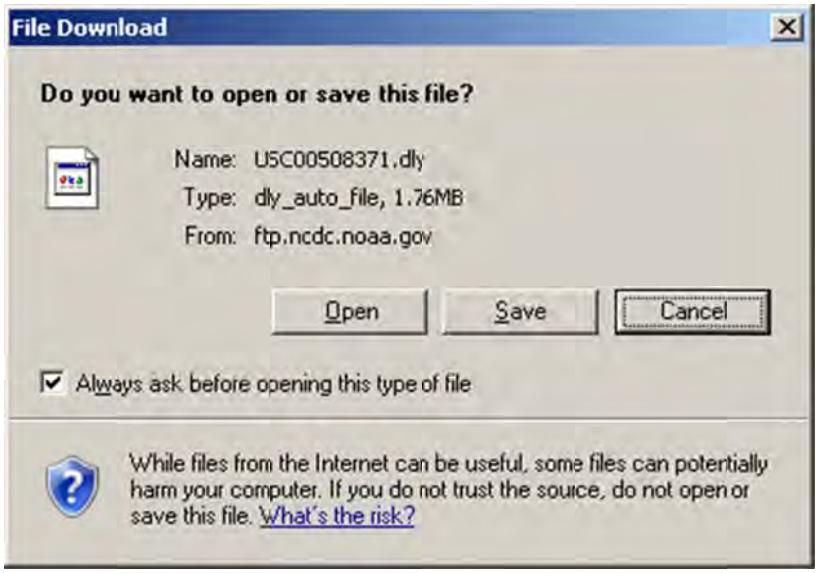


Figure 11-1. File download options.

4. COOP data files include the entire period of record. When archiving the original data files, they are organized by period of record and saved on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Downloads

5. Rename the COOP data file using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].dly

Where:

[TYPE] refers to the station type (e.g. COOP, refer to Table 11-1)
[NAME] is the four letter acronym for the station name (e.g. SEWA, refer to Table 11-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage "dwnld"
.dly is the file type

Example: COOP_SEWA_19080201_20100105_20100114dwnld.dly

Open the text file to determine the start and end date for the period of record used for file naming. Note that records will extend to the current date, but data will not necessarily be available. Use the last date of available data for [enddate].

5. The file type needs to be ".dly" so that the data processing program can recognize the specific import format of COOP data. Verify the file extension. If file extensions are hidden, change the settings in the Folder Options menu on the Windows Control Panel (Figure 11-3). Uncheck the box for "Hide Extensions for known file types". If needed, change the extension type from ".txt" to ".dly" by renaming the file. (Figure 11-2). Regardless of file type, the file can still be opened using a text editor like Notepad.

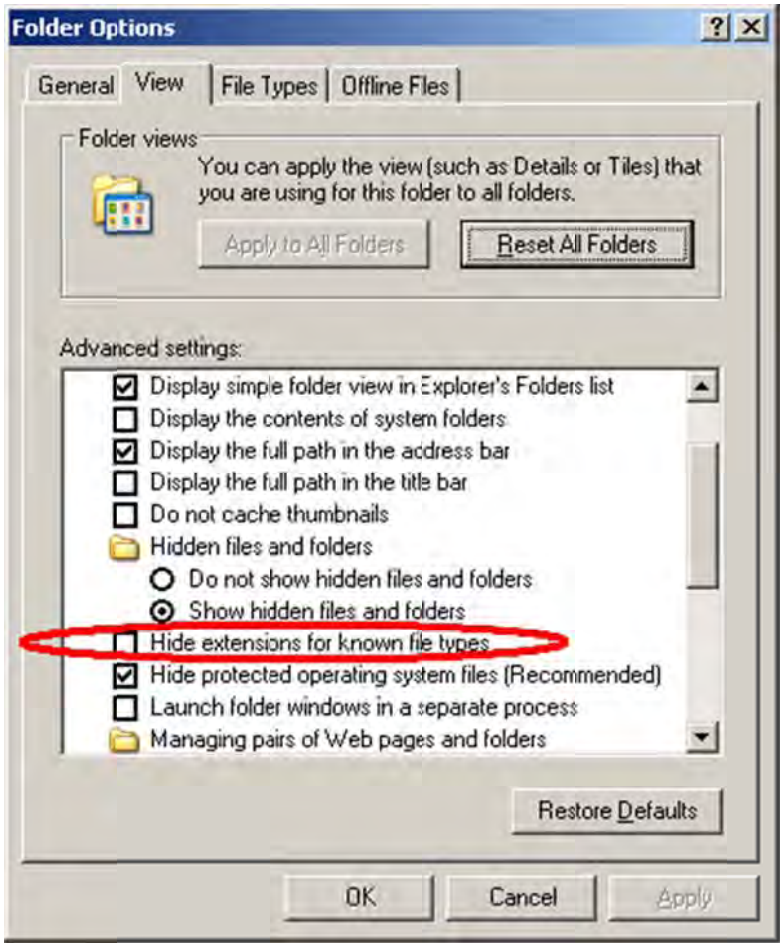


Figure 11-2. Windows Control Panel folder options for enabling file extensions (if necessary).

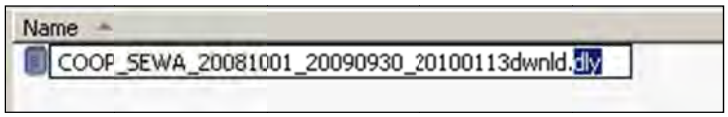


Figure 11-3. Changing the file extension for COOP data (if necessary).

Additional Formatting

COOP data from the NCDC includes data for the entire period of record. The data processing program used for summarizing COOP data is capable of handling and summarizing the entire period of record or a subset of this data. For consistency with other climate data sets, it is also useful to organize COOP data by hydrologic year. This requires extracting data for the current (most recent) hydrologic year from the period of record data set.

Procedures

1. Open the COOP data file for the entire period of record using a text editor (e.g. Notepad). Each record (line) in the file contains one month of daily data separated by an end-of-line character (e.g. □). Six possible climatic elements are available which means that up to six lines of data contain data for a specific month. Each record (line) begins with:

[USC/Wxxxxxxxx][YYYYMM][elem]

Where:

[USC/Wxxxxxxxx] is the GHCN station ID code (refer to Table 11-1)
[YYYYMM] is the year and month
[elem] is the climatic element represented by that line (possible elements include PRCP, SNOW, SNWD, TMAX, TMIN, TOBS)

2. Locate the data for the current (most recent) hydrologic year. Select all records for the period of interest (most recent hydrologic year). Start the selection immediately after the end-of-line character (□) and complete the selection by including the end-of-line character (Figure 11-4).

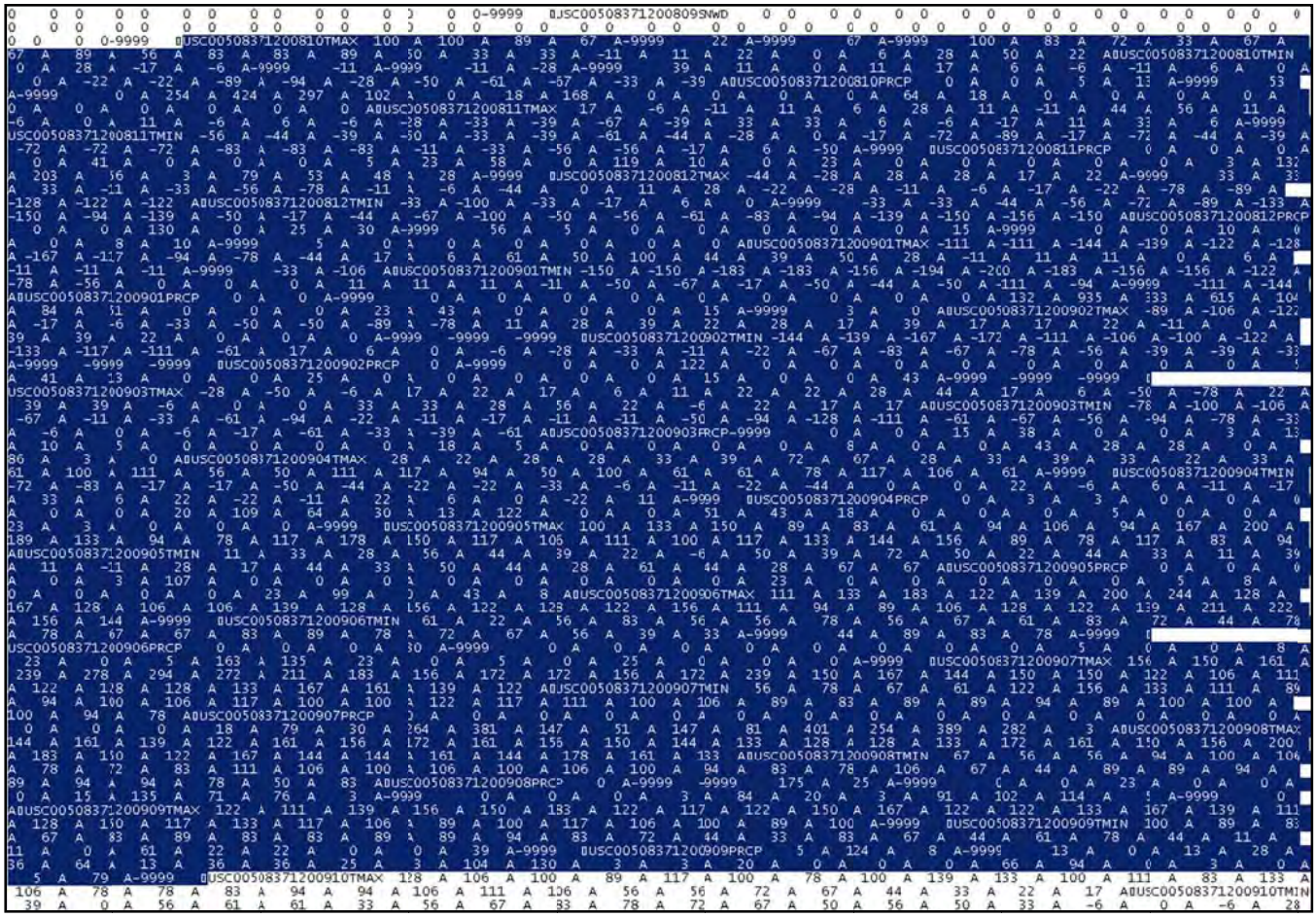


Figure 11-4. Selection of data records for one hydrologic year (e.g. October 2008 through September 2009).

3. Copy and paste these records to a new text file. Save the file using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].dly

Where:

[TYPE] refers to the station type (e.g. COOP, refer to Table 11-1)
[NAME] is the four letter acronym for the station name (e.g. SEWA, refer to Table 11-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage "dwnld"
.dly is the file type

Example: COOP_SEWA_20081001_20090930_20100114dwnld.dly

4. Change the file extension to ".dly" and verify that ANSI encoding is used (Figure 11-5).

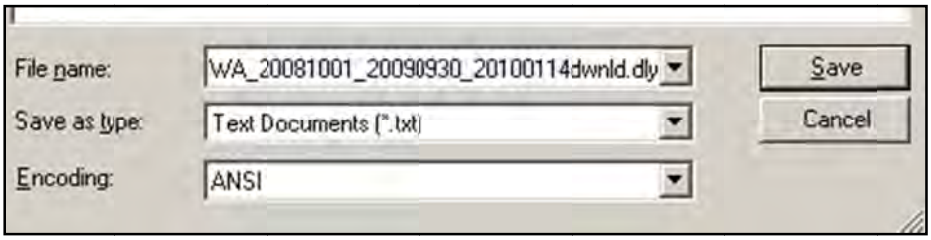


Figure 11-5. File type, extension, and encoding for COOP data.

Data Processing

A customized program (Python script) is used to convert COOP data into a standardized list of climate elements and to summarize hourly data into daily, monthly, and yearly (hydrologic year) measures. Running this program also checks for invalid or missing date and time values, replaces flagged data values with a common identifier (-9999) and converts input units to both metric and U.S. customary units.

Data Processing Program

The program COOPdata_FormatSummarizeConvert.py is used to process COOP data. The executable program is stored on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Programs_Scripts

The current version of the processing program is denoted by the most recent [filedatestage] (in YYYYMMDD format) appended to the program file name.

Example:

COOPdata_FormatSummarizeConvert_20100217.py

Input Format

The expected input data set for COOP data is a fixed-column format text file with a ".dly" extension. The specific data file format is that used by the Global Historical Climatology Network (GHCN) daily database (refer to ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/readme.txt).

Executing the Program

1. Double clicking the program will execute open it.

2. A file dialog will ask for the location of the input data (Figure 11-6). Pressing cancel will abort the operation. This program is capable of reading in multiple files at once and appending the data. This is useful to avoid calculating summaries for partial water years when using calendar year annual input data. The inputs are sorted alphabetically, so the names must be in alphabetic order by date. If the names are in the format described above with a date string following the station name, this will already be the case. The data must not overlap in time. Alternatively, data can be appended by hand using a text editor, and then fed to the program as one file.

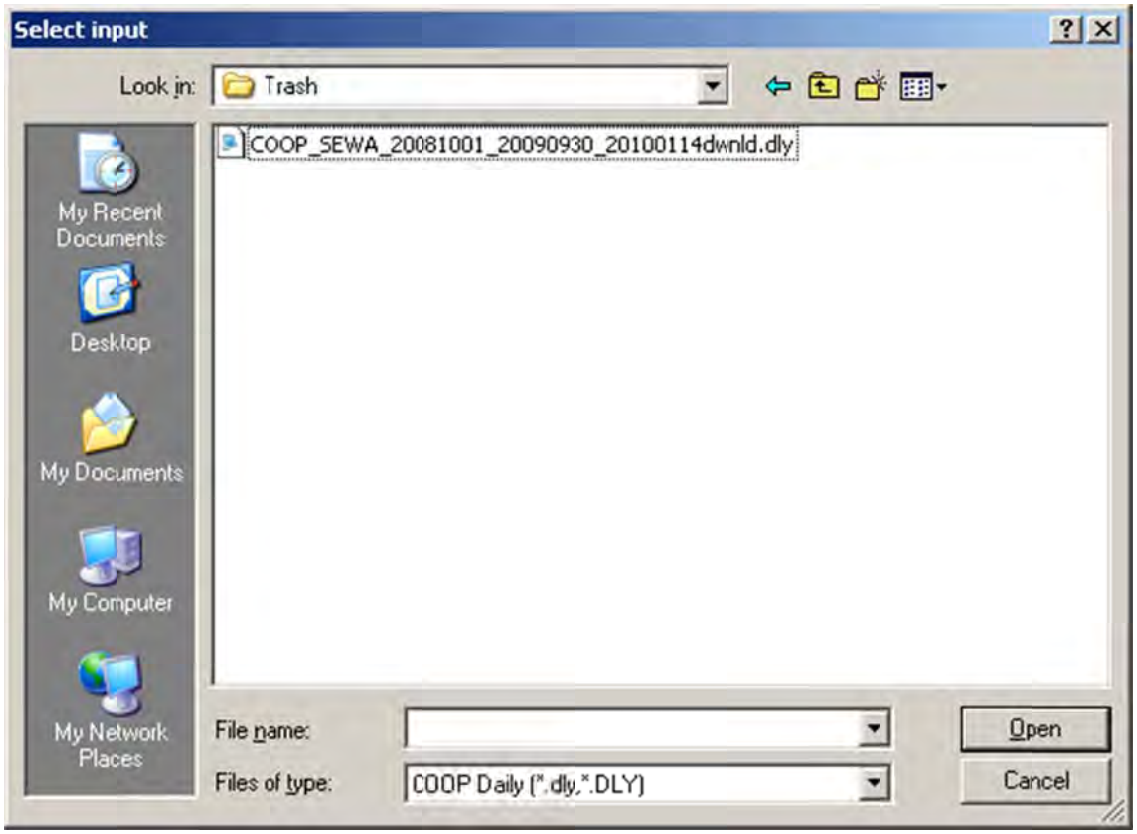


Figure 11-6. COOPdata_FormatSummarizeConvert.py file input dialog.

3. A second dialog will ask where the data should be saved (Figure 11-6). Not specifying a location will save the data in the current directory. Pressing cancel will abort the operation.

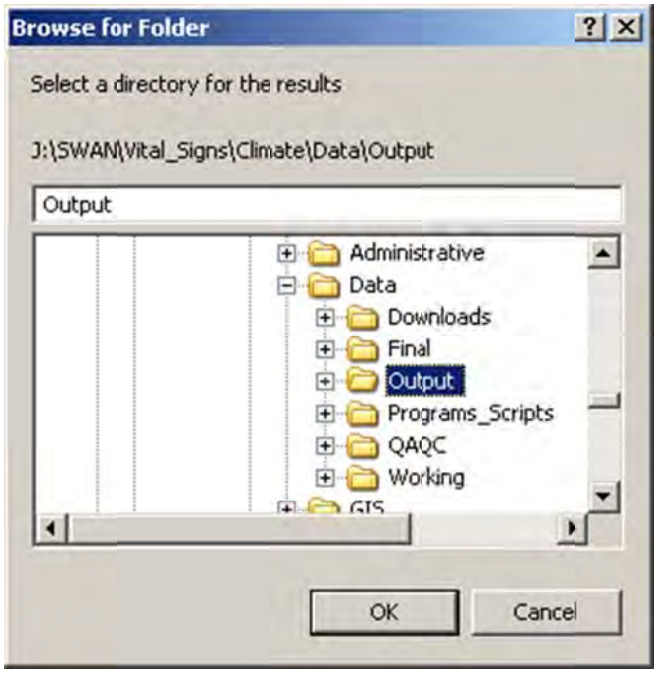


Figure 11-6. COOPdata_FormatSummarizeConvert.py file output dialog.

4. The program will parse, process, and write the data into multiple output products. The duration of this process will depend on the size of the input file, but for a year's worth of daily data, the process shouldn't take more than a second (Figure 11-7). Should an error occur, a message should be provided that should be useful in resolving the problem.

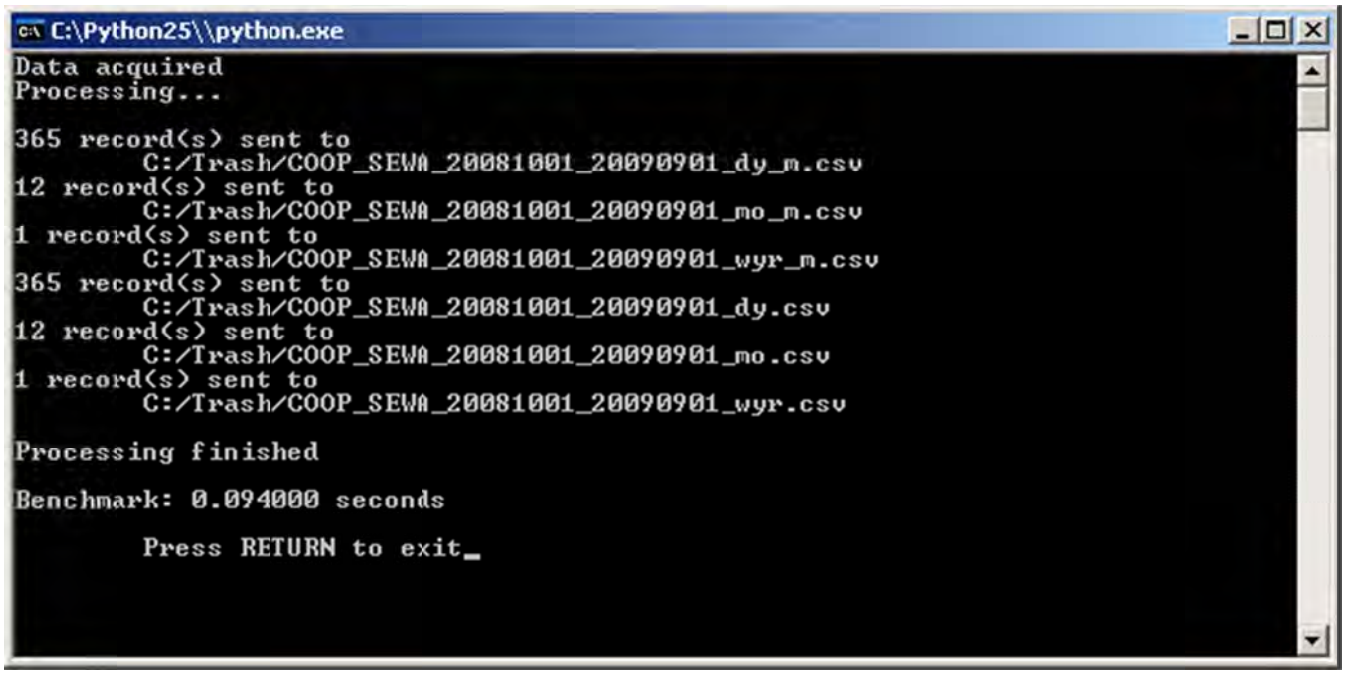


Figure 11-7. COOPdata_FormatSummarizeConvert.py file processing dialog after successful completion.

5. Note each output file name is appended (e.g. _hr_m) in order to indicate sampling interval and units. Summaries are provided at the daily (_dy), monthly (_mo), and annual (_wyr) rates and in both metric (_m) and U.S. customary (not appended with "_m") units. Output file names are also appended with [filedatestage] (in format YYYMMDDfromPy) to be consistent with SWAN file naming conventions.

e.g. COOP_SEWA_20081001_20090930_hr_m_20081103fromPy.csv

Output Format

Table 11-2. Output format and elements availability for COOPdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
OBSV	yyyymmddhhmm		Date and time of observation	Y
%OBSV	%	%	% valid data transmissions during sampling interval	Y
DATE/TIME	yyyy/mm/dd hh:mm		Date and time of observation (Excel/SigmaPlot format)	Y
ATAV	°F	°C	Mean temperature during sampling interval	optional*
%ATAV	%	%	% valid temperature observations during sampling interval	optional*
ATMX	°F	°C	Maximum temperature during sampling interval	Y
%ATMX	%	%	% valid temperature observations during sampling interval	Y
ATMN	°F	°C	Minimum temperature during sampling interval	Y
%ATMN	%	%	% valid temperature observations during sampling interval	Y
TOBS	°F	°C	Mean temperature at time of observation during sampling interval	Y
%TOBS	%	%	% valid TOBS during sampling interval	Y
WSAV	mph	m/s	Mean wind speed during sampling interval (scalar average)	N
%WSAV	%	%	% valid wind speed observations during sampling interval	N
WDAV	deg	deg	Mean wind direction during sampling interval (time-averaged using sum of unit vectors from each observation independent of wind speed)	N
WSPK	mph	m/s	Maximum wind speed (instantaneous) during sampling interval	N
%WSPK	%	%	% valid wind speed observations during sampling interval	N
WDPK	deg	deg	Corresponding wind direction for WSPK	N
RHAV	%	%	Mean relative humidity during sampling interval	N
%RHAV	%	%	% valid relative humidity observations during sampling interval	N
STPR	in Hg	hPa	Mean atmospheric pressure at station during sampling interval	N
%STPR	%	%	% valid atmospheric pressure observations during sampling interval	N
SLPR	in Hg	hPa	Mean atmospheric pressure at sea level during sampling interval	N
%SLPR	%	%	% valid SLPR observations during sampling interval	N
VISI	mi	km	Mean visibility during sampling interval	N
%VISI	%	%	% valid visibility observations during sampling interval	N
SRAD	Ly	W/m^2	Average solar radiation during hourly sampling interval, cumulative solar radiation during daily, monthly, and yearly sampling interval	N
%SRAD	%	%	% valid solar radiation observations during sampling interval	N
PRCP	in	mm	Total precipitation during sampling interval	Y
%PRCP	%	%	% valid precipitation observations during sampling interval	Y
PCUM	in	mm	Cumulative precipitation during period of summary (e.g. hydrologic year)	Y
SNOW	in	mm	Total snow accumulation during sampling interval	Y
%SNOW	%	%	% valid snow accumulation observations during sampling interval	Y
SD	in	mm	Mean snow depth during sampling interval	Y
%SD	%	%	% valid snow depth observations during sampling interval	Y
WTAV	°F	°C	Mean sea water temperature during sampling interval	N

Table 11-2 continued. Output format and elements availability for COOPdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
%WTAV	%	%	% valid sea water temperature observations during sampling interval	N
WVHT	ft	M	Mean wave height during sampling interval	N
%WVHT	%	%	% valid wave height observations during sampling interval	N
AWPD	sec	sec	Mean wave period during sampling interval	N
%AWPD	%	%	% valid wave period observations during sampling interval	N
DWPD	sec	sec	Mean maximum wave energy (period) during sampling interval	N
%DWPD	%	%	% valid DWPD observations during sampling interval	N
MWVD	deg	Deg	Mean wave direction (associated with DWPD) during sampling interval	N
%MWVD	%	%	% valid MWVD observations during sampling interval	N
TIDE	ft	m	Mean tide height during sampling interval	N
%TIDE	%	%	% valid observations during sampling interval	N
STAV	°F	°C	Mean ground surface (skin) temperature during sampling interval	N
%STAV	%	%	% valid STAV observations during sampling interval	N
SOT1	°F	°C	Mean soil temperature #1 during sampling interval (refer to station info.)	N
%SOT1	%	%	% valid SOT1 observations during sampling interval	N
SOT2	°F	°C	Mean soil temperature #2 during sampling interval (refer to station info.)	N
%SOT2	%	%	% valid SOT2 observations during sampling interval	N
SOT3	°F	°C	Mean soil temperature #3 during sampling interval (refer to station info.)	N
%SOT3	%	%	% valid SOT3 observations during sampling interval	N
SOT4	°F	°C	Mean soil temperature #4 during sampling interval (refer to station info.)	N
%SOT4	%	%	% valid SOT4 observations during sampling interval	N

* COOP.py is capable of estimating ATAV as the midpoint between mean ATMX and ATMN of monthly or annual timescales. To enable this edit the program and set 'self.estimate_atav = True' within the dataBuffer class.

SOP #12: Downloading and Processing ASOS & AWOS Data
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for downloading data from Automated Surface Observing System (ASOS) and Automated Weather Observing System (AWOS) stations from the National Climatic Data Center (NCDC) Quality Controlled Local Climatological Data server and using a customized program (Python script) that both summarizes (down samples) hourly ASOS observations (to daily, monthly, and yearly measures) and sub-hourly AWOS observations (to hourly, daily, monthly, and yearly measures) and converts data to a standardized format in both metric and U.S. customary units.

Downloading ASOS and AWOS Data

There are currently five ASOS and one AWOS station monitored by the SWAN (Appendix C-1). Data from these stations will be used in conjunction with information from other climate networks to generate annual climate summaries, to identify climatic extremes, and to aid in the analysis and interpretation of trends in other monitored vital signs.

Procedures

Access the Quality Controlled Local Climatological Data (QCLCD) server managed by the National Climatic Data Center. This database is the official archive for hourly data from ASOS and AWOS stations. Daily summary data for the ASOS stations is available from other databases, including the Global Historical Climatology Network (GHCN).

1. Access the NCDC data at: https://ols.nndc.noaa.gov/sub-login.html

2. A password is required to access data free of charge (Figure 12-1). This password is provided to the SWAN by the NCDC. Contact the PI of the climate monitoring vital sign for the password.

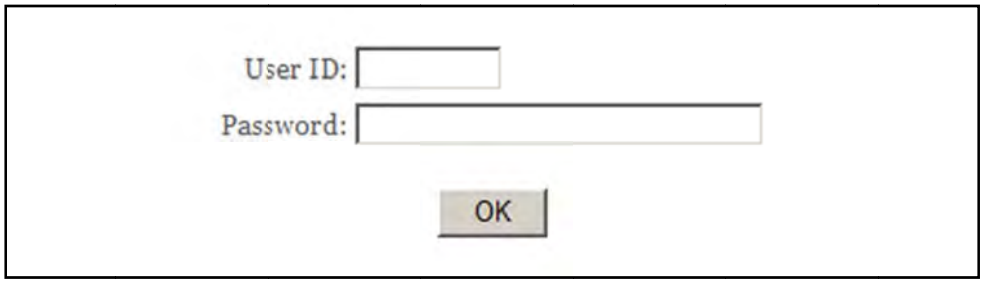


Figure 12-1. NCDC data subscription login.

3. Enter user ID and password. After successful login, click “Continue”. Select “Quality Controlled Local Climatological Data” from the list (Figure 12-2) and click “Continue”.

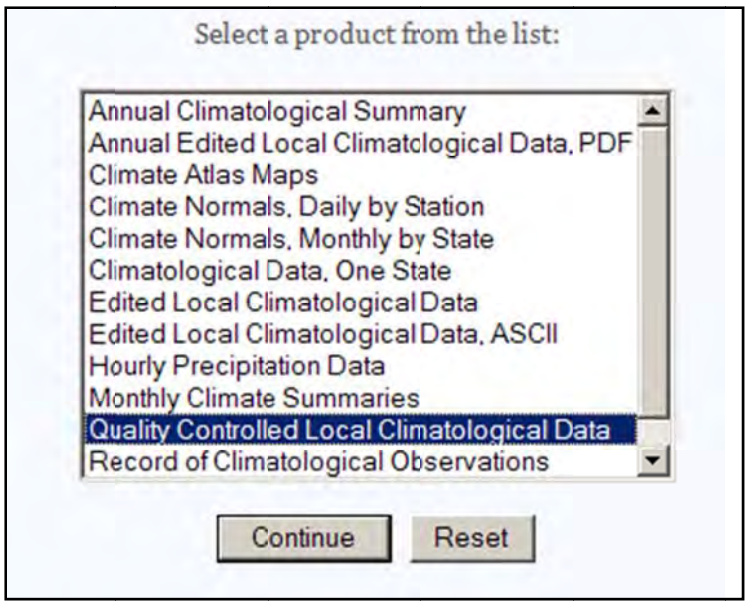


Figure 12-2. NCDC data products.

4. Select “All” stations (Figure 12-3) and click “Submit”.

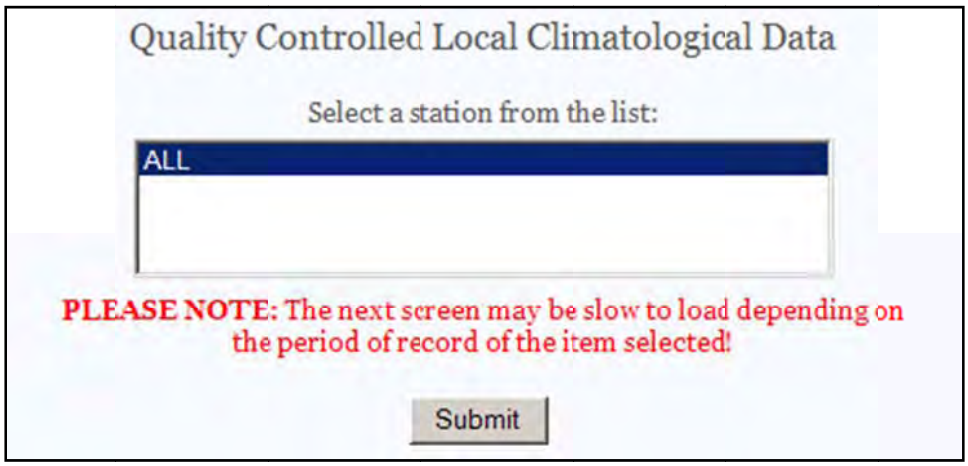


Figure 12-3. QCLCD initial station list.

5. The NCDC is in the process of implementing a new local climatological data system. In the interim, users are prompted to select between the ULCD and QCLCD systems. Select “Data for 01/2005 or After” to access the QCLCD system.

6. Select QCLCD data from Alaska Stations (Figure 12-4) and click “Continue”.

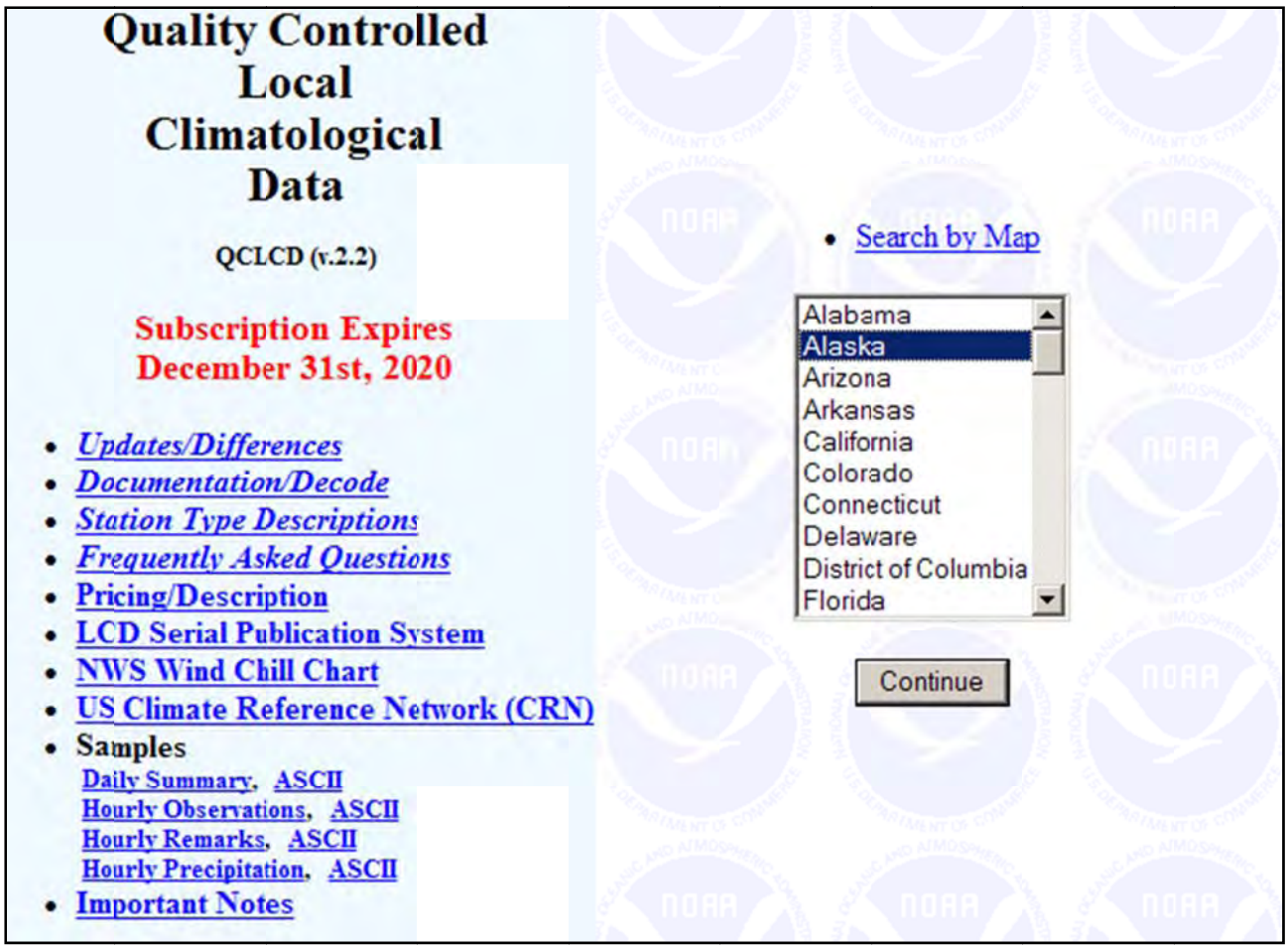


Figure 12-4. QCLCD state list.

7. Select the desired station (refer to Table 12-1) and click “Continue” (Figure 12-5).

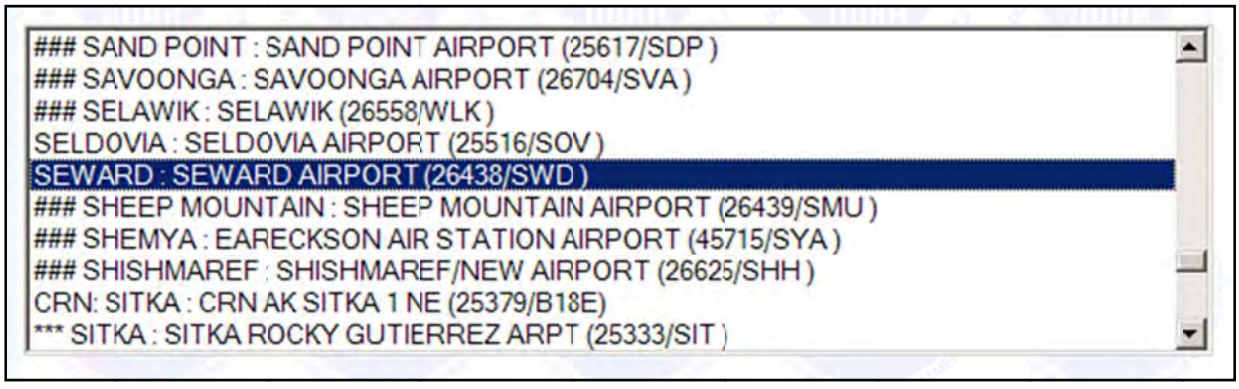


Figure 12-4. QCLCD station list.

Table 12-1. ASOS and AWOS stations monitored by the SWAN.

Station name	Station type [TYPE]	Acronym [NAME]	WBAN ID#
Homer Airport	ASOS	HOAI	25507
Iliamna Airport	ASOS	ILAI	25506
Kenai Airport	ASOS	KEAI	26523
King Salmon Airport	ASOS	KISA	25503
Port Heiden Airport	AWOS	POHE	25508
Seward Airport	ASOS	SEWA	26438

8. Data for ASOS and AWOS stations are available by month. Select the desired month and click "Continue". Both hourly and daily data are available for ASOS stations. Sub-hourly data is available for the AWOS stations. Select "E" to access data for the entire month and click on "ASCII Download (Hourly Obs.)" (Figure 12-5).

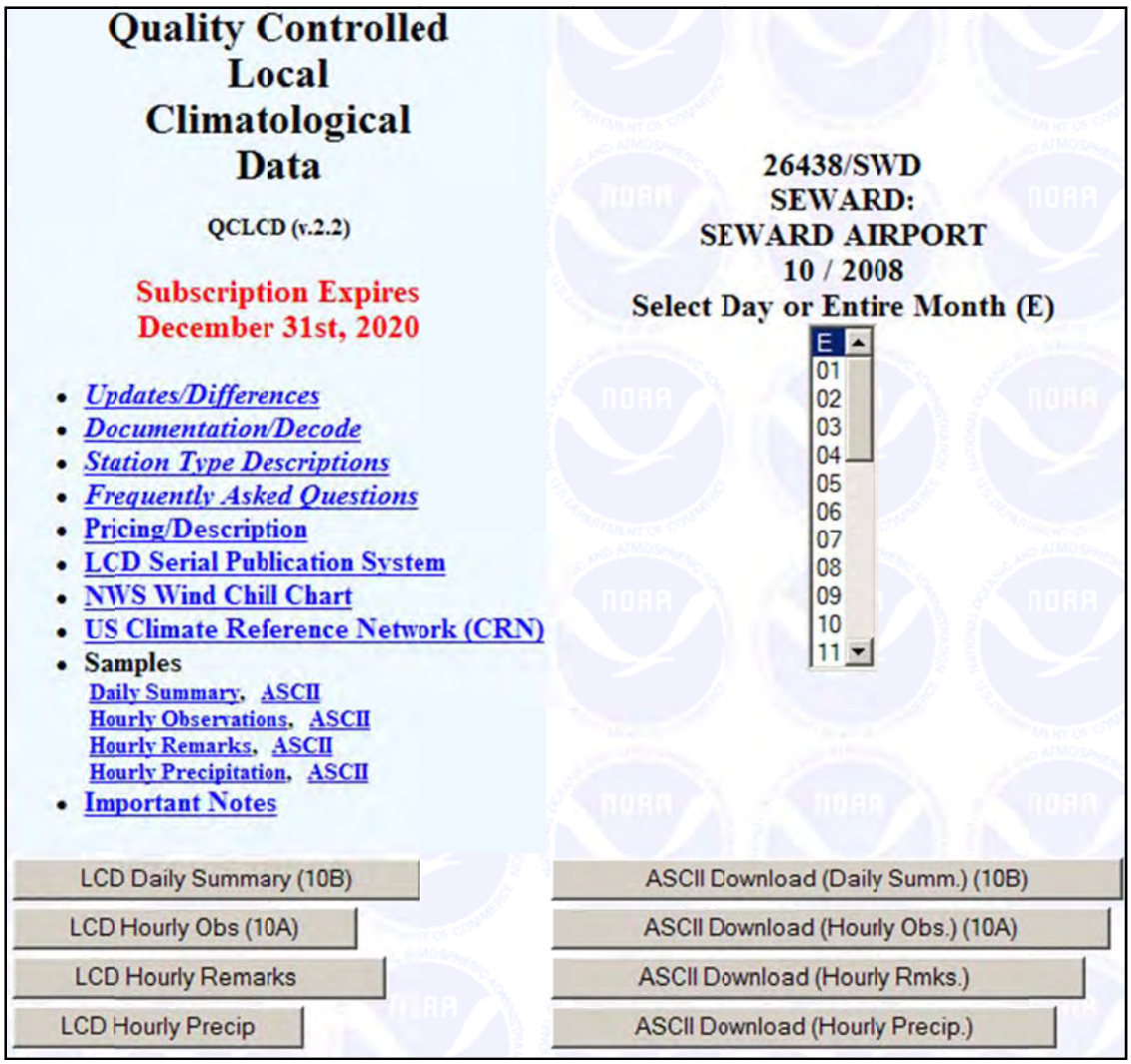
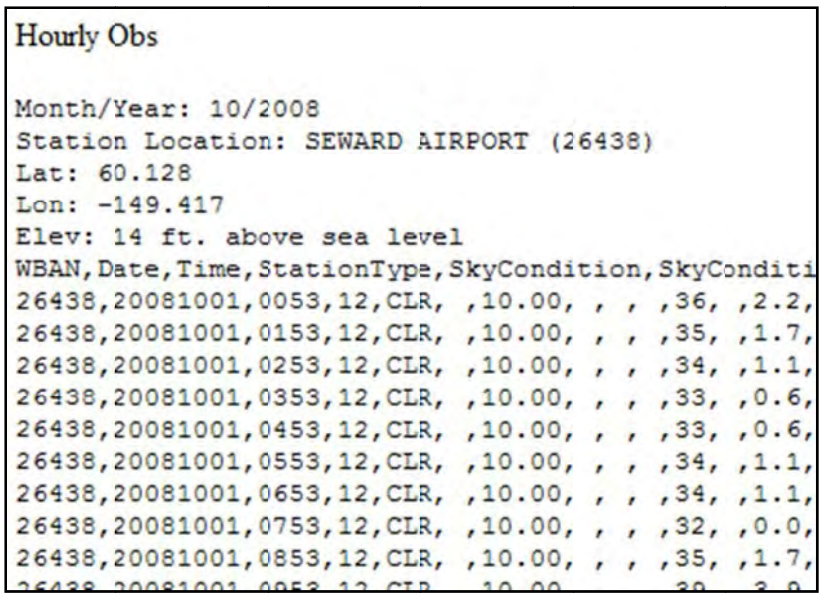


Figure 12-5. QCLCD data options for monthly station data.

9. Comma delimited hourly (or sub-hourly) data is provided in HTML format (Figure 12-6).



Hourly Obs

Month/Year: 10/2008
Station Location: SEWARD AIRPORT (26438)
Lat: 60.128
Lon: -149.417
Elev: 14 ft. above sea level

```
WBAN,Date,Time,StationType,SkyCondition,SkyConditi
26438,20081001,0053,12,CLR, ,10.00, , , ,36, ,2.2,
26438,20081001,0153,12,CLR, ,10.00, , , ,35, ,1.7,
26438,20081001,0253,12,CLR, ,10.00, , , ,34, ,1.1,
26438,20081001,0353,12,CLR, ,10.00, , , ,33, ,0.6,
26438,20081001,0453,12,CLR, ,10.00, , , ,33, ,0.6,
26438,20081001,0553,12,CLR, ,10.00, , , ,34, ,1.1,
26438,20081001,0653,12,CLR, ,10.00, , , ,34, ,1.1,
26438,20081001,0753,12,CLR, ,10.00, , , ,32, ,0.0,
26438,20081001,0853,12,CLR, ,10.00, , , ,35, ,1.7,
```

Figure 12-6. Hourly ASOS data in HTML format.

10. Download the monthly data. Save the webpage as a text file (.txt) (Figure 12-7).

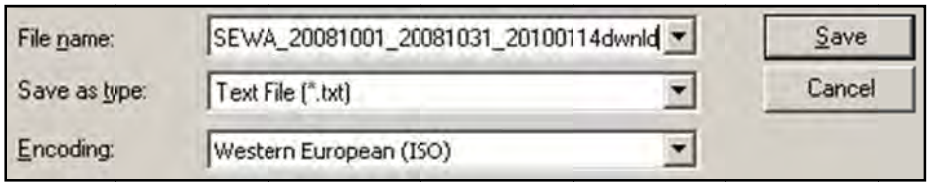


Figure 12-6. Browser "Save As" window.

11. When archiving the original data files, they are initially organized by month and saved on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Downloads

Using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].csv

Where:

[TYPE] refers to the station type (e.g. ASOS, refer to Table 12-1)
[NAME] is the four letter acronym for the station name (e.g. SEAI, refer to Table 12-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage "dwnld"
.csv is the file type

Example: ASOS_SEAI_20081001_20081031_20100114dwnld.dly

Appending Monthly Data

For consistency with other climate data formats, hourly ASOS and sub-hourly AWOS data (available by month) are acquired for the entire hydrologic year and then appended into one file.

Procedures

1. Open Excel. Open the monthly data file with the oldest data. The "Text Import Wizard" will prompt if the file is delimited or fixed width (Figure 12-7). Select "delimited" and click "Next".



Figure 12-7. MS Excel Text Import Window (step 1).

2. When prompted, indicate that the file is comma delimited (Figure 12-8) and click "Next" and then click "Finish".

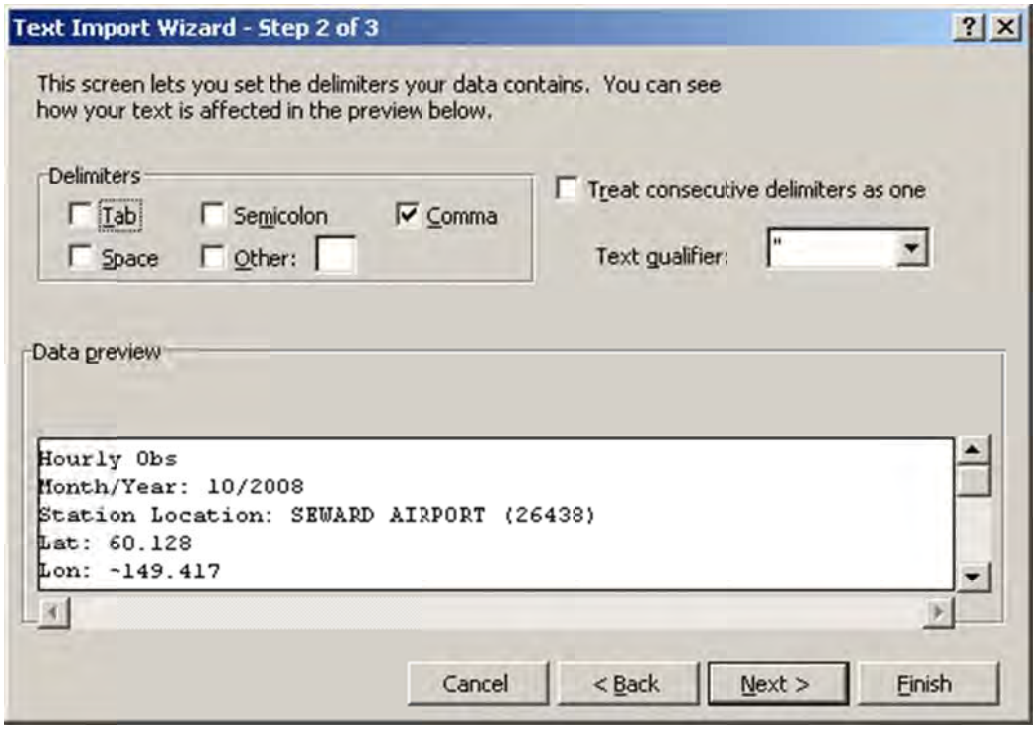


Figure 12-8. MS Excel Text Import Wizard (step 2).

3. Delete the first six header lines. Insert a header row immediately above the remaining row of headers. Enter the station name, and state in the first cell of this new header (Figure 12-9).

Seward Airport, Alaska						
WBAN	Date	Time	StationTyp	SkyCondit	SkyCondit	V
26438	20081001	53	12	CLR		
26438	20081001	153	12	CLR		
26438	20081001	253	12	CLR		
26438	20081001	353	12	CLR		
26438	20081001	453	12	CLR		
26438	20081001	553	12	CLR		

Figure 12-9. Two rows of headers, after modification.

4. Open the next consecutive monthly data file. The “Text Import Wizard” will prompt if the file is delimited or fixed width. Select “delimited” and indicate that the import should begin at row eight (Figure 12-10). This will remove all header information from data that will be appended to the preceding data set. Click “Next”. When prompted, indicate that the file is comma delimited. Click “Next” and then click “Finish”.

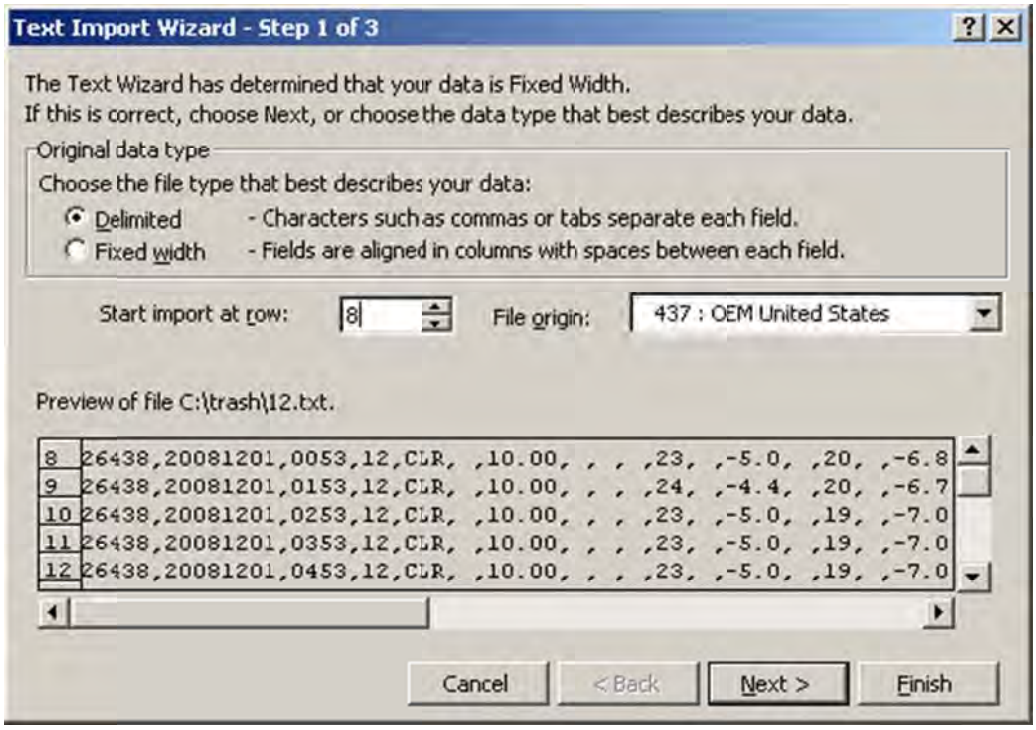


Figure 12-10. MS Excel Text Import Wizard (step 16).

5. Append this data to the preceding data by selecting all the data (select the upper-left most data cell, hold the Shift key, and select the lower-right most data cell), copying it, and pasting it below the oldest data. Repeat this procedure for the desired months. When finished, verify that: 1) only two rows of header information are present; and 2) the Date and Time columns are in consecutive order (from preceding to consecutive). Some data may be missing. Subsequent data processing will account for this missing data.

6. Save the file as a comma delimited (.csv) text file (Figure 12-11).

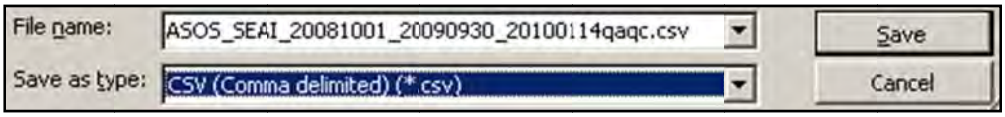


Figure 12-11. Excel "Save As" window.

7. When saving the modified (appended) data files, they are organized by hydrologic year and saved on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\QAQC

Using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].csv

Where:

[TYPE] refers to the station type (e.g. ASOS, refer to Table 12-1)
[NAME] is the four letter acronym for the station name (e.g. SEAI, refer to Table 12-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was modified and the file stage "qaqc"
.csv is the file type

Example: ASOS_SEAI_20081001_20090930_20100114qaqc.csv

Data Processing

A customized program (Python script) is used to convert ASOS and AWOS data into a standardized list of climate elements and to summarize hourly data into daily, monthly, and yearly (hydrologic year) measures. Running this program also checks for invalid or missing date and time values, replaces flagged data values (except for data flagged with an "S", which means manually edited data passing all system checks, which are passed) with a common identifier (-9999) and converts input units to both metric and U.S. customary units.

Data Processing Program

The program ASOSandAWOSdata_FormatSummarizeConvert.py is used to process ASOS and AWOS data. The executable program is stored on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Programs_Scripts

The current version of the processing program is denoted by the most recent [filedatestage] (in YYYYMMDD format) appended to the program file name.

Example:

ASOSandAWOSdata_FormatSummarizeConvert_20100218.py

Input Format

The expected input data set for ASOS and AWOS data is a comma delimited text file with a ".csv" extension with a two-line header followed by observations sorted by date and time in the subsequent rows. The first line of the header is ignored; the second line contains "WBAN" in the first coloum. The other columns may be in any order, but are expected to contain the case-sensitive fields documented in Table 12-2.

Table 12-2. Input format specifications for ASOSandAWOSdata_FormatSummarizeConvert.py. If additional fields are present, they are ignored.

Second-line Header label	Format	Units
WBAN	numeric	
Date	numeric	YYYYMMDD
Time	numeric	hhmm
SkyCondition	string	
SkyConditionFlag	string	
Visibility	numeric	miles
VisibilityFlag	string	
WeatherType	string	
WeatherTypeFlag	string	
DryBulbFarenheit	numeric	°F
DryBulbFarenheitFlag	string	
RelativeHumidity	numeric	%
RelativeHumidityFlag	string	
WindSpeed	numeric	mph
WindSpeedFlag	string	
WindDirection	numeric	degrees
WindDirectionFlag	string	
StationPressure	numeric	inHg
StationPressureFlag	string	
SeaLevelPressure	numeric	inHg
SeaLevelPressureFlag	string	
HourlyPrecip	numeric	in
HourlyPrecipFlag	string	

Executing the Program

1. Double clicking the program will execute open it.

2. A file dialog will ask for the location of the input data (Figure 12-12). Pressing cancel will abort the operation. This program is capable of reading in multiple files at once and appending the data. This is useful to avoid calculating summaries for partial water years when using calendar year annual input data. The inputs are sorted alphabetically, so the names must be in alphabetic order by date. If the names are in the format described above with a date string following the station name, this will already be the case. The data must not overlap in time.

Alternatively, data can be appended by hand using a text editor, and then fed to the program as one file.

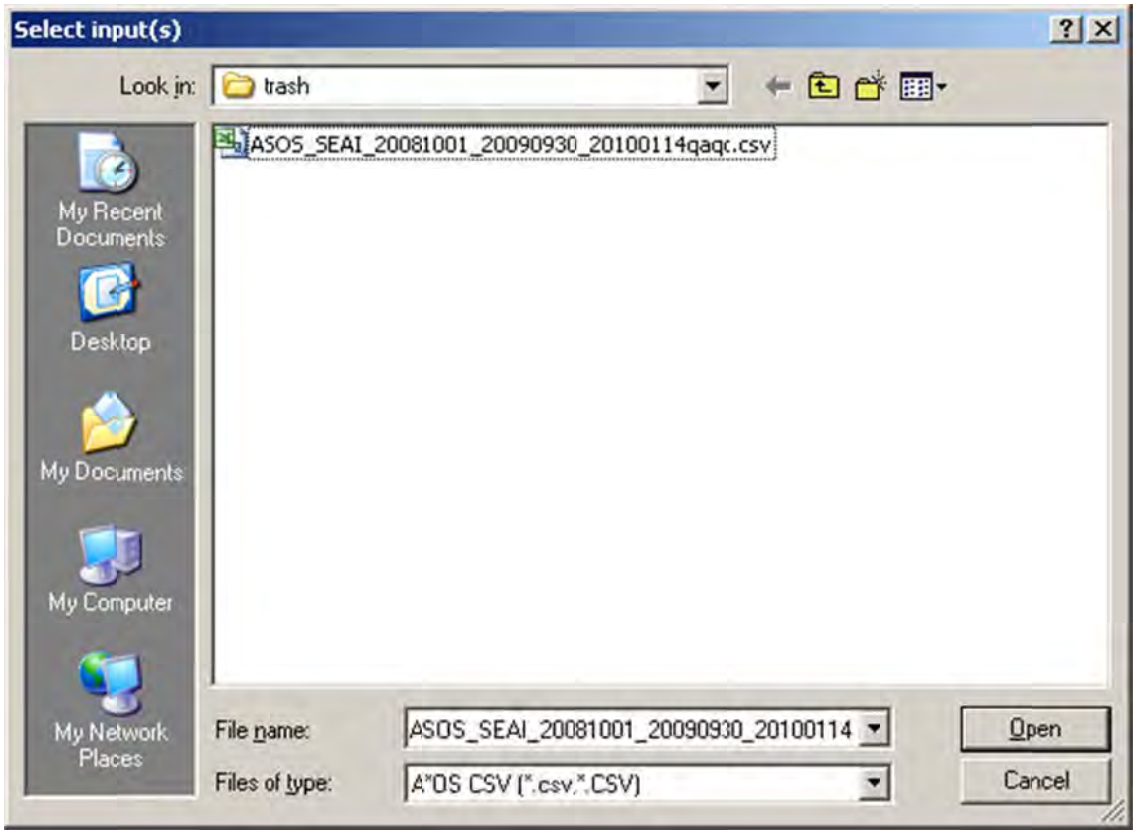


Figure 12-12. ASOSandAWOSdata_FormatSummarizeConvert.py file input dialog.

3. A second dialog will ask where the data should be saved (Figure 12-13). Not specifying a location will save the data in the current directory. Pressing cancel will abort the operation.

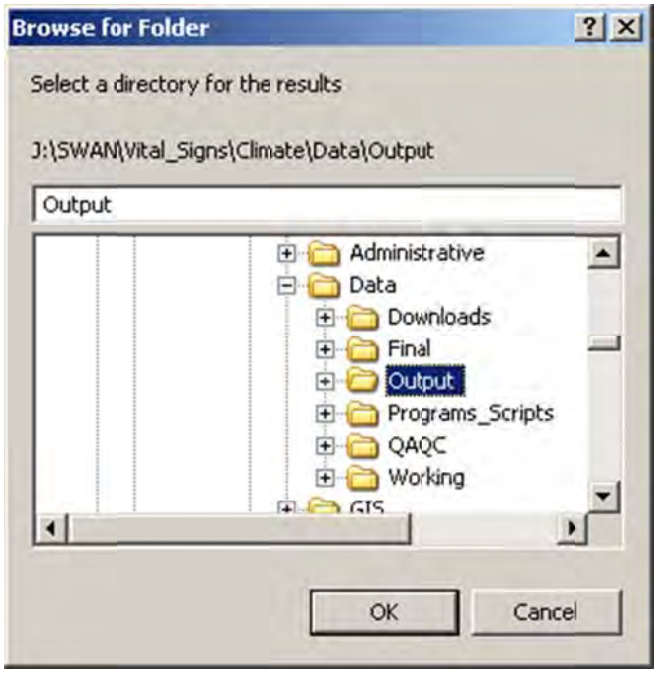


Figure 12-13. ASOSandAWOSdata_FormatSummarizeConvert.py file output dialog.

4. The program will parse, process, and write the data into multiple output products. The duration of this process will depend on the size of the input file, but for a year's worth of daily data, the process shouldn't take more than a few seconds (Figure 12-14). Should an error occur, a message should be provided that should be useful in resolving the problem.

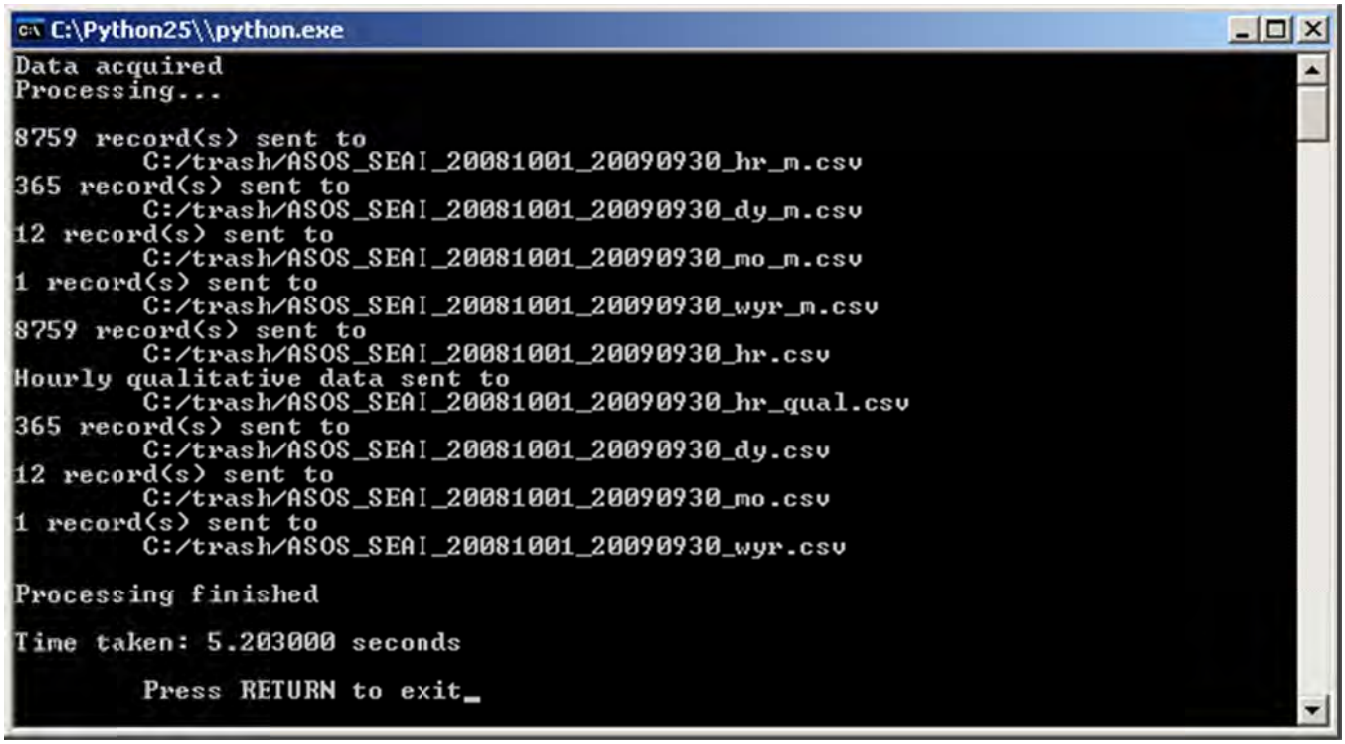


Figure 12-14. ASOSandAWOSdata_FormatSummarizeConvert.py file processing dialog after successful completion.

5. Note each output file name is appended (e.g. _hr_m) in order to indicate sampling interval and units. Summaries are provided at the daily (_dy), monthly (_mo), and annual (_wyr) rates and in both metric (_m) and U.S. customary (not appended with "_m") units. Output file names are also appended with [filedatestage] (in format YYYMMDDfromPy) to be consistent with SWAN file naming conventions.

e.g. ASOS_SEAI_20081001_20090930_hr_m_20100114fromPy.csv

Output Format

Table 12-3. Output format and elements availability for ASOSandAWOSdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
OBSV	yyyymmddhhmm		Date and time of observation	Y
%OBSV	%	%	% valid data transmissions during sampling interval	Y
DATE/TIME	yyyy/mm/dd hh:mm		Date and time of observation (Excel/SigmaPlot format)	Y
ATAV	°F	°C	Mean temperature during sampling interval	Y
%ATAV	%	%	% valid temperature observations during sampling interval	Y
ATMX	°F	°C	Maximum temperature during sampling interval	Y
%ATMX	%	%	% valid temperature observations during sampling interval	Y

Table 12-3 continued. Output format and elements availability for ASOSandAWOSdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
ATMN	°F	°C	Minimum temperature during sampling interval	Y
%ATMN	%	%	% valid temperature observations during sampling interval	Y
TOBS	°F	°C	Mean temperature at time of observation during sampling interval	N
%TOBS	%	%	% valid TOBS during sampling interval	N
WSAV	mph	m/s	Mean wind speed during sampling interval (scalar average)	Y
%WSAV	%	%	% valid wind speed observations during sampling interval	Y
WDAV	deg	deg	Mean wind direction during sampling interval (time-averaged using sum of unit vectors from each observation independent of wind speed)	Y
WSPK	mph	m/s	Maximum wind speed (instantaneous) during sampling interval	N
%WSPK	%	%	% valid wind speed observations during sampling interval	N
WDPK	deg	deg	Corresponding wind direction for WSPK	N
RHAV	%	%	Mean relative humidity during sampling interval	Y
%RHAV	%	%	% valid relative humidity observations during sampling interval	Y
STPR	in Hg	hPa	Mean atmospheric pressure at station during sampling interval	Y
%STPR	%	%	% valid atmospheric pressure observations during sampling interval	Y
SLPR	in Hg	hPa	Mean atmospheric pressure at sea level during sampling interval	Y
%SLPR	%	%	% valid SLPR observations during sampling interval	Y
VISI	mi	km	Mean visibility during sampling interval	Y
%VISI	%	%	% valid visibility observations during sampling interval	Y
SRAD	Ly	W/m^2	Average solar radiation during hourly sampling interval, cumulative solar radiation during daily, monthly, and yearly sampling interval	N
%SRAD	%	%	% valid solar radiation observations during sampling interval	N
PRCP	in	mm	Total precipitation during sampling interval*	Y
%PRCP	%	%	% valid precipitation observations during sampling interval	Y
PCUM	in	mm	Cumulative precipitation during period of summary (e.g. hydrologic year)	Y
SNOW	in	mm	Total snow accumulation during sampling interval	N
%SNOW	%	%	% valid snow accumulation observations during sampling interval	N
SD	in	mm	Mean snow depth during sampling interval	N
%SD	%	%	% valid snow depth observations during sampling interval	N
WTAV	°F	°C	Mean sea water temperature during sampling interval	N
%WTAV	%	%	% valid sea water temperature observations during sampling interval	N
WVHT	ft	M	Mean wave height during sampling interval	N
%WVHT	%	%	% valid wave height observations during sampling interval	N
AWPD	sec	sec	Mean wave period during sampling interval	N
%AWPD	%	%	% valid wave period observations during sampling interval	N
DWPD	sec	sec	Mean maximum wave energy (period) during sampling interval	N
%DWPD	%	%	% valid DWPD observations during sampling interval	N
MWVD	deg	Deg	Mean wave direction (associated with DWPD) during sampling interval	N
%MWVD	%	%	% valid MWVD observations during sampling interval	N
TIDE	ft	m	Mean tide height during sampling interval	N
%TIDE	%	%	% valid observations during sampling interval	N
STAV	°F	°C	Mean ground surface (skin) temperature during sampling interval	N

Table 12-3 continued. Output format and elements availability for ASOSandAWOSdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
%STAV	%	%	% valid STAV observations during sampling interval	N
SOT1	°F	°C	Mean soil temperature #1 during sampling interval (refer to station info.)	N
%SOT1	%	%	% valid SOT1 observations during sampling interval	N
SOT2	°F	°C	Mean soil temperature #2 during sampling interval (refer to station info.)	N
%SOT2	%	%	% valid SOT2 observations during sampling interval	N
SOT3	°F	°C	Mean soil temperature #3 during sampling interval (refer to station info.)	N
%SOT3	%	%	% valid SOT3 observations during sampling interval	N
SOT4	°F	°C	Mean soil temperature #4 during sampling interval (refer to station info.)	N
%SOT4	%	%	% valid SOT4 observations during sampling interval	N

*Values where HourlyPrecip = T (trace) in input is equated to 0.

SOP #13: Downloading and Formatting Snow Course Data
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for downloading Snow Course data from the National Resources Conservation Service (NRCS) National Water and Climate Center, manually extracting data for the most recent hydrologic year, and storing this data in a standardized format in both metric and U.S. customary units.

Downloading Snow Course Data

There are currently five snow courses and two aerial snow markers monitored by the SWAN (Appendix D-1). Snow Courses provide measures of snow depth and snow water equivalent (SWE) monthly during winter, while aerial snow markers provide only a measure of snow depth. This data offers insight to the temporal variation in snow pack and will be used in conjunction with information from other climate monitoring stations to generate annual climate summaries, to identify climatic extremes, and to aid in the analysis and interpretation of trends in other monitored vital signs.

Procedures

1. Access monthly snow course data from the National Water and Climate Center at the NRCS web site: http://www.wcc.nrcs.usda.gov/snowcourse/.

2. Click on "Snow Course Data" (Figure 13-1).

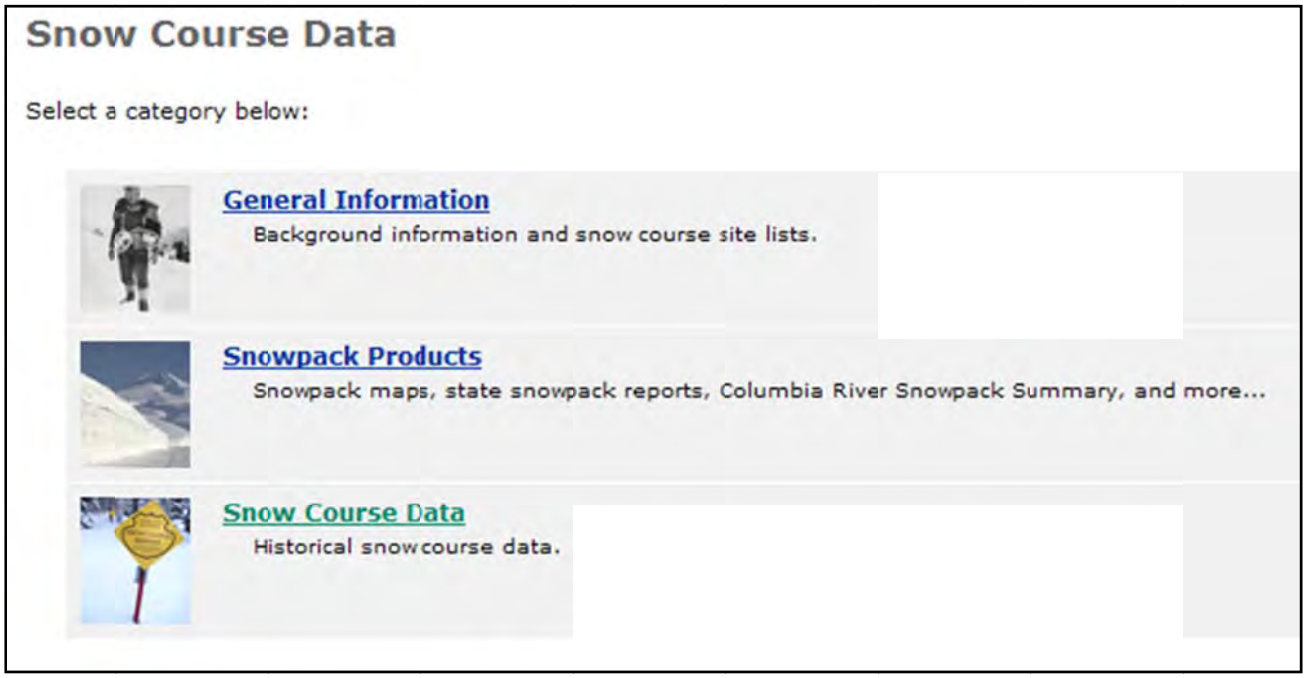


Figure 13-1. Snow Course data from the NRCS National Water and Climate Center.

3. Click on "Snow Course Historical Data – Individual Sites" (Figure 13-2).



Figure 13-2. Snow Course historical data from the NRCS National Water and Climate Center.

4. Select the state where the desired stations are located from the menu (Figure 13-3).

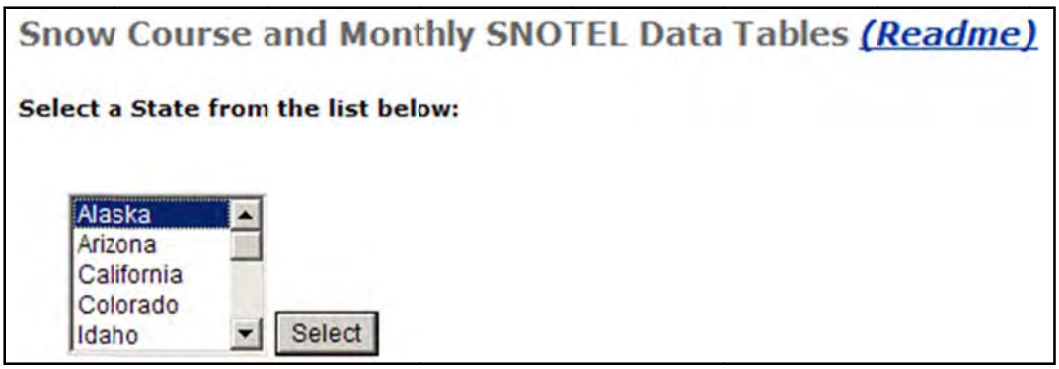


Figure 13-3. Snow Course historical data state list.

5. Access monthly data for the period of record by clicking on the desired station name (refer to Table 13-1; Figure 13-4).

Table 13-1. Snow Courses monitored by the SWAN.

Snow Course name	Station type [TYPE]	Acronym [NAME]	NRCS ID #
Brooks Camp	SNCO	BRCA	55J01
Exit Glacier	SNCO	EXGL	49L18
Fishtrap Lake	SNCO	FILA	54L02
Port Alsworth	SNCO	POAL	54L01
Telaquana Lake	SNCO	TELA	53L01
Three Forks	SNCO	THFO	55J02
Upper Twin Lakes	SNCO	UTLA	53L02

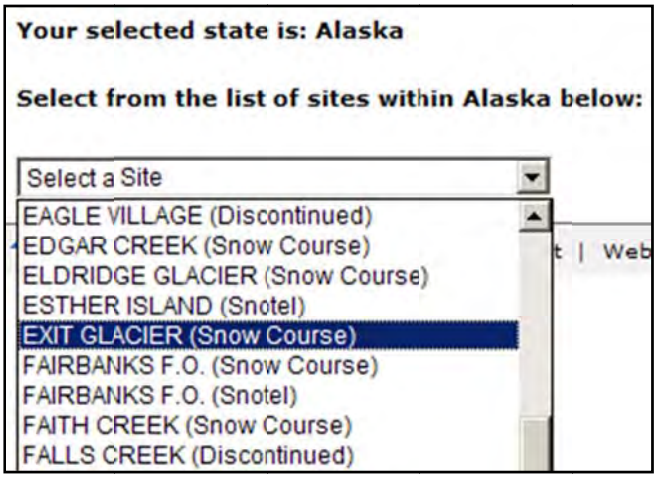


Figure 13-4. Snow Course historical data station list.

4. Data is provided in html format and contains fixed width formatted columns. Each line represents monthly data (Figure 13-5) for one calendar year. Data is followed by information listing calculated snow depth and snow water equivalent averages along with 30-year averages from 1971-2000.

```
Station : 49L18, EXIT GLACIER
-------
Unit = inches
year/   January          February         March           April            May
card date dep  swe   date dep  swe   date dep  swe   date dep  swe   date dep  swe
     ---- --- ----- ---- --- ----- ---- --- ----- ---- --- ----- ---- --- -----
89-1 K/30  31   7.4 2/03  45  11.7 3/01  44  11.6 3/29  38  11.0

90-1 1/02  34   8.1 2/01  53  15.0 2/28  65  16.9 3/30  62  18.6 5/01  28  10.8
91-1 1/03  19   3.6 2/05  31   6.6 3/01  26   8.2 4/02  39  11.3 5/03  20   5.5
92-1 K/30  60  13.3 1/31  60  19.7 2/27  81  24.0 3/30  89  31.2 4/28  68  26.1
93-1 K/29  26   8.0 1/25  35   9.7 3/01  39  13.9 4/01  49  17.9 4/28  26  10.6
94-1 1/03  26   7.0 1/26  36   8.8 2/28  37   9.7 3/28  45  12.7 5/02  15   5.1
```

Figure 13-5. Monthly Snow Course data for the period of record from the NRCS.

5. To save all available data for the period of record, select "File" on the browser and then select "Save As" and name the file using the file naming structure outlined below. Date is saved as a text (.txt) file (Figure 13-6).

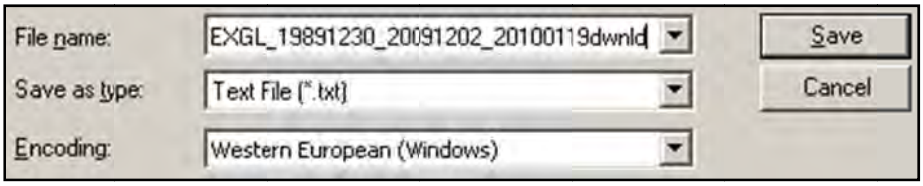


Figure 13-6. Browser "Save As" window.

6. When archiving the original data files, they are organized by period of record and saved on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Downloads

Using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].txt

Where:

[TYPE] refers to the station type (e.g. SNCO, refer to Table 13-1)
[NAME] is the four letter acronym for the station name (e.g. EXGL, refer to Table 13-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage "dwnld"
.txt is the file type

Example: SNCO_EXGL_19891230_20091202_20100119dwnld.txt

NRCS Snow Course Data Format

The data format for Snow Course data are fixed width column formatted text files with a ".txt" extension. Header information, data descriptions, and units are those specified by the NRCS (refer to ftp://ftp.wcc.nrcs.usda.gov/data/snow/snow_course/README.txt).

Extracting Snow Course data by Hydrologic Year

For consistency with other climate data formats, monthly Snow Course data are acquired for the entire period of record and then data from the most recent hydrologic year are extracted. Snow Course data for the most recent hydrologic year are then stored in a standard format in both metric and U.S. customary units.

Procedures

1. Open the U.S. customary unit standard format template for Snow Course data using Excel. There are two templates – one in U.S. customary units (_mo) and one in metric (_mo_m) units. The read-only templates are stored on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Templates

SNCO_NAME_YYYYMMDD_YYYYMMDD_mo_YYYYMMDDextractHY.csv

SNCO_NAME_YYYYMMDD_YYYYMMDD_mo_m_YYYYMMDDextractHY.csv

2. Open the most recent period-of-record Snow Course archived data file (…dwnld.txt) for the desired station.

3. Populate data fields in the standard format (…extractHY.csv) data file with corresponding data from the period-of-record (…dwnld.txt) file as specified in Table 13-2. Values for the fields %OBSV, %PRCP, and %SD are set to "100" if a Snow Course observation is available for that month. Although time of observation is not available for Snow Course data, the time stamp in the DATE/TIME field should remain "23:59" so that the format is recognized by plotting software (e.g. Excel, SigmaPlot). An example of this procedure is presented using data from the 2009 hydrologic year in Figures 13-7 and Figure 13-8.

Table 13-2. Corresponding fields for Snow Course data in NRCS and SWAN data formats.

NRCS field (…dwnld.txt)	format	SWAN field (…extractHY.csv)	_mo format (U.S. customary units)	_mo_m format (metric units)
		%OBSV	%	%
date	m/dd	DATE/TIME	yyyy/mm/dd hh:mm	yyyy/mm/dd hh:mm
		%PRCP	%	%
swe		PCUM	in	mm
		%SD	%	%
dep	in	SD	in	mm

4. Repeat steps 1-3 using the metric standard format template for Snow Course data. Convert values for the fields PCUM and SD from inches to mm using the conversion factor 1 in = 25.4 mm. Round values to the nearest millimeter.

	A	B	C	AA	AB	AC	AD	AE	AF	AG	AH
1	Source: SNCO				Precipitation						
2	OBSV	%OBSV	DATE/TIME	%SRAD	PRCP	%PRCP	PCUM	SNOW	%SNOW	SD	%SD
3	yyyymmddhhmm		yyyy/mm/dd hh:mm		in		in	in		in	
4			2008/10/31 23:59								
5			2008/11/30 23:59								
6		100	2008/12/31 23:59			100	5.5			26	100
7		100	2009/01/30 23:59			100	8.1			35	100
8		100	2009/02/27 23:59			100	9.4			34	100
9		100	2009/03/30 23:59			100	12.5			47	100
10		100	2009/04/29 23:59			100	8.8			24	100
11			2009/05/31 23:59								
12			2009/06/30 23:59								
13			2009/07/31 23:59								
14			2009/08/31 23:59								
15			2009/09/30 23:59								

Figure 13-7. Snow Course standard format data file (…extractHY.csv) for a hydrologic year (U.S. customary units). Snow Course data for the 2009 hydrologic year has been entered (data corresponds to the highlighted selection in Figure 13-8).

```
-------
Unit = inches
year/    January          February         March          April            May              June
card  date dep  swe   date dep  swe   date dep  swe   date dep  swe   date dep  swe   date dep  swe
      ---- --- -----  ---- --- -----  ---- --- -----  ---- --- -----  ---- --- -----  ---- --- -----
89-1  K/30  31   7.4  2/03  45  11.7  3/01  44  11.6  3/29  38  11.0
90-1  1/02  34   8.1  2/01  53  15.0  2/28  65  16.9  3/30  62  18.6  5/01  28  10.8
91-1  1/03  19   3.6  2/05  31   6.6  3/01  26   8.2  4/02  39  11.3  5/03  20   5.5
92-1  K/30  60  13.3  1/31  60  19.7  2/27  81  24.0  3/30  89  31.2  4/28  68  26.1
93-1  K/29  26   8.0  1/25  35   9.7  3/01  39  13.9  4/01  49  17.9  4/28  26  10.6
94-1  1/03  26   7.0  1/26  36   8.8  2/28  37   9.7  3/28  45  12.7  5/02  15   5.1
95-1  1/04  38  11.2  1/30  54  15.1  2/25  58  18.2  3/29  70  20.6  5/05  21   8.4
96-1                   1/31   4   1.0  2/26  42   9.1  4/01  29  10.5  4/29  16   6.8
97-1                   2/01  38   8.5  2/27  40  11.9  3/27  47  15.1
98-1  1/06  36   9.0  2/02  42  12.7  3/02  48  15.9  4/02  45  15.7  5/02   3  15.8
99-1  1/04  59  11.5  1/29  52  13.5  2/26  68  17.5  4/01  77  23.9  5/03  58  18.9
 0-1                   2/02  86  18.5  3/06  68  23.0  3/28  68  23.2  5/01  47  18.7
 1-1                   1/27  38  11.1  2/27  53  16.6  3/31  79  23.0  4/30  43  17.3
 2-1                   2/06  56  15.5  3/08  67  22.8  4/03  66  22.3  5/05  38  14.6
 3-1  E/ST  20   3.2  E/ST  23   7.4  E/ST  19   6.9  3/30  28   9.9  E/ST   0   0.0
 4-1                   2/13  61  18.5  3/09  64  21.6
 5-1  K/29  39  11.2
 6-1                   1/31  24   4.1  2/27  28   9.5  4/01  34  10.9  5/06  16   6.6
 7-1                   2/01  51  16.4  3/01  50  17.2  4/02  53  19.4  5/02  26  10.7
 8-1  K/31  39   9.6  2/01  50  14.6  2/29  62  20.3  3/31  74  24.5  5/01  62  24.7
 9-1  K/31  26   5.5  1/30  35   8.1  2/27  34   9.4  3/30  47  12.5  4/29  24   8.8
 6-3  K/03   9   1.9
 7-3  K/01  16   2.0
```

Figure 13-8. Snow Course data from a period-of-record data file (…dwnld.txt). Snow Course data for the 2009 hydrologic year is highlighted.

2. After extracting data for the most recent hydrologic year in both U.S. customary and metric units, Select “File” on the Excel menu and then select “Save As” and name the file using the file naming structure outlined below. Date is saved as a comma delimited text (.csv) file (Figure 13-9).

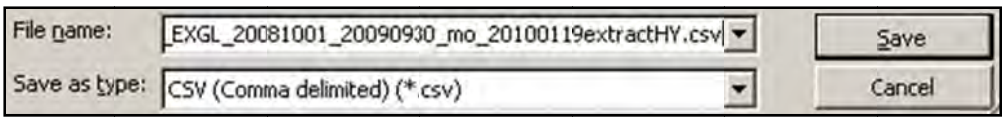


Figure 13-9. Excel "Save As" window.

Extracted Snow Course data files are organized by hydrologic year and saved on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Output

Using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_mo_[filedatestage].txt

[TYPE]_[NAME]_[startdate]_[enddate]_mo_m_[filedatestage].txt

Where:

[TYPE] refers to the station type (e.g. SNCO, refer to Table 13-1)
[NAME] is the four letter acronym for the station name (e.g. EXGL, refer to Table 13-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
_mo indicates monthly data in U.S. customary units
_mo_m indicates monthly data in metric units
[filedatestage] is the date data was extracted and the file stage "extractHY"
.csv is the file type

Example: SNCO_EXGL_19891230_20091202_mo_20100119extractHY.txt

SOP #14: Downloading and Processing SNOTEL Data
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for downloading SNOTEL data from the National Resources Conservation Service (NRCS) and using a customized program (Python script) that summarizes (down samples) SNOTEL data (to monthly and yearly measures) and converts data to a standardized format in both metric and U.S. customary units.

Downloading SNOTEL Data

There are currently two SNOTEL stations monitored by the SWAN (Appendix D-1). SNOTEL stations collect snowpack and related climatic data. This data will be used in conjunction with information from other climate monitoring stations to generate annual climate summaries, to identify climatic extremes, and to aid in the analysis and interpretation of trends in other monitored vital signs.

Procedures

1. Access SNOTEL data from the Alaska Snow, Water, and Climate Services (AMBCS) site: http://ambcs.org/. Quality controlled data from Alaska SNOTEL stations are only available as daily summary data. Data acquisition and data quality control is performed at the NRCS National Water and Climate Center and data is then transferred to the Alaska NRCS where it is served by the Alaska Snow, Water, and Climate Service site. SNOTEL data available from the National Water and Climate Center does not include all available meteorological elements and the date is off by one day.

2. Click on "Daily Telemetry Data Summarized for Past Wateryears" (Figure 14-1).



Figure 14-1. Data for Alaska SNOTEL sites from the NRCS at http://ambcs.org/.

3. Select the desired hydrologic year and click "Go!"

4. Access daily summary data for the hydrologic year by clicking on the desired station name (refer to Table 14-1, Figure 14-2).

Table 14-1. SNOTEL stations monitored by the SWAN.

Snow Course name	Station type [TYPE]	Acronym [NAME]	NRCS ID #
Exit Glacier	SNTE	EXGL	49l18
Nuka Glacier	SNTE	NUGL	50k06s

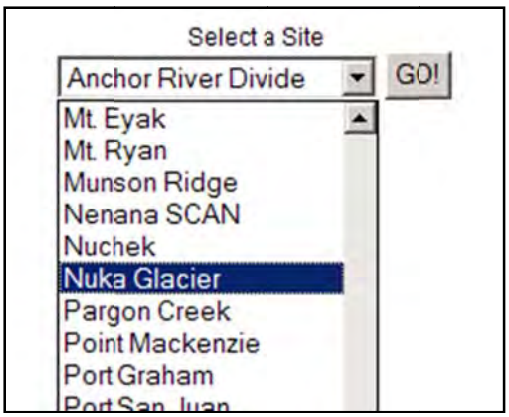


Figure 14-2. SNOTEL data – Alaska station list.

5. Data is provided in html format and contains space delimited data. Each line represents summary data for one day (Figure 14-3).

DATE	vBMN	XXXX	iPSM	fTAM	fTAX	fTAN	fTAA	iSDM	wSRA	pRHM	fTS2	fTS4	fTS7	pSM2	pSM4	pSM7
2008/10/01	12.9	-99.9	0.1	30.9	46.0	25.3	34.9	0.0	70.0	96.0	36.7	39.5	40.2	15.0	1.0	3.0
2008/10/02	12.9	-99.9	0.1	39.2	43.2	29.5	38.8	1.0	108.0	86.0	37.5	39.3	39.7	15.0	1.0	3.0
2008/10/03	12.8	-99.9	0.2	33.3	41.4	28.8	35.4	2.0	81.0	96.0	37.6	39.3	39.5	15.0	1.0	3.0
2008/10/04	12.9	-99.9	0.3	31.5	41.4	30.7	34.9	2.0	84.0	96.0	37.2	39.3	39.3	15.0	1.0	2.0
2008/10/05	12.9	-99.9	0.3	27.9	39.6	24.4	32.2	1.0	81.0	95.0	37.2	39.0	39.1	15.0	1.0	3.0
2008/10/06	12.9	-99.9	0.4	31.5	37.8	27.5	31.8	1.0	81.0	90.0	37.1	38.9	38.9	16.0	1.0	3.0
2008/10/07	12.9	-99.9	0.4	31.6	35.8	29.8	32.2	1.0	74.0	82.0	36.6	38.5	38.7	16.0	2.0	3.0
2008/10/08	13.7	-99.9	0.4	26.1	37.0	22.8	31.3	0.0	139.0	76.0	35.6	38.1	38.4	16.0	2.0	2.0

Figure 14-3. Available SNOTEL data for a selected station.

6. Use the mouse to highlight the desired area of text (i.e. headers and all data for hydrologic year) and then select “Edit” from the browser menu and click on “Copy”. Paste the selection into a new text file (.txt) using a text editor (e.g. Notepad). Verify that that data is in consecutive (from older to more recent) order and that one row of header information is present.

7. Select “File” on the text editor menu and then select “Save As” and name the file using the file naming structure below (Figure 14-4).

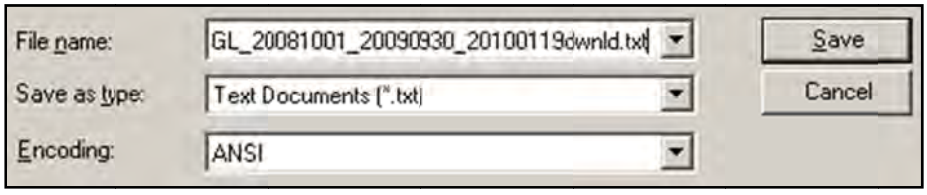


Figure 14-4. Text editor “Save As” window.

8. When archiving the original data files, they are organized by hydrologic year and saved on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Downloads

Using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].txt

Where:

[TYPE] refers to the station type (e.g. SNTE, refer to Table 14-1)
[NAME] is the four letter acronym for the station name (e.g. NUGL, refer to Table 14-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage "dwnld"
.txt is the file type

Example: SNTE_NUGL_20081001_20090930_20100119dwnld.txt

Data Processing

A customized program (Python script) is used to convert SNOTEL data into a standardized list of climate elements and to summarize daily data into monthly and yearly (hydrologic year) measures. Running this program will also check for invalid or missing date and time values, replacing flagged data values (e.g. NRCS flags -99.9) with a common identifier (-9999) and converting input units to both metric and U.S. customary units.

Data Processing Program

The program SNTEdata_FormatSummarizeConvert.py is used to process SNOTEL data. The executable program will be stored on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Programs_Scripts\

The current version of the processing program is denoted by the most recent [filedatestage] (in YYYYMMDD format) appended to the program file name.

Example:

SNTEdata_FormatSummarizeConvert_20110201.py

Input Format

The expected input data set for SNOTEL data is a space delimited text file with a ".txt" extension and one row of header information followed by observations sorted by date and time in the subsequent rows. Column formatting is expected to follow the format specified by the AMBCS (refer to http://ambcs.org/AMBCSBriefLabels.pdf).

Executing the Program

1. Double clicking the program will execute it.

2. A file dialog will ask for the location of the input data (Figure 14-5). Pressing cancel will abort the operation. This program is capable of reading in multiple files at once and appending the data. This is useful to avoid calculating summaries for partial water years when using calendar year annual input data. The inputs are sorted alphabetically, so the names must be in alphabetic order by date. If the names are in the format described above with a date string following the station name, this will already be the case. The data must not overlap in time. Alternatively, data can be appended by hand using a text editor, and then fed to the program as one file.

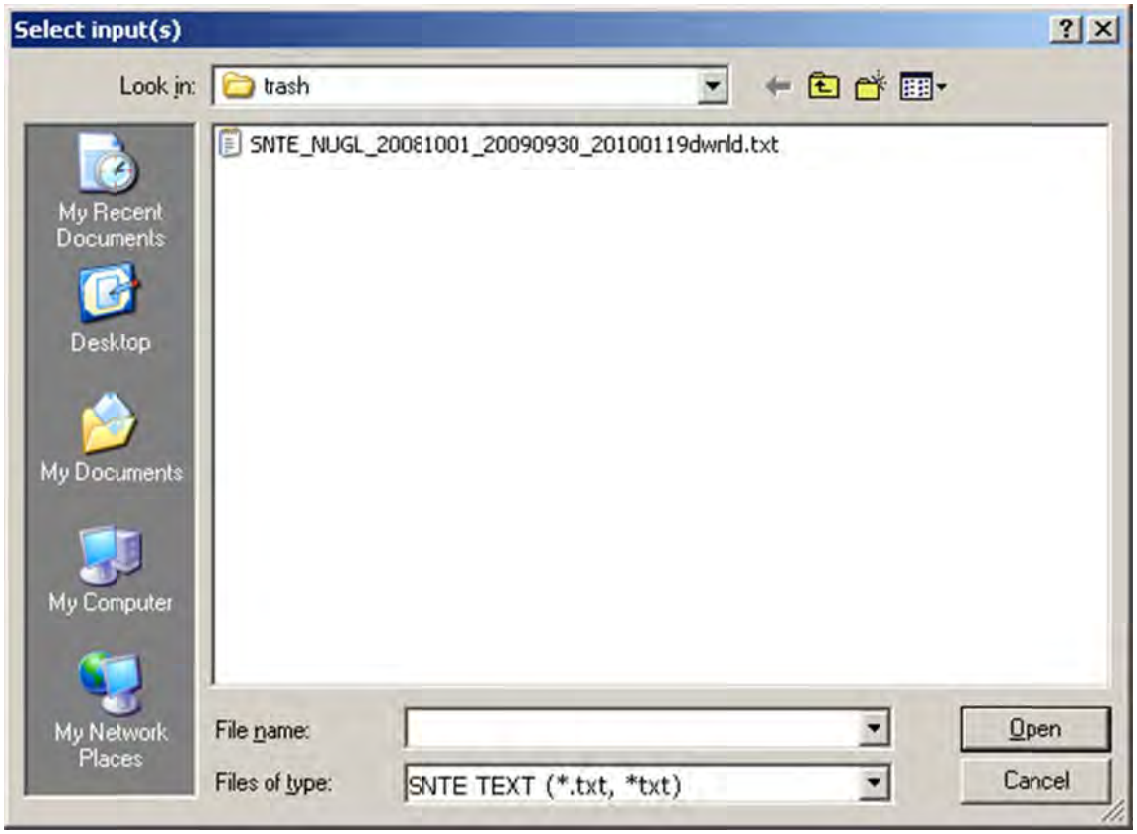


Figure 14-5. SNTEdata_FormatSummarizeConvert.py file input dialog.

3. A second dialog will ask where the data should be saved (Figure 14-6). Not specifying a location will save the data in the current directory. Pressing cancel will abort the operation.

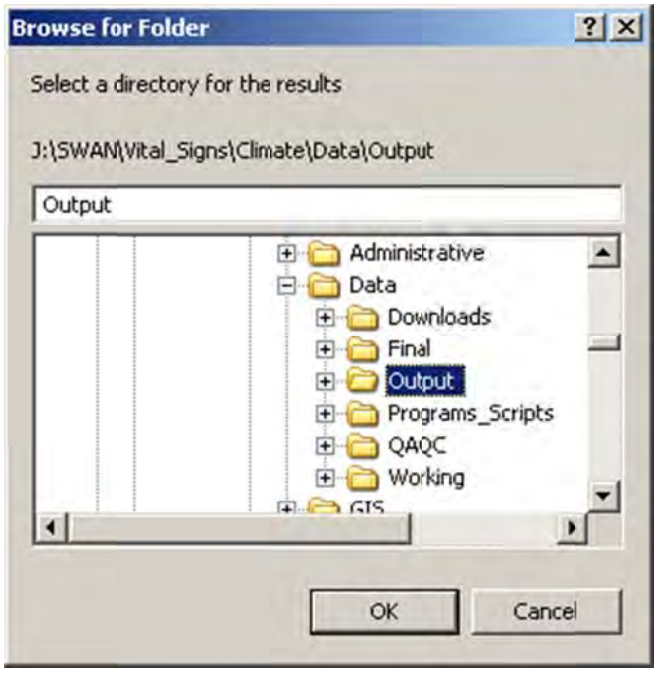


Figure 14-6. SNTEdata_FormatSummarizeConvert.py file output dialog.

4. The program will parse, process, and write the data into multiple output products. The duration of this process will depend on the size of the input file, but for a year's worth of daily data, the process shouldn't take more than a few seconds (Figure 14-7). Should an error occur, a message should be provided that should be useful in resolving the problem.

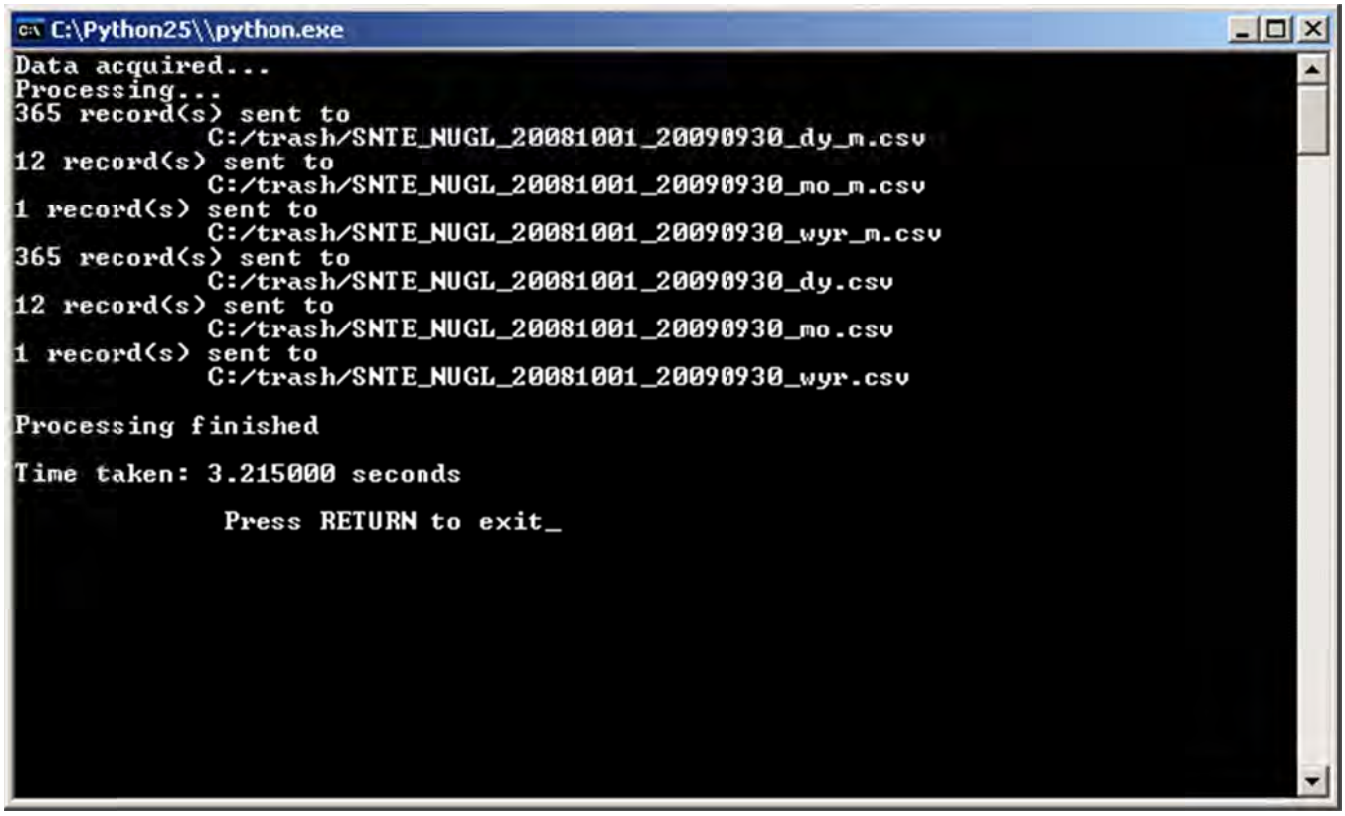


Figure 14-7. SNTEdata_FormatSummarizeConvert.py file processing dialog after successful completion.

5. Note that each output file name is appended (e.g. _mo_m) in order to indicate sampling interval and units. Summaries are provided at the daily (_dy), monthly (_mo), and annual (_wyr) rates and in both metric (_m) and U.S. customary (not appended with "_m") units. Output file names are also appended with [filedatestage] (in format YYYMMDDfromPy) to be consistent with SWAN file naming conventions.

e.g. SNTE_NUGL _20081001_20090930_dy_m_20100119fromPy.csv

Output Format

Table 14-2. Output format and elements availability for SNTEdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
OBSV	yyyymmddhhmm		Date and time of observation	Y
%OBSV	%	%	% valid data transmissions during sampling interval	Y
DATE/TIME	yyyy/mm/dd hh:mm		Date and time of observation (Excel/SigmaPlot format)	Y
ATAV	°F	°C	Mean temperature during sampling interval	Y
%ATAV	%	%	% valid temperature observations during sampling interval	Y

Table 14-2 continued. Output format and elements availability for SNTEdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
ATMX	°F	°C	Maximum temperature during sampling interval	Y
%ATMX	%	%	% valid temperature observations during sampling interval	Y
ATMN	°F	°C	Minimum temperature during sampling interval	Y
%ATMN	%	%	% valid temperature observations during sampling interval	Y
TOBS	°F	°C	Mean temperature at time of observation during sampling interval	N
%TOBS	%	%	% valid TOBS during sampling interval	N
WSAV	mph	m/s	Mean wind speed during sampling interval (scalar average)	N
%WSAV	%	%	% valid wind speed observations during sampling interval	N
WDAV	deg	deg	Mean wind direction during sampling interval (time-averaged using sum of unit vectors from each observation independent of wind speed)	N
WSPK	mph	m/s	Maximum wind speed (instantaneous) during sampling interval	N
%WSPK	%	%	% valid wind speed observations during sampling interval	N
WDPK	deg	deg	Corresponding wind direction for WSPK	N
RHAV	%	%	Mean relative humidity during sampling interval	N
%RHAV	%	%	% valid relative humidity observations during sampling interval	N
STPR	in Hg	hPa	Mean atmospheric pressure at station during sampling interval	N
%STPR	%	%	% valid atmospheric pressure observations during sampling interval	N
SLPR	in Hg	hPa	Mean atmospheric pressure at sea level during sampling interval	N
%SLPR	%	%	% valid SLPR observations during sampling interval	N
VISI	mi	km	Mean visibility during sampling interval	N
%VISI	%	%	% valid visibility observations during sampling interval	N
SRAD	Ly	W/m^2	Average solar radiation during hourly sampling interval, cumulative solar radiation during daily, monthly, and yearly sampling interval	N
%SRAD	%	%	% valid solar radiation observations during sampling interval	N
PRCP	in	mm	Total precipitation during sampling interval*	Y
%PRCP	%	%	% valid precipitation observations during sampling interval	Y
PCUM	in	mm	Cumulative precipitation during period of summary (e.g. hydrologic year)	Y
SNOW	in	mm	Total snow accumulation during sampling interval	N
%SNOW	%	%	% valid snow accumulation observations during sampling interval	N
SD	in	mm	Mean snow depth during sampling interval	Y
%SD	%	%	% valid snow depth observations during sampling interval	Y
WTAV	°F	°C	Mean sea water temperature during sampling interval	N
%WTAV	%	%	% valid sea water temperature observations during sampling interval	N
WVHT	ft	M	Mean wave height during sampling interval	N
%WVHT	%	%	% valid wave height observations during sampling interval	N
AWPD	sec	sec	Mean wave period during sampling interval	N
%AWPD	%	%	% valid wave period observations during sampling interval	N
DWPD	sec	sec	Mean maximum wave energy (period) during sampling interval	N
%DWPD	%	%	% valid DWPD observations during sampling interval	N
MWVD	deg	Deg	Mean wave direction (associated with DWPD) during sampling interval	N
%MWVD	%	%	% valid MWVD observations during sampling interval	N
TIDE	ft	m	Mean tide height during sampling interval	N

Table 14-2 continued. Output format and elements availability for SNTEdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
%TIDE	%	%	% valid observations during sampling interval	N
STAV	°F	°C	Mean ground surface (skin) temperature during sampling interval	N
%STAV	%	%	% valid STAV observations during sampling interval	N
SOT1	°F	°C	Mean soil temperature #1 during sampling interval (refer to station info.)	Y
%SOT1	%	%	% valid SOT1 observations during sampling interval	Y
SOT2	°F	°C	Mean soil temperature #2 during sampling interval (refer to station info.)	Y
%SOT2	%	%	% valid SOT2 observations during sampling interval	Y
SOT3	°F	°C	Mean soil temperature #3 during sampling interval (refer to station info.)	Y
%SOT3	%	%	% valid SOT3 observations during sampling interval	Y
SOT4	°F	°C	Mean soil temperature #4 during sampling interval (refer to station info.)	Y
%SOT4	%	%	% valid SOT4 observations during sampling interval	Y

SOP #15: Downloading and Processing CMAN & Buoy Data
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for downloading data from Coastal-Marine Automated Network (CMAN) stations and moored buoys from the National Data Buoy Center's (NCBC) Standard Meteorological Historical Data and using a customized program (Python script) that both summarizes (down samples) half-hourly CMAN and hourly buoy observations (to hourly, daily, monthly, and yearly measures) and converts data to a standardized format in both metric and U.S. customary units.

Downloading CMAN and Buoy Data

There are currently two CMAN stations and one moored buoy monitored by the SWAN (Appendix E-1). Data from these stations will be used in conjunction with information from other climate networks to generate annual climate summaries, to identify climatic extremes, and to aid in the analysis and interpretation of trends in other monitored vital signs.

Procedures

Access the Standard Meteorological Historical Data server managed by the National Data Buoy Center (NDBC). This database is the official archive for half-hourly data from CMAN and hourly data from moored buoys.

1. Access the NDBC data at: http://www.ndbc.noaa.gov/.

2. Enter the desired station ID (refer to Table 15-1) in the Station ID Search window (Figure 15-1).

Table 15-1. CMAN stations and moored buoys monitored by the SWAN.

Station name	Station type [TYPE]	Acronym [NAME]	NDBC ID#
Drift River Terminal	CMAN	DRRI	DRFA2
Pilot Rock	CMAN	PIRO	PILA2
Shelikof Strait	BUOY	SHST	46077

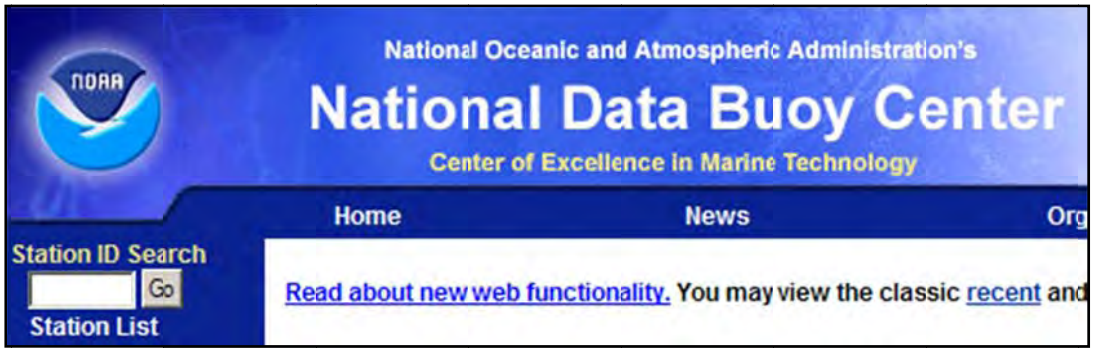


Figure 15-1. NDBC Station ID Search window.

3. Station metadata, both current observations and historical data, and station maintenance status are available. Select “Historical Data & Climatic Summaries” from the bottom of the screen (Figure 15-2).

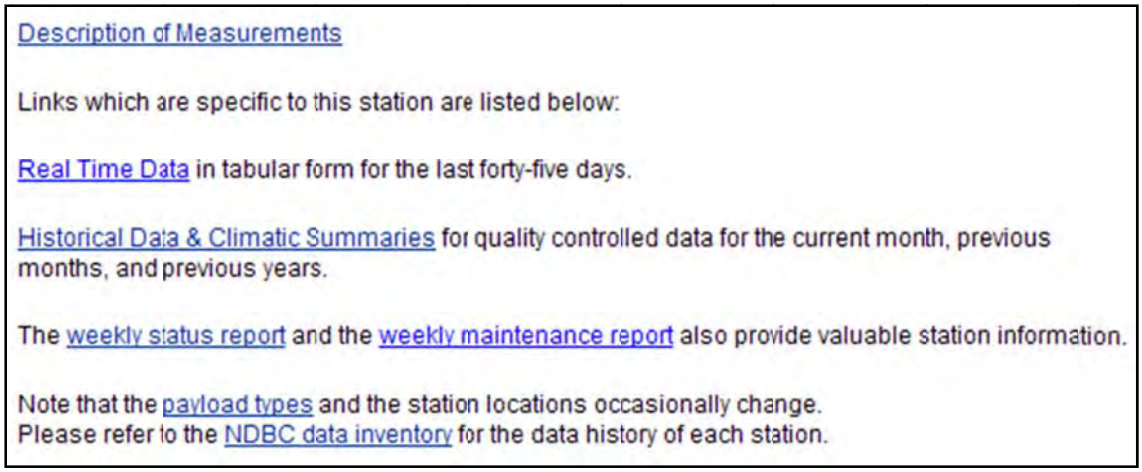


Figure 15-2. Available options (partial list) from the NDBC station information page.

4. Data is organized by calendar year (historical data) and by month (data for current year). Selecting from "standard meteorological data", click on the desired month or year (Figure 15-3).

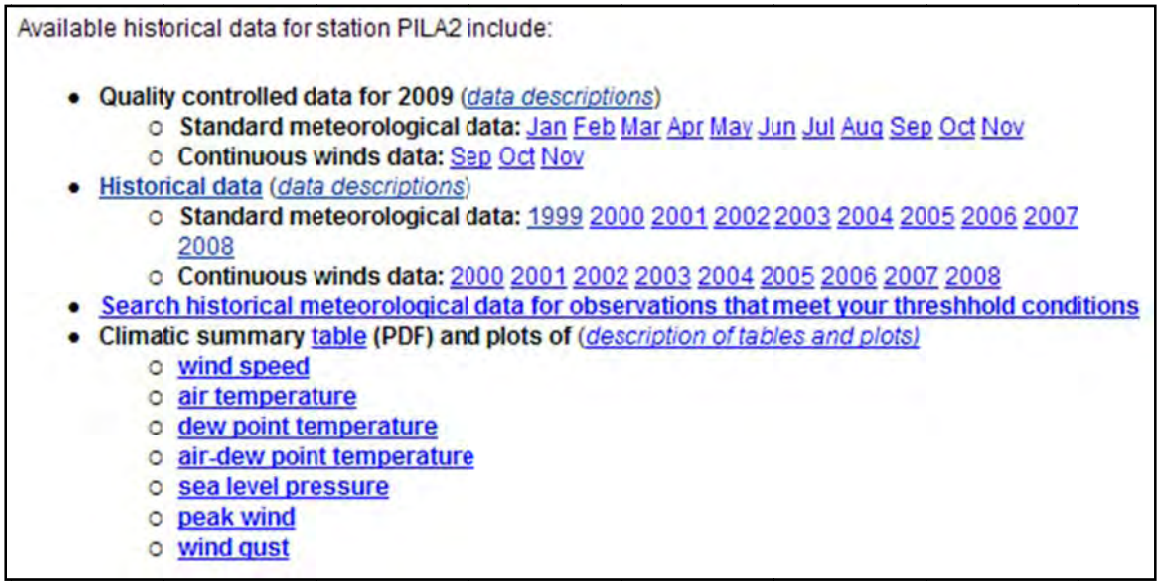
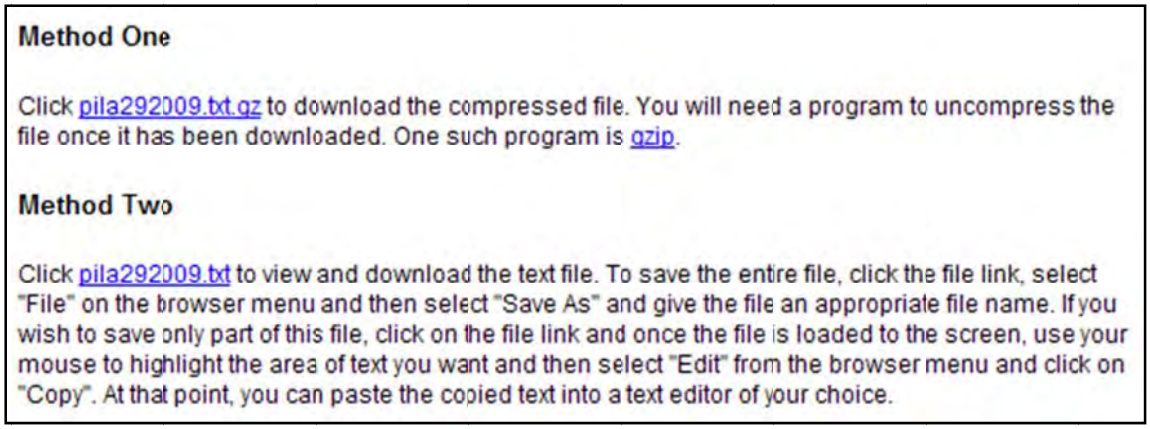


Figure 15-3. Available historical data from a NDBC station.

5. Two methods are available for downloading data (Figure 15-4). Select method two by clicking on the file link with the ".txt" file extension. To save the entire file, select "File" on the browser and then select "Save As" and name the file using the file naming structure discussed below. For consistency with other climate data formats, CMAN and moored buoy data should be acquired for the entire hydrologic year and appended into one file.



Method One

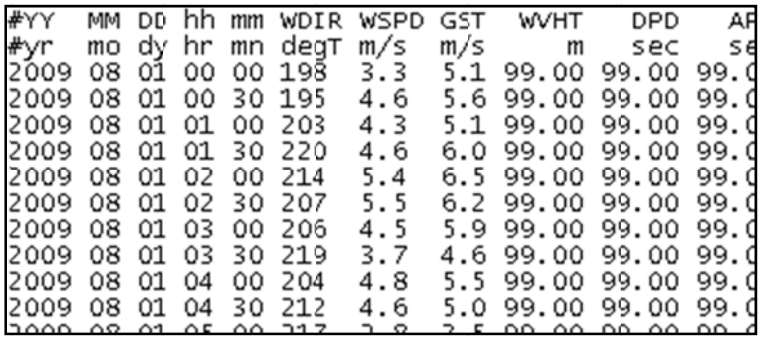
Click pila292009.txt.gz to download the compressed file. You will need a program to uncompress the file once it has been downloaded. One such program is gzip.

Method Two

Click pila292009.txt to view and download the text file. To save the entire file, click the file link, select "File" on the browser menu and then select "Save As" and give the file an appropriate file name. If you wish to save only part of this file, click on the file link and once the file is loaded to the screen, use your mouse to highlight the area of text you want and then select "Edit" from the browser menu and click on "Copy". At that point, you can paste the copied text into a text editor of your choice.

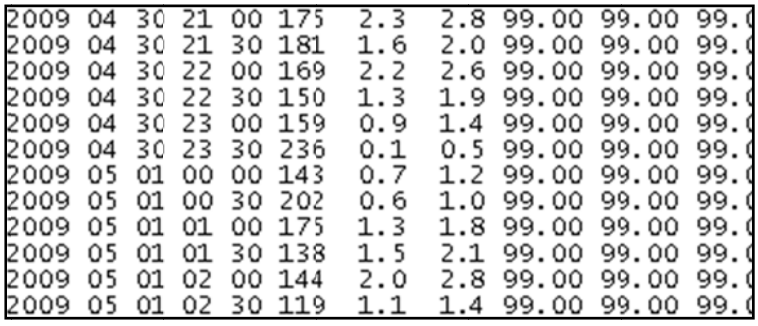
Figure 15-4. Two methods for downloading data from a NDBC station.

6. Use the mouse to highlight the desired area of text (the data needed for compiling the hydrologic year) and then select “Edit” from the browser menu and click on “Copy”. Paste the selection into a new text file (.txt) using a text editor (e.g. Notepad). Verify that only two rows of header information are present for the entire file and that data is in consecutive (from older to more recent) order (Figure 15-5 and 15-6). Some data may be missing (original data from station) but subsequent data processing will account for this missing data.



```
#YY  MM DD hh mm WDIR WSPD GST  WVHT   DPD   AP
#yr  mo dy hr mn degT m/s  m/s     m   sec   se
2009 08 01 00 00 198  3.3  5.1 99.00 99.00 99.0
2009 08 01 00 30 195  4.6  5.6 99.00 99.00 99.0
2009 08 01 01 00 203  4.3  5.1 99.00 99.00 99.0
2009 08 01 01 30 220  4.6  6.0 99.00 99.00 99.0
2009 08 01 02 00 214  5.4  6.5 99.00 99.00 99.0
2009 08 01 02 30 207  5.5  6.2 99.00 99.00 99.0
2009 08 01 03 00 206  4.5  5.9 99.00 99.00 99.0
2009 08 01 03 30 219  3.7  4.6 99.00 99.00 99.0
2009 08 01 04 00 204  4.8  5.5 99.00 99.00 99.0
2009 08 01 04 30 212  4.6  5.0 99.00 99.00 99.0
```

Figure 15-5. Appending monthly CMAN data using a text editor. Correct header information is shown.



```
2009 04 30 21 00 175  2.3  2.8 99.00 99.00 99.0
2009 04 30 21 30 181  1.6  2.0 99.00 99.00 99.0
2009 04 30 22 00 169  2.2  2.6 99.00 99.00 99.0
2009 04 30 22 30 150  1.3  1.9 99.00 99.00 99.0
2009 04 30 23 00 159  0.9  1.4 99.00 99.00 99.0
2009 04 30 23 30 236  0.1  0.5 99.00 99.00 99.0
2009 05 01 00 00 143  0.7  1.2 99.00 99.00 99.0
2009 05 01 00 30 202  0.6  1.0 99.00 99.00 99.0
2009 05 01 01 00 175  1.3  1.8 99.00 99.00 99.0
2009 05 01 01 30 138  1.5  2.1 99.00 99.00 99.0
2009 05 01 02 00 144  2.0  2.8 99.00 99.00 99.0
2009 05 01 02 30 119  1.1  1.4 99.00 99.00 99.0
```

Figure 15-6. Appending monthly CMAN data using a text editor. The correct transition between consecutive monthly data is shown. Note that date/time is UTC.

7. When archiving the original data files, they are organized by hydrologic year and saved on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Downloads

Using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].txt

Where:

[TYPE] refers to the station type (e.g. CMAN, refer to Table 15-1)
[NAME] is the four letter acronym for the station name (e.g. PIRO, refer to Table 15-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage "dwnld"
.txt is the file type

Example: CMAN_PIRO_20081001_20090930_20100115dwnld.txt

8. Convert the space delimited text file (.txt) into a comma delimited text file (.csv). Open Excel and open the downloaded text file. When prompted, indicate that the file is delimited and not fixed width (Figure 15-7) and click "Next".

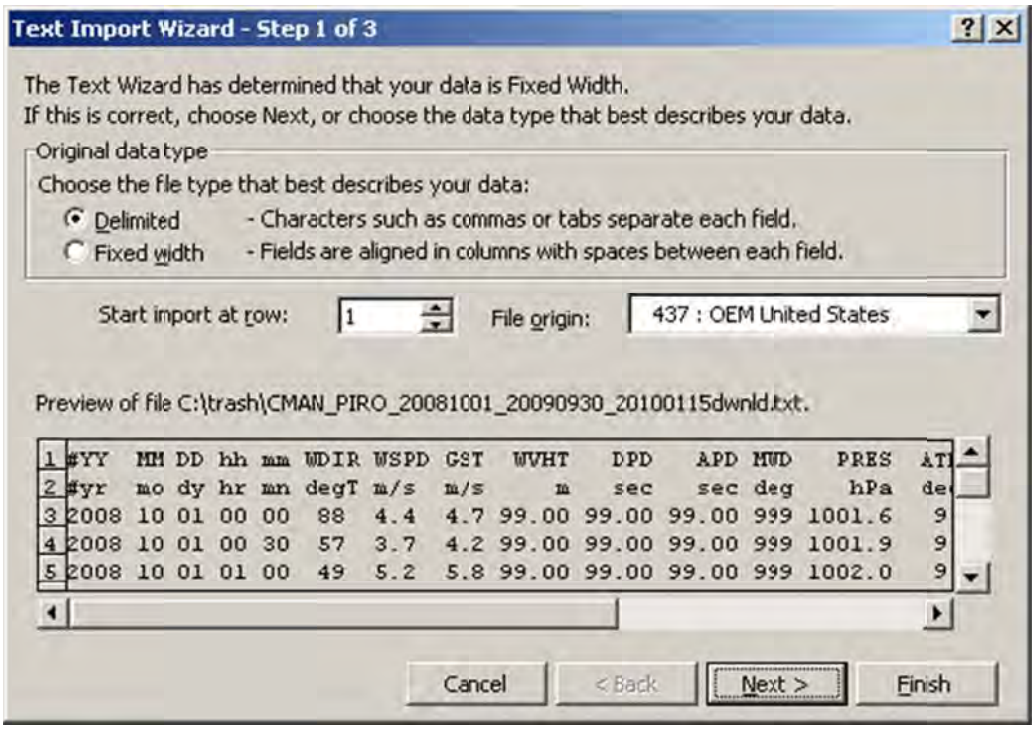


Figure 15-7. MS Excel Text Import Window (step 1).

9. When prompted, indicate that the file is space delimited (Figure 15-8). Inspect the data preview to verify that the delimiting will be successful. Click "Next" and then click "Finish".



Figure 15-8. MS Excel Text Import Window (step 2).

10. Select "File" from the Excel menu and then select "Save As". Specify comma delimited (.csv) as the file type (Figure 15-9). Use the same file naming format described above in step seven but note that the file extension will be ".csv".

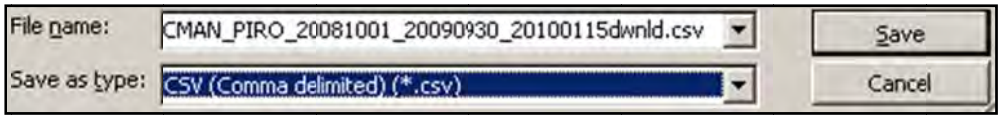


Figure 15-9. Excel "Save As" window.

Data Processing

A customized program (Python script) is used to convert CMAN and moored buoy data into a standardized list of climate elements and to summarize sub-hourly data into hourly and/or hourly data into daily, monthly, and yearly (hydrologic year) measures. Running this program also checks for invalid or missing date and time values, replaces flagged data values (NDBC flags 99, 999, or 9999) with a common identifier (-9999) and converts input units to both metric and U.S. customary units.

Data Processing Program

The program CMANandBUOYdata_FormatSummarizeConvert.py is used to process CMAN and BUOY data. The executable program is stored on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Programs_Scripts

The current version of the processing program is denoted by the most recent [filedatestage] (in YYYYMMDD format) appended to the program file name.

Example:

CMANandBUOYdata_FormatSummarizeConvert_20100212.py

Input Format

The expected input data set for CMAN and moored Buoy data is a comma delimited text file with a ".csv" extension with a two-line header followed by observations sorted by date and time in the subsequent rows. The first line of the header is used to determine column order; the second line is ignored. The other columns are expected to contain the case-sensitive fields documented in Table 15-2. The program will attempt to determine whether the input data is hourly (moored buoy) or sub-hourly (CMAN stations). If problems are encountered, the text "hourly" or "half-hourly" can be entered into the second header value (first row, second column) of the text file.

Table 15-2. Input format specifications for CMANandBUOYdata_FormatSummarizeConvert.py.

First-line Header label	Format	Units
#YY	numeric	YYYY
MM	numeric	MM
DD	numeric	DD
hh	numeric	hh
mm	numeric	mm
WDIR	numeric	degrees
WSPD	numeric	m/s
GST	numeric	m/s
WVHT	numeric	m
DPD	numeric	sec
APD	numeric	sec
MWD	numeric	degrees
PRES	numeric	hPa
ATMP	numeric	°C
WTMP	numeric	°C
DEWP	numeric	°C
VIS	numeric	nautical mi
TIDE	numeric	ft

Executing the Program

1. Double clicking the program will execute it.

2. A file dialog will ask for the location of the input data (Figure 15-10). Pressing cancel will abort the operation. This program is capable of reading in multiple files at once and appending the data. This is useful to avoid calculating summaries for partial water years when using calendar year annual input data. The inputs are sorted alphabetically, so the names must be in alphabetic order by date. If the names are in the format described above with a date string following the station name, this will already be the case. The data must not overlap in time. Alternatively, data can be appended by hand using a text editor, and then fed to the program as one file.

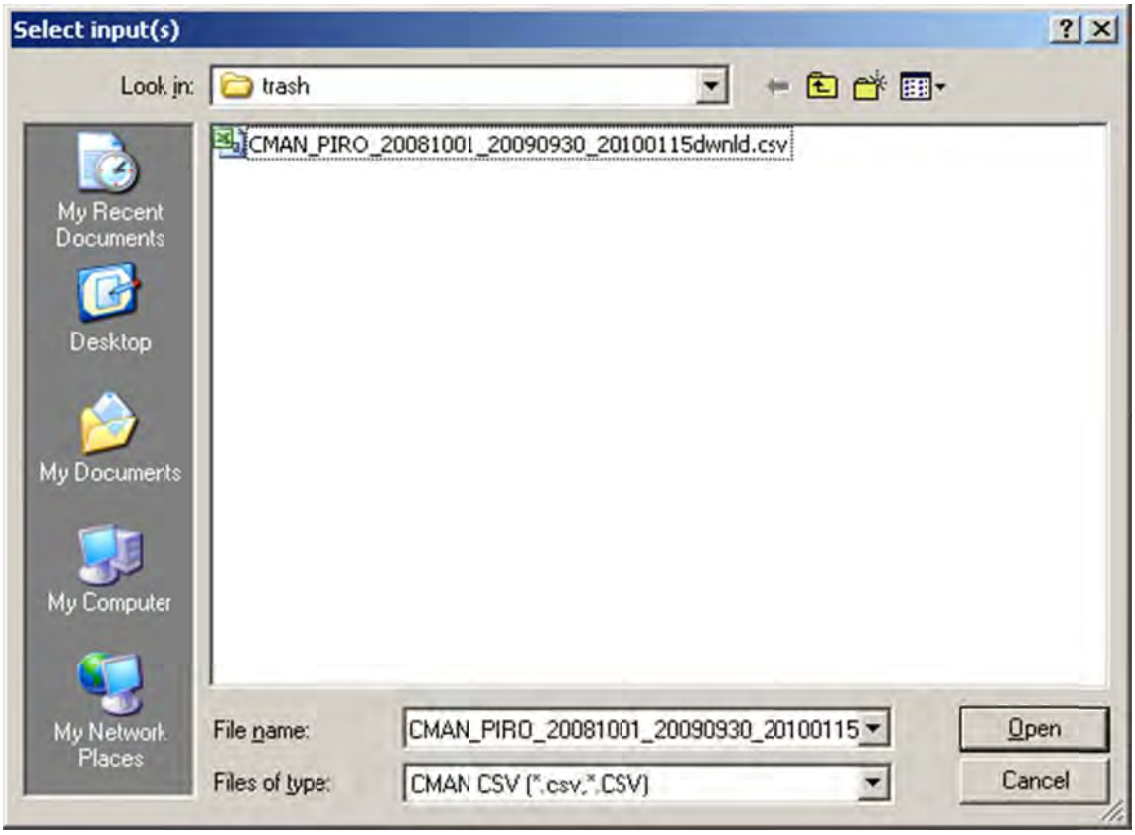


Figure 15-10. CMANandBUOYdata_FormatSummarizeConvert.py file input dialog.

3. A second dialog will ask where the data should be saved (Figure 15-11). Not specifying a location will save the data in the current directory. Pressing cancel will abort the operation.

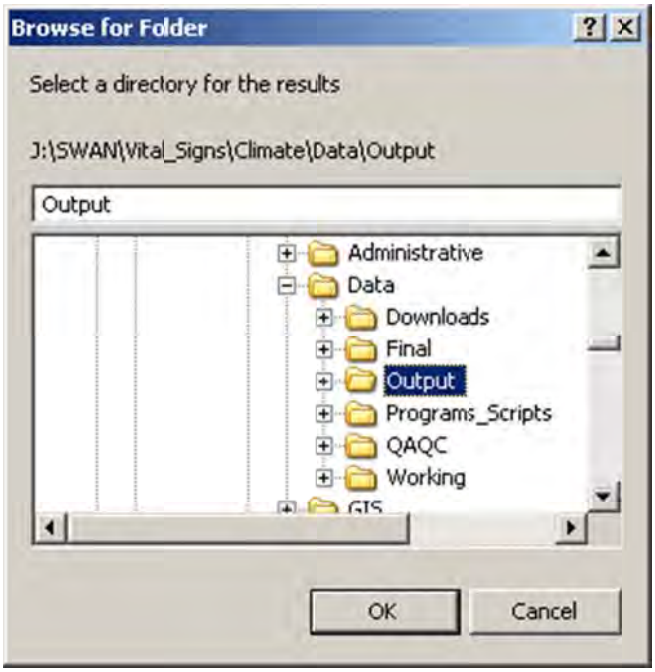


Figure 15-11. CMANandBUOYdata_FormatSummarizeConvert.py file output dialog.

4. The program will parse, process, and write the data into multiple output products. The duration of this process will depend on the size of the input file, but for a year's worth of daily data, the process shouldn't take more than a few seconds (Figure 15-12). Should an error occur, a message should be provided that should be useful in resolving the problem. Note that the program will display the sampling rate that was used to process the data. Verify that this is the correct sampling rate for the input data set.

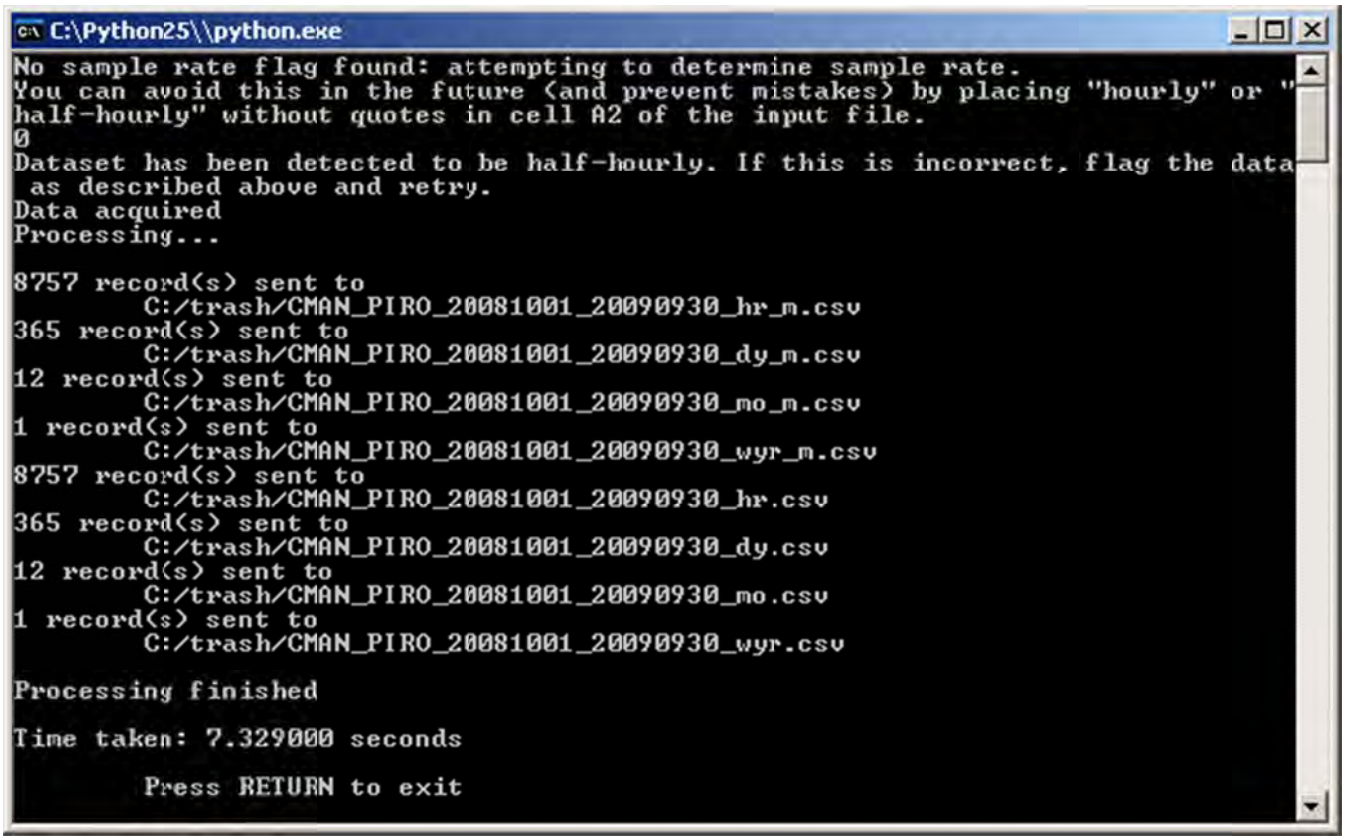


Figure 15-12. CMANandBUOYdata_FormatSummarizeConvert.py file processing dialog after successful completion.

5. Note that each output file name is appended (e.g. _hr_m) in order to indicate sampling interval and units. Summaries are provided at the daily (_dy), monthly (_mo), and annual (_wyr) rates and in both metric (_m) and U.S. customary (not appended with "_m") units. Output file names are also appended with [filedatestage] (in format YYYMMDDfromPy) to be consistent with SWAN file naming conventions.

e.g. CMAN_PIRO_20081001_20090930_hr_m_20100215fromPy.csv

Output Format

Table 15-3. Output format and elements availability for CMANandBUOYdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
OBSV	yyyymmddhhmm		Date and time of observation	Y
%OBSV	%	%	% valid data transmissions during sampling interval	Y
DATE/TIME	yyyy/mm/dd hh:mm		Date and time of observation (Excel/SigmaPlot format)	Y

Table 15-3 continued. Output format and elements availability for CMANandBUOYdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
ATAV	°F	°C	Mean temperature during sampling interval	Y
%ATAV	%	%	% valid temperature observations during sampling interval	Y
ATMX	°F	°C	Maximum temperature during sampling interval	Y
%ATMX	%	%	% valid temperature observations during sampling interval	Y
ATMN	°F	°C	Minimum temperature during sampling interval	Y
%ATMN	%	%	% valid temperature observations during sampling interval	Y
TOBS	°F	°C	Mean temperature at time of observation during sampling interval	N
%TOBS	%	%	% valid TOBS during sampling interval	N
WSAV	mph	m/s	Mean wind speed during sampling interval (scalar average)	Y
%WSAV	%	%	% valid wind speed observations during sampling interval	Y
WDAV	deg	deg	Mean wind direction during sampling interval (time-averaged using sum of unit vectors from each observation independent of wind speed)	Y
WSPK	mph	m/s	Maximum wind speed (instantaneous) during sampling interval	Y
%WSPK	%	%	% valid wind speed observations during sampling interval	Y
WDPK	deg	deg	Corresponding wind direction for WSPK	N
RHAV	%	%	Mean relative humidity during sampling interval	Y
%RHAV	%	%	% valid relative humidity observations during sampling interval	Y
STPR	in Hg	hPa	Mean atmospheric pressure at station during sampling interval	N
%STPR	%	%	% valid atmospheric pressure observations during sampling interval	N
SLPR	in Hg	hPa	Mean atmospheric pressure at sea level during sampling interval	Y
%SLPR	%	%	% valid SLPR observations during sampling interval	Y
VISI	mi	km	Mean visibility during sampling interval	Y
%VISI	%	%	% valid visibility observations during sampling interval	Y
SRAD	Ly	W/m^2	Average solar radiation during hourly sampling interval, cumulative solar radiation during daily, monthly, and yearly sampling interval	N
%SRAD	%	%	% valid solar radiation observations during sampling interval	N
PRCP	in	mm	Total precipitation during sampling interval*	N
%PRCP	%	%	% valid precipitation observations during sampling interval	N
PCUM	in	mm	Cumulative precipitation during period of summary (e.g. hydrologic year)	N
SNOW	in	mm	Total snow accumulation during sampling interval	N
%SNOW	%	%	% valid snow accumulation observations during sampling interval	N
SD	in	mm	Mean snow depth during sampling interval	N
%SD	%	%	% valid snow depth observations during sampling interval	N
WTAV	°F	°C	Mean sea water temperature during sampling interval	Y
%WTAV	%	%	% valid sea water temperature observations during sampling interval	Y
WVHT	ft	M	Mean wave height during sampling interval	Y
%WVHT	%	%	% valid wave height observations during sampling interval	Y
AWPD	sec	sec	Mean wave period during sampling interval	Y
%AWPD	%	%	% valid wave period observations during sampling interval	Y
DWPD	sec	sec	Mean maximum wave energy (period) during sampling interval	Y
%DWPD	%	%	% valid DWPD observations during sampling interval	Y
MWVD	deg	Deg	Mean wave direction (associated with DWPD) during sampling interval	Y

Table 15-3 continued. Output format and elements availability for CMANandBUOYdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
%MWVD	%	%	% valid MWVD observations during sampling interval	Y
TIDE	ft	m	Mean tide height during sampling interval	Y
%TIDE	%	%	% valid observations during sampling interval	Y
STAV	°F	°C	Mean ground surface (skin) temperature during sampling interval	N
%STAV	%	%	% valid STAV observations during sampling interval	N
SOT1	°F	°C	Mean soil temperature #1 during sampling interval (refer to station info.)	N
%SOT1	%	%	% valid SOT1 observations during sampling interval	N
SOT2	°F	°C	Mean soil temperature #2 during sampling interval (refer to station info.)	N
%SOT2	%	%	% valid SOT2 observations during sampling interval	N
SOT3	°F	°C	Mean soil temperature #3 during sampling interval (refer to station info.)	N
%SOT3	%	%	% valid SOT3 observations during sampling interval	N
SOT4	°F	°C	Mean soil temperature #4 during sampling interval (refer to station info.)	N
%SOT4	%	%	% valid SOT4 observations during sampling interval	N

SOP #16: Downloading and Processing CRN Data
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains the procedures for downloading data from Climate Reference Network (CRN) stations via FTP access from the National Climatic Data Center (NCDC) and using a customized program (Python script) that summarizes (down samples) hourly CRN observations (to daily, monthly, and yearly measures) and converts data to a standardized format in both metric and U.S. customary units.

Downloading CRN Data

There are currently two Climate Reference Network (CRN) station monitored by the SWAN (Appendix F-1). Data from this station will be used in conjunction with information from other climate networks to generate annual climate summaries, to identify climatic extremes, and to aid in the analysis and interpretation of trends in other monitored vital signs.

Procedures

1. Access hourly data from the CRN via anonymous FTP at:
ftp://ftp.ncdc.noaa.gov/pub/data/uscrn/products/hourly02.

2. Open the directory for the desired calendar year of CRN data by clicking on the year (Figure 16-1).

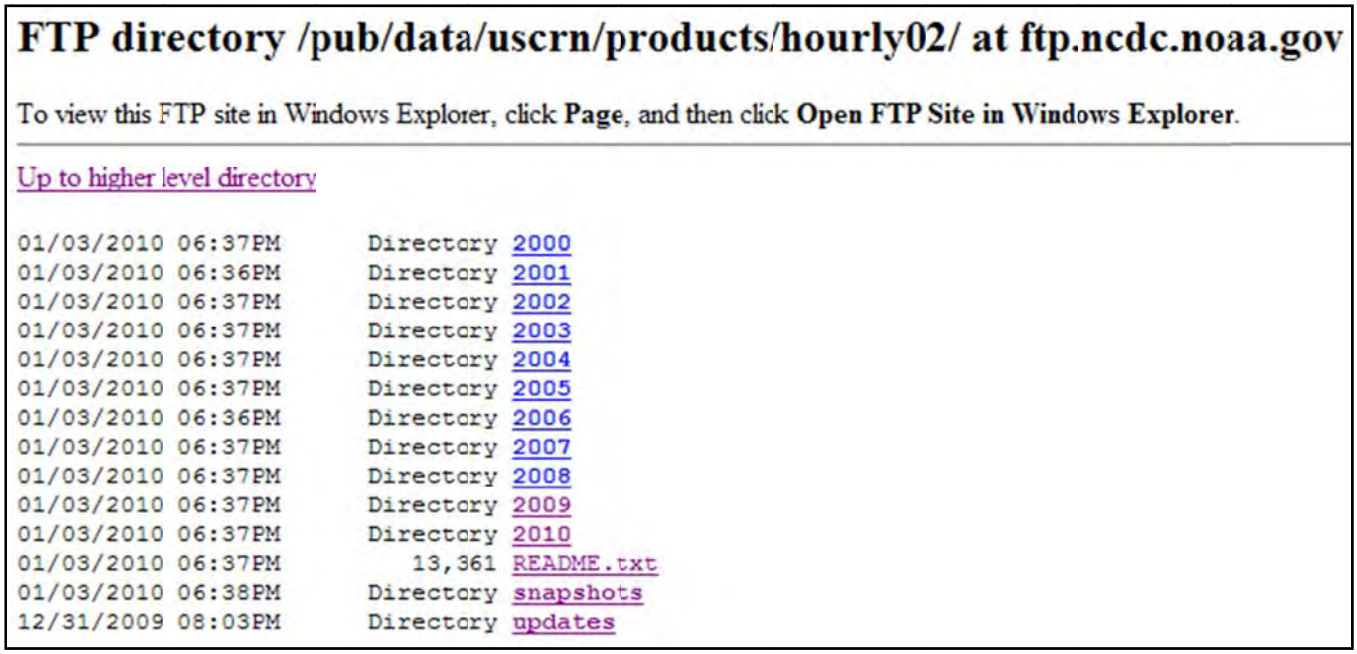


Figure 16-1. NCDC hourly02 CRN data product directory.

3. Access hourly data for the selected calendar year by clicking on the desired station name (refer to Table 16-1; Figure 16-2).

Table 16-1. CRN stations monitored by the SWAN.

Station name	Station type [TYPE]	Acronym [NAME]	NCDC Station ID
King Salmon 42 SE	CLRN	KS42	AK_King_Salmon_42_SE
Port Alsworth 1 SW	CLRN	P1SW	AK_Port_Alsworth_1_SW



FTP directory /pub/data/uscrn/products/hourly02/2009/ at ftp.ncdc.noaa.gov

To view this FTP site in Windows Explorer, click **Page**, and then click **Open FTP Site in Windows Explorer**.

Up to higher level directory

```
01/12/2010 07:40AM      2,181,240 CRNH0201-2009-AK_Barrow_4_ENE.txt
01/12/2010 07:40AM      2,181,240 CRNH0201-2009-AK_Fairbanks_11_NE.txt
01/12/2010 07:40AM        585,399 CRNH0201-2009-AK_Port_Alsworth_1_SW.txt
01/12/2010 07:40AM        800,037 CRNH0201-2009-AK_Sand_Point_1_ENE.txt
01/12/2010 07:40AM      2,181,240 CRNH0201-2009-AK_Sitka_1_NE.txt
```

Figure 16-2. NCDC hourly02 CRN data organized by station name.

4. Data is provided in html format and contains fixed width formatted columns. Each line represents one hour's observations from one station (Figure 16-3).

```
26562 507572 20090925 0200 20090924 1700  2.302 -154.32   60.20 -9999.0 -9999.0 -9999.
26562 507572 20090925 0300 20090924 1800  2.302 -154.32   60.20      5.2      5.1      5.
26562 507572 20090925 0400 20090924 1900  2.302 -154.32   60.20      4.6      5.1      5.
26562 507572 20090925 0500 20090924 2000  2.302 -154.32   60.20      4.6      4.5      4.
26562 507572 20090925 0600 20090924 2100  2.302 -154.32   60.20      4.1      4.5      5.
26562 507572 20090925 0700 20090924 2200  2.302 -154.32   60.20      3.8      3.9      4.
26562 507572 20090925 0800 20090924 2300  2.302 -154.32   60.20      3.8      4.1      4.
26562 507572 20090925 0900 20090925 0000  2.302 -154.32   60.20      3.7      3.7      3.
26562 507572 20090925 1000 20090925 0100  2.302 -154.32   60.20      3.8      3.8      3.
26562 507572 20090925 1100 20090925 0200  2.302 -154.32   60.20      3.7      3.7      3.
```

Figure 16-3. Fixed width formatted hourly CRN observations.

5. Two methods are available for downloading data. To save all available data for the calendar year, select "File" on the browser and then select "Save As" and name the file using the file naming structure discussed below. For consistency with other climate data formats, CRN should be acquired for the entire hydrologic year and appended into one file.

6. Use the mouse to highlight the desired area of text (e.g. several month's data) and then select "Edit" from the browser menu and click on "Copy". Paste the selection into a new text file (.txt) using a text editor (e.g. Notepad). Repeat this step to append with additional data. Verify that that data is in consecutive (from older to more recent) order (Figure 16-4) for the entire hydrologic year. Note that the local (AKST) date and time are represented by the fifth and sixth columns respectively.

```
26494 502966 20090101 0500 20081231 2000  1.302 -147.51   64.97   -32.7   -32.8   -32
26494 502966 20090101 0600 20081231 2100  1.302 -147.51   64.97   -32.9   -32.8   -32
26494 502966 20090101 0700 20081231 2200  1.302 -147.51   64.97   -32.3   -32.6   -32
26494 502966 20090101 0800 20081231 2300  1.302 -147.51   64.97   -33.0   -32.8   -32
26494 502966 20090101 0900 20090101 0000  1.302 -147.51   64.97   -33.4   -32.9   -32
26494 502966 20090101 1000 20090101 0100  1.302 -147.51   64.97   -33.3   -33.5   -33
26494 502966 20090101 1100 20090101 0200  1.302 -147.51   64.97   -33.2   -33.1   -32
26494 502966 20090101 1200 20090101 0300  1.302 -147.51   64.97   -32.4   -32.8   -32
```

Figure 16-4. Appending monthly CMAN data using a text editor – correct transition between data from different years is shown. Note that the local (AKST) date and time are represented by the fifth and sixth columns respectively.

7. Select “File” on the text editor menu and then select “Save As” and name the file using the file naming structure below (Figure 16-5).

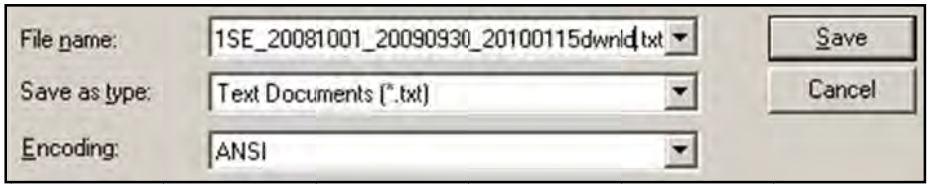


Figure 16-5. Text editor “Save As” window.

8. When archiving the original data files, they are organized by hydrologic year and saved on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Downloads

Using the standardized naming format:

[TYPE]_[NAME]_[startdate]_[enddate]_[filedatestage].txt

Where:

[TYPE] refers to the station type (e.g. CLRN, refer to Table 16-1)
[NAME] is the four letter acronym for the station name (e.g. P1SW, refer to Table 16-1)
[startdate] is the start of the data range in YYYYMMDD format
[enddate] is the end of the data range in YYYYMMDD format
[filedatestage] is the date file was downloaded and the file stage “dwnld”
.txt is the file type

Example: CLRN_P1SW_20081001_20090930_20100115dwnld.txt

Data Processing

A customized program (Python script) is used to convert CRN data into a standardized list of climate elements and to summarize sub-hourly data into hourly and/or hourly data into daily, monthly, and yearly (hydrologic year) measures. Running this program also checks for invalid or missing date and time values, replaces flagged data values (NCDC flags -9999 and -9999.0) with a common identifier (-9999) and converts input units to both metric and U.S. customary units.

Data Processing Program

The program CLRNdata_FormatSummarizeConvert.py is used to process CRN data. The executable program is stored on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Programs_Scripts

The current version of the processing program is denoted by the most recent [filedatestage] (in YYYYMMDD format) appended to the program file name.

Example:

CLRNdata_FormatSummarizeConvert_20100212.py

Input Format

The expected input data set for CRN data is a fixed width column formatted text file with a ".txt" extension and no header information followed by observations sorted by date and time in the subsequent rows. Column formatting is expected to follow the format specified by the NCDC (refer to ftp://ftp.ncdc.noaa.gov/pub/data/uscrn/products/hourly02/README.txt).

Executing the Program

1. Double clicking the program will execute it.

2. A file dialog will ask for the location of the input data (Figure 16-6). Pressing cancel will abort the operation. This program is capable of reading in multiple files at once and appending the data. This is useful to avoid calculating summaries for partial water years when using calendar year annual input data. The inputs are sorted alphabetically, so the names must be in alphabetic order by date. If the names are in the format described above with a date string following the station name, this will already be the case. The data must not overlap in time. Alternatively, data can be appended by hand using a text editor, and then fed to the program as one file.

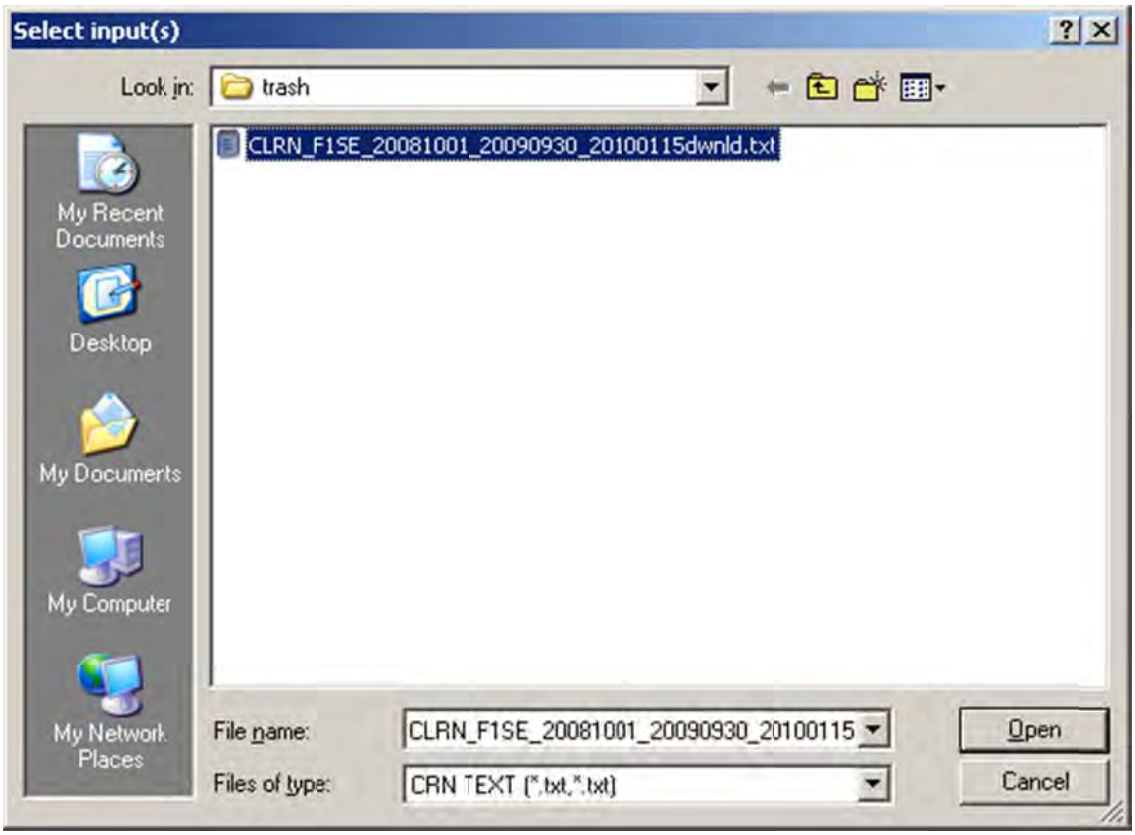


Figure 16-6. CLRNdata_FormatSummarizeConvert.py file input dialog.

3. A second dialog will ask where the data should be saved (Figure 16-7). Not specifying a location will save the data in the current directory. Pressing cancel will abort the operation.

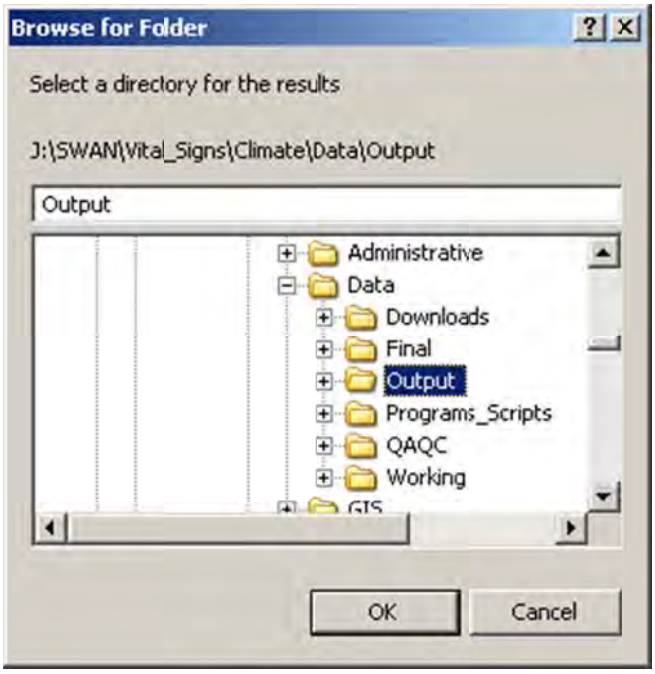


Figure 16-7. CMANandBUOYdata_FormatSummarizeConvert.py file output dialog.

4. The program will parse, process, and write the data into multiple output products. The duration of this process will depend on the size of the input file, but for a year's worth of daily data, the process shouldn't take more than a few seconds (Figure 16-8). Should an error occur, a message should be provided that should be useful in resolving the problem.

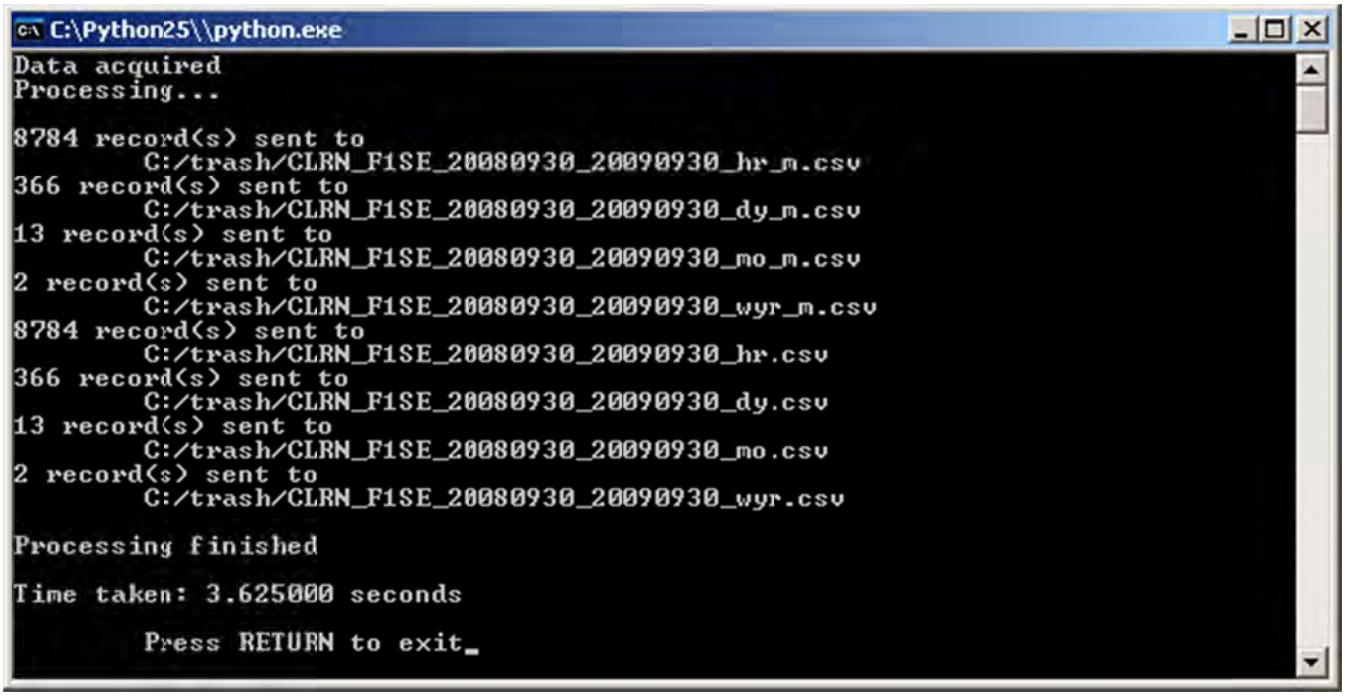


Figure 16-8. CLRNdata_FormatSummarizeConvert.py file processing dialog after successful completion.

5. Note that each output file name is appended (e.g. _hr_m) in order to indicate sampling interval and units. Summaries are provided at the daily (_dy), monthly (_mo), and annual (_wyr) rates and in both

metric (_m) and U.S. customary (not appended with "_m") units. Output file names are also appended with [filedatestage] (in format YYYMMDDfromPy) to be consistent with SWAN file naming conventions.

e.g. CLRN_P1SW_20081001_20090930_hr_m_20100119fromPy.csv

Output Format

Table 16-2. Output format and elements availability for CLRNdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
OBSV	yyyymmddhhmm		Date and time of observation	Y
%OBSV	%	%	% valid data transmissions during sampling interval	Y
DATE/TIME	yyyy/mm/dd hh:mm		Date and time of observation (Excel/SigmaPlot format)	Y
ATAV	°F	°C	Mean temperature during sampling interval	Y
%ATAV	%	%	% valid temperature observations during sampling interval	Y
ATMX	°F	°C	Maximum temperature during sampling interval	Y
%ATMX	%	%	% valid temperature observations during sampling interval	Y
ATMN	°F	°C	Minimum temperature during sampling interval	Y
%ATMN	%	%	% valid temperature observations during sampling interval	Y
TOBS	°F	°C	Mean temperature at time of observation during sampling interval	N
%TOBS	%	%	% valid TOBS during sampling interval	N
WSAV	mph	m/s	Mean wind speed during sampling interval (scalar average)	N
%WSAV	%	%	% valid wind speed observations during sampling interval	N
WDAV	deg	deg	Mean wind direction during sampling interval (time-averaged using sum of unit vectors from each observation independent of wind speed)	N
WSPK	mph	m/s	Maximum wind speed (instantaneous) during sampling interval	N
%WSPK	%	%	% valid wind speed observations during sampling interval	N
WDPK	deg	deg	Corresponding wind direction for WSPK	N
RHAV	%	%	Mean relative humidity during sampling interval	Y
%RHAV	%	%	% valid relative humidity observations during sampling interval	Y
STPR	in Hg	hPa	Mean atmospheric pressure at station during sampling interval	N
%STPR	%	%	% valid atmospheric pressure observations during sampling interval	N
SLPR	in Hg	hPa	Mean atmospheric pressure at sea level during sampling interval	N
%SLPR	%	%	% valid SLPR observations during sampling interval	N
VISI	mi	km	Mean visibility during sampling interval	N
%VISI	%	%	% valid visibility observations during sampling interval	N
SRAD	Ly	W/m^2	Average solar radiation during hourly sampling interval, cumulative solar radiation during daily, monthly, and yearly sampling interval	Y
%SRAD	%	%	% valid solar radiation observations during sampling interval	Y
PRCP	in	mm	Total precipitation during sampling interval*	Y
%PRCP	%	%	% valid precipitation observations during sampling interval	Y
PCUM	in	mm	Cumulative precipitation during period of summary (e.g. hydrologic year)	Y
SNOW	in	mm	Total snow accumulation during sampling interval	N
%SNOW	%	%	% valid snow accumulation observations during sampling interval	N

Table 16-2 continued. Output format and elements availability for CLRNdata_FormatSummarizeConvert.py.

Header	Units	Units (metric)	Description	Available element
SD	in	mm	Mean snow depth during sampling interval	N
%SD	%	%	% valid snow depth observations during sampling interval	N
WTAV	°F	°C	Mean sea water temperature during sampling interval	N
%WTAV	%	%	% valid sea water temperature observations during sampling interval	N
WVHT	ft	M	Mean wave height during sampling interval	N
%WVHT	%	%	% valid wave height observations during sampling interval	N
AWPD	sec	sec	Mean wave period during sampling interval	N
%AWPD	%	%	% valid wave period observations during sampling interval	N
DWPD	sec	sec	Mean maximum wave energy (period) during sampling interval	N
%DWPD	%	%	% valid DWPD observations during sampling interval	N
MWVD	deg	Deg	Mean wave direction (associated with DWPD) during sampling interval	N
%MWVD	%	%	% valid MWVD observations during sampling interval	N
TIDE	ft	m	Mean tide height during sampling interval	N
%TIDE	%	%	% valid observations during sampling interval	N
STAV	°F	°C	Mean ground surface (skin) temperature during sampling interval	Y
%STAV	%	%	% valid STAV observations during sampling interval	Y
SOT1	°F	°C	Mean soil temperature #1 during sampling interval (refer to station info.)	Y
%SOT1	%	%	% valid SOT1 observations during sampling interval	Y
SOT2	°F	°C	Mean soil temperature #2 during sampling interval (refer to station info.)	Y
%SOT2	%	%	% valid SOT2 observations during sampling interval	Y
SOT3	°F	°C	Mean soil temperature #3 during sampling interval (refer to station info.)	Y
%SOT3	%	%	% valid SOT3 observations during sampling interval	Y
SOT4	°F	°C	Mean soil temperature #4 during sampling interval (refer to station info.)	Y
%SOT4	%	%	% valid SOT4 observations during sampling interval	Y

SOP #17: Data Analysis and Reporting
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) includes procedures for summarizing and analyzing climate data used to generate annual reports for Southwest Alaska Network (SWAN) parks. It also presents a framework for comprehensive analysis and trend reporting that should take place every five years.

Introduction

An annual report on the climatic conditions of the most recent hydrologic year (October – September) will be completed by the end of the calendar year (December). The primary audience for these reports is park management, particularly natural resource staff, researchers, and collaborators. The overall objective of the annual report is to summarize and interpret climate parameters, at varying spatial and temporal scales. In addition, the report provides an inventory of, and indirect access to, national climate databases to facilitate the use of climate data in the analysis of other vital signs.

Report Content

Annual reports will include the following information for each climate station that is monitored:

- Brief description of climate stations, including the associated climate-monitoring program, location of station, station overview, period of record, and any equipment or data problems and issues that occurred during the recent hydrologic year.

- Annual summaries with monthly measures for the common climatic parameters (temperature, precipitation, snow depth, wind, and solar radiation).

- A brief narrative summarizing significant weather events, the degree and magnitude of climatic extremes, and departure from climate normal or period of record averages.

Reports will also include network-wide summaries that will include the following information

- Graphical comparisons, tables, and a narrative that summarizes and interprets network-wide patterns for temperature and precipitation.

Procedures

Timing and Overview

Due to a lag-time in the availability of quality-controlled data, reporting will be initiated approximately one month after the end of the hydrologic year (i.e. November). Development of the report involves seven general steps:

1. Obtaining quality-controlled climate data that has undergone data processing and standardized formatting (described in SOPs 10-16);

2. Summarizing and analyzing climate data from the recent hydrologic year (includes the production of tables and graphs);

3. Accessing and modifying the Natural Resource Technical Report (NRTR) NPS publication series template for the annual report;

4. Inserting text, tables, graphs, and summary statistics into the report template;

5. Interpretation of results – including consultation with a climatologist if necessary;

6. Obtaining peer review of the draft report;

7. Editing and formal submission of the report.

8. Distribution of the report to network parks.

Annual Report Template

Annual reports will be published in the NPS Natural Resource Technical Report (NRTR) publication series. A Microsoft Word template used for producing annual climate reports is located on the SWAN server at: J:\SWAN\Vital_Signs\Climate\Reports\Annual_Technical\ AuthorFirstInitial_YYYY_SWAN_AnnualClimateReportTemplateNRTRv3pt4.docx

Additional directions and details for report submittal can be found at: http://www.nature.nps.gov/publications/nrpm/.

The report should be titled: "Climate Monitoring in the Southwest Alaska Network – *Annual Report for the YYYY Hydrologic Year*". "YYYY" should be replaced with the relevant hydrologic year. A brief description of the report content is provided below:

1. **Abstract**: This should be a brief (~300 words) summary of the annual report highlighting if and where the year departs from normal/recent climatic conditions. It should be concise and written for a broad audience including superintendents and the public.

2. **Introduction**: The section should include the purpose and goals of the report, the definition of the hydrologic year, and basic information regarding climate monitoring in network parks. The introduction should also include a brief climate characterization of network parks.

3. **Methods**: This section documents original data sources (e.g. which stations were used), describes data acquisition and quality control, and documents the methods used for analysis.

4. **Results**: This section addresses data completeness and data limitations. It includes a narrative and both tabular and graphical summaries for temperature and precipitation. Straightforward narrative summarizes the results. The location of summary tables and graphs for individual stations (in the report appendices) is identified.

5. **Discussion**: This section includes a cautionary note on the assessment of trends and average conditions in the context of the relatively short temporal record. Climatic extremes and trend assessments are included for stations with a long period of record. Significant discrete weather events that occurred during the recent hydrologic year are discussed along with significant climatic departures from normal conditions. The status of climate monitoring in network parks is discussed. Summaries of station maintenance and any issues affecting station performance are incorporated.

6. **Conclusion**: The conclusion is a brief but comprehensive synthesis of the results and discussion and provides integration across climate variables. It should contain more detailed information than the Abstract.

7. **Appendices**: The appendices contain station summaries for each station monitored by the network. Individual station summaries include: 1) a climate summary table with monthly measures for the common climatic parameters; 2) summary plots for the common climatic parameters, which include temperature, precipitation, snow depth, and wind.

Data Analysis and Graphics

Both U.S. Customary (e.g. °F, in, mph, Ly) and metric (e.g. °C, mm, m/s, W/m^2) units will be used in annual reporting of the components below. In the interest of brevity, individual station summaries will only be reported in U.S. Customary units.

Overview of Climate Data

1. An overview of climate monitoring programs and the number of stations by program in network parks is presented in tabular form that includes relevant station metadata.

2. Stations whose data are used for reporting are identified on a map.

3. Data completeness for all stations is presented in tabular form listing the percentage of valid temperature and precipitation observations (%ATAV, %ATMX & %ATMN, %PRCP calculated during data processing) for the hydrologic year.

Temperature – Network-wide Summary

1. Mean monthly temperatures and departures from the 1981-2010 average (when available) for selected stations are presented in tabular form for each month of the hydrologic year.

2. Mean 12-month temperature and departures from the 1981-2010 average (when available), for all stations are presented on a map. Gridded PRISM data (currently only the 1971-2000 average is available) is displayed for reference.

Temperature – Individual Station Summary (Appendices)

1. Monthly mean, maximum, and minimum temperature, percentage of valid temperature observations and departure from the 1981-2010 average (when available) or the period of record for all stations are presented in tabular form for the hydrologic year.

2. Daily mean temperature, the 1981-2010 mean (when available), and historic extreme temperatures (when available) are presented in graphical form.

Table 17-1 provides an example of an individual station summary report. An example of a summary graph is shown in Figure 17-2.

Precipitation – Network-wide Summary

1. Total monthly precipitation and percentages of total monthly precipitation versus the 1981-2010 average (when available) for selected stations are presented in tabular form for each month of the hydrologic year.

2. Precipitation totals for the hydrologic year and departures from the 1981-2010 average (when available) for all stations are presented on a map. Gridded PRISM data (currently only the 1971-2000 average is available) is displayed for reference.

Precipitation – Individual Station Summary (Appendices)

1. Monthly precipitation, mean snow depth (when available), percentage of valid precipitation observations, and departure from the 1981-2010 average (when available) or the period of record for all stations are presented in tabular form for the hydrologic year.

2. Daily precipitation and snow depth (when available) and the 1981-2010 mean monthly precipitation (when available) for all stations are presented in graphical form.

Wind Speed and Direction – Individual Station Summary (Appendices)

1. Monthly mean (scalar) wind speed, maximum wind speed and corresponding wind direction, and percentage of valid wind speed observations for all stations (when available) are presented in tabular form for each month of the hydrologic year.

2. Daily mean (scalar) wind speed, mean (unit vector) wind direction, and maximum wind speed for all stations (when available) are presented in graphical form.

Solar Radiation – Individual Station Summary (Appendices)

1. Monthly total solar radiation (when available) and percentage of valid solar radiation observations for all stations are presented in tabular form for each month of the hydrologic year.

Table 17-1. Example of an individual station summary from an annual report.

2009 Hydrologic Year – LACL RAWS HILA (Hickerson Lake)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year
Minimum air temperature (°F)													
Min.	18.5	10.6	2.8	-6.5	-6.5	3.2	15.4	31.3	37.9	43.2	41.5	32.2	-6.5
Max.	36.5	30.4	34.3	34.2	29.3	28	36.7	49.6	49.8	63.3	52.9	49.3	63.3
Mean	27.9	21.5	19.4	15.3	15.6	16.5	28.5	39.7	42.2	49.3	47.3	43.1	30.6
# days < 32 °F	23	30	28	28	28	31	20	1	0	0	0	0	189
% valid obs	100	100	100	100	100	100	100	100	98.5	99.7	99.7	100	99.8
Maximum air temperature (°F)													
Min.	28.2	21	11.3	6.3	8.1	16	28.8	38.7	45	49.6	49.8	39.6	6.3
Max.	49.8	36.9	36.9	44.2	39.6	45.1	54.7	72.1	73.6	80.6	69.3	66.6	80.6
Mean	38.2	30.5	27.2	25.3	27.5	29.3	40.5	54.6	57.1	61.8	60.3	52.4	42.1
# days < 32 °F	3	18	23	20	18	22	2	0	0	0	0	0	106
% valid obs	100	100	100	100	100	100	100	100	98.5	99.7	99.7	100	99.8
Mean air temperature (°F)													
Observed	32.2	25.7	23.1	20.1	21	22.5	33.4	46.8	49.1	55.3	53.1	47.2	35.9
% valid obs	100	100	100	100	100	100	100	100	98.5	99.7	99.7	100	99.8
POR mean 1971-2000													
Precipitation (in)													
Total[2]	1.93	0.53	0.45	3.13	0.61	0.47	1.73	5.62	2.67	9.69	5.57	5.51	37.91
% valid obs	100	100	100	100	100	100	100	100	98.3	99.7	99.9	100	99.8
POR mean 1971-2000													
Snow depth (in)													
Average	0.5	4.2	5.9	6.2	13.6	26.4	20.3	1	0.2	0.2	0.4	0.4	
% valid obs	98.9	99.6	100	92.9	100	98.5	99.4	98.3	97.6	84.7	96	93.9	
POR mean													
Wind (mph, degrees)													
Mean speed	10.6	12.9	13.9	14	9.9	12.4	11.2	7.2	5.3	9.3	7.8	12.4	
% valid obs	100	100	100	100	100	100	100	21.9	4.4	99.7	99.7	100	
Max speed	60.2	72.3	84.8	60.2	54.8	75.4	50.1	33.3	14.3	93.3	75.8	88.8	93.3
Max direction	3	1	10	60	336	14	0	6	186	0	5	9	0
Solar radiation (KWh/m^2)													
Total	45.7	13.5	7.1	11.9	32.2	76.4	118.4	161.2	151.3	133.2	119.6	63.9	934.2
% valid obs	100	100	100	100	100	100	100	100	98.5	99.7	99.9	100	99.8

[2]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.

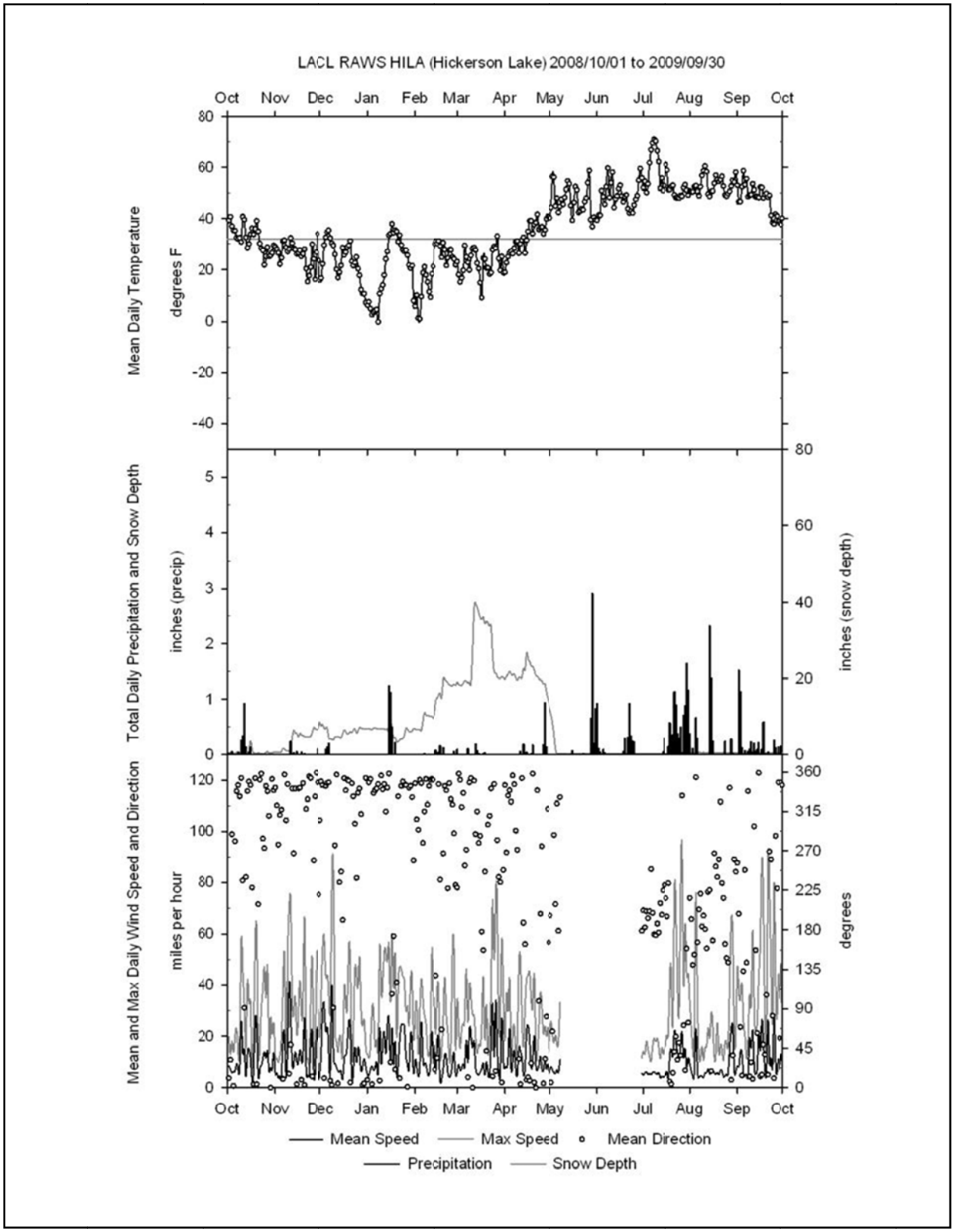


Figure 17-2. Example of a summary graph for an individual station from an annual report.

Trend Reporting

SWAN reporting requirements state the need for comprehensive analysis and trend reporting every five years. The objectives of this reporting process are to: (1) provide comprehensive analyses of inter-annual variability and trends in climate, and (2) to deliver high-quality climate datasets that can be used as covariate data in the analysis of other vital signs. The purpose of this reporting process is to provide park management, researchers, and park interpreters with reliable, periodic, and pertinent assessments of park climates. Surpassing annual reports in the degree of analysis and data quality control, trend reports will include statistically rigorous comparisons to established climate normals (e.g. 1981-2010) or the period of record. Comprehensive analysis and trend reporting will likely require collaboration and/or contracting with a climatologist. Ultimately, the trend analysis report should be suitable for publication in a peer-reviewed climatological journal.

SOP #18: Submitting Data for Upload to the I&M Enterprise Climate Database

Version 1.0

Change History

Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification
1.0	01/09/2012		SOP acquired from IRMA: Reference Code 2166928; Reference Status as of 03/27/2012: Active.	

This Standard Operating Procedure (SOP) documents the process for submitting a time series of climate data to the enterprise climate database maintained centrally by the Inventory and Monitoring Division. This SOP was acquired from the NPS Integrated Resource Management Applications (IRMA) Portal (reference code 2166928). It is current as of 27 March 2012. This SOP is presented with only marginal additional formatting. It is provided here for reference and to ensure accessibility.

The I&M program, at the national level, has recently developed a SQL Server climate database for the purpose of climate monitoring – a vital sign common to each of the I&M networks. This database holds daily records for temperature and precipitation for a variety of station types including RAWS. It does not support hourly records or other weather observations like wind and solar radiation. However, this database does allow a user to upload versioned climate data that can include edited data and/or additional weather observations (e.g. wind, solar radiation). The SWAN plans to upload the data it currently processes to this database and explore its potential for reporting purposes.

Introduction

This SOP documents the process for submitting a time series of climate data to the enterprise climate database maintained centrally by the Inventory and Monitoring Division. An Excel workbook template for submitting the data is found here:

https://irma.nps.gov/App/Reference/Profile/2166928

If you are using Excel 2007 or newer, you will need to save the workbook in Excel 2003 format (*.xls). This is because newer versions are stored in .xml format, which the data processing program cannot read.

Given that a data version is uniquely defined by a station and parameter, there are three scenarios that need to be supported, each with its own workflow.

Scenario #1: You are submitting a version of data for a station that is not currently managed in the national I&M climate database.

In this case, you will need to fully document the station information in addition to providing the data.

See the SQL Server views viewer.StationsInDatabase for an inventory of all stations currently managed within the climate database.

Scenario #2: You are replacing a version of the data for a station that is managed in the database.

In addition to the data, you will need to provide only the unique Version ID which you intend to replace. We will remove that version and link your new version of the data to the same station.

See the SQL Server view viewer.VersionInfo for an inventory of all versions currently managed within the climate database.

Scenario #3: You are adding a new version of data for a station that is managed in the database

In addition to the data, you will need to provide the unique Climate DB Station Code (CDB_S code) in the StationInDB spreadsheet.

See the SQL Server view viewer.StationsInDatabase for an inventory of all stations currently managed within the climate database.

The following graphic presents the general workflow articulated in this SOP (Figure 18-1).

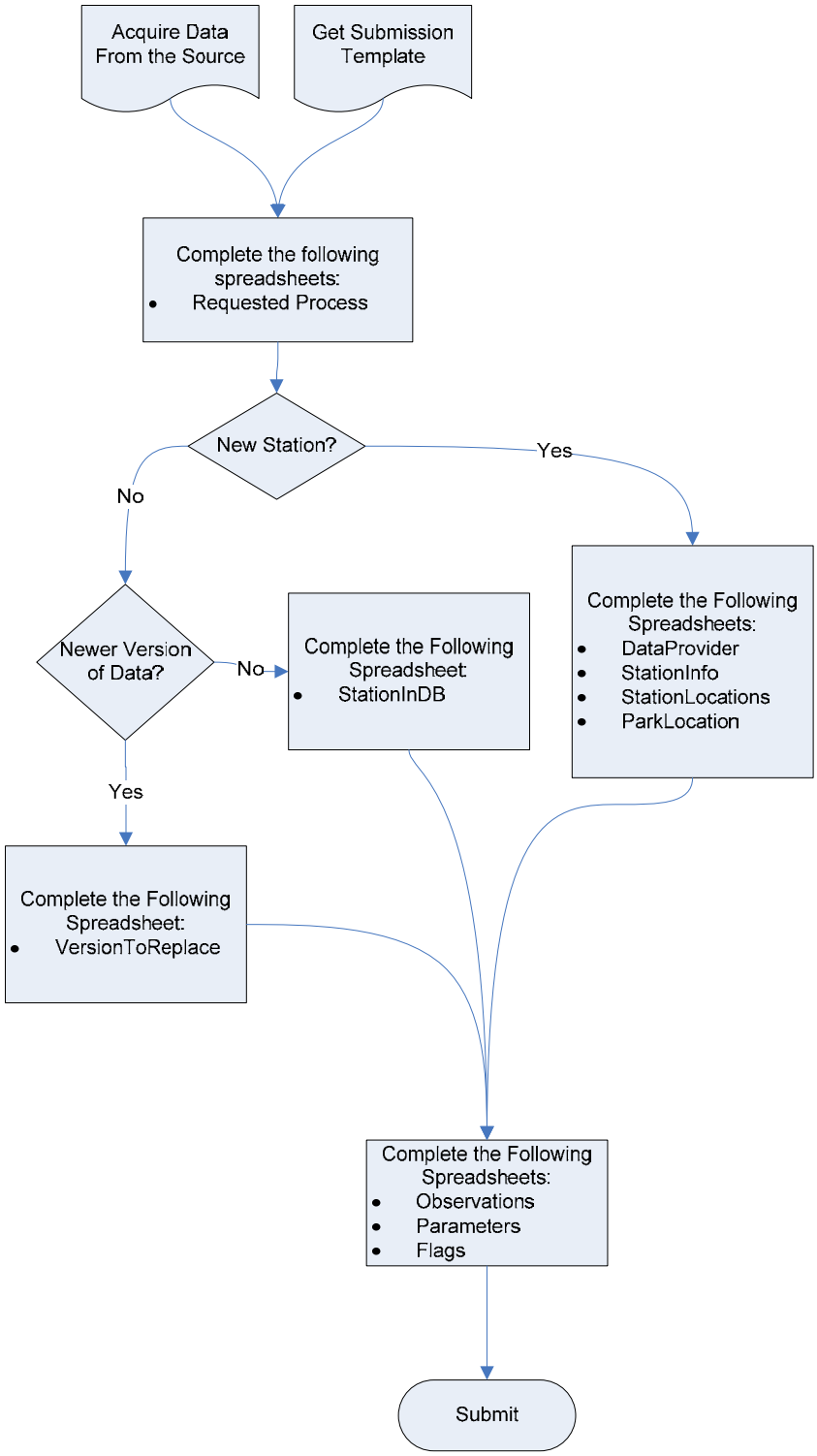


Figure 18-1. General workflow articulated in this SOP.

Please note the following before proceeding:

This SOP is designed for submitting data for a single station. If there is more than one station, you will be required to submit each separately.

Confirm this is the latest SOP. It is your responsibility to check the NRInfo Portal to see whether a newer version exists (https://irma.nps.gov/App/Reference/Profile/2166928).

Review the Database Documentation Document which provides table and field definitions (https://irma.nps.gov/App/Reference/Profile/2170262).

Worksheets

This section describes each of the spreadsheets provided in the data submission Excel workbook template. In addition to the spreadsheets, there are examples of how information might be entered.

Download related Excel workbook (see URL above). This worksheet is located on the SWAN server at:

\SWAN\Vital_Signs\Climate\Data\Upload_to_DB

Rename the workbook to "[Network/ParkCode]_[StationName/Code_[DateSubmitted].xlsx". Dates should be formatted as YYYYMMDD.

Requested Process:

This spreadsheet confirms which process you need to have supported.

Open worksheet "RequestedProcess".

Follow directions to choose type of process; delete all other options.

Version to Replace

Only complete this spreadsheet if you intend to replace a version of data already existing in the database.

StationInDB

Only complete this spreadsheet if you intend to add new data for a station already existing in the database. For this, you must specify both a StationId and provide a description of the version. We recommend you be as descriptive as possible with the version since it will be up to you to manage your version lineage.

Data Source

A data source is the organization that provides the data for one or more climate stations. This spreadsheet allows you to document who that data source is.

Open next worksheet called "DataSource".

Fill out all required fields (Table 18-1). Optionally complete the others. Pay attention to the domain.

Table 18-1. Data source fields.

Field	Type	Required?	Domain	Notes
Name	varchar(50)	Yes	N/A	The name of the data source. In many cases, a data provider may have more than one station. Examples are “COOP”, “SNOTEL”..
Description	varchar(50)	Yes	N/A	Description of the data source. Indicate who they are beyond what the name would suggest, such as “National Climate Data Center”
URL	varchar(100)	No	N/A	If there is a URL for the data source’s web site, indicate that here.
Contacts	varchar(50)	No	N/A	Many data providers will likely have a point of contact, either as a contact name and phone number or perhaps as a URL.
UpdateCycle	varchar(50)	No	N/A	This indicates how often the observed data is updated by the source. For example, some providers do annual updates while others update the observations monthly. You can approximate the times if you are not sure.
Agency	varchar(50)	Yes	N/A	In a few cases, the data source may be identified within a larger agency. For example, the data provider may be the climate group of a larger entity known as the agency. An example is “NWS” for the National Weather Service.

Station Info

This table contains information specific to a single weather/climate station provided by the data provider. This table allows you to describe this station in detail.

Open worksheet “StationInfo”

Fill out all required fields (Table 18-2). Optionally complete the others. Pay attention to the domain.

Table 18-2. Station info fields.

Field	Type	Required?	Domain	Notes
Code/ID	varchar(50)	Yes	N/A	This is the unique code given to station by the data provider. If there is not a code, you are encouraged to create a meaningful code with no more than 10 characters (no spaces).
Name	varchar(255)	No	N/A	This is the full station name given by the data provider. If there is not a name, you are encouraged to create a meaningful name of no more than 255 characters (spaces are allowed).
StartDate	date	No	Between 1/1/1700 and today. Times are ignored.	Known start date when station began recording (this may be different than the available data). Format: M/D/YYYY
EndDate	date	No	Between 1/1/1700 and today. Times are ignored.	Known end date when station ended recording (this may be different than the available data).). Format: M/D/YYYY Between 1/1/1700 and today. Use 12/31/9999 if still active.
Description	nvarchar(max)	No	N/A	This is a more thorough description of the station. When possible, use the description used by the data provider or create your own.

Station Locations

A station can move multiple times, therefore this table provides the opportunity to indicate the known locations where the station was located over its operating period.

Open worksheet “StationLocations”

Fill out all required fields (Table 18-3). Optionally complete the others. Pay attention to the domain.

Table 18-3. Station location fields.

Field	Type	Required?	Domain	Notes
LocationName	Varchar(50)	Yes	N/A	Name of the station location. If there is no name provided by the data provider, then create a simple descriptive name.
Latitude_deg	float	Yes	-90.00 to 90.00	Latitude in decimal degrees. Points in the northern hemisphere are positive; those in the southern hemisphere are negative (e.g., 40.75).
Longitude_deg	float	Yes	-180.00 to 180.00	Longitude in decimal degrees. Points in the western hemisphere are negative; those in the eastern hemisphere are positive (e.g., -100.82).
Elevation_m	float	No	-86.0 to 6194.0	Elevation of the station measured in meters. If the station is not measured in meters, you will need to convert it.
Aspect_deg	smallint	No	0 to 359	Aspect is the direction of the slope where the station is located. North facing slopes have an aspect of 0. If the aspect is not measured in degrees, you will need to convert it.
Slope_deg	tinyint	No	0 to 90	Slope is the gradient of the slope where the station is located. A zero degree slope indicates a completely flat surface. If the slope is not measured in degrees, you will need to convert it.
Description	varchar(max)	No	N/A	Description of the specific station location. Ideally, location description distributed by the data provider. Otherwise, create your own description.
StartDate	date	No	Between 1/1/1700 and today	This is the date the station began recording data at this particular location. If station didn't move this is the length of record from "StationInfo".). Format: M/D/YYYY
EndDate	date	No	Between 1/1/1700 and today	Use 12/31/9999 if still active location.). Format: M/D/YYYY

Park Location

For the purpose of some analyses and summaries, it will be important to indicate for which park units the station should be included.

Open worksheet “ParkLocation”

Fill out all required fields (Table 18-4). Optionally complete the others. Pay attention to the domain.

Table 18-4. Park location fields.

Field	Type	Required?	Domain	Notes
LocationName	varchar(50)	Yes	Same as from Locations table	Name of the station location identified in the StationLocations spreadsheet
ParkCode	varchar(10)	Yes	N/A	Indicate all distinct park codes for which this station should be affiliated. Generally, this is a 4-letter code (e.g., ROMO).There is no need to add network or regional codes since these can be inferred from the park.
InPark	bit	No	True or False	Indicate whether the location is within the park boundary.
DistanceToParkBoundary_m	smallint	No	Between 0 and 32,767	If not within the park, indicate the distance to the park boundary in meters.

Parameters

All observations should be identified by a parameter code which describes what is measured as well as the measurement units.

First, identify all parameter codes used in the Observations spreadsheet. Determine definitions for each code.

Second, run the following query in the climate database to determine whether this parameter code already exists for the data provider. If so, then do not include it again.

```
SELECT Source.Name AS SourceName, Source.Code AS SourceCode, Parameter.Code,
Parameter.Name, Parameter.Description, Parameter.Unit
FROM Parameter
INNER JOIN Source ON Parameter.SourceID = Source.ID
```

Finally, for those parameter codes not already present for a given data provider, include the fields shown in Table 18-5.

Table 18-5. Parameter fields.

Field	Type	Required?	Domain	Notes
ParameterCode	varchar(50)	Yes	N/A	The parameter code used by the data provider. In general, we recommend that you do not modify the parameter values if you are getting information from a third party. If the provider does not use codes, you will need to create one.
Name	varchar(50)	Yes	N/A	Name of the parameter being measured
Description	varchar(500)	Yes	N/A	Text description of what parameter is being measured
Unit	varchar(50)	Yes	N/A	The measurement unit described as precisely as possible. No symbols or special characters not found on a standard keyboard, such as degree symbols (°), subscripts, or superscripts. Degrees are implied with temperature; just indicate scale (C or F).
MinValue	Varchar(50)	No	N/A	Minimum acceptable value
MaxValue	Varchar(50)	No	N/A	Maximum acceptable value

Flags

Most data providers have observation and data quality flags associated with each observation.

First, identify all flags used in the Observations spreadsheet. Determine definitions for each flag.

Second, run the following query to determine whether this flag already exists for the data provider. If so, then do not include it again.

```
SELECT Source.Name AS SourceName, Flag.Code AS Flag, Flag.Description,
Flag.Type, Flag.Error
FROM Source
INNER JOIN Flag ON Source.ID = Flag.SourceID
ORDER BY SourceName, Type, Flag
```

Finally, for those flags not already present for a given data provider, include the fields shown in Table 18-6.

Table 18-6. Flag fields.

Field	Type	Required?	Domain	Notes
FlagCode	varchar(50)	Yes	N/A	A code representing the flag. Flags should generally not be more than 4 characters. Flags should be non-blank.
FlagType	varchar(50)	Yes	Measure, Quality	Measure – Pertaining to the actual collection of the data by the source provider. Includes whether there were issues with the instrumentation or other associated atmospheric events. Examples include there was a severe storm which damaged some of the instrumentation or caused them to go offline. Quality – Pertaining to any quality control applied to the data following collection. Quality control may include modifications to the original observations by the source provider
FlagDescription	varchar(1000)	Yes	N/A	Full description of the flag
IncludeInAnalysis	bit	Yes	Yes/No	Indicates whether this flag should prevent the observed value from being included in any of the summary analyses used by the Climate database.

Observations

This is the table that contains all of the weather observations for a single station. You can include as many parameters as you want for a single station. Observation fields are shown in Table 18-7.

Table 18-7. Observation fields.

Field	Type	Required?	Domain	Notes
SourceFile	varchar (255)	No	N/A	The Name of the file from which you pulled the data to submit. This file name is entirely for your own recordkeeping. We are assuming you will likely maintain a copy of the original data that you obtained from a third party source.
Date	date	Yes	M/D/YYYY	Date of the observation. Note that the database currently does not support more than one observation per day (per parameter per station).
ParameterCode	varchar(50)	Yes	N/A	Provided in Parameters spreadsheet or already in database
Value	float	Yes	N/A	Value – The actual observation value from the data provider
DataQualityFlag	varchar(50)	Yes	N/A	Comma-delimit all data quality flags. If there are no flags, leave blank.
DataMeasureFlag	varchar(50)	Yes	N/A	Comma-delimit all data measure flags. If there are no flags, leave blank.

Submit Station Request and Weather Observation Data

Email the Excel file containing the required information for the requested stations to the following contacts listed below. Additionally it is requested the weather observation data (section 2.10 above), also be submitted as a tab delimited text file in the following format: [Network/ParkCode]_[StationName/Code]_ [YYYYMMDD].txt.:

Jeff Stark (jeffrey_stark@contractor.nps.gov)

Brent Frakes (brent_frakes@nps.gov)

Follow Up

You will be notified by email once the upload has been processed. Although we will take every effort to ensure the upload was successful, **you are ultimately responsible for evaluating the uploaded data to ensure there were no errors**. If there are errors, you should first confirm that there is not an issue in how you formatted the data prior to contacting us.

SOP #19: Revising the Protocol Narrative and SOPs
Version 1.0

Change History
Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

The following revisions have occurred to this plan since October 2012:

Version #	Date	Revised by	Changes	Justification

This Standard Operating Procedure (SOP) explains how to make and track changes to the Climate Monitoring Protocol Narrative and associated SOPs for the Southwest Alaska Network (SWAN) Inventory & Monitoring (I&M) program. These methods will require modifications as both monitoring equipment and climate data needs change. Changes should be evaluated, subjected to appropriate review, and if approved, implemented in a timely manner.

Revising the Protocol Narrative and SOPs

Procedures

1. The SWAN climate monitoring effort benefits from – and builds upon – existing climate monitoring programs. Documenting changes in station performance, data collection methods, and data availability will require network staff to frequently review climate-station metadata, data availability, and data access pathways. Station performance for those stations (RAWS) that are operated and maintained by the SWAN will be evaluated periodically (SOP #7) and on-site during maintenance visits. Station metadata (Appendices A – F), data availability, and data access pathways for other stations monitored by the network should be reviewed and updated yearly during the reporting process.

2. Modifications to these methods for monitoring climate need to be reviewed for practical and technical soundness. Small changes will be reviewed in-house by network staff; however, significant changes may require a substantive external review. Experts with familiarity in climate monitoring and data analysis should be solicited for these reviews.

3. All changes will be documented and updated protocol versions will be recorded in the change history log that accompanies both the Protocol Narrative and each SOP. Version numbers will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures.

4. Modifications to the programs that are used to process climate data constitute SOP modifications and will be documented in the change history log for that SOP, included as a comment in the program header, and documented through versioning in the program file name. Previous versions of the programs will be archived.

4. Any changes to the Protocol Narrative and SOPs that are recorded in the change history log that accompanies both the Protocol Narrative and SOPs will also be documented in the master version table, which is part of this SOP (Table 19-1). The master version number is clearly documented on the cover of the combined Protocol Narrative and SOPs. This master version number will be incremented by a whole number (e.g. Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g. Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures. Previous versions of Protocol Narrative and SOPs will be archived.

Table 19-2. Master version table for the methods for monitoring climate in Southwest Alaska Network parks (protocol narrative and SOPs).

Master version number (v. #)	Date of change (mm/dd/yyyy)	Narrative (v. #)	SOP # 1 (v. #)	SOP # 2 (v. #)	SOP # 3 (v. #)	SOP # 4 (v. #)	SOP # 5 (v. #)	SOP # 6 (v. #)	SOP # 7 (v. #)	SOP # 8 (v. #)	SOP # 9 (v. #)	SOP # 10 (v. #)	SOP # 11 (v. #)	SOP # 12 (v. #)	SOP # 13 (v. #)	SOP # 14 (v. #)	SOP # 15 (v. #)	SOP # 16 (v. #)	SOP # 17 (v. #)	SOP # 18 (v. #)	SOP # 19 (v. #)
1.0	10/01/2012	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 965/117178, October 2012

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
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