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Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

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This sampling protocol consists of this Protocol Narrative and the following Standard Operating Procedures (SOPs):

SOP 1: RAWS Primer
SOP 2: Programming the Vaisala (Handar) 555
SOP 3: Programming the Handar 540
SOP 4: Snow Survey Sampling Guide
SOP 5: National Weather Service Observing Handbook No. 2
SOP 6: Snow Measurement Guidelines
SOP 7: Instructions for National Weather Service WS Form B-91
SOP 8: Instructions for National Weather Service WS Form B-92
SOP 9: Operating the Remote Observation System Automation (ROSA)
SOP 10: Data Management
SOP 11: Downloading NWS-Coop Climate Data
SOP 12: Downloading SNOTEL Climate Data
SOP 13: Downloading and Processing RAWS Climate Data
SOP 14: Downloading Snow Course Climate Data
SOP 15: Downloading and Processing SNOWNET Climate Data
SOP 16: Data Analysis and Reporting
SOP 17: Revising the Protocol Narrative and SOPs

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I. Background and Objectives

Issue Being Addressed and Rationale for Monitoring Climatic Conditions

Climate is a key driver of ecosystem structure and function, and is one of the four interactive controls in the conceptual model of ecosystem sustainability (Chapin et al. 1996). Long-term patterns in rainfall and temperature provide first-order constraints on potential ecosystem structure and function (Whitford 2002). Secondary constraints are realized from the intensity and duration of individual weather events, and additionally, from seasonality and interannual variability. These constraints influence the fundamental properties of ecological systems, such as soil-water relationships, plant-soil processes, nutrient cycling, as well as disturbance rates and intensity. These properties, in turn, influence the life-history strategies supported by a climatic regime (Neilson 1987).

Broad-scale climatic conditions of the Northern Colorado Plateau Network (NCPN) are largely influenced by surrounding mountain ranges. The NCPN is dominated by shrub and juniper-pinyon woodlands due to the orographic effects of surrounding mountain ranges (West 1988). The Sierra Nevada and Cascade mountains on the western boundary and the Rocky Mountains to the east intercept moist winter air masses. The Plateau resides in the "rain shadow" of these ranges. Based on interpolated estimates of precipitation, >65% of the NCPN land area has an average of less than 300 mm of precipitation annually (Evenden et al. 2002). Local topographic factors, however, contribute to regional variability in temperature and precipitation. Mean annual temperature ranges from 1.9 ^{o}C near Cedar Breaks NM to 16.2 ^{o}C at Zion NP; mean annual precipitation varies from 190 mm at Capitol Reef NP to 750 mm near Cedar Breaks NM (Fig. 1) (Evenden et al. 2002).

Southern monsoonal storms are an important source of summer precipitation in the southeastern region of the NCPN. The mean northwestern extent of summer precipitation associated with monsoonal circulation patterns divides the Colorado Plateau into two broad climatic regions (Fig. 1) (Mitchell 1976, Peterson 1994). The area southeast of this boundary is characterized by winter and summer precipitation maxima, and accounts for ca. two-thirds of the Plateau; winter precipitation dominates the northwestern portion of the Plateau (Evenden et al. 2002). NCPN park units located the farthest from the monsoonal boundary exhibit a late-summer decrease in average monthly precipitation, while units located closer to the boundary exhibit increasing summer precipitation with increasing elevation (Evenden et al. 2002). Park units located near the monsoonal boundary also exhibit high inter-annual variability in precipitation.

Local precipitation and temperature patterns determine soil-water availability, which greatly influences ecosystem responses in the xeric NCPN (Miller and Thomas 2004). Intensity, duration, and timing of precipitation determines soil-water recharge rates. This in turn determines primary production and attendant secondary production, and hydrological properties of riparian and spring-seep systems. Given high rates of evapo-transpiration during the hot summers in the desert-shrub systems, high-intensity, short-duration summer precipitation contributes little to soil-water storage. Increases in precipitation intensity and duration, however, can lead to pulses in soil-water availability, and immediate or delayed vegetative responses. Researchers working in other dryland systems have found 1-3 yr lags in the response of above-ground net primary production to precipitation (Lauenroth and Sala 1992, Oesterheld et al. 2001, Wiegand et al. 2004). Similar precipitation-production lags have been hypothesized for the dryland systems of the NCPN (see Miller and Thomas 2004). Systems at higher elevations have cooler summer temperatures and are less sensitive to precipitation intensity and duration. Since the Colorado Plateau is a cool desert, winter precipitation typically occurs in the form of snow, even at the lower elevations. Gradual snowmelt from winter precipitation provides deeper infiltration into the soil (West 1988), and largely contributes to available soil water in the NCPN.

Precipitation and temperature patterns also influence disturbance rates and patterns in the NCPN. Fuel moisture and temperature in conjunction with lightening events drive the occurrence and effects of wildfire in the pinyon pine systems (Swetnam and Baisan 1994). Drought conditions can increase infestation rates of insects and pathogens in woodland and forest systems (Swetnam and Baisan 1994), and increase the susceptibility of sites to exotic-plant invasion.

Global climatic change may have a profound impact on the landscape of the NCPN. Elevated concentrations of heat-trapping gases in the atmosphere are predicted to increase average global temperatures from 1.0 to 3.5 ^{o}C by the middle of the 21st century (Houghton and Woodwell, 1989; Houghton et al. 1996). Responses of ecosystems to global warming have been postulated, and likely will vary among systems (Shaver et al. 2000). Warming trends may increase primary production in systems with low annual temperatures. Conversely, production may decrease in mesic and xeric environments, such as the NCPN, where temperatures already correspond to peak production. Interactions among processes also may constrain realized change in system structure. In dryland systems, increased evapo-transpiration may effectively offset temperature-driven increases in plant production (Saleska et al. 1999). Given the influence of the monsoonal boundary, the effects of changes in circulation patterns and precipitation due to global climatic change may be seen relatively early in the NCPN compared to other regions (Ehleringer et al. 2000; Williams and Ehleringer 2000).

Understanding the role of climate as a forcing agent for other vital signs is critical to NCPN monitoring. Observed changes in vital signs may be in response to multiple factors, such as anthropogenic stressors or variation in climatic conditions. Discerning reasons for observed changes that are responsive to mitigation measures (e.g., soil erosion vs. climate-driven change) will ensure effective management recommendations. Furthermore, untangling the effects of intrinsic climatic variation and climatic change will provide useful insights into regional trends in environmental change.

The NCPN climate monitoring effort will capitalize on extant climate monitoring programs. These programs provide consistent monitoring of climatic conditions, and in same cases, provide a long-term period of record. Information from existing climate stations in NCPN parks units will be archived on the NCPN server. Procedures for acquiring and archiving observations are developed in this protocol. The databases established and maintained by this protocol will provide key information to understanding coarse-scale changes in climatic patterns in the NCPN, and aid in the interpretation and analyses of trends in the other monitored vital signs.

By design, this protocol pertains to monitoring coarse-scale climatic conditions. Climate stations are sparsely distributed across the NCPN park units, and provide point-based measures of climate. Although these data are of value, they do not necessarily provide a means to interpolate climatic patterns over a park's landscape. For certain vital signs, fine-scale measures may be critical in discerning reasons for observed trends. Spatially extensive monitoring of fine-scale climatic conditions (e.g., at the scale of monitored field plots) is proposed in two other NCPN monitoring protocols – Integrated Upland and Integrated Riparian.

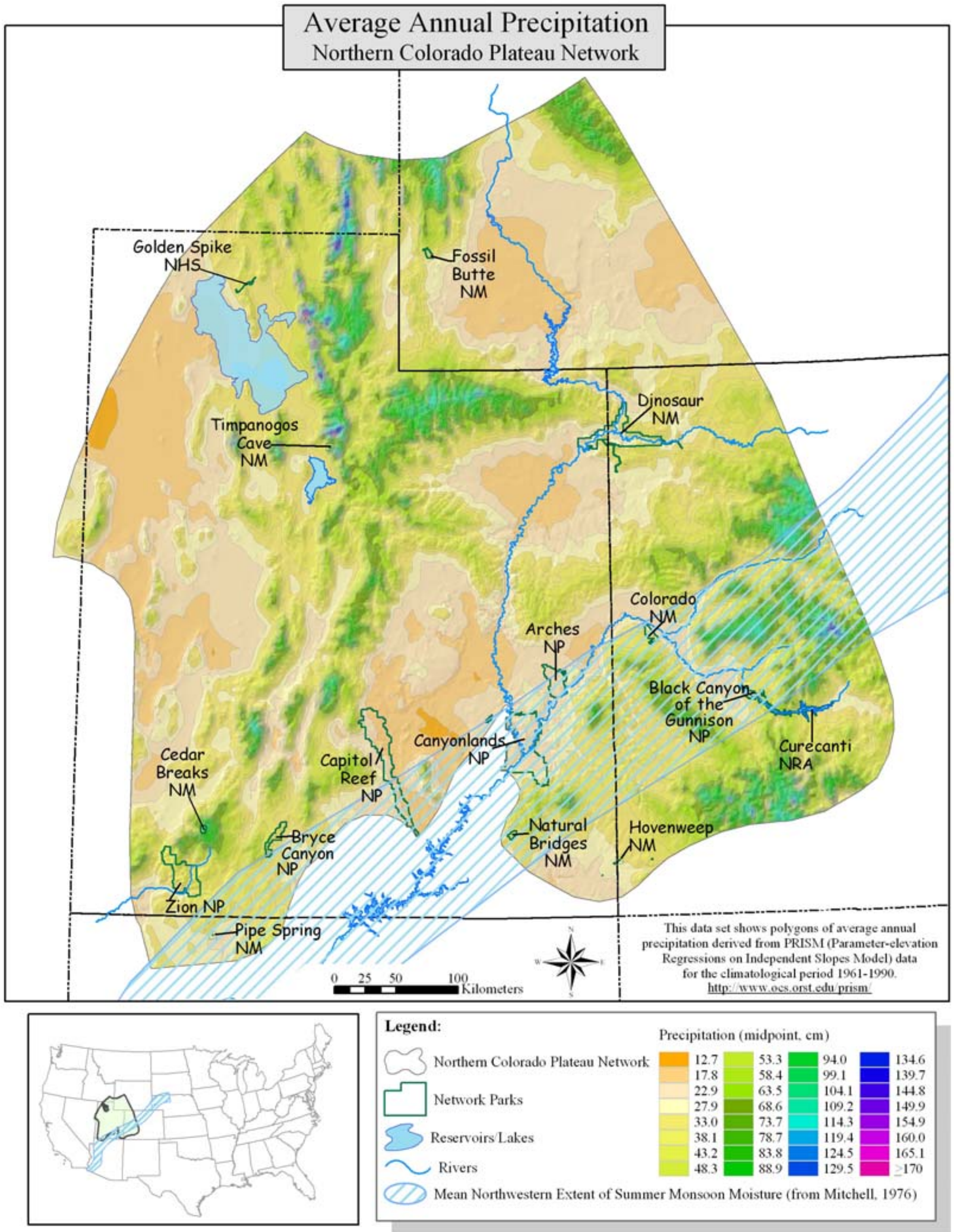


Figure 1. Average annual precipitation in the NCPN, and location of the mean northwestern extent of the summer monsoon boundary.

Historical Development of Climate Monitoring in the NCPN

Climatic conditions have been monitored in NCPN park units largely since the 1960's, with some periods of record extending back to the 1940's. The seven climate monitoring programs in the NCPN are primarily administered by other federal agencies (Table 1).

Table 1. Climate monitoring programs in NCPN park units.

Climate Monitoring program	Agency	No. stns.
NWS-Coop (National Weather Service Cooperative Observing Program)	National Oceanic and Atmospheric Administration (NOAA)-National Weather Service (NWS)	17
RAWS (Remote Automated Weather Stations)	National Interagency Wildfire Program (FS, BLM, NPS, et al.)	6
SNOTEL (SNOwpack TELemtery); Snow Course	National Resources Conservation Service (NRCS)	1;1
SNOWNET (incl. Avalanche network)	MesoWest (Univ.of Utah), USDA Forest Service	3
CRN (Climate Reference Network)	NOAA	2
CLIM-MET (Climate Metereology)	USGS Earth Surface Dynamics Program - SW Climate Impacts	2

The majority of established weather stations are administered by The National Weather Service (NWS) Cooperative Observing Program (Coop). The NWS-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. Core observations from the NWS-Coop stations include 24-hour minimum and maximum temperatures, and 24-hour precipitation (rain and water-equivalent of snow fall) (Appendices A-1, A-2). Additionally, observations of precipitation duration and other general climatic conditions are recorded daily. Park personnel are responsible for recording daily measures, reporting daily measures to regional NWS offices, and reporting monthly tallies of all climatic observations to the National Climate Data Center (NCDC) and NWS (Appendix B). The NWS-Coop stations have the longest period of record of all weather stations deployed in the NCPN. The NWS maintains all Coop weather stations. The Western Regional Climate Center (WRCC), located in Reno Nevada, is the official repository for NWS-Coop data.

In support of wildland fire management, six RAWS (Remote Automated Weather Stations) systems were installed in four NCPN park units (Appendices C-1, C-2). The RAWS network is comprised of agency-supported climate stations. RAWS data are used by fire-management personnel in various federal and state agencies (including NCPN park staff) to estimate a fire-danger rating in support of preventive measures, and to forecast the behavior of wildland fires. The oldest RAWS station in the NCPN was established June 1990; most stations were deployed in the mid to late 1990's. RAWS stations consist of automated sensors that record air temperature and relative humidity, precipitation, wind speed and direction, and measures of fuel moisture and temperature. Data are recorded every 15 minutes and are automatically 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 Automated Sorting, Conversion and Distribution System (ASCADS) retrieves data from the GOES, converts it to a format compatible with the Weather Information Management System (WIMS) (http://www.fs.fed.us/fire/planning/nist/wims.htm) and the Western Regional Climate Center (WRCC) in Reno, Nevada (www.wrcc.dri.edu), and forwards the data to these agencies. WIMS is the host site for the National Fire Danger Rating System (NFDRS), and is designed to manage forestry weather information nationwide, to maintain fire weather, and for purposes of fire-danger rating forecasting. Support personnel for WIMS are the US Forest Service, National Information Systems Team Support Group in Boise, Idaho, located at NIFC. The WRCC is the official repository for RAWS data.

The SNOTEL (SNOwpack TELemtery) network of climate stations is administered by the USDA Natural Resources Conservation Service (NRCS). Bryce Canyon National Park is the only NCPN park unit with a SNOTEL station (Appendix D-1). SNOTEL stations provide real-time snow and climate data using automated remote sensing 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 meteorburst 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 near Boise, Idaho, and Ogden, Utah, receive the data and transmit it to the Central Computer Facility of the National Water and Climate Center located in Portland, OR.

A NRCS Snow Course site also is located in Bryce Canyon National Park (Appendices D-1 to D-3). Snow Course is observer-based, where measures of snow attributes (depth and snow-water equivalent) are collected manually along a permanent transect. Snow Course is the pre-cursor to the SNOTEL program. Although information from the Snow Course site is limited in scope, it has been monitored since 1935. This long-term record provides useful insight into the temporal variation in snow pack at Bryce Canyon National Park.

Three automated stations in the NCPN are assigned to the SNOWNET network by MesoWest (Appendix E). MesoWest is a cooperative project among the University of Utah, NWS-Salt Lake, the NWS Western Region Headquarters, other universities, and commercial firms. MesoWest archives data from automated climate stations in the Western U.S. These archives are used for general monitoring of weather by NWS, and in research and forecasting. The three SNOWNET stations in the NCPN were established by various programs. The station at Timpanogos Cave NM is in the USDA Forest Service Avalanche program. The station at ZION National Park is included in the NWS-Coop program. The station at Capitol Reef National Park was established by the park in cooperation with the NWS Forecast Office in Salt Lake City. Stations measure air temperature and precipitation parameters; snow depth is measured at only one of the stations. Data from these stations are regularly transmitted to the NWS Forecast Office. MesoWest acquires the data directly from this office.

Two U.S. CRN (Climate Reference Network) stations were established in Dinosaur National Monument and Black Canyon of the Gunnison in 2004 (Appendices F-1, F-2). The CRN is a network of climate stations being developed as part of a National Oceanic and Atmospheric Administration (NOAA) initiative. The primary goal is to provide long-term observations of temperature and precipitation that can be coupled to past long-term observations for the detection of climatic change. The automated CRN stations are designed to operate over a wide range of environmental conditions but are located in areas that are anticipated to be unaffected by factors (e.g., urban expansion) that could modify local environmental conditions. The proposed final network will consist of 110 stations nationwide. The CRN records standard parameters such as air temperature and precipitation, as well as measures of ground-surface temperature, solar radiation, wind speed, and sensor performance. CRN sensors sample measures ca. every 2 seconds. Fifteen-minute and 1-hr measures are internally derived, depending on the element. Data are automatically transmitted to the NCDC data management and processing facility in Asheville, NC. NCDC provides data ingest, quality control, data processing and archiving, and eventually distributes data to the climate research community and the public. Data from CRN stations will be archived by the Western Regional Climate Center (WRCC) in Reno. WRCC is in the process of developing web-based, data dissemination methods for CRN data. The NCPN I&M program will begin to extract and archive these data from the WRCC site whenever the CRN-data access feature becomes functional.

The CLIM-MET (Climate Meteorology) network is administered by the USGS Earth Surface Dynamics Program, South West Climate Impacts program. Two stations belonging to this network are located in Canyonlands National Park, and were established starting in 1999 (Appendix G). Stations automatically record measures of atmospheric and surficial processes at regular intervals. Recorded data are stored on-site and are periodically retrieved. Sensors and site locations of these stations are subject to change to accommodate changes in research needs.

<u>Objectives</u>

This protocol addresses two objectives:

1. Provide monthly and annual summaries of climatic parameters in NCPN park units. Common climatic parameters include air temperature and precipitation; additional parameters include wind speed and direction, solar radiation, fuel temperature and moisture.
2. Identify extremes of climatic conditions for common parameters (precipitation and air temperature), and other parameters where sufficient data are available (e.g., wind speed and direction, solar radiation, fuel temperature and moisture).

II. Sampling Design

Rationale for Sampling Design and Site Selection

The goals and objectives of external climate monitoring programs have dictated the numbers and locations of weather stations in the NCPN. In most cases, a rigid sampling design was not used to locate stations. For instance, the NWS-Coop stations largely were located based on year-round ease of access, and thus, are located near park visitor centers. CLIM-MET stations were located to support specific USGS climate research. Site location can be changed at any time to accommodate new objectives. The locations of RAWS stations were motivated by available agency support and local wildfire threat. A sampling design is more apparent for SNOTEL locations, where coverage of mountainous areas motivates station placement. To some extent, the sighting of new RAWS stations accounts for holes in the existing network of these stations. For instance, the proposed addition of a RAWS station at Colorado National Monument is partly in response to filling a regional void. By design, the CRN network is an attempt by NOAA to establish a systematic grid of climate stations across the U.S.

Population being Monitored

The existing climate stations provide point-based observations, although the climatic footprint extends beyond the physical limits of a station. Measures from several climate stations, however, do not capture the inherent variability of a park's landscape. This is especially true given that stations of the various monitoring programs tend to be either co-located or in close proximity within a park unit. Moreover, topographic variability within especially the larger parks results in climatic gradients not adequately represented by one or two climate stations. The lack of spatially distributed information is compensated for by the geographic extent of NCPN stations and the temporal sample. Collectively, NCPN climate-station data offer important insights into sub-regional trends in climate, especially in relation to the monsoonal boundary that traverses the lower portion of the NCPN (Fig. 1). The relatively long observational period of especially the NWS-Coop stations provides an important record of historical trends, and a basis for evaluating climatic extremes and change.

Within the geographic bounds of the NCPN there are an additional 296 NWS-Coop, 110 RAWS, and 113 SNOTEL stations (Fig. 2). Where necessary, data from these climate stations can be accessed and combined with park data for analyses. In this regard, the larger collection of available stations provides samples of climatic conditions at the scale of the NCPN region.

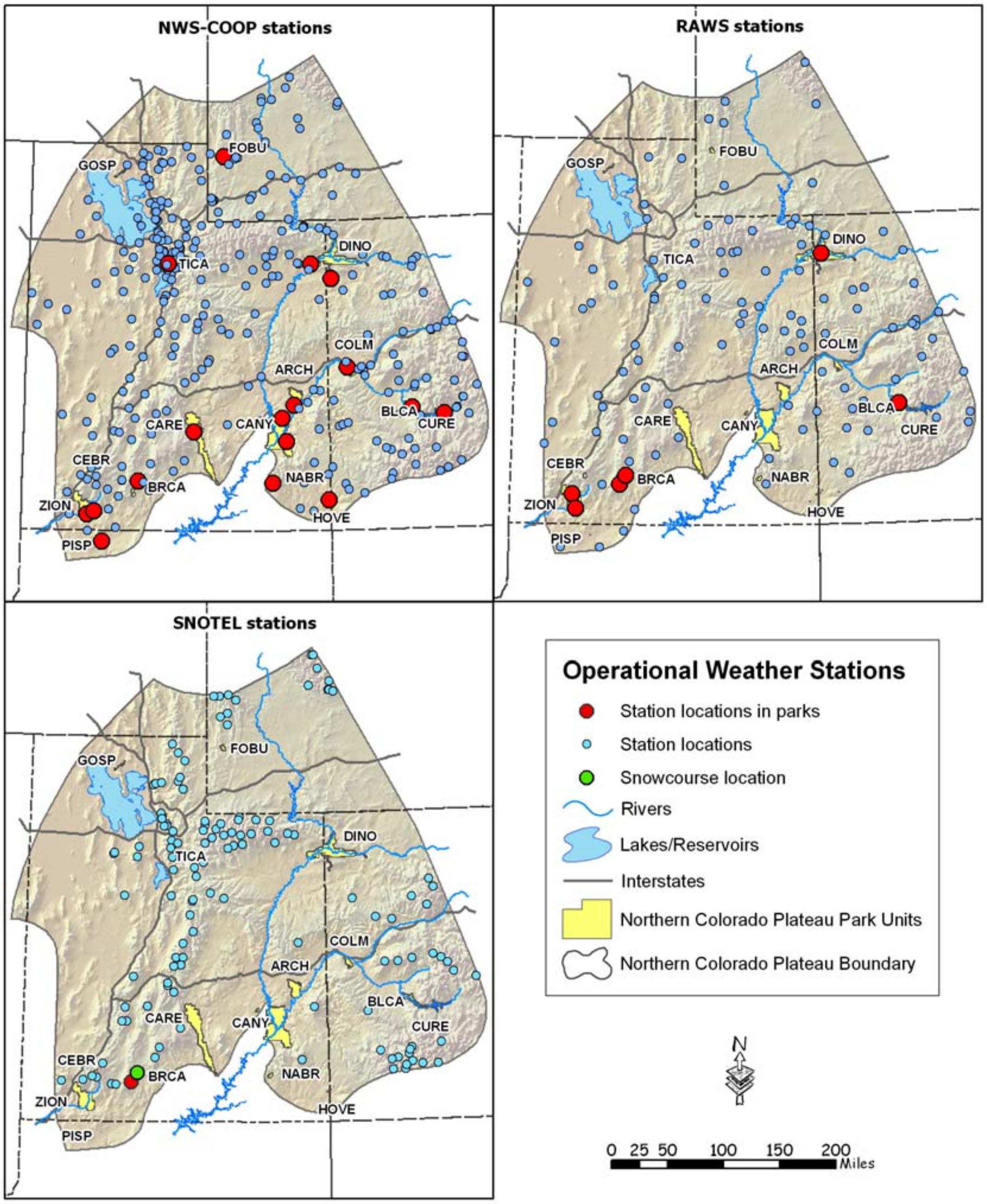


Figure 2. Locations of climate stations in the three dominant climate-monitoring programs in the NCPN. See Table 2 for definition of park-unit acronyms.

Table 2. Acronyms of NCPN park units.

Park unit	Acronym	State
Arches National Park	ARCH	UT
Black Canyon of the Gunnison National Park	BLCA	CO
Bryce Canyon National Park	BRCA	UT
Canyonlands National Park	CANY	UT
Capitol Reef National Park	CARE	UT
Cedar Breaks National Monument	CEBR	UT
Colorado National Monument	COLM	CO
Curecanti National Recreation Area	CURE	CO
Dinosaur National Monument	DINO	CO/UT
Fossil Butte National Monument	FOBU	WY
Golden Spike National Historic Site	GOSP	UT
Hovenweep National Monument	HOVE	CO/UT
Natural Bridges National Monument	NABR	UT
Pipe Spring National Monument	PISP	AZ
Timpanogos Cave National Monument	TICA	UT
Zion National Park	ZION	UT

Observation Frequency and Replication

Observation frequency varies among the climate networks. Observations from NWS-Coop stations generally are 24-hour measures (Appendices A-1, 2), and are reported daily and monthly year round to climate data centers (Appendix B). The Snow Course site at Bryce Canyon National Park is monitored 1-2 times a month during winter. All other climate stations are automated, and record information at least every 15 minutes. Data from these stations are automatically transmitted about every hour to regional and national climate data centers year round. There are two exceptions. The CLIM-MET stations record data to an on-site data logger which is manually retrieved every 6-months and mailed to the USGS principle investigator located in Denver, CO. RAWS stations may be operated year round or shut down in winter.

III. Field Methods

Equipment Setup, Maintenance, and Inspection

Seasonal preparations and equipment setup are minimal given that most climate stations are operated year round. Maintenance and calibration of climate stations tend to be the responsibility of external agencies (Table 3). Data from NWS-Coop and SNOTEL stations are consistently monitored by NWS and NRCS, respectively, to determine aberrant values and possible equipment malfunction. NRCS has a maintenance staff to support SNOTEL stations. Park staff are responsible for minor maintenance of NWS-Coop stations, such as replacement of malfunctioning equipment. Otherwise, regional NWS representatives service these stations. Both programs require agency representatives to inspect climate stations once a year. A USDA Avalanche Program representative monitors the Timpanogos Cave NM SNOWNET station, and contacts park staff for needed repairs. NWS services the SNOWNET station at ZION NP. The SNOWNET station at CARE is maintained by park staff. CRN stations are supported and monitored by NOAA in Asheville, NC. A park representative is contacted to resolve minor problems; otherwise NOAA specialists maintain CRN stations. CLIM-MET stations are maintained by the USGS Climate Research program.

RAWS stations require maintenance by park staff prior to the beginning of each fire season. Standardized procedures for the inspection and checkout, and related documents are provided on the Interagency RAWS web page (www.fs.fed.us/raws) under Field Guide and Tech Notes Forms. Pre-inspection and inspection procedures are presented in the RAWS PRIMER (SOP#1). Programming instructions for the Data Collection Platform (SOPs #2, #3), instructions to access the Automated Sorting, Conversion and Distribution System (ASCADS) which is used to record sensor performance and in the electrical checkout (Appendix H), and the RAWS Field Checklist (Appendix I) are included with this protocol to ensure accessibility. During operation, equipment malfunction is reported by NIFC to a park contact (e.g., a member of the fire management team), typically through the ASCADS. Park staff are responsible for immediate resolution of equipment problems.

Table 3. Personnel responsible for recording and reporting climate data, and maintaining climate stations.

	Observation recording & reporting	**Maintenance and calibration**	
Climate Network	**Responsible Personnel**	**Frequency**	**Responsible Personnel**
NWS-Coop	Park staff	Once per year	Regional district NWS staff
RAWS	Automated recording and transmission	Once per year	Park fire-management staff
SNOTEL	Automated recording and transmission	Once per year	NRCS
Snow Course	Park staff at Bryce Canyon NP	na	na
SNOWNET	Automated recording and transmission	Once per year	Regional district NWS staff (ZION), USDA Forest Service and park staff (TICA), park staff (CARE)
CRN	Automated recording and transmission	Once per year	NOAA, Ashville, NC
CLIM-MET	Automated recording, data logger collected every 6-mo. and sent to USGS Earth Surface Dynamics Program (ESDP), Denver, CO.	Twice a year	USGS-BRD at Canyonlands Field Station, and USGS - ESDP

Observation Methods

Automated Stations. The 15 automated climate stations in the NCPN directly transmit climate observations to receiving agencies. RAWS and SNOWNET stations record data at 15-minute intervals, and transmit data at least every hour. The only automated NWS-Coop station (ZION NP East Gate) also records observations at 15-min intervals. The Avalanche station at Timpanogos Cave transmits data at 1-hour intervals. The SNOTEL station provides daily measures of weather parameters. The CRN stations transmit data to NCDC about every hour. The data loggers of the CLIM-MET stations are retrieved by staff at the USGS Moab Field Station every 6-months, and sent to the USGS principle investigator.

Snow Course. The Snow Course site in Bryce Canyon National Park is monitored 1-2 times a month, generally from January to June. Years with heavy snow fall may require monitoring to commence in November. Snow surveys are conducted along the established transect (snow course) that was initiated in 1935 (Appendix D-3). Snow depths and snow-water equivalents are measured. Procedures, equipment lists, and example data sheets for snow course measures are documented in SOP #4. Data sheets are sent to NRCS at the end of the snow season. The data are archived by NRCS, and made available on the NRCS Snow Course web page.

NWS-Coop Stations. Observer-based NWS-Coop stations require manual recording of climate observations on a daily basis. Although some of these stations have electronic instrumentation, they lack automated transmission capability. Daily observations are obtained by park personnel by directly reading instruments (e.g., min-max thermometers), by reading digital displays connected to electronic sensors, 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 for manual measurements are provided in the NWS Observing Handbook No. 2 (July 1989) (see SOP #5). An updated procedure for measuring snow attributes was published in 1996, and is included as SOP #6. Daily measures are recorded on a NWS paper form. Stations without an evaporation pan record observations on NWS Form B91 (SOP #7). Those with an evaporation pan record observations on NWS Form B92 (SOP #8).

With few exceptions, 24-hour temperature and precipitation observations are immediately transmitted after being recorded to designated regional offices of the NWS (Appendix B). Three transmission methods are employed in the NCPN. Observations are transmitted by phone to a recording device or entered into a NWS web-page (WXCODER). Both of these methods prompt the observer for specific information, and thus do not require specific SOPs for operation. Two parks still use the ROSA (Remote Observation System Automation) method. This method uses the key pad of a specialized phone (the ROSA phone) to enter and send observations. ROSA procedures are documented in SOP #9.

The monthly summary of daily measures is distributed to a designated regional office of the NWS. Forms B91, B92 are mailed or uploaded in WXCODER by the 3rd of the following month. Punch tapes from the Belfort Rain Gauge (B18) are mailed by the 15th of the following month. NCDC eventually receives all monthly reports, transcribes the data from paper copies to electronic data bases (where necessary), archives the data, and distributes error-checked daily values to cooperating agencies (e.g., regional climate centers).

IV. Data Management

Data Acquisition

Data from all but four of the climate stations on NCPN park lands will be archived on the NCPN server. Data from the two CLIM-MET stations are not archived due to the temporary nature of these stations. Also, data for these stations can be easily accessed via the CLIM-MET web page (http://esp.cr.usgs.gov/info/sw/clim-met/sitedata.html). Data for the two CRN stations are not accessible. Public access to the other data sources can be limited to recent years or to historical daily means instead of daily values. Also, accessing historical data can be tedious, especially where agency web pages serve data at a daily or monthly time scale. Local storage of data from NCPN climate stations will greatly increase data access and facilitate their use in the analyses of other vital signs.

Data acquisition and archive procedures described below and in SOPs focus on climate stations in NCPN park units. Evaluations of climatic trends and trend analyses of other vital signs may be enhanced with data from climate stations adjacent to park lands. Acquisition procedures described below can, in fact, be used to acquire data from any station belonging to one of the five main climate monitoring programs. However, due to computer disk-space considerations, the NCPN is reluctant to consistently archive data from non-NPS stations. The need for archiving data from these stations will have to be addressed on a case by case basis.

Procedures have been developed to access or derive daily measures for 28 of the NCPN climate stations. NWS-Coop, RAWS, and SNOTEL data are provided by WRCC. WRCC stores all western-U.S. Coop data, and is the national repository for historical RAWS data. WRCC also acquires NRCS SNOTEL data and provides data-quality flags in the downloadable versions of the data. Procedures for accessing NWS-Coop, SNOTEL, and RAWS are described in SOP #11, SOP #12, and SOP #13, respectively. Procedures are based on current access restrictions. A Memorandum of Understanding between the National Park Service and WRCC is being developed that will result in more efficient and comprehensive data access. Snow Course data are archived by NRCS. Procedures for downloading these data from the NRCS web site are described in SOP #14. Data for the three SNOWNET stations are archived by MesoWest. Procedures for acquiring these data are provided in SOP #15. Procedures will be developed to access CRN data once WRCC provides access to archived data.

Climate data are stored in their native format, and with exception, are subsequently uploaded into NCPN climate databases (described below). RAWS and SNOWNET stations provide climate observations at <24-hour time scales. To facilitate data use, climate parameters in these sources are first summarized to daily values before being added to the MS-Access databases. Customized programs are used to summarize RAWS and MesoWest data to daily values. Procedures for running these programs are described in SOP #13 (RAWS data) and SOP #15 (SNOWNET data). As part of this summary process, error and domain checking are performed. Domain checks follow MesoWest data-quality guidelines (Appendix J). Data not satisfying domain checks are dropped from the daily summary. Daily minimum, maximum, and arithmetic means are derived for temperature, precipitation, fuel measures, snowfall and snow depth. Additionally, minimum and maximum wind speed, and maximum wind gust are generated. Vector averaging (Gilhousen 1987) is used to derive average wind direction. For all derived measures, the percentage of valid observations within a 24-hr period is included in the summarized data as a measure of the reliability of derived, mean values.

Overview of NCPN Database Design

Climate data are merged into a standardized system to facilitate queries and analyses. The climate data model consists of six separate Access XP databases, one for each of the climate monitoring programs and one that contains details on individual climate stations (e.g., location, equipment). A series of macros and queries automate the process of importing climate data into the Access tables. Detailed description of the climate data model, procedures for importing data, and archiving standards are provided in SOP #10.

Data Entry, Verification, and Editing

The conversion of the raw climate data to Access tables employs checks for invalid date and time values, and non-numeric values when numeric are required. Errors are operator corrected by supplying date and time values within valid ranges, and entering a value of -9999 when a non-numeric character is found.

Metadata Procedures

Metadata will be maintained at several levels. Each table and field in Access databases are defined and documented, and a complete and up-to-date Dataset Catalog record will be maintained for each database. GIS layers pertaining to, or created from climate data, will have a completed FGDC-compliant metadata record. Version numbers of the narrative and SOPs in effect at the time data are recorded will be tracked in the Master Version Table (documented in SOP #17). The complete protocol for this project (Narrative and all SOPs) and the Master Version Table are an integral component of the project metadata. Data should not be distributed independently of the complete protocol.

Data Archiving Procedures

Raw data obtained from NWS-Coop, SNOWNET, SNOTEL, Snow Course, and RAWS will be archived in their native format before any manipulation. In addition, archive files will be created prior to database-version upgrades. All archives are stored on a secure NCPN server that is regularly backed-up.

V. Analysis and Reporting

An annual report on the climatic conditions of the most recent year is to be distributed by February of the following year. There are four components to the climate report: 1) a monthly summary of reported climatic parameters; 2) an annual summary; 3) assessments of annual, monthly, and daily measures in the context of historical trends (i.e., climatic extreme assessments); and 4) a comparison of climatic conditions among the NCPN park units. Components #1-3 are produced for each climate station in a park unit; assessments of climatic extremes (#3) involve comparisons of recent-year conditions with the historical period of record. All climate stations in the NCPN are employed in component #4. Reporting requirements dictate the need for an annual status report every year, and comprehensive analyses and synthesis reports every 3-5 yrs for all monitored vital signs (see the NCPN Monitoring Plan, Chapter 7). Given the annual frequency of data collection and the historical period of record, annual climate reports will contain both status and synthesis information.

Data Summaries and Climatic-extremes Assessments

Climate Station Summaries.

Procedures for analyses and reporting are provided in SOP #16. Procedures for monthly and annual summaries are well developed. General procedures for assessing and reporting on climatic extremes are developed, but these will undergo further enhancement as methods and needs evolve. Rudimentary methods are developed for network-wide comparisons, and likewise, will be expanded with experience.

Summaries and assessments are tailored to include all climatic parameters reported at a station. The common variables among all stations will include minimum, maximum, and average temperature, and precipitation. Summaries provide a tabulation of climatic variables (e.g., Tables 4, 5. Assessments of climatic extremes compare current-year conditions with historical trends (e.g., Figure 3). Extremes are defined as values that occur near or exceed historical limits. Custom PC-based programs and graph templates are available to perform and to visualize these assessments.

Assessments of climatic extremes eventually will be performed using a NCPN web-tool application. This tool will allow a user to implement customized analyses of climatic extremes. All climatic parameters stored in the NCPN climate databases (see SOP #10) will be accessible. The user will be able to select specific climatic parameters for analysis, to specify observational periods for comparisons, and to specify types of analytical summaries. This tool is being designed for two end users. The NCPN will use it for the basic assessments included in the annual climate report. NCPN park staff have expressed the need to perform assessments of climatic trends and extremes on an as-needed basis. The web application is intended to provide park staff with this capability. The functionality of this tool will evolve as assessments advance, and in response to feedback from park personnel. A rudimentary version of this tool is available on the NCPN web page. Its underlying structure and current functionality are documented in SOP #16.

Network-wide Assessments. Network-wide comparisons will consist, at a minimum, of arraying key climatic variables along environmental gradients of the NCPN park units, and a similar qualitative comparison of climatic extremes (e.g., Figure 4). Trends in climatic variables will be graphically arrayed along latitude, longitude, and elevation gradients to examine geographic patterns. The network comparison of climatic extremes initially will focus on trends in the percentage of observations that exceed a specific historical level (e.g., 5th or 95th percentile). For each key climatic variable, trends will be arrayed along environmental gradients to assess spatial patterns of extreme events.

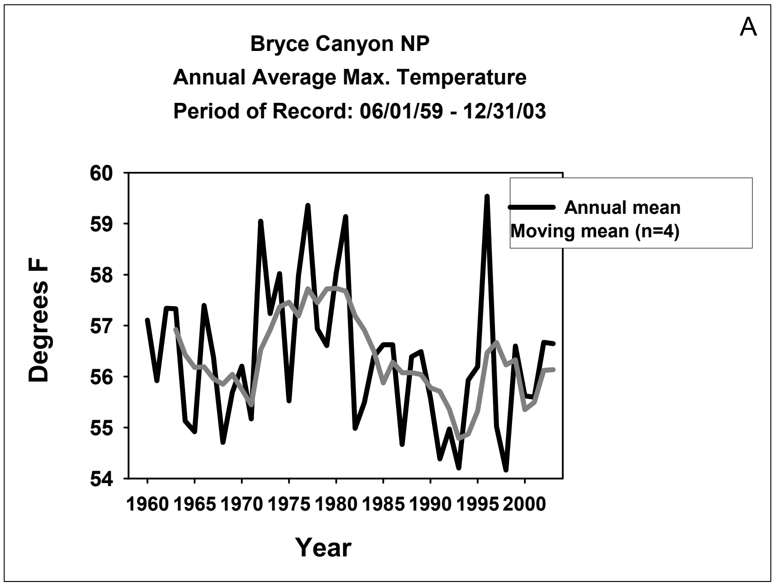
Table 4. Monthly climate summary for Arches National Park – December 2003 (NWS-Coop Stn. ID – ANPU1).

December 2003	Temperature (°F)			Precipitation (in)		
Day	**Minimum**	**Maximum**	**Average**	**Rainfall**	**Snowfall**	**Snowdepth**
1	26	50	38	0	0	0
2	26	52	39	0	0	0
3	25	56	41	0	0	0
4	22	48	35	0	0	0
5	22	52	37	0	0	0
6	30	50	40	0	0	0
7	31	51	41	0	0	0
8	35	55	45	0.38	0	0
9	28	43	36	0.13	0	0
10	22	45	34	0	0	0
11	24	43	34	0	0	0
12	21	45	33	0	0	0
13	23	44	34	0	0	0
14	28	45	36	0	0	0
15	29	52	40	0.03	0	0
16	16	44	30	0	0	0
17	16	40	28	0	0	0
18	17	40	28	0	0	0
19	18	42	30	0	0	0
20	21	45	33	0	0	0
21	25	44	34	0	0	0
22	34	52	43	0	0	0
23	24	52	38	0	0	0
24	24	44	34	0	0	0
25	28	46	37	-	-	-
26	28	51	40	0.04	-	0
27	30	49	40	0	0	0
28	15	38	26	0	0	0
29	12	38	25	0	0	0
30	22	38	30	0.15	2	2
31	23	44	34	0.0	0	1
Minimum	12	38	25	-	-	1
Maximum	35	56	45	-	-	2
Average	24	46	35	-	-	-
Total	-	-	-	0.79	2	-
% Valid records	100	100	100	96.8	93.3	96.8

Climate Attribute	**Number of days**
Minimum Air Temp < 32° F	29
Minimum Air Temp < 17° F (5th percentile)	5
Maximum Air Temp < 32° F	0
Maximum Air Temp > 102° F (95th percentile)	0
Rainfall ≥ 0.01 in	6
Rainfall ≥ 0.1 in	3
Rainfall ≥ 1.0 in	0
Snowfall ≥ 0.01 in	1
Snowfall ≥ 0.1 in	1
Snowfall ≥ 1.0 in	1

Table 5. Annual climate summary for Arches National Park, 2003 (NWS-Coop Stn. ID – NPU1).

2003	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Minimum Air Temperature (°F)													
Min	20	16	21	28	32	52	62	60	40	28	12	12	32
Max	34	40	47	58	68	70	79	78	68	59	45	35	57
Average	25	29	35	41	48	61	70	67	53	45	31	24	44
No. of days													
≤ 17°F	0	2	0	0	0	0	0	0	0	0	3	5	10
≤ 32°F	30	19	7	7	1	0	0	0	0	1	16	29	110
% of days with valid records	100	100	100	100	100	100	100	100	100	100	100	100	100
Maximum Air Temperature (°F)													
Min	39	37	44	56	64	85	102	90	73	66	34	38	61
Max	59	61	78	83	104	102	116	107	100	95	71	56	86
Average	51	52	62	73	84	94	107	100	88	81	54	46	74
No. of days													
≥102°F	0	0	0	0	3	3	31	12	0	0	0	0	49
≤ 32°F	0	0	0	0	0	0	0	0	0	0	0	0	0
% of days with valid records	100	100	100	100	100	100	100	100	100	100	100	100	100
Precipitation Rainfall (in)													
Total	0.1	1.18	1.02	0.0	1.09	0.28	0.15	0.35	0.51	0.36	0.27	0.79	6.1
No. of days													
≥0.01”	2	7	6	1	4	4	2	6	3	4	5	6	50
≥ 0.1”	0	4	2	0	1	1	0	2	2	1	0	3	16
≥ 1.0”	0	0	0	0	0	0	0	0	0	0	0	0	0
% of days with valid records	100	100	100	96.7	100	100	100	100	100	100	96.7	96.8	99.2
Snowfall (in)													
Total	0	0	0	0	0	0	0	0	0	0	0	2	2.0
No. of days													
≥0.01”	0	0	0	0	0	0	0	0	0	0	0	1	1
≥ 0.1”	0	0	0	0	0	0	0	0	0	0	0	1	1
≥ 1.0”	0	0	0	0	0	0	0	0	0	0	0	1	1
% of days with valid records	100	100	100	100	100	100	100	100	100	100	93.3	93.3	98.9
Snow Depth (in)													
Average	0	0	0	0	0	0	0	0	0	0	0	0.10	-
% of days with valid records	100	100	100	100	100	100	100	100	100	100	90	96.8	98.9



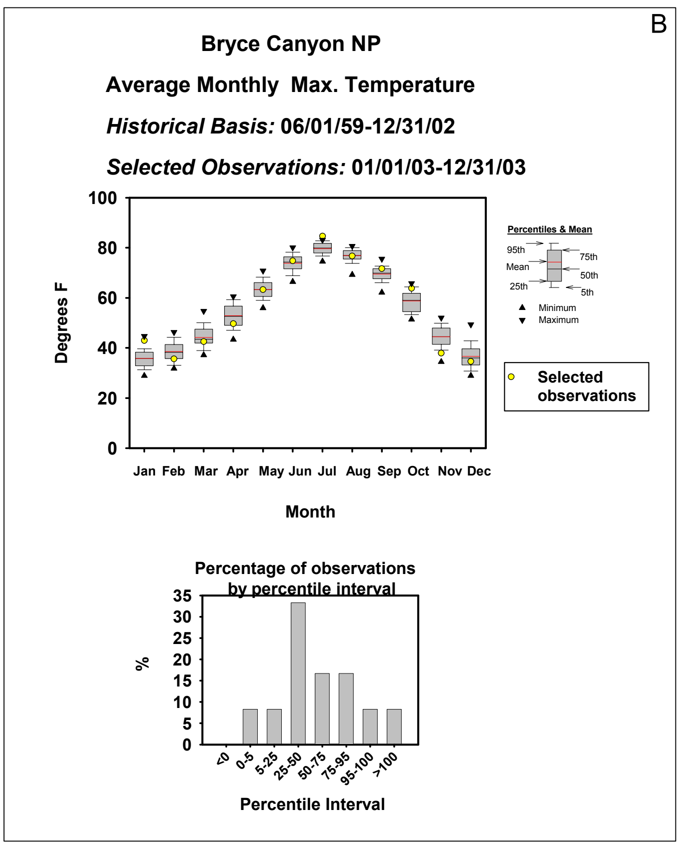


Figure 3. Example of a moving mean analysis of annual average maximum temperature (A), of an assessment of extremes in average monthly maximum temperature (B), and of an assessment of extremes in daily maximum temperature (C). See SOP #16 for details.

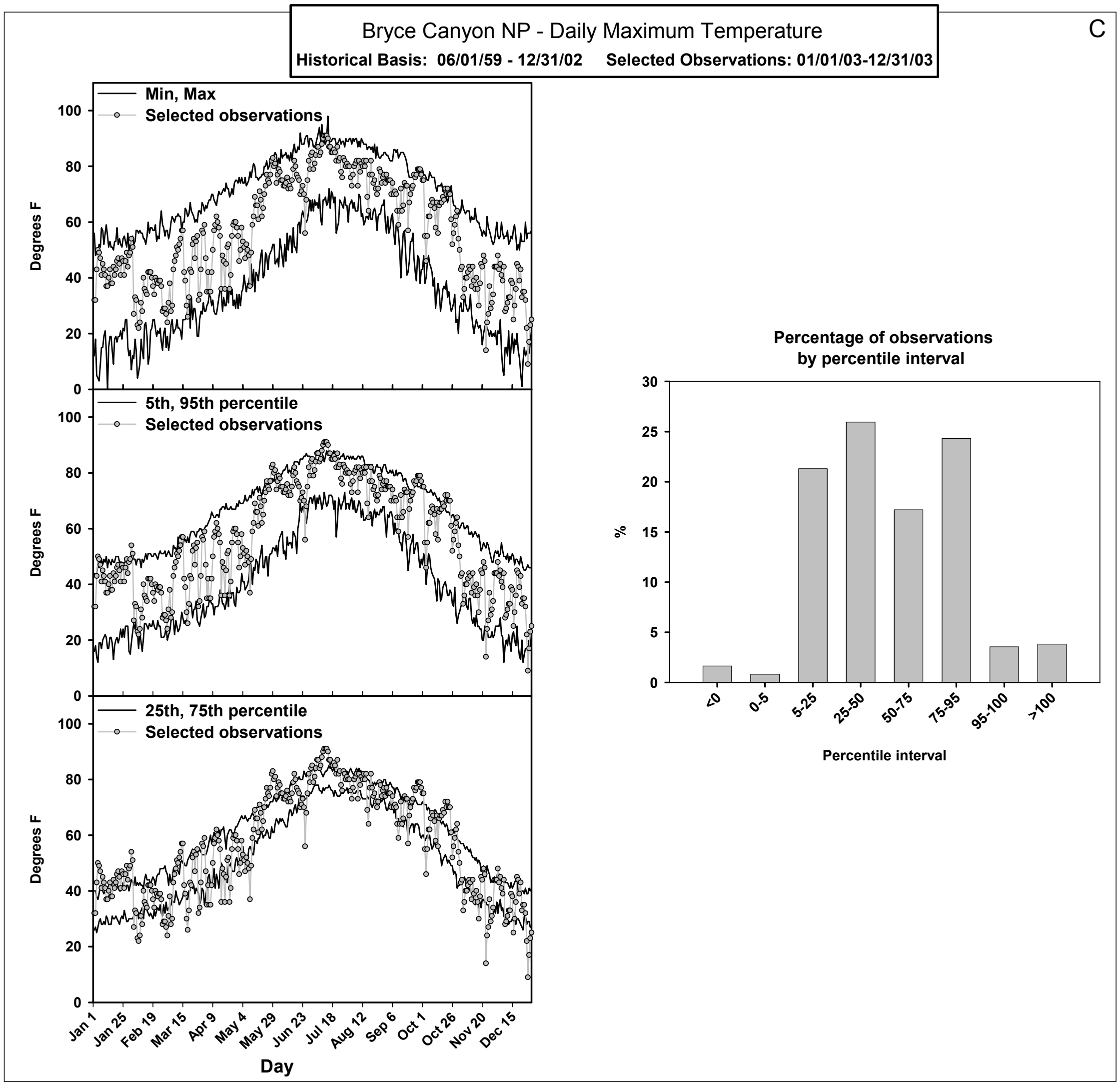
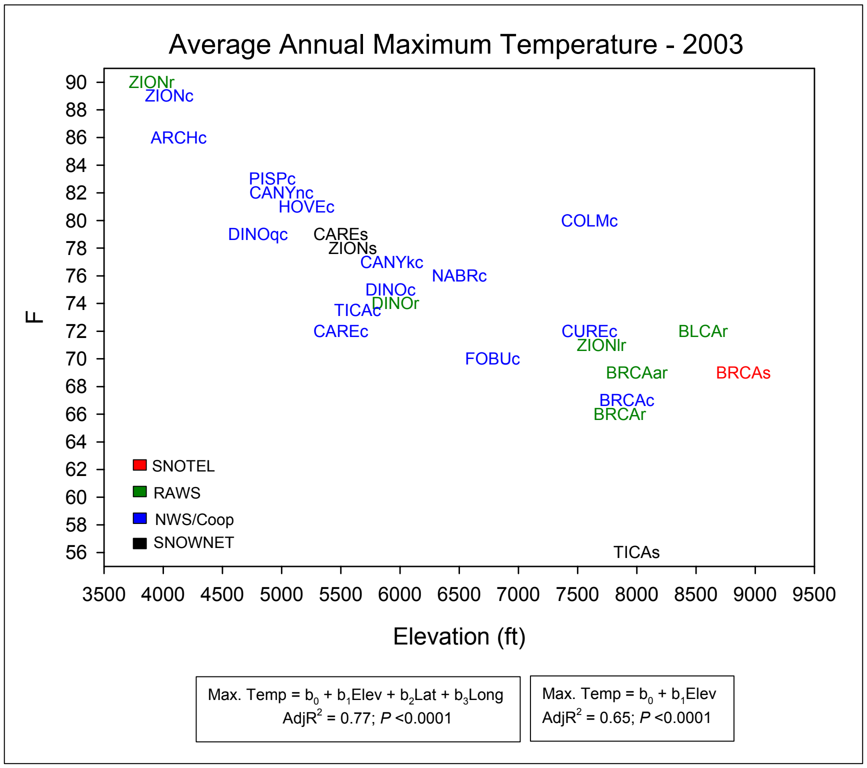


Figure 3. cont.



Climate Monitoring Program	Figure Code	Park/Station name	Climate Monitoring Program	Figure Code	Park/Station name
SNOTEL	BRCAs	BRCA /Agua Canyon	NWS/Coop	COLMc	COLM
RAWS	BLCAr	BLCA		CUREc	CURE
	BRCAar	BRCA /Agua Canyon		DINOqc	DINO/Quarry
	BRCAr	BRCA /Bryce Canyon		DINOc	DINO/National Monument
	DINOr	DINO		FOBUc	FOBU
	ZIONlr	ZION/Lava Pt.		HOVEc	HOVE
	ZIONr	ZION Headquarters		NABRc	NABR
NWS/Coop	ARCHc	ARCH		PISPc	PISP
	BLCAc	BLCA		TICAc	TICA
	BRCAc	BRCA		ZIONc	ZION
	CANYkc	CANY/ The Neck	SNOWNET	CAREs	CARE
	CANYnc	CANY/ The Needles		TICAs	TICA
	CAREc	CARE		ZIONs	ZION/East Gate

Figure 4. Comparison of average annual maximum temperature in 2003 among climate stations included in the NCPN climate databases.

Report Format

The annual climate report will contain information specific to a park, requiring a separate report for each park. Park-specific information will include the following for each climate station in a park unit:

- Brief description of the climate station(s), including the associated climate-monitoring program, location information, a general overview of the station sensors, the period of record, and any equipment or data problems and issues that occurred during the year
- Monthly summaries and the annual summary for the full suite of climatic parameters reported by a climate station
- Assessments of climatic extremes (annual, monthly, and daily trends for min. and max. temperature, total precipitation), including a brief narrative summarizing and interpreting the degree and magnitude of extremes

Additionally, each report will include the same network-wide comparisons of the key climatic parameters. The network comparison section will include:

- A table showing the types of stations in the network, including elevation and location information
- Graphical comparisons of key parameters along environmental gradients of the NCPN park units, and a narrative that summarizes and interprets network-wide patterns for each climatic variable
- Graphical comparisons, tables, and a narrative that summarizes and interprets network-wide patterns in climatic extremes for the key climatic variables

Regional Climate Assessment

Broad-scale representation of climatic parameters may be of value to various assessments. Data models depicting climatic conditions over time and over the broader NCPN region (e.g., area shown in Fig. 1) provide interpolated estimates of conditions for areas not otherwise sampled by the widely distributed climate stations. The depiction of regional climatic conditions may be of interest to park managers and could be included in annual reports. Additionally, these estimates may provide important insight into reasons for observed trends (both spatial and temporal) in other monitored vital signs. The Oregon State University Spatial Climate Analysis Service (OSU SCAS) provides climate data models for the U.S. free of charge (http://www.ocs.orst.edu/prism/). Data models are produced using the PRISM model (Daly et al. 1994), which uses data from regional NWS-Coop and RAWS stations and advanced algorithms to interpolate climatic conditions over the landscape at a 4-km spatial grain. The potential use of broad-scale climate interpolations in analyses and reporting is acknowledged, but procedures for acquiring and using these data are not developed. If use of these data models becomes frequent, associated procedures for acquisition, analysis, and reporting will be developed and included in this protocol.

VI. Personnel Requirements and Training

Roles and Responsibilities

Recording and reporting measures from climate stations is the role of either park staff or is automated (Table 3). Personnel responsible for equipment maintenance, inspection, and calibration of climate stations are discussed above in section III.

Data acquisition and storage on the NCPN server is the responsibility of the NCPN Data Manager. Summaries and assessments for annual reports largely will be designed by the NCPN Ecologist, but implemented by Data Management staff. The interpretation and reporting of summaries and assessments, however, will be the sole responsibility of the NCPN Ecologist.

Qualifications and Training

Climate Station Observations. The NWS Observing Handbook No. 2 (Cooperative Station Observations) (SOP #5) details procedures for recording and reporting NWS-Coop measurements. New observers are required to review this document and to be checked-out onsite by a NWS representative. Otherwise, there is no formal training. Typically, a park-staff member with experience in climate-station operations instructs new observers on procedures. Also, a brief narrative of the NWS instructions (SOPs #6-8) generally is made available to all observers to ensure consistency in recording and reporting among permanent and seasonal staff.

Instructions for the maintenance and calibration of RAWS stations are provided on the Interagency RAWS web page (SOP #1). Contacts for national and regional RAWS coordinators also are provided to aid in resolving questions or problems. Park staff assigned to support RAWS stations are provided with these resources and are instructed by experienced staff. Otherwise no formal training is required or provided.

All other automated stations do no require specialized qualifications or training for operation.

Instructions for Snow Course observations are provided by NRCS in Agriculture Handbook No. 169 (SOP #4). New observers are to familiarize themselves with these procedures. No further training is provided.

Data Acquisition and Archiving.

Instructions and procedures for downloading and archiving climate-station data are described in SOPs #10-15. Procedures are automated, and require no special skills or technical expertise. Staff responsible for acquisition and archiving will be required to peruse the SOPs prior to data acquisition; initial engagement in acquisition procedures will be supervised by the NCPN Data Manager.

VII. Operational Requirements

Annual Workload and Field Schedule

Climate Station Observations.

The NCPN will not be directly involved in reading, recording, and reporting the observations from a climate station. Park staff will be involved in recording daily observations of NWS-Coop stations. Inspection and calibration of RAWS stations by park staff is required prior to the fire season. The Timpanogos Cave NM Avalanche station is serviced twice a year by park staff.

Data Acquisition

. The acquisition and archiving of data for each climate station in the NCPN will be performed at least once a year by NCPN Data Management. This is required to satisfy analysis and reporting requirements. However, data can be accessed more frequently if necessary to support ongoing data analyses or in response to requests by NCPN collaborators and researchers.

Facility and Equipment Needs

Existing climate stations are supplied with sensors necessary to meet the goals and objectives of the administrating agency. These external agencies determine necessary sensor additions or enhancements. RAWS stations are an exception. There are basic sensors that must be included to participate in the Interagency RAWS program. But, additional sensors can be added to meet park needs. Based on discussions with fire-management staff, no new sensors are required on the existing six RAWS stations in the NCPN. However, a new RAWS station is being considered for Colorado National Monument. This station will be funded by various agencies; the potential for the NCPN to contribute will be determined.

Startup Costs and Budget Constraints

With the exception of RAWS stations, climate stations are funded by external agencies. Through various agreements, the National Park Service permits agencies to locate stations on park lands. For the NWS-Coop stations, parks ensure that measures are recorded daily and that NWS reporting requirements are met. Otherwise, there are no annual costs.

RAWS stations must meet national standards to participate in the Interagency RAWS program (National Wildfire Coordinating Group 2004). Given these standards, RAWS climate stations in FY05 dollars cost from $12-$15,000 dollars. Broken sensors can be replaced at no cost through an exchange program with the Interagency Fire Lab, Boise ID, if the damaged sensor is returned to the Lab within a certain time of receiving the replacement. The park is responsible for providing staff to perform the annual maintenance and calibration of RAWS stations, and for emergency service. Otherwise, there are no operating costs.

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

Revisions to the Protocol Narrative and SOPs will be inevitable over time. Explicit documentation of these changes is critical for proper acquisition, processing, interpretation, and analysis of climate data. Procedures for changing the protocol narrative and related SOPs are documented in SOP #17. The Protocol Narrative and all SOPs are labeled with version numbers, and included in a Revision History Log. Changes to either document type are to be accompanied by changes in version numbers; version numbers and dates, the changes, reasons for the changes, and the author of the changes are to be recorded in the Revision History Log. The updated version numbers must be recorded in the Climate Master Version Table (see SOP #17) and conveyed to the Data Manger for proper updating of the master version table database. Previous versions of the Protocol Narrative and SOPs must be archived in the NCPN Climate Protocol Library (X:\Archive\Monitoring_Archive\Climate\Protocol_Library\).

VIII. References

Chapin, F. S., III, M. S. Torn, and M. Tateno. 1996. Principles of ecosystem sustainability. The American Naturalist **148**:1016-1037.

Daly, C., R.P. Neilson, and D.L. Phillips. 1994. A Statistical-Topographic Model for Mapping Climatological Precipitation over Mountanious Terrain. J. Appl. Meteor. **33**: 140-158.

Ehlering, J. R., S. Schwinning, and R. Gebauer. 2000. Water use in arid land ecosystems. Pages. 347-365 *in* M. C. Press, J. D. Scholes, and M. G. Barker, eds. Physiological Plant Ecology. Proceedings of the 39th Symposium of the British Ecological Society, 7-9 September 1998, University of York. Blackwell Science, Boston.

Evenden, A., M. Miller, M. Beer, E. Nance, S. Daw, A. Wight, M. Estenson, and L. Cudlip. 2002. Northern Colorado Plateau Vital Signs Network and Prototype Cluster, Plan for Natural Resources Monitoring: Phase I Report, October 1, 2002, Vol I. National Park Service, Northern Colorado Plateau Network, Moab, UT. 138p.

Gilhousen, D. B. 1987. A field evaluation of NDBC moored buoy winds. Journal of Atmospheric and Oceanic Technology **4**:94-104.

Houghton, J. T., L. G. Meira Filho, B. A. Callander, N. Harris, A. Kattenberg, and K. Maskell. 1996. Climate Change 1995: The Science of Climate Change. Contribution of WG1 to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge (UK): Cambridge University Press.

Houghton, R. A., and G. M. Woodwell. 1989. Global climate change. Scientific American **260**:36-44.

Lauenroth, W. K., and O. E. Sala. 1992. Long-term forage production of North American shortgrass steppe. Ecological Applications **2**:397-403.

Miller, M. E., and L. P. Thomas. 2004. The Structure and Functioning of Dryland Ecosystems – Conceptual Models to Inform the Vital-Sign Selection Process. USGS white paper – see Appendix H of the NCPN Monitoring Plan.

Mitchell, V. L. 1976. The regionalization of climate in the western United States. Journal of Applied Meteorology **15**:920-927.

National Wildfire Coordinating Group. 2004. NWCG, National Fire Danger Rating System Weather Station Standards. USDA, USDI, and National Association of State Foresters, PMS 426-3. (www.fs.fed.us/raws/standards/NFDRS.rev0402.pdf). Access 10 December 2004.

Neilson, R. P. 1987. Biotic regionalization and climatic controls in western North America. Vegetatio **70**:135-147.

Oesterheld, M., J. Loreti, and O. E. Sala. 2001. Inter-annual variation in primary production of a semi-arid grassland related to previous-year production. Journal of Vegetation Science **12**:137-142.

Peterson, K. L. 1994. Modern and Pleistocene climatic patterns in the West. Page. 27-53 *in* K. T. Harper, L. L. St. Clair, K. H. Thorne, and W. M. Hess, eds. Natural history of the Colorado Plateau and Great Basin. University Press of Colorado, Niwot, CO.

Saleska, S., J. Harte, and M. Torn. 1999. The effect of experimental ecosystem warming on CO_2 fluxes in a montane meadow. Global Change Biology **5**:125-141.

Shaver, G. R., J. Canadell, F. S. Chapin III, J. Gurevitch, J. Harte, G. Henry, P. Ineson, S. Jonasson, J. Melillo, L. Pitelka, and L. Rustad. 2000. Global warming and terrestrial ecosystems: a conceptual framework for analysis. BioScience **50**:871-882.

Swetnam, R. W., and C. H. Baisan. 1994. Historical fire regime patterns in the Southwestern United States since AD 1700. Pages 11-32 *in* C. D. Allen (Tech. ed.). Fire Effects in Southwestern Forests, USDA Forest Service, Rocky Mountain Forest and Range Exp. Stn., Gen. Tech. Report, RM-GTR-286. 216pp.

West, N. E. 1988. Intermountain deserts, shrub steppes, and woodlands. Pages 210-230 *in* M. G. Barbour and W. D. Billings (eds). North American Terrestrial Vegetation. Cambridge University Press, New York. 434 pp.

Whitford, W. G. 2002. Ecology of desert systems. Academic Press, New York. 343 pp.

Wiegand, T., H. A. Snyman, K. Kellner, and J. M. Paruelo. 2004. Do grasslands have a memory: Modeling phytomass production of a semiarid South African grassland. Ecosystems **7**: 243-258.

Williams, D. G., and J. R. Ehleringer. 2000. Intra- and interspecific variation for summer precipitation in pinyon-juniper woodlands. Ecological Monographs **70**:517-537.

Appendix A-1. Attributes of the 17 National Weather Service (NWS) Coop stations located in NCPN park units.

					24-hr measures – Observation time and Instrumentation					
Park/ Coop Stn ID/ Coop Stn. no.	**Location: UTM Northing Easting**	**Elevation ft (m)**	**Climate network[1]**	**Period of record**	**Observation time**	**Min., max., air temp[2]**	**Precip.[3]**	**Snow fall[4]**	**Snow depth[4]**	**Other instrumentation[5]**
ARCH/ ANPU1/ 420336	4275204 620212	4130 (1259)	A, B, C	6/1/80 – present	0800	MXMN	SRG	Snow stick	3' snow stake	Belfort Gauge (15-min precip.) Evaporation Station (24-hr evaporation)
BLCA/ BKCC2/ 50754	4270811 265847	8150 (2484)	A, C	10/9/03 - present	0800	MXMN	SRG	Snow stick	5' snow stake	
BRCA/ BRYU1/ 421008	4166638 396948	7915 (2412)	A, B	6/1/59 - present	0900	MMTS	SRG	Snow stick	Snow Stick	Belfort Gauge (15-min precip)
CANY – Neck/ CNYU1/ 421163	4256408 603257	5930 (1807)	A	6/17/65 - present	0800	MMTS	SRG	Snow stick	3' snow stake	
CANY-Needles/ CNDU1/ 421168	4223196 609524	4998 (1523)	A, B	6/18/65 - present	0800	MMTS	SRG	Snow stick	3' snow stake	
CARE/ TEAU1/ 421171	4237285 476677	5500 (1676)	A, B, C	3/1/67 - present	0800	MMTS	SRG	Snow stick	Snow stick	
COLM/ CNMC2/ 51772	4330319 696008	7600 (2316)	A	8/1/48 - present	0800	MXMN	SRG	Snow stick	3' snow stake	
CURE/ BMKC2/ 50797	4259937 311146	7600 (2316)	A, B	11/1/67 - present	0800	MMTS	SRG	Snow stick	3' snow stake	

Appendix A-1. Cont'd.

					24-hr measures – Observation time and Instrumentation					
Park/ Coop Stn ID/ Coop Stn. no.	**Location: UTM Northing Easting**	**Elevation ft (m)**	**Climate network[1]**	**Period of record**	**Observation time**	**Min., max., air temp[2]**	**Precip.[3]**	**Snow fall[4]**	**Snow depth[4]**	**Other instrumentation[5]**
DINO-Quarry/ DINU1/ 422173	4477485 643976	4800 (1463)	B	4/1/58 - present	1600	MXMN	SRG	Snow stick	Snow stick	
DINO NM/DINC2/ 52286	4456830 672502	5920 (1804)	A, B	6/1/65 - present	1630	MMTS	SRG	Snow stick	Snow stick	
FOBU/ FBMW4/ 483582	4631297 519374	6780 (2066)	B	8/1/90 - present	1600	MMTS	SRG	Snow stick	Snow stick	Belfort Gauge (15-min precip)
HOVE/ HOVU1/ 424100	4139559 669972	5210 (1588)	A, B	4/2/57 - present	0800	MMTS	SRG	Snow stick	Snow stick	
NABR/ NBMU1/ 426053	4163770 589724	6500 (1981)	A	6/17/65 - present	0800	MMTS	SRG	Snow stick	3' snow stake	
PISP/ PIPA3/ 26616	4080598 345012	4920 (1500)	A, C	6/1/63 - present	1700	MMTS	SRG	Snow stick	Snow stick	
TICA/ AMRU1/ 428733	4477940 440642	5640 (1719)	B	7/1/48 - present	1700	MMTS	ET	Snow stick	Snow stake	
ZION/ ZNPU1/ 429717	4119827 323929	4050 (1234)	A, B, C	7/1/48- present	1700	MXMN	SRG	Snow stick	Snow stick	Belfort Gauge (15-min precip.)
ZION East Gate[6]/ ZPEU1/ 429720	4123976 333923	5600 (1707)	B, C	7/30/98 - present	-	-	-	-	-	TEMPX (temp.) PCPNX (precip.) WINDX (wind speed and direction)

Notes for Appendix A-1.

Footnote	Explanation
[1] **Climate network**	Stations are included in one or more network depending on the NWS programs supported by the observed data (climatology, meteorology, or hydrology). A – Data support climate description of the United States. At a minimum, these stations observe and report daily 24-hr precipitation totals, and most stations report 24-hr maximum and minimum temperatures. B – Data support NWS hydrological programs, such as the forecast and warning program and the water resource forecast service program. Stations report 24-hr precipitation, maximum and minimum temperatures, and some report evaporation. C – Data support meteorological forecast and warning, and public service programs of the NWS. Stations are used primarily for local public service purposes, research and special purposes, or have a period of record of 50+ yrs with the prospect for continuation with little change in the surrounding environment. Stations report maximum and minimum temperature, and 24-hr precipitation.
[2] **Min., max. air temperature**	The **MXMN** (maximum and minimum thermometers) system consists of two liquid-in-glass thermometers located within an instrument shelter. The minimum thermometer is filled with alcohol. The maximum thermometer contains mercury. Thermometers are mounded horizontally within the instrument shelter. Temperatures are manually observed and recorded, and thermometers are reset daily. The instrument shelter is a white, ventilated wooden box mounted on four wooden legs with the bottom of the box located ca. 4 feet above the ground.
	The **MMTS** (maximum-minimum temperature system) system is an electronic thermistor that records the maximum and minimum temperature since initializing internal memory, and current temperature. MMTS systems are read from a digital display on a control panel which is typically located inside the visitor center. The 24-hr maximum and minimum temperature, and the temperature at time of observation are accessed using a toggle switch on the display. A reset button on the control panel initializes the MMTS memory. RMS Tech. Inc. (Newport News, VA) has been the primary manufacture for NWS-Coop MMTS systems used in the NCPN.
[3] **Precip.**	The **SRG** (Standard Rain Gauge) deployed in NCPN park units is an 8” (funnel-top diameter) metal non-recording gauge that consists of a large diameter outer can with a smaller diameter measuring tube insert, and a funnel that directs precipitation into the measuring tube. A SRG is supported by 3, 3’ metal legs. Precipitation is observed by manually measuring precipitation accumulation with a graduated, metal measuring stick.
	ET is an electronic rain gauge (tipping bucket – Campbell Scientific). Measures are recorded to a data logger every 15 minutes.

Notes for Appendix A-1. Cont'd.

Footnote	Explanation
[4] **Snow fall and depth**	A **snow stick** is either a wooden or metal yard stick, and is used to measure snow fall and snow depth. A **snow stake** is a graduated wooden stake permanently located on flat ground, and is used to measure snow depth.
[5] **Other instrumentation**	The **Belfort Gauge** (Fischer & Porter) records precipitation on a moving paper scroll every 15 minutes. The gauge has an 8" funnel (top diameter) that directs precipitation into an internal collection bucket. An internal weighing device automatically measures precipitation levels which are recorded onto the paper tape in 0.10" increments. An internal electronic timer advances the paper scroll. The paper tape is replaced at the first of each month.
	The **Evaporation Station** provides measures of evaporation over a 24-hr period. The station consists of a metal evaporation pan (10" deep, 47.5" inside diameter), a fixed-point gauge (a pointed rod) inserted inside a metal stilling well (2.5 – 3.5 "outside" diameter, 10" long), a 3-cup 5-digit counter anemometer, and a Six's min-max thermometer. The stilling well and Six's thermometer are located inside the water-filled evaporation pan. Evaporation is measured every 24-hr period by determining the volume of water required to bring the water level in the stilling well exactly to the tip of the pointed rod. The anemometer is located adjacent to the evaporation pan, with the wind cups located just above the surface of the pan. The digital display of the anemometer records wind movement in miles.
	TEMPX, PCPN, WINDX, and **MST** at the ZION East Gate station are electronic sensors (Campbell Scientific Inc.) that record observations every 15 minutes to a data logger (model CR10X). • TEMPX (min, max, current temperature) – model CS500 Temperature probe • PCPNX – model TE525 Tipping Bucket Rain Gauge • WINDX (wind speed, peak speed, current direction) – R. M. Young Wind Monitor
[6] **ZION East Gate**	This is the only automated climate station in the NCPN that is officially in the NWS Coop program. Data from this station are transmitted to NWS hourly, but are most accessible through The Utah State Climatology Center (MesoWest - see text).

Appendix A-2. NWS-Coop instrumentation standards
(http://www.nws.noaa.gov/directives/010/pd01013002b.pdf).

Parameter	**Accuracy**	**Range**	**Resolution**
Air temperature (^{o}F)	$\pm$ 2.0^{o}F from -62 to -50^{o}F $\pm$ 1.0^{o}F from -50 to +122^{o}F $\pm$ 2.0^{o}F from +122 to +132^{o} F	-62 to +132^{o}F	0.1^{o}F
Liquid precipitation (in)	$\pm$ 0.02 in or 4% of hourly amount (whichever is greater)	$\leq$10 in/hr	0.01 in
Freezing precipitation (in)	Detection occurs whenever 0.01 inch accumulates	0-40 in	0.01 in
Frozen precipitation (water equivalent - in)	$\pm$ 0.04 inches or 1% of total accumulation	0-40 in	0.01 in
Snow depth (in)	$\pm$ 0.05 in for depths 0-5 in $\pm$1.0 in for depths >5-99 in	0-99 in	1 in
Wind speed (knots)	$\pm$ 1 knot up to 10 knots $\pm$10% above 10 knots	2-90 knots	1 knot
Wind direction (degrees)	$\pm$ 5.0 degrees when wind speed is $\geq$ 5 knots	1-360 degrees	10 degrees

Appendix B. Reporting requirements for the 17 National Weather Service (NWS) Coop stations located in NCPN park units.

	Daily[1]		Monthly[2]	
Park	**NWS recipient[3]**	**Reporting method[4]**	**NWS recipient[3]**	**Reporting method[5]**
ARCH	GJT	WXCODER	GJT, NCDC	B92, B18
BLCA	GJT	WXCODER	GJT, NCDC	B91
BRCA	N/A	N/A	SLC, NCDC	B91, B18
CANY- Neck	GJT	WXCODER	GJT, NCDC	B91
CANY- Needles	GJT	ROSA	GJT, NCDC	B91
CARE	SLC	Phone	SLC, NCDC	B91
COLM	N/A	N/A	GJT, NCDC	B91
CURE	GJT	WXCODER	GJT, NCDC	B91
DINO - Quarry	GJT	WXCODER	GJT, NCDC	B91
DINO - NM	GJT	WXCODER	GJT, NCDC	B91, B18
FOBU	RIW	WXCODER	RIW, NCDC	B91
HOVE	GJT	WXCODER	GJT, NCDC	B91
NABR	GJT	WXCODER	GJT, NCDC	B91
PISP	VEF	ROSA	VEF, NCDC	B91
TICA	N/A	N/A	SLC, NCDC	B91
ZION HQ	SLC	Phone	VEF, NCDC	B91, B18
ZION – East Gate	SLC (every 15 minutes)	Telephone (Campbell Scientific Inc. DC 112 Phone Modem)	N/A	N/A

Notes for Appendix B.

Footnote	Explanation
[1] **Daily**	Daily measures include 24-hr minimum and maximum temperature, temperature at the time of observation, 24-hr precipitation including 24-hr snow fall, and accumulated snow depth.
[2] **Monthly**	Monthly tallies of daily measures, plus daily precipitation duration and general weather conditions (B91, B92 forms). Daily evaporation observations (B92) and hourly precipitation records (B18) are reported only on a monthly basis.
[3] **NWS Recipient**	GJT – National Weather Service, 792 Eagle Drive, Grand Junction, CO 81506-8646 NCDC (National Climate Data Center) – Federal Building, 151 Patton Avenue, Asheville NC 28801-5001 RIW – National Weather Service, 12744 West U.S. Highway 26, Riverton, WY 82501 SLC – National Weather Service, 2242 West North Temple, Salt Lake City, UT 84116 VEF - National Weather Service, 7851 Industrial Rd., Las Vegas, NV 89139-6628
[4] **Reporting Method (Daily)**	WXCODER – National Weather Service Web Xmitted Cooperative Observer Data Encoded Report (http://www.crh.noaa.gov/wxcoder/login.php). A park-specific Username and UserID are required to connect to the web-based WXCODER system. Phone – Commercial telephone is used to report daily measures to a recording device located at a regional office of the National Weather Service. ROSA (Remote Observation System Automation) – see SOP #9.
[5] **Reporting Method (Monthly)**	B91 is the monthly report form used by observer-based stations lacking evaporation pans; B92 is the monthly report form for stations with evaporation pans. Forms are mailed (or uploaded in WXCODER) by the 3rd of the following month to the agency listed first under Monthly/NWS recipient. Punch tapes (B18) are mailed by the 15th of the following month. NCDC eventually receives all monthly reports, transcribes the data from paper copies to electronic data bases (where necessary), archives the data, and distributes error-checked daily values to cooperating agencies (e.g., regional climate centers).

Appendix C-1. Attributes of the six RAWS climate stations located in NCPN park units.

				Instrumentation & Vaisala (Handar) model no.							
Park/Stn name/ NESDIS ID[1]	**Location: UTM Northing Easting**	**Elevation ft (m)**	**Period of record**	**Data collection platform, data logger, transmitter**	**Air temperature**	**Rel. humidity**	**Precip.**	**Wind speed & direction**	**Solar radiation**	**Fuel moisture**	**Fuel temperature**
BLCA/ Black Canyon/ 325A5076	4269462 265823	8560 (2609)	6/97 - present	Vaisala 540, FTS-12S data logger, G3/G4 GOES transmitter	Humidity & Temp. Probe - 435A	Humidity & Temp. Probe - 435A	Tipping Bucket Rain gauge – 444A	Wind Speed Sensor - 430A; Wind Direction Sensor - 431A	Solar Radiation Sensor – 441A	-	Fuel Temp. Sensor – 433E
BRCA/ Agua Canyon/ FA44220E	4153565 387677	8000 (2438)	6/90 - present	Vaisala 555B, FTS-12S data logger, G3/G4 GOES transmitter	Humidity & Temp. Probe - 435A	Humidity & Temp. Probe - 435A	Tipping Bucket Rain gauge - 444A	Wind Speed Sensor - 430A; Wind Direction Sensor - 431A	Solar Radiation Sensor – 441A	Fuel Moisture Sensor – 439C	Fuel Moisture Sensor – 439C
BRCA/ Bryce Canyon/ FA63C226	4166704 396581	7855 (2394)	1/03 – present	Vaisala 555B, FTS-12S data logger, G3/G4 GOES transmitter	Humidity & Temp. Probe - 435E	Humidity & Temp. Probe - 435E	Tipping Bucket Rain gauge - 444A	Ultrasonic Wind Sensor – 425A	Solar Radiation Sensor – 441A	Fuel Moisture Sensor – 439C	Fuel Moisture Sensor – 439C
DINO/ Dinosaur NM Success/ FA45B596	4486307 677030	5960 (1816)	7/98 – present	Vaisala 540, FTS-12S data logger, G3/G4 GOES transmitter	Humidity & Temp. Probe - 435A	Humidity & Temp. Probe - 435A	Tipping Bucket Rain gauge – 444A	Wind Speed Sensor - 430A; Wind Direction Sensor - 431A	-	Fuel Moisture Sensor – 439C	Fuel Moisture Sensor – 439C

Appendix C-1. Attributes of the six RAWS climate stations located in NCPN park units.

				Instrumentation & Vaisala (Handar) model no.							
Park/Stn name/ NESDIS ID[1]	**Location: UTM Northing Easting**	**Elevation ft (m)**	**Period of record**	**Data collection platform, data logger, transmitter**	**Air temperature**	**Rel. humidity**	**Precip.**	**Wind speed & direction**	**Solar radiation**	**Fuel moisture**	**Fuel temperature**
ZION/ Lava Pt/ FA61745C	4140273 319512	7700 (2347)	7/95 – present	Vaisala 555B, FTS-12S data logger, G3/G4 GOES transmitter	Humidity & Temp. Probe - 435A	Humidity & Temp. Probe - 435A	Tipping Bucket Rain gauge - 444A	Wind Speed Sensor - 430A; Wind Direction Sensor - 431A	Solar Radiation Sensor – 441A	Fuel Moisture Sensor – 439C	Fuel Moisture Sensor – 439C
ZION/ ZION HQ or ZION Canyon/ FA63B4B6	4119415 324488	3901 (1189)	11/02 – present	Vaisala 555B, FTS-12S data logger, G3/G4 GOES transmitter	Humidity & Temp. Probe - 435E	Humidity & Temp. Probe - 435E	Tipping Bucket Rain gauge - 444A	Ultrasonic Wind Sensor – 425A	Solar Radiation Sensor – 441A	Fuel Moisture Sensor – 439C	Fuel Moisture Sensor – 439C

[1] NESDIS is the National Environmental Satellite, Data, and Information Service identification number associated with each RAWS station that transmits data to the National Interagency Fire Center (NIFC) through the Geostationary Operational Environmental Satellite (GOES). The NESDIS ID is also referred to as the GOES ID on the National Weather Service National RAWS Data Server (http://raws.boi.noaa.gov/rawsobs.html).

Appendix C-2. RAWS instrumentation standards (National Wildfire Coordinating Group, 2004).

Parameter	Accuracy	Range	Resolution
Air temperature (°F)	± 0.1°F	-58 to +140°F	not specified
Relative humidity (%)	± 2.0% from 0-80% at 20°C ± 5.0% from 80-100% at 20°C	0-100 %	not specified
Precipitation (in)	not specified	0-99.9 in	0.01 in
Wind speed (mph)	not specified	0-150 mph	0.25 mph
Wind direction (degrees)	± 2.0 degrees	0-359 degrees	1 degree
Solar radiation (W/m^2)	± 5.0%	not specified	not specified
Fuel temperature (°F)	not specified	-58 to +122° F	0.1° F
Fuel Moisture (%)	10%	0-25 grams (water mass addition to 100-g dowel)	not specified

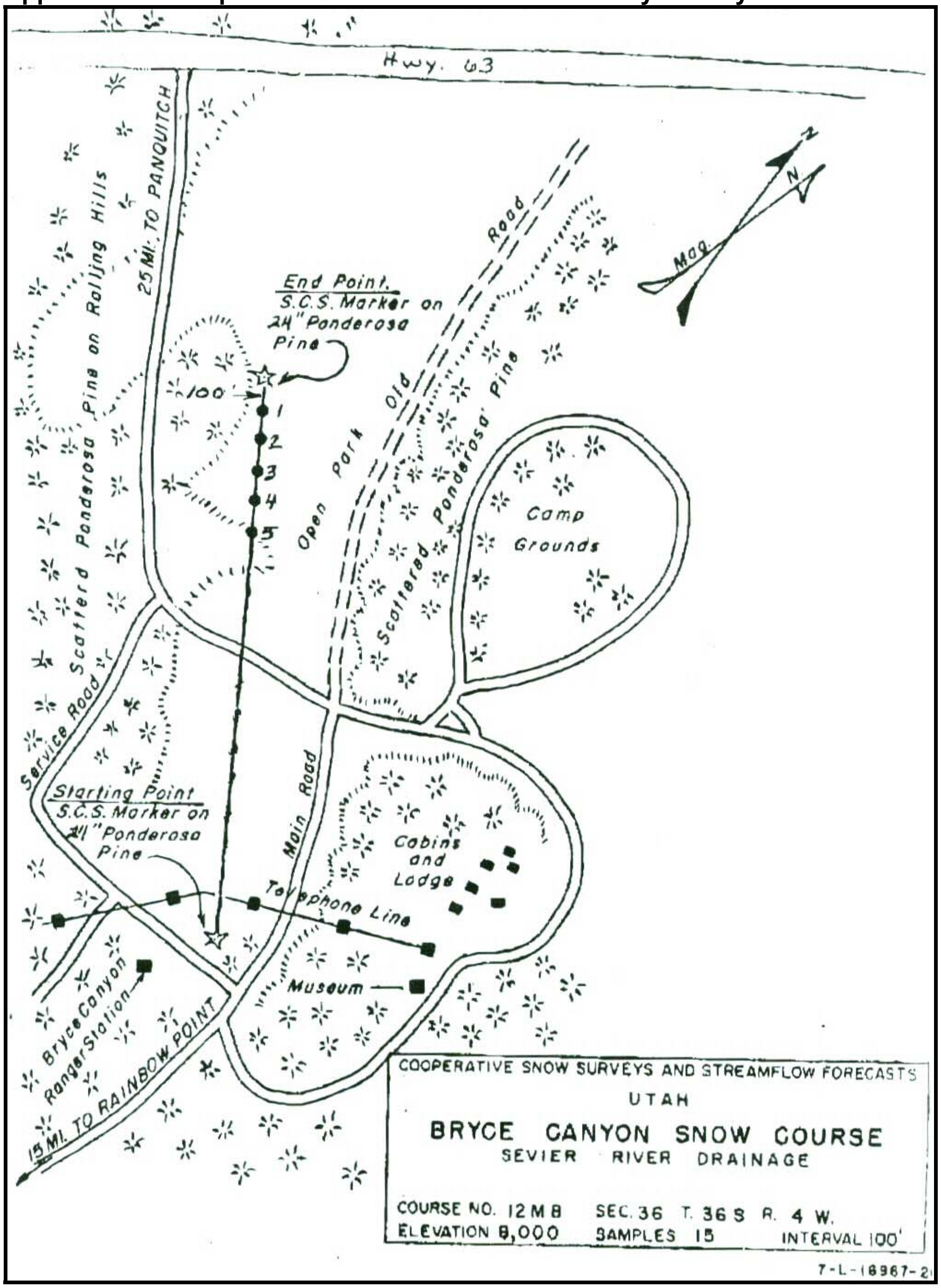
Appendix D-1. Attributes of the SNOTEL climate station and the Snow Course site located in Bryce Canyon National Park.

					Instrumentation					
Park/ Site name/ Site ID	**Location: UTM Northing Easting**	**Elevation ft (m)**	**Climate network**	**Period of record**	**Data transmission**	**Min., max., air temp.**	**Precip.**	**Wind speed & direction**	**Snow fall**	**Snow depth**
BRCA/ Agua Canyon/ 12m26S	4152946 387992	8900 (2712)	SNOTEL - Natural Resources Conservation Service (NRCS)	10/7/94-present	Meteorburst System	Shielded thermistor	All season storage gauge	-	Snow pillow device and a pressure transducer	Sonic sensor
BRCA/ Bryce Canyon/ 12m08	4166517 396775	8000 (2438)	Snow Course (NRCS)	1/1/35 – present	-	-	Manual determination of snow-water equivalent	-	-	Manual determination of snow depth with snow stick

Appendix D-2. Snow Course measurement standards (also see SOP #4).

Parameter	Resolution
Snow depth (in)	0.5 in
Snow water equivalent (in)	0.5 inches (derived from snow-tube scale that measures inches of water). Deviation among re-measurements required to be < 3%.

Appendix D-3. Map of the Snow Course transect in Bryce Canyon National Park.



Appendix E. Attributes of SNOWNET climate stations located in NCPN park units.

					Instrumentation					
Park/ Site name/ Site ID	**Location: UTM Northing Easting**	**Elevation ft (m)**	**Climate network**	**Period of record**	**Data collection platform, data logger**	**Min., max., air temp.**	**Precip.**	**Wind speed & direction**	**Snow fall**	**Snow depth**
CARE/ Capital Reef NP/ CRN	4238083 477085	5500 (1676)	SNOWNET	12/15/97 – present	Campbell Scientific Inc., CR10X data logger	Model CS500 Temp. probe	ETI Tipping Bucket Rain Gauge	R. M. Young Wind Monitor	Measured as snow-water equivalent	-
TICA/ Timpanogos Cave/TPC	4476899 440086	7999 (2438)	USDA Forest Service - Avalanche	12/28/97 - present	Campbell Scientific Inc., CR10X data logger	HMP45C temperature and rel. humidity probe	TE525I Tipping Bucket Rain Gauge	R.M. Young wind monitor	Measured as snow-water equivalent	Judd Communication snow-depth gauge
ZION/ Zion NP/ ZNP East gate	4123976 333923	5600 (1707)	SNOWNET; National Weather Service-COOP	11/2/97 – present	Campbell Scientific Inc., CR10X data logger	Model CS500 Temp. probe	TE525 Tipping Bucket Rain Gauge	R. M. Young Wind Monitor	Measured as snow-water equivalent	-

Appendix F-1. Attributes of the two CRN climate stations located in NCPN park units.

				Instrumentation						
Park	**Location: UTM Northing Easting**	**Elevation ft (m)**	**Period of record**	**Data collection platform, data logger, transmitter**	**Air temperature**	**Ground temperature**	**Rel. humidity**	**Precip.**	**Wind speed**	**Solar radiation**
BLCA	4269509 265237	8398 (2559)	7/04 - present	Climatronics Corp. Tower C-33HD with B-18 base; Campbell Scientific Inc. Data Logger CR23X; GOES transmitter	Thermometrics Corp. Platinum Resistance Thermometer with a Met One 7308 aspirated solar shield	Apogee Instruments IRTS-P infrared temp. sensor	To be added after 2004 testing	Geonor T-200B precip. gauge (collection bucket with 3 vibrating wires)	Met One Model 014A anemometer	Kipp & Zonen SP Lite Pyranometer
DINO	4456876 672864	6063 (1848)	9/04 - present	Climatronics Corp. Tower C-33HD with B-18 base; Campbell Scientific Inc. Data Logger CR23X; GOES transmitter	Thermometrics Corp. Platinum Resistance Thermometer with a Met One 7308 aspirated solar shield	Apogee Instruments IRTS-P infrared temp. sensor	To be added after 2004 testing	Geonor T-200B precip. gauge (collection bucket with 3 vibrating wires)	Met One Model 014A anemometer	Kipp & Zonen SP Lite Pyranometer

Appendix F-2. CRN instrumentation standards (htpp://www.ncdc.noaa.gov/crn/instrdoc).

Parameter	**Accuracy**	**Range**	**Resolution**
Air temperature (^{o}F)	$\pm$ 0.04%	-60 to +300^{o} F	0.01^{o} C
Ground temperature (^{o}C)	$\pm$ 0.2^{o} C from 15-35 ^{o} C $\pm$ 0.3^{o} C from 5-45^{o} C	0-50^{o} C	0.1^{o} C
Precipitation (mm)	0.25 mm	0-12 liters	0.25 mm
Wind speed (m/sec)	$\pm$1.5%	0-60 m/sec	0.5 m/sec
Solar radiation (W/m^2)	$\pm$ 0.15% per ^{o}C	0-1000 W/m^2	100 microVolts per W/m^2

Appendix-G. Attributes and standards of the two CLIM-MET climate stations located in Canyonlands National Park.

Station Name	Location: UTM Northing, Easting	Elevation (ft/m)
Needles Housing Area CLIM-MET #3	4224489, 608979	4910 / 1497
Virginia Park CLIM-MET #2	4216970, 601707	5630 / 1716

	Instrumentation										
	Storage Module; Data logger	**Air temperature**	**Rel. humidity**	**Precipitation**	**Solar Radiation**	**Wind speed & direction**	**Soil temperature**	**Soil moisture**	**Erosion**	**Dust collector**	**Dust sampler**
Description	Campbell Scientific Inc. SM716; Campbell CR10X	Campbell HMP35C	Campbell HMP35C	Campbell TE525 Tipping bucket	Licor LI200X	Campbell model 5103	Campbell model 107	Campbell CS615 Water Content Reflectometer	Sensit model H7	Airfoil ("frisbee") dust collector	BSNE field-dust sampler
Range	-	-35 °C to +50oC	0 – 100%	Infinite in increments of 0.1mm	Sensitivity = 0.2 $kWm^{-2}mV^{-1}$; measures solar radiation in light spectrum bands from 400-1100 nm	Speed - 0 – 60 m/sec Direction – 0 -360 deg.	-35 °C to +50°C	not specified	A pulse that equals one particle impact A pulse that represents a fixed amount of kinetic energy	not specified	not specified
Accuracy or efficiency	-	± 0.4°C from -24° to +48°C; ±0.9°C from -38° to +53°C	±2% from 0-90%; ±3% from 90-100%	1% at ≤50.8mm/hr	±3-5% in natural daylight	Speed - ± 0.9m/sec Direction - ± 3%	± 0.4°C from -24° to +48°C; ±0.9°C from -38° to +53°C	±2% when calibrated to the soil	not specified	not specified	Most efficient with particle sizes > 60u

Appendix H. Accessing ASCADS

ASCADS

Automated Sorting, Conversion and Distribution System

PLEASE NOTE: Connecting to ASCADS requires a **three-step** process. Failure to follow all of the steps in the order given will delay your ability to successfully connect to ASCADS.

STEP 1:

In order to access ASCADS, you must first obtain a logon ID and password.

- Access Profile Request </LI< ul>
- Users must also read and understand these access guidelines.

  PLEASE NOTE: You will not be contacted about your logon information. Once you have set your computer up to access ASCADS, you must call the BLM's Remote Sensing Fire Weather Support Unit (RSFWSU) to obtain your logon information. Do not call RSFWSU until you have your computer set up properly (STEP 2).

STEP 2:

Contact Kolleen Shelley kshelley@fs.fed.us or Linnea Keating lkeating@fs.fed.us to obtain the instructions on setting up your computer to access ASCADS.

Please include the following information in your request:

Name
Email Address
Telephone Number
Reason for Requesting ASCADS Access

Incomplete requests will not be honored.

STEP 3:

Upon completion of steps 1 and 2, contact the BLM's RSFWSU at 208-387-5475 to obtain logon and password information and final verification for successful connection to ASCADS.

Appendix I. RAWS field checklist

RAWS Field Checklist

On-site General Inspection:

Thoroughly inspect the station visually, physically, and – as well as possible – electronically.

1. Inspect all guy wires and footings.
2. Use torpedo levels on towers to check for plumb.
3. Check that cables are neatly tied down and secured.
4. Check for vandalism or animal damage.
5. Verify and record all serial numbers of the sensors, antenna, solar panel, and DCP on the Site Documentation Record.
6. Check antenna and cable for physical serviceability.
    - Are any of the elements (prongs) bent or missing? Is the antenna properly aligned for the GOES satellite? Check with compass and inclinometer.
7. Verify and record the firmware version in the DCP. This will be helpful if you encounter problems with the DCP. This information will assist the BLM RSSU folks with troubleshooting efforts.

Tipping Bucket

- Disassemble, inspect, and clean the entire tipping bucket.
- Level and tighten tipping bucket platform as needed.
- If installing a new bucket, be sure to remove the rubber band securing the tipping mechanism. RE-INSTALL THE RUBBER BAND ON THE OLD BUCKET TO PREVENT DAMAGE DURING RETURN SHIPPING. Reassemble.
- Verify and record the accumulated precipitation. This is necessary if you intend to continue with an ongoing count. You'll re-enter this later in the programming process.
    - IT IS IMPORTANT TO COORDINATE TO ASSURE THAT THE WIMS STATION CATALOG INFORMATION REFLECTS PRECIP NUMBERS (reset to zero or continuing with ongoing count).

Wind Speed

- Wind speed cups tight and properly aligned.
- Easily and freely spins at a fast walk.

- Verify and record W/S sensor ice skirt size (either 1&190;" or 2"). You'll need this for the programming process. Doing it now will be especially useful if you need to return to the site at some later date. You'll not need to re-climb or lower the tower to check the skirts.

Wind Direction

- Wind direction vanes true and tight.
- Verify and record crossarm orientation to assure proper installation of WD sensor.
- When installing the wind direction sensor, verify that the "arrow" points south (180 degrees) and remove the pin only after securing the sensor in its bracket.

Cables

- Inspect and clean cable ends as necessary.
- Even if not replacing sensor, remove cable, inspect, clean, and retape.
- Document potential cable problems and note need for replacement as necessary.
- In replacing certain cables, note that some cables can be installed in either direction. Be sure that cable is installed with the shielding alignment to prevent water from entering cable.
- If replacing cables, use quality black tiedown straps (white tiedowns break down in sunlight).
- Inspect/replace older straps as necessary.
- When attaching sensors to the cable, make sure the fitting is snug but not tight. All connectors are thoroughly and carefully wrapped with quality environmental tape. BE CAREFUL NOT TO COVER DRAIN HOLES ON THE SENSORS WHILE APPLYING TAPE!

Fuel Temp

- Part of the process for installing the fuel temperature or fuel moisture/temperature sensor is to rehabilitate the fuel bed. The stick should be facing south, approximately 10" above the fuel bed. The fuel bed should be 3 feet square and 2" deep using typical vegetation found in the area. This is especially important if you have a fuel moisture/temperature sensor. PLEASE REFER TO NFES 2140 "Weather Station Handbook - an Interagency Guide for Wildland Managers" for complete information on appropriate fuel bed conditions.
- Fuel stick dowels in good condition.

Batteries/Solar Panel

- Check the DCP voltage regulator with the VOM.

- If you have the equipment, check output of solar panel (both voltage and current) with volt ohmmeter (VOM) and clean surface as necessary.
- Check batteries (internal and external) for leakage or corrosion and test with voltage meter or load tester.

At this time the belt weather kit (BWK) is deployed, and all parameters are checked and recorded. The BWK parameters are used for general comparison purposes only.

With the programming set or laptop connected, refer now to the programming guide for the Handar 540 or 555.

Refer to the BLM standards for further information on annual site visit procedures, including proper cable and sensor installation and weatherproofing. Refer to the Weather Station Handbook – an Interagency Guide for Wildland Managers (NFES 2140) for additional weather station information.

Site Documentation Record

Moist/Temp			(Y/N)	
Soil Moist/Temp			BP Limits: Full Zero SM/ST Limits: Full Zero WT/G Limits: Full Zero	
Baro Pressure				
CP S/N			Tower PN: SSN:	
DCP	Chan:	Firmware:	Talker: (Y/N) Up-Date Interval ___:___ Data Size:__________Match: (Y/N) Gust-Chan Up-Date: : Future (Y/N)	
Solar Panel				
Antenna			Run(Y/N) NXmit___:___ NScan___:__ ID Correct: (Y/N) XMit Next ___:__:__ Diff Time: ___	
Weight Gauge		WWV		
LAST DATA			FORCE SCAN	
T/B	BP		T/B	BP
W/S	FM		W/S	FM
W/D	SM		W/D	SM
AT	ST		AT	ST
FT	WD/G		FT	WD/G
RH	WS/G		RH	WS/G
Batt	WT/G		Batt	WT/G

Notes:

Appendix J. MesoWest data standards (www.met.utah.edu/cgi-bin/database/variable_select.cgi) (9/16/04).

MesoWest Database

Variable ID	Variable	Description	Units	Min	Max	Data Table
4	DWPF	Dew Point	Fahrenheit	-75.00	135.00	
91	ALLV	All variables				
3	TMPF	Temperature	Fahrenheit	-75.00	135.00	BASIC
5	RELH	Relative Humidity	%	0.00	100.00	BASIC
6	SKNT	Wind Speed	Knots	0.00	125.00	BASIC
7	DRCT	Wind Direction	Degrees	0.00	360.00	BASIC
8	GUST	Wind Gust	Knots	0.00	150.00	BASIC
35	QFLG	Quality control flag	code	-10.00	10.00	BASIC
71	VOLT	Battery voltage	volts	0.00	100.00	BATTERY
29	CHC3	High_cloud height/coverage	code	0.00	8009.00	CLOUD
30	CSYL	Low_cloud symbol	code	0.00	9.00	CLOUD
31	CSYM	Mid_cloud symbol	code	10.00	19.00	CLOUD
32	CSYH	High_cloud symbol	code	20.00	29.00	CLOUD
49	CHC1	Low_cloud height/coverage	code	0.00	18009.00	CLOUD
50	CHC2	Mid_cloud height/coverage	code	0.00	8009.00	CLOUD
63	CIG	Ceiling	feet	0.00	80000.00	CLOUD
64	CLC	Cloud-coded	code			CLOUD
65	CLD	Cloud-decoded	text			CLOUD
61	FT	Fuel Temperature	Fahrenheit	-75.00	150.00	FUEL
62	FM	10_hr_Fuel Moisture	gm	0.00	100.00	FUEL
25	TLKE	Lake Temperature	Fahrenheit	-75.00	150.00	LAKE
86	TLRW	Raw Lake Temperature	Fahrenheit	-75.00	150.00	LAKE
58	HI6	6 Hr High Temperature	Fahrenheit	-75.00	150.00	MISC
59	LO6	6 Hr Low Temperature	Fahrenheit	-75.00	150.00	MISC
60	PEAK	Peak Wind Speed	Knots	0.00	150.00	MISC
41	P05I	Precipitation 5min	Inches	0.00	0.50	PRECIP
13	SNOW	Snow total	Inches	0.00	500.00	PRECIP
20	PREC	Precipitation accumulated	Inches	0.00	150.00	PRECIP
42	P10I	Precipitation 10min	Inches	0.00	0.50	PRECIP
40	P03I	Precipitation 3hr	Inches	0.00	6.00	PRECIP
43	P15I	Precipitation 15min	Inches	0.00	0.50	PRECIP
39	P01I	Precipitation 1hr	Inches	0.00	2.00	PRECIP

38	SSTM	Snowfall-storm	Inches	0.00	500.00	PRECIP
37	PSTM	Precipitation storm	Inches	0.00	150.00	PRECIP
51	P06I	Precipitation 6hr	Inches	0.00	12.00	PRECIP
52	P24I	Precipitation 24hr	Inches	0.00	48.00	PRECIP
67	PACM	Precipitation smoothed	Inches	0.00	150.00	PRECIP
74	SACM	Snow smoothed	Inches	0.00	500.00	PRECIP
75	PREM	Precipitation manual	Inches	0.00	150.00	PRECIP
76	P01M	Precipitation 1hr manual	Inches	0.00	2.00	PRECIP
77	P03M	Precipitation 3hr manual	Inches	0.00	6.00	PRECIP
78	P05M	Precipitation 5min manual	Inches	0.00	0.50	PRECIP
79	P10M	Precipitation 10min manual	Inches	0.00	0.50	PRECIP
80	P15M	Precipitation 15min manual	Inches	0.00	0.50	PRECIP
81	P06M	Precipitation 6hr manual	Inches	0.00	12.00	PRECIP
82	P24M	Precipitation 24hr manual	Inches	0.00	48.00	PRECIP
83	SNOM	Snow manual	Inches	0.00	500.00	PRECIP
84	SINT	Snow interval	Inches	0.00	500.00	PRECIP
88	WEQS	Snow water equivalent	inches	0.00	900.00	PRECIP
89	P30I	Precipitation 30 min	Inches	0.00	2.00	PRECIP
92	PWVP	Precipitable water vapor	Inches	0.00	100.00	PRECIP
1	ALTI	Altimeter	inches Hg	24.00	34.00	PRESS
2	PRES	Pressure	Mb	600.00	1049.00	PRESS
21	PMSL	Sea_level pressure	Mb	950.00	1049.00	PRESS
33	P03D	Pressure Tendency	code	0.00	8999.00	PRESS
66	PCHA	Pressure change	code			PRESS
56	RMK	Remarks	text			RAWOB
57	RAW	Raw observation	text			RAWOB
44	RNUM	Road sensor number		1.00	10.00	ROAD
45	TRD	Road Temperature	Fahrenheit	-75.00	150.00	ROAD
46	TFZ	Road Freezing Temperature	Fahrenheit	-75.00	150.00	ROAD
47	RSS	Road Surface Conditions	code	1.00	100.00	ROAD
48	ALR	unknown		0.00	100.00	ROAD
15	TSOI	Soil Temperature	Fahrenheit	-75.00	150.00	SOIL
68	TIR	IR_Soil Temperature	Fahrenheit	-75.00	150.00	SOIL
69	TIC	Temperature in_case	Fahrenheit	-75.00	150.00	SOIL
70	MSOI	Soil Moisture	%	0.00	100.00	SOIL
85	TSRD	Road Subsurface Temperature	Fahrenheit	-75.00	150.00	SOIL
87	EVAP	Evapotranspiration	inches	0.00	100.00	SOIL
14	SOLR	Solar Radiation	W/m**2	-5.00	1500.00	SOLAR
22	HSUN	Hours of sun	Hours	0.00	1000.00	SOLAR
72	ITIM	Data Insert Date/Time	minutes	0.00	16000000.00	TIME

73	UTIM	Data Update Date/Time	minutes	0.00	16000000.00	TIME
26	WNUM	Weather conditions	code	0.00	512000.00	WX
53	VSBY	Visibility	Statute miles	0.00	1000.00	WX
54	WXC	Weather-coded	code			WX
55	WXD	Weather-decoded	text			WX

Climate Monitoring Protocol for the Park Units of the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #1

RAWS PRIMER

Version 1.00 (December 15, 2004)

Revision History Log:

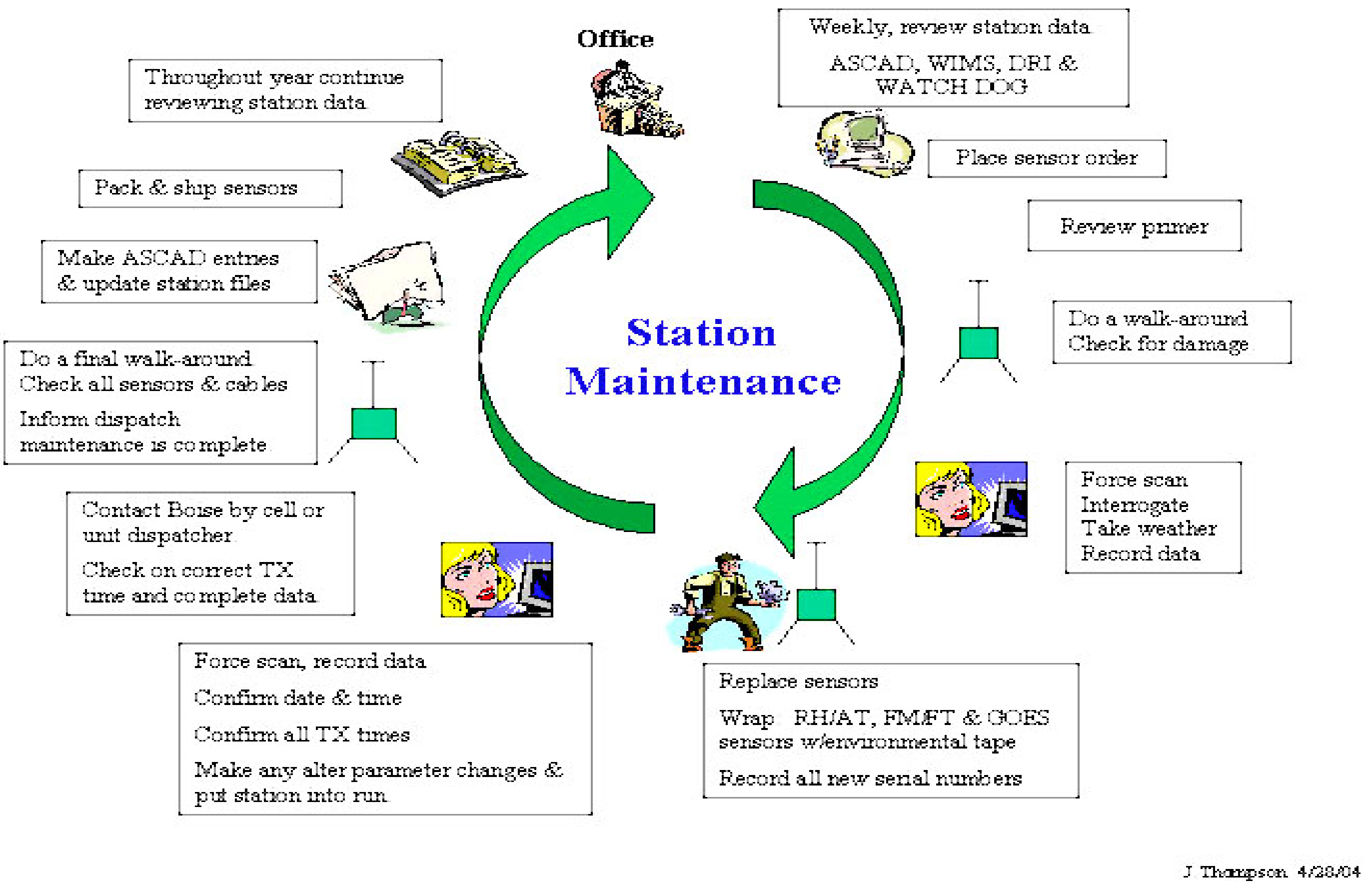
Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for the inspection and check-out of RAWS climate stations, and for station shut down. Procedures are provided for: 1) pre-season preparation; 2) the maintenance visit; and 3) the end of the season. Addtionally, forms and checklists required used in an inspection are included. This SOP was extracted from the Interagency RAWS web page: (http://www.fs.fed.us/raw/book/vaisala/vaisannualmtnceguide.shtml) under Field Guide and Tech Notes Forms without alteration, and is provided here to ensure accessibility. It is current as of November 12, 2004. To retain the pagination of the original document, this page and the following flow diagram are not numbered.

RAWS PRIMER

For Vaisala (Handar) Stations

A Guide Designed for the "Once a Year RAWS Tech"



All references and software referred to in this guidebook are available from any of the individuals listed in the "**HELP! Phone List**".

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For Vaisala (Handar) Stations

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March 1997
Revised January 2004

RAWS PRIMER
A Guide Designed for the "Once a Year RAWS Tech"

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PRESEASON

Check equipment

√ Programming set or laptop set is working.

- √ Batteries are charged or replaced.
- √ Software is loaded as needed (540, 555 and/or Secure Netterm for ASCADS). Download latest software version for 555 (if necesary) from www.vaisala.com and load on your laptop.
- √ Necessary programming interface cables on hand (order if necessary).

Tools and Supplies

√ Check tool kit (See tool/supply list).

- √ Replace lost/damaged tools.
- √ Refurbish Supplies.
- √ Gloves and hard hat.

Towers

√ Assure that any tower you are servicing that requires climbing meets OSHA certification standards. If a tower must be climbed, be sure that climbers are certified per OSHA standards.

Communications

√ Cell phone is available/working

OR,

√ Forest/District radio is available/working and someone on the other end will be available to answer if needed.

√ Batteries are charged or available for these units.

ASCADS

√ Copy of the **ASCADS** Connection software is loaded on a **PC**.

√ You or your office contact person have an ID and Password assigned by BLM and your Secure Netterm licence number from your Regional RAWS/DCP Coordinator. You have verified that you can access the ASCADS Connection without problems.

√ You and your office contact have had training on how to use ASCADS.

Other equipment

√ A reliable time piece (although the programming set or computer have internal clocks you will need to know the exact time for a variety of reasons. CAUTION- laptop clocks are often unreliable and you need to verify or reset this clock at the site).

√ The ability to set this clock to 24 hour time is a REQUIREMENT.

Office Supplies

√ Suggest preprinted return address labels for the Great Basin Warehouse (this will help with the speedy return of used parts).

BLM/NIFC
Great Basin Warehouse
ATTN: RAWS Returns
3833 South Development Avenue
Boise, ID 53705-5354

√ Requisition forms handy to FAX to the warehouse.

√ An established job code to be used for ordering parts (**NOTE**: parts you order from the depot are paid for by your unit in advance, the management code is needed for tracking purposes **AND FOR BILLING IF PARTS ARE NOT RETURNED**)

√ A supply of the "**REMS** Repair and Return Form".

√ A supply of packaging tape.

TWO WEEKS BEFORE ON-SITE MAINTENANCE VISIT

Determine which station(s) you'll visit.

√ Where possible, it is recommended you schedule only one station per day.

√ Review the previous years ASCADS maintenance records and Annual Preventative Maintenance Checklist Form to determine which sensors need routine replacement.

√ Check ASCADS, call you regional RAWS coordinator or call the Depot to check for problems or failures at the site. This may dictate what sensors/parts are needed to successfully refurbish the station.

√ Review ASCADS and/or your Station Narrative Supplement (attached) for special considerations for the selected station. Information about how the station has been set up, special or non-standard sensors, non-standard cable lengths or other important information will be contained on one or the other of these documents.

√ **If a Station Narrative Supplement for the selected station has not been completed be sure to take one with you the day of your first visit!**

Prepare requisition form to order refurbished parts (See www.fs.fed.us/raws for specific instructions on how to order).

√ Call the RSSU Depot at 208-387-5475 and verify with a technician that your order is correct before you fax it to the warehouse.

√ Once verified correct, FAX requisition to the Great Basin Warehouse. 208-387-5573.

P L E A S E N O T E : **Do not hold on to parts!** There is a limited number of available sensors and they must be kept moving. If your station visit is postponed it may be better to return the parts and re-order at a later date. This especially true in the spring when everyone needs parts at the same time. In order to avoid charges to your job code return your "used" parts **ASAP**.

DAY BEFORE ON-SITE MAINTENANCE VISIT

Organize for the trip.

√ Check programming set/laptop; its charged and working and your spare batteries are ready.

√ Tool kit is ready.

√ Replacement parts are ready.

√ Clock/timepiece ready.

√ Is a special key needed for the DCP? A key or combination to get through a locked gate? Arrangements to cross private property? If so make note of it in ASCADS for future use.

√ Check to be sure all documentation is ready:

√ Programming guide (if needed).

√ The ASCADS screen capture for the particular station. If ASCADS is up to date this will have all the information you need to get your station running; time/channel, sensors, everything.

√ Documentation forms ready to record information about the station if ASCADS needs to be updated.

WHERE POSSIBLE IT IS RECOMMENDED YOU SCHEDULE ONLY ONE STATION PER DAY.

√ Determine what time your selected station will transmit and schedule your maintenance visit around this time. Plan your departure to give yourself enough time for travel and completion of the actual maintenance work and programming at the station **prior to a scheduled transmission**. The rational is to be at the site when the station transmits. If all has gone well, within 10 seconds of transmission your station will appear in ASCADS. Using your cell phone or radio you can then contact your dispatch or the BLM Depot Facility for a complete check of operational parameters and the accuracy and integrity of sensor data from the station. (See "***Another Explanation of Time***" sheet for a more complete explanation.)

DAY OF MAINTENANCE VISIT

Before leaving the office

√ Set clocks by calling WWV at 303-499-7111 and set programming set/computer and watch/clock with the exact GMT time.

√ Use the TIME key on programming set or from a windows environment on your laptop, click on the "start" menu and go to "settings" then to "Control Panel" and select "Date and Time" (note: you may need to get administrative privileges to do this).

√ Access ASCADS and "activate" the station in the STATUS field.

√ It is advisable to notify the Depot of your intention to visit the site. They will be prepared for your call later in the day when you ask them to check the station. Of course, if you'll be checking the station locally on ASCADS you'll need to coordinate with the person who'll be doing that from the office.

At the site

√ Thoroughly inspect the station visually, physically and, as well as possible, electronically.

- √ Inspect all guy wires and footings.
- √ Use torpedo levels on towers to check for plumb.
- √ Check that cables are tied down neatly and secured.
- √ Check for animal damage or vandalism.
- √ Check batteries (internal and external) for leakage or corrosion and test with voltage meter or load tester.
- √ Check antenna and cable for physical serviceability.
    - √ Are any of the elements (prongs) bent or missing. Is the antenna properly aligned for the GOES satellite? Check with compass and inclinometer.
- √ Disassemble, inspect and clean the entire tipping bucket.
    - √ Level and tighten tipping bucket platform as needed.
    - √ If installing a new bucket be sure to remove the rubber band securing the tipping mechanism. **JUST AS IMPORTANTLY, SECURE THE TIPPING MECHANISM ON THE OLD BUCKET TO PREVENT DAMAGE DURING RETURN SHIPPING!** Reassemble.
- √ If you have the equipment, check output of solar panel (both voltage and current) with volt ohmmeter (VOM) and clean surface as necessary.
- √ Check the DCP voltage regulator with the VOM.

- √ Verify and record all serial numbers of the sensors, antenna, solar panel and DCP on the Site Documentation Record (attachment).

√ If you have not previously done so, now would be a good time to record necessary information on the Station Narrative Supplement (attachment). This is very useful if you have a nonstandard station setup. By doing so there will be a permanent record of what the cable lengths are or special items to order rather that relying on memory.

- √ While verifying serial numbers thoroughly inspect sensor.
  - √ Wind speed cups tight and properly aligned.
    - √ Easily and freely spins at a fast walk.
  - √ Wind direction vanes true and tight.
  - √ Fuel stick dowels in good condition.
  - √ Verify and record W/S sensor ice skirt size (either 1-3/4" or 2") you'll need this for the programming process. Doing so now will be especially useful if you need to return to site at some later date. You'll not need to re-climb or lower the tower to check the skirts!
  - √ Verify and record crossarm orientation to assure proper installation of WD sensor.
- √ Proceed with sensor changeout on the tower.
  - √ Inspect and clean cable ends as necessary.
    - √ Even if not replacing sensor, remove cable, inspect, clean and retape.
    - √ Document potential cable problems and note need for replacement as necessary.
    - √ In replacing certain cables, note that some cables can be installed in either direction. Be sure that cable is installed with the shielding alignment to prevent water from entering cable.
    - √ If replacing cables use quality black tiedown straps (white tie downs break down in sunlight).
    - √ Inspect/replace older straps as necessary.
    - √ When attaching sensors to the cable make sure the fitting is snug but not tight. All connectors are thoroughly and carefully wrapped with quality environmental tape. **BE CAREFUL NOT TO COVER DRAIN HOLES ON THE SENSORS WHILE APPLYING TAPE!!**
  - √ When installing the wind direction sensor verify the "arrow" points south (180 degrees) and remove the pin only after securing the sensor in its bracket.
  - √ Part of the process for installing the fuel temperature or fuel moisture/temperature sensor is to rehabilitate the fuel bed. The stick should be

facing south, approximately 10" above the fuel bed. The fuel bed should be 3 feet square and 2" deep using typical vegetation found in the area. This is especially important if you have a fuel moisture/temperature sensor. **PLEASE REFER TO NFES 2140** "Weather Station Handbook - an Interagency Guide for Wildland Managers" for complete information on appropriate fuel bed conditions.

- √ Verify and record the accumulated precipitation amount. **This is necessary if you intend to continue with an ongoing count. You'll re-enter this amount later in the programming process**.

  IT IS IMPORTANT TO COORDINATE TO ASSURE THAT THE WIMS STATION CATALOG INFORMATION REFLECTS PRECIP NUMBERS (reset to zero or continuing with ongoing count).

- √ Verify and record the goes channel number.

- √ Verify and record the firmware version in the DCP. This will be helpful to have should you encounter problems with the DCP. This information will assist the BLM RSSU folks with assisting your troubleshooting efforts.

√ With the physical inspection complete, thorough operational and electrical checkout is performed. At this time the belt weather kit (BWK) is deployed and all parameters checked and recorded. The BWK parameters are used for general comparison purposes only.

- √ The DCP programmer/test set is used throughout the test/check process to verify and calibrate all individual functions of the RAWS.

√ With the programming set or laptop connected, refer now to the programming guide for the Vaisala 540 or 555.

Refer to the standards for further information on annual site visit procedures including proper cable and sensor installation and weatherproofing.

Refer to the Weather Station Handbook - an Interagency Guide for Wildland Managers (NFES 2140) for additional weather station information.

END OF SEASON

Do not deactivate station in ASCADS if it is still transmitting, REGARDLESS of whether or not you are using the data. If the station is transmitting, you have a legal obligation to monitor its accuracy via the WATCHDOG function in ASCADS on a regular basis.

If your station cannot survive the off season without risking transmitting bad data, you should plan to shut it off (at the site) while you can still reach it.

If you do deactivate your station (at the site), you also need to deactivate it in ASCADS.

SUPPLEMENTAL PROGRAMMING INFORMATION

PROGRAM IN THE OFFICE

You may find it convenient to pre-program your 540 DCP in the office the day before your field visit. Everything can be done ahead of time per the programming guide. HOWEVER, it is important to be sure that you set the channel in the DCP so that the system does not actually try to transmit data when not connected to an antenna. This can be accomplished by setting the first digit of the channel selection switches (the hundreds digit) to "9".

CAUTION: You must remember to change it back to zero when you are in the field. Otherwise your station will not transmit.

AVOID programming your station more than one or two days prior to actual planned installation in the field. Otherwise, your battery may not survive the use without solar or a/c recharge.

SUPPLEMENT TO STANDARD PROGRAMMING GUIDE

If you wish to tailor your programming instructions to each of your stations (GMT, channel, etc.), the 540 and 555 programming guide is available at www.fs.fed.us/raws.

You may make modifications to that file to fit your individual station needs.

Station Narrative Supplement

Last Updated: 11/96

______________________________________ STATION INFORMATION
(station name)

RAWS Type: (Vaisala 540 or 555 or FTS 12s) ___________________
Weather Service Number: _________________ NESS ID: _____________
Latitude: _____________ Longitude: ______________ Elevation: _________
TRS: _________________________ Site: _______________________
1. Transmit Channel: ___________________ Transmit Time (GMT): _______________
2. Vaisala Tower Install? (if standard installation go to #10) Yes _____ No _____
3. Rohn Tower Install. Yes _____ No ______ Total Tower Height: ___________
4. Cross Arm Cable Length: ____________ Shielding Length: _______________________
Cross Arm Orientation (Should be at true north/south) ___________________
5. Antenna Cable Length: ______________ Shielding Length: _______________
6. Antenna Alignment, Azimuth: __________________ Elevation _________________
7. Solar Panel Cable Length: _________ Shielding Length: ____________________
8. Aspirated Vane Cable Length: ________ Shielding Length: ___________________
9. Fuel Temp/Moisture Cable Length: _______ Shielding Length: _______________
10. Precip Gauge Unheated or Heated: ___________ Make: _______________________
Precip Gauge Cable Length: ________ Shielding Length: ___________________
11. Barometric Pressure Gauge (Y/N): ____ Limits: Upper ______ Lower ________
12. Vaisala Software Version: __________________________

ACTIVE CHANNELS

1	Precipitation Gauge:	_________	Barometric Pressure:	_________
2	Wind Speed:	_________	Wind Gust-Direction:	_________
3	Wind Direction:	_________	Wind Gust Speed:	_________
4	Air Temp:	_________	Fuel Moisture:	_________
5	Fuel Temp:	_________		_________
6	Relative Humidity:	_________		_________
7	Battery Voltage:	_________		_________

Location/Directions:

Notes:

IT IS A GOOD IDEA TO PUT AS MUCH OF THIS INFORMATION INTO ASCADS AS POSSIBLE. USE THE NARRATIVE AREA AND CHECK PARAMETERS SUCH AS LAT/LONG TO ASSURE THEY ARE CORRECT

Site Documentation Record

: ___________________ Name: ____ Date:________________

Class: TX:____:____:____ Chan: Dist:

Sensor:	New Serial #	Old Serial #	TB Reset (Y/N) Cal: \50 Last:	
Tipping Bucket			S/P VDC	MA
Wind Speed			Reg VDC	MA
Wind Direction			Battery No Load	Load
RH/AT			Tries: 5M: 10M: 15M:	
Fuel/Temp	Changed	OK	Belt weather: Wet Dry RH	
Battery	Changed	OK	FWD TX:	REV TX:
Fuel Moist/Temp			Lat : : Long : : GPS (Y/N)	
Soil Moist/Temp			BP Limits: Full Zero SM/ST Limits: Full Zero WT/G Limits: Full Zero	
Baro Pressure				
DCP S/N			Tower PN: SSN:	
DCP Chan: Firmware:			Talker: (Y/N) Up-Date Interval ___:___ Data Size:___________Match: (Y/N) Gust-Chan Up-Date: : Future (Y/N)	
Solar Panel				
Antenna			Run(Y/N) NXmit___:___ NScan___:__ ID Correct: (Y/N) XMit Next ___:__:__ Diff Time: ___	
Weight Gauge		WWV		

LAST DATA		FORCE SCAN	
T/B	BP	T/B	BP
W/S	FM	W/S	FM
W/D	SM	W/D	SM
AT	ST	AT	ST
FT	WD/G	FT	WD/G
RH	WS/G	RH	WS/G
Batt	WT/G	Batt	WT/G

Notes:

Annual Preventative Maintenance Checklist

STATION: ____

I = Date new sensor was installed.
R = Date of next scheduled replacement
A = Entered in ASCADS

SENSOR	RECOMMENDED REPLACEMENT	**I**	**R**	**A**	**I**	**R**	**A**
RH/AT	EVERY YEAR						
FM/FT	EVERY YEAR						
WIND SPEED	2 YEARS						
WIND DIRECTION	2 YEARS						
FUEL TEMP	3 YEARS						
TIP BUCKET	3 YEARS						
DCP	4 YEARS						
AUX BATTERY	3 YEARS						
SOLAR RADIATION	2 YEARS						
ANTENNAS	AS NEEDED*						
SOLAR PANEL	AS NEEDED*						
CABLES	AS NEEDED*						
BAROMETRIC PRESSURE	AS NEEDED*						
OTHER							
OTHER							
OTHER							

* AS NEEDED= REPLACE IF COMPONENT IS DAMAGED, CORODED OR IF YOU ARE EXPERIENCING
PROBLEMS.

ANOTHER EXPLANATION OF TIME

For the purposes of programming, it is usually best to work only in GMT time at the site. This avoids mistakes in converting to local time. The following example is for the purposes of planning the time of arrival at your site so you can be sure to be finished with your rehab and programming prior to the next scheduled transmission.

EXAMPLE: You have station that transmits every 3 hours at 0944, 1244, and 1544 LOCAL TIME. Lets assume the following scenario for this station. Say your work day begins at 0800. After your morning routine you travel 2 hours to the station arriving around 1030. You then spend 2 hours performing the maintenance and programming. At 1240 you call the RSSU Facility (or your local contact who IS LOGGED INTO ASCADS) and you verify that the station transmitted and that its operationally correct. If all is well then pack up and head for home. If things are not right the RSSU folks (or your ASCADS person) can tell you what may have gone wrong and advise you how to fix it. At this point you'll need to decide how to proceed. The next time the station transmits will be 1544 and the folks at the depot WILL HAVE GONE HOME FOR THE DAY (they are on Mountain time). IF you have someone who can check ASCADS you might try again to bring the station up and wait until 1544 to see if it transmitted correctly. If you do not have someone to check ASCADS it may be advisable to return the following day. Do not allow a station to remain on the air if it is not right. This is especially true of time and channel errors as they may well be interfering with another station.

TO OBTAIN GMT FROM LOCAL TIME USE CORRECTIONS AS SHOWN (EG. 1000 PDT IS 1000 + 700 = 1700 GMT)

PDT TO GMT +7	PST TO GMT +8	MDT TO GMT +6	MST TO GMT +7
PDT <> GMT	**PST <> GMT**	**MDT <> GMT**	**MST <> GMT**
0000 - 0700	0000 - 0800	0000 - 0600	0000 - 0700
0100 - 0800	0100 - 0900	0100 - 0700	0100 - 0800
0200 - 0900	0200 - 1000	0200 - 0800	0200 - 0900
0300 - 1000	0300 - 1100	0300 - 0900	0300 - 1000
0400 - 1100	0400 - 1200	0400 - 1000	0400 - 1100
0500 - 1200	0500 - 1300	0500 - 1100	0500 - 1200
0600 - 1300	0600 - 1400	0600 - 1200	0600 - 1300
0700 - 1400	0700 - 1500	0700 - 1300	0700 - 1400
0800 - 1500	0800 - 1600	0800 - 1400	0800 - 1500
0900 - 1600	0900 - 1700	0900 - 1500	0900 - 1600
1000 - 1700	1000 - 1800	1000 - 1600	1000 - 1700
1100 - 1800	1100 - 1900	1100 - 1700	1100 - 1800
1200 - 1900	1200 - 2000	1200 - 1800	1200 - 1900
1300 - 2000	1300 - 2100	1300 - 1900	1300 - 2000
1400 - 2100	1400 - 2200	1400 - 2000	1400 - 2100
1500 - 2200	1500 - 2300	1500 - 2100	1500 - 2200
1600 - 2300	1600 - 0000	1600 - 2200	1600 - 2300
1700 - 0000	1700 - 0100	1700 - 2300	1700 - 0000
1800 - 0100	1800 - 0200	1800 - 2400	1800 - 0100
1900 - 0200	1900 - 0300	1900 - 0100	1900 - 0200
2000 - 0300	2000 - 0400	2000 - 0200	2000 - 0300
2100 - 0400	2100 - 0500	2100 - 0300	2100 - 0400
2200 - 0500	2200 - 0600	2200 - 0400	2200 - 0500
2300 - 0600	2300 - 0700	2300 - 0500	2300 - 0600

CDT TO GMT +5	CST TO GMT +6	EDT TO GMT +4	EST TO GMT +5
CDT <> GMT	**CST <> GMT**	**EDT <> GMT**	**EST <> GMT**
0000 - 0500	0000 - 0600	0000 - 0400	0000 - 0500
0100 - 0600	0100 - 0700	0100 - 0500	0100 - 0600
0200 - 0700	0200 - 0800	0200 - 0600	0200 - 0700
0300 - 0800	0300 - 0900	0300 - 0700	0300 - 0800
0400 - 0900	0400 - 1000	0400 - 0800	0400 - 0900
0500 - 1000	0500 - 1100	0500 - 0900	0500 - 1000
0600 - 1100	0600 - 1200	0600 - 1000	0600 - 1100
0700 - 1200	0700 - 1300	0700 - 1100	0700 - 1200
0800 - 1300	0800 - 1400	0800 - 1200	0800 - 1300
0900 - 1400	0900 - 1500	0900 - 1300	0900 - 1400
1000 - 1500	1000 - 1600	1000 - 1400	1000 - 1500
1100 - 1600	1100 - 1700	1100 - 1500	1100 - 1600
1200 - 1700	1200 - 1800	1200 - 1600	1200 - 1700
1300 - 1800	1300 - 1900	1300 - 1700	1300 - 1800
1400 - 1900	1400 - 2000	1400 - 1800	1400 - 1900
1500 - 2000	1500 - 2100	1500 - 1900	1500 - 2000
1600 - 2100	1600 - 2200	1600 - 2000	1600 - 2100
1700 - 2200	1700 - 2300	1700 - 2100	1700 - 2200
1800 - 2300	1800 - 0000	1800 - 2200	1800 - 2300
1900 - 0000	1900 - 0100	1900 - 2300	1900 - 0000
2000 - 0100	2000 - 0200	2000 - 0000	2000 - 0100
2100 - 0200	2100 - 0300	2100 - 0100	2100 - 0200
2200 - 0300	2200 - 0400	2200 - 0200	2200 - 0300
2300 - 0400	2300 - 0500	2300 - 0300	2300 - 0400

FIELD TOOL/ SUPPLY LIST

Note: If your station is anything other than a standard Vaisala installation i.e. a Rohn Tower, you may need additional tools not covered by this list.

tape measure
pocket knife
phillips head screwdriver set
slotted screwdriver set
combination wrench set (9/16 & 1/2)
small sledge hammer
torpedo level (2)
a set of nut drivers(9/16 & 1/2 deep well)
rachet
crescent wrench
pliers
needle nose pliers
set of allen wrenches
side cutters (wire snips)
aerosol battery terminal cleaner
small mylar space blanket (for use as sun screen when using laptops)
distilled water
small paintbrush to clean tipping bucket and general dusting of small parts.
rags
spare fuses*

- micro amp fuses [radial lead micro fuses by Little Fuse], (available at Radio Shack or other electronics shop). They are 1/2 and 1/4 amp fuses.
- 2 and 5 amp glass buss fuses.

locktight
belt weather kit
garbage bag
multimeter
compass
programming set or laptop
tipping bucket calibration container*
canteen of water for above
Several rolls of high quality "environmental" style electricians tape.
Black cable ties (white ones break down in sunlight).
Spare batteries for your multi-meter.

*available from the depot

HELP! Telephone List

Name	Phone	e-mail
BLM Remote Sensing Support Unit		
Buddy Adams buddy_adams@nifc.blm.gov	208-387-5475	
USFS National RAWS Coordinator		
Kolleen Shelley	208-476-8362	kshelley@fs.fed.us
Linnea Keating	208-476-8312	lkeating@fs.fed.us
USFS Regional RAWS Coordinators		
R01 – Bruce Thoricht	406-329-4875	bthoricht@fs.fed.us
R02 - Dave Clement	303-275-5791	dclement@fs.fed.us
R03 – Richard Naden	505-842-3415	rnaden@fs.fed.us
R04 - Tenna Biggs	208-737-3210	tbiggs@fs.fed.us
R05 - Beth Little	530-226-2710	blittle@fs.fed.us
R06 – Russ Hurst	541-962-8665	rhurst@fs.fed.us
R08 - Eddy Holt	423-476-9700	eholt@fs.fed.us
R09 –Steve Marien stephen_marien@nps.gov	612-713-7300	
R10 – Wayne Bushnell	907-743-9459	wbushnell@fs.fed.us

FORMS AND DOCUMENTATION LIST

KEY Code Legend - Listing of laptop programming keys and their functions.

STATION NARRATIVE SUPPLEMENT- Format for recording station configuration information for later entry into ASCADS.

ASCADS PDT Format - Format for recording station information when planning a new station and can be used as a hard copy reference to RAWS Network documentation.

ORDER PARTS - Procedures for ordering replacement/repair sensors from the BLM RSSU (RAWS) under the depot agreement. Includes the REMS Repair and Return Form and the REMS/RAWS NFES Mini-Catalog.

RAWS PROGRAMMING GUIDE - Produced by the BLM RSSU Group

RAWS STANDARDS – NWCG publication PMS 426-3.

WEATHER STATION HANDBOOK - NFES 2140..."Weather Station Handbook - an Interagency Guide for Wildland Managers"

SITE DOCUMENTATION RECORD - Format used by the BLM technicians to record serial numbers and last and new data measurements (force scan).

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #2

Programming the Vaisala (Handar) 555

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for programming the Handar 555 data collection platform. This SOP was extracted from the Interagency RAWS web page: (http://www.fs.fed.us/raws/book/vaisala/555_program.shtml) under Field Guide and Tech Notes Forms without alteration, and is provided here to ensure accessibility. It is current as of November 13, 2004.

How to Program a Vaisala (Handar) 555

****** NOTE: If your DCP comes through the BLM Depot after being ordered, it will already have this programming prepared.*******

For Windows 95 or earlier computers: If you need to install or upgrade to a new version of 555 software, put the 555 disk in your computer. Change to the A: drive in MS-DOS. Type "instl555". While going through the directions, select the "EXTENDED" Option. Once installed, you can change directories to C:\HNDR555. Type "555" to begin the program.

For Windows 2000 computers: If you need to install or upgrade to a new version of 555 software, put the Vaisala 555 WinPro and Online 2000 cd into your disk drive. Go to the Start button, select Run, type in d:\setup.exe and follow the on screen instructions.

HELPFUL HINTS for DOS version of 555 programming:

- **The Arrow keys will navigate the options.**
- **The Enter key will select.**
- **The Esc key will exit the current option/window.**
- **The mouse, if present, will work to select options.**

Once the most recent version of 555 software has been installed:

1. Select 'File' from the menu at the top of the screen.
2. Select 'New' to create a new working space for the program.
3. Select 'yes'.

Sensor assignments

Select 'Program' from the menu. To add Sensors to your program, select 'Sensor Assignments'. Sensor definitions follow. Find out which sensor models you have for your station and enter those sensor assignments. **Note: order of entry is not important.** The ** shows that the sensor/definition is field accessible.

Precipitation

**ID	Tipping Bucket	MODULE: Tipping Bucket Accumulation, H2.00
	Input Location	TB (default switch)
	Tip units	.01 inches
	Accumulator	.00 (.00 to 99.99)
		FAV: Reset Rainfall **[note: add new field accessable value]**
		00.00 Minimum Value
		99.99 Maximum Value
		value: .00

Wind

ID:	430 Wind Speed	MODULE: 430A Wind Speed, H2.03

	Input Location	WS (default) or (01 Frequency Input)
	Speed units	miles per hour
	Comment	Jumper W3 must be installed
	Sw. 12v (0=none)	0 (0 to 2)
ID:	431 Wind Direct	MODULE: 431A Wind Direction, H2.01
	Input Location	1A
	Comment	Do not use resistor between
	Comment	GND and selected analog input
	Center pot gap?	Y

Temperature/Humidity:

ID:	435 Air Temp	MODULE: 435A/435E Air Temperature, H2.00
	Input Location	2A
	Temp. Units	Degrees F
	Comment	Use 20kohm 0.1% resistor between
	Comment	VREF and selected analog input
ID:	439C Fuel Temp	MODULE: 439C Fuel Temperature, H2.00
	Input Location	3A
	Temp. Units	Degrees F
	Comment	Use 20kohm 0.1% resistor between
	Comment	VREF and selected analog input
ID:	435 Rel Humid	MODULE: 435A/435E Relative Humidity, H2.00
	Input Location	1B
	Switched 12v out	1 (1 to 2)
ID:	439C Fuel Moist	MODULE: 439C Fuel Moisture H2.00
	Input Location	2B
	Switched 12v source	1 (1 to 2)

Misc. Single Ended Analog

ID:	Battery Voltage	MODULE: Battery Voltage, H2.00
	Input Location	8B
	Comment	Select channel 8b if using internal jumper W4.

Pressure

ID:	Setra Baro Press	MODULE: Altimeter: Setra Model 270, H2.00
	Input Location	8A
	Comment	Internal option: use ch. 8A
	Switched 12v out	1 (1 to 2)
	Comment	Internal option: use 12v out 1
	Sensor range	600 to 1100 mb
	Altimeter units	inches Hg.
	Elevation (ft.)	0 (0 to 15000)

		FAV: Set BP Elevation **[note: add new field accessable value]**
		Value: 0

Solar Radiation

ID:	441A Solar Rad	MODULE: 441A Solar Radiation, H2.00
	Input Location	5A/5B
	Calib. ua/kw/m^2	75.0 (20.0 to 150.0)
		FAV: Solar Rad Calib **[note: add new field accessable value]**
		Value: 75.0
	Shunt resistance	100 (39 to 499) [no to field accessable]
	Comment	Use selected .1% resistor shunt between selected analog inputs.
	Comment	Output units: watts/m^2
	Comment	Max out: 5*10^7/(cal * shunt)

System Functions **[note: must add this]**

ID:	Temp Comp	MODULE: ADC/RTC Temperature Compensation, H2.01
	Input Location	6B
	Comment	Select analog channel 6b and jumper jack W10 at 2-3
**ID	GPS Receiver	MODULE: GPS Time Set Run With Battery Sentry, H2.02
	Input Location	Specl-01(default) with 7 fields
	Using 555-6020?	Y
	Port selection	2 (0 to 3)
	Sw. 12v source	1 (1 to 2)
	Scan start time	00:00:00 [no to field accessable]
	Scan interval	01-00:00:00
		FAV: GPS Scan Interval **[note: add new field access value]**
		Value: 01-00:00:00
	GPS Pwr Advance	00:02:00 [no to field accessable]
	Xmtr timebase?	Y
	GPS Acquisitions	0 (0 to 65535)
		FAV: GPS Acquisitions **[note: add new field access value]**
		Value: 01-00:00:00
	Clock Error	0.0 (-60.0 to 60.0)
		FAV: Clock Error **[note: add new field accessable value]**
		Value: 0.0
	ARGOS/SCD Xmtr?	N
	Battery ID.	Battery Volt

Suspend voltage	11.50	(11.00 to 12.00)
Resume voltage	12.00	(11.75 to 12.75)

Add Process Definitions

Select 'Program' from the menu. To add processes to your program, select 'Process Definitions'. Add the processes that will take readings from the above sensors. The following processes are used to sample averages, take max or min readings, and reformat data to weather standards.

Intermediate Data Processing
-Averaged Data

ID:	I-Avg Wind Speed	MODULE: Averaged Data, H2.04
	Sample invl HMS	00:00:01 (00:00:01 to 23:59:59)
	Sample count	600 (3 to 32767)
	Source ID.	430 Wind Speed
ID:	I-Avg Rel Hum	MODULE: Averaged Data, H2.04
	Sample invl HMS	00:00:01 (00:00:01 to 23:59:59)
	Sample count	600 (3 to 32767)
	Source ID.	435 Wind Speed

Intermediate Data Processing
-Averaged Angle Data

ID:	I-Avg Wind Speed	MODULE: Averaged Angle Data, H2.05
	Sample invl HMS	00:00:01 (00:00:01 to 23:59:59)
	Sample count	600 (3 to 32767)
	Source ID.	431 Wind Direct

Intermediate Data Processing
- Forward Max S1 and S2 at Max S1

ID:	I-Max WS & WD	MODULE: Forward Max S1 and S2 at max S1, H2.02
	Sample count	3600 (3 to 65535)
	Sample invl HMS	00:00:01 (00:00:01 to 23:59:59)
	S1 Source ID.	430 Wind Speed
	S2 Source ID.	431 Wind Direct
	Fields	3
	FIELD #1	Maximum S1 (0 to 0) **[note: doesn't matter which one you select, just select one to get out of screen.]**
	FIELD #2	S2 at max S1 (0 to 0)
	FIELD #3	Timestamp @ max (0 to 0)

Intermediate Data Processing
- Forward Max Data Scanner

ID:	I-Air temp high	MODULE: Forward Maximum Data Scanner Process,

		H2.04
	Sample invl HMS	[00:05:00 if you want to check data every 5 minutes]
	Sample count	[total in 24 hours - 288 for every 5 minutes]
	Source ID.	435 Air Temp
	Fields	2 **[note: doesn't matter which one you select, just select one to get out of screen.]**
ID:	I-Rel humid high	MODULE: Forward Maximum Data Scanner Process, H2.04
	Sample invl HMS	[00:05:00 if you want to check data every 5 minutes]
	Sample count	[total in 24 hours - 288 for every 5 minutes]
	Source ID.	435 Rel Humid
	Fields	2 **[note: doesn't matter which one you select, just select one to get out of screen.]**

Intermediate Data Processing - Forward Min Data Scanner

ID:	I-Air temp low	MODULE: Forward Minimum Data Scanner Process, H2.04
	Sample invl HMS	[00:05:00 if you want to check data every 5 minutes]
	Sample count	[total in 24 hours - 288 for every 5 minutes]
	Source ID.	435 Air Temp
	Fields	2 **[note: doesn't matter which one you select, just select one to get out of screen.]**
ID:	I-Rel humid low	MODULE: Forward Minimum Data Scanner Process, H2.04
	Sample invl HMS	[00:05:00 if you want to check data every 5 minutes]
	Sample count	[total in 24 hours - 288 for every 5 minutes]
	Source ID.	435 Rel Humid
	Fields	2 **[note: doesn't matter which one you select, just select one to get out of screen.]**

Intermediate Data Processing - Reformat Data

ID:	Reformat Battery	MODULE: Reformat Date, H2.00
	Source ID.	Battery Voltage
	Decimal position	1 (0 to 6)
	Byte count	2 (1 to 4)
ID:	Reformat Fuel M	MODULE: Reformat Date, H2.00
	Source ID.	439C Fuel Moist

	Decimal position	0 (0 to 6)
	Byte count	2 (1 to 4)

ID:	Reformat BP	MODULE: Reformat Date, H2.00
	Source ID.	Setra Baro Press
	Decimal position	2 (0 to 6)
	Byte count	2 (1 to 4)

The following collection processes are used to prepare for GOES transmission
Note: you can add the 1st GOES buffer process and then copy the rest with the corrected info.

Handar GOES Trans Support (or GOES/GMS/Meteosat Support)
- Buffer Self-timed GOES Xmit Data

**ID:	GB-Precip or TB or Rain	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Instant Start **[note: add new field access value]** Value: 00-00:00:00
	Scans per xmit	1 [3 if 3hrly] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	5 [00.00] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	1 (1 to 99)
	Source ID.	Tipping Bucket
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing

**ID:	GB-Avg Wind Spd	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: AVG Start Time **[note: add new field access value]** Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3 [000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	2 (1 to 99)
	Source ID.	I-Avg Wind Speed

	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Avg Wind Dr	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: AVG Start Time **[note: pick this from FAV list]** Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3 [000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	2 (1 to 99)
	Source ID.	I-Avg Wind Dir
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Air Temp	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Instant Start **[note: pick this from FAV list]** Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3 [000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	4 (1 to 99)
	Source ID.	435 Air Temp
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Fuel Temp	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Instant Start **[note: pick this from FAV list]** Value: 00-00:00:00

	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3 [000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	5 (1 to 99)
	Source ID.	439C Fuel Temp
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Avg Rel Hum	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Avg Start Time **[note: pick this from FAV list]** Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3 [000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	6 (1 to 99)
	Source ID.	I-Avg Rel Hum
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Battery Volt	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Instant Start **[note: pick this from FAV list]** Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	4 [00.0] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	7 (1 to 99)
	Source ID.	Reformat Batt
	Log xmit data?	Y
	Storage size	0 (0 to 65504)

	Comment	Select 0 for automatic sizing

[note: the remaining Data channel fields have "?". You need to determine which sensor data you will transmit.]

**ID:	GB-Fuel Moist	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Instant Start **[note: pick this from FAV list]** Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3 [000 or decimal] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	? (1 to 99)
	Source ID.	439C Fuel Moist [or Reformat Fuel M]
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Baro Press	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Instant Start **[note: pick this from FAV list]** Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	5 [00.00] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	? (1 to 99)
	Source ID.	Reformat BP
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Max Wind Dir	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Instant Start **[note: pick this from FAV list]**

		Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3[000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	? (1 to 99)
	Source ID.	I-Max WS & WD , S2 at max S1
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Max WS	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59)
		FAV: Instant Start **[note: pick this from FAV list]**
		Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3[000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	? (1 to 99)
	Source ID.	I-Max WS & WD , Maximum S1
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Solar Rad	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59)
		FAV: Instant Start **[note: pick this from FAV list]**
		Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	5[00000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	? (1 to 99)
	Source ID.	441a Solar Rad
	Log xmit data?	Y

	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Air temp high	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Hi/Low start [note: add this new field access. value] Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3[000 or decimal] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	? (1 to 99)
	Source ID.	I-Air temp high, Maximum
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Air temp low	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Hi/Low start **[note: pick this from FAV list]** Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3[000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	? (1 to 99)
	Source ID.	I-Air temp low, Minimum
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Rel humid high	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Hi/Low start **[note: pick this from FAV list]** Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)

	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3[000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	? (1 to 99)
	Source ID.	I - Rel humid high, Maximum
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
**ID:	GB-Rel humid low	MODULE: Buffer Self-Timed GOES Xmit Data, H2.06
	Start time (HMS)	00:00:00 (00:00:00 to 23:59:59) FAV: Hi/Low start **[note: pick this from FAV list]** Value: 00-00:00:00
	Scans per xmit	1 [or 3] (1 to 99)
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format
	Character count	3[000] (1 to 16)
	Comment	Max digit count + 1 if signed
	Comment	+ 1 for covered decimal point
	Data Channel	? (1 to 99)
	Source ID.	I - Rel humid low, Minimum
	Log xmit data?	Y
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing

Now that all the GOES buffer processes are done, you can add the GOES transmitter process, speech (if present), and WWV (if present).

GOES Transmitter (or GOES/GMS/Meteosat Support)
- GOES Self-Timed Data Xmit., H2.10

**ID:	GOES Transmitter	MODULE: GOES Self-Timed Data Xmit., H2.10
	Note: be sure you have this latest version of software in the above line (example: H2.10)	
	Xmit time error	0.0 (-60.0 to 60.0) FAV: Clock Error **[note: add new field access value]** Value: 0.0
	Scan ordered	N
	Comment	Enter N for channel ordered
	ASCII format?	Y
	Comment	Enter N for Pseudo-binary format

Short preamble?	Y
Line end space?	N
Comment	Must enter Y if limit flag used
Redundant sets	0 (0 to 3)

Speech Processor Support
- Radio Speech if DTMF Station ID

Note: The format used is P=pause; 50 miliseconds; S=speak; #=phrase (see handout); P=pause; 50 miliseconds.

ID:	Radio Speech	MODULE: Radio Speech if DTMF Station ID, H2.01
	Data scan start	00:00:00 (00:00:00 to 23:59:59)
	Data scan invl.	00-00:15:00 (00-00:00:01 to 45-12:15:00)
	Data source IDs	? [# channels you want] (1 to 22) [enter to bring up sensor list]
	Tipping Bucket	
	Ident. vocab. 1	P50S750P50
	Ident. vocab. 2	* **Note: Do not take out * or program won't assemble.**
	Ident. vocab. 3	*
	Post data vocab.	S241
	I-Avg Wind Speed	
	Ident. vocab. 1	P50S1P50
	Ident. vocab. 2	*
	Ident. vocab. 3	*
	Post data vocab.	S61
	I-Avg Wind Dir	
	Ident. vocab. 1	P50S2P50
	Ident. vocab. 2	*
	Ident. vocab. 3	*
	Post data vocab.	S228
	435 Air Temp	
	Ident. vocab. 1	P50S4P50
	Ident. vocab. 2	*
	Ident. vocab. 3	*
	Post data vocab.	S228
	439C Fuel Temp	
	Ident. vocab. 1	P50S6P50
	Ident. vocab. 2	*
	Ident. vocab. 3	*
	Post data vocab.	S228
	I-Avg Rel Hum	
	Ident. vocab. 1	P50S3P50
	Ident. vocab. 2	*
	Ident. vocab. 3	*

Post data vocab.	S706
Reformat Batt	
Ident. vocab. 1	P50S39P50
Ident. vocab. 2	*
Ident. vocab. 3	*
Post data vocab.	S890
Reformat BP	
Ident. vocab. 1	P50S36P50
Ident. vocab. 2	*
Ident. vocab. 3	*
Post data vocab.	S421S663S585
Reformat Fuel M	
Ident. vocab. 1	P50S5P50
Ident. vocab. 2	*
Ident. vocab. 3	*
Post data vocab.	S706
I-Max WS & WD, direction	
Ident. vocab. 1	P50S582S2P50
Ident. vocab. 2	*
Ident. vocab. 3	*
Post data vocab.	S228
I-Max WS & WD,speed	
Ident. vocab. 1	P50S582S1P50
Ident. vocab. 2	*
Ident. vocab. 3	*
Post data vocab.	S61
Avg Sol Rad	
Ident. vocab. 1	P50S7P50
Ident. vocab. 2	*
Ident. vocab. 3	*
Post data vocab.	*
Comment	Set 555 station ID to desired
Comment	1 to 16 character DTMF ID
Power down DTMF?	N

Note: If you have both GOES **and** voice (or modem), you will need to add a process to post the data. This example is for maximum wind speed. You will have to post data for each element chosen for voice (or modem). After you complete the posted data processes, go back and edit the GB processes to change the source to Posted Data.

Intermediate Data Processing
- Interval Posted Data

ID:	I-Post Max WS	MODULE: Extern. 541 WWV Receiver Support, H2.03

	Start time (HMS)	00:00:00 (no for field accessable)
	Scan interval	01-00:05:00 (for 5 minute interval; no for field accessable)
	Source ID	I-Max WS & WD, maximum S1

Add if you are using WWV instead of GPS:
System/General Processes
- External 541 WWV Receiver Support

**ID:	WWV Receiver	MODULE: Extern. 541 WWV Receiver Support, H2.03
	Scan start time (HMS)	00:00:00 (00:00:00 to 23:59:59)
		FAV: Start WWV Time **[note: add this new field access value]**
		Value: 00-00:00:00
	Scan interval	01-00:00:00 (00-00:10:00 to 10-00:00:00) (no for field accessable)
	SDI-12 address	0 (no for field accessible)
	GOES timebase?	Y
	Clock Error	0
		FAV: Clock Error **[note: pick this from FAV list]**
		Value: 0.0
	Comment	Clock error must be defined outside this process
	WWV acquisitions	0 (0 to 65535)
		FAV: Reset WWV Locks **[note: add new field access val.]**
		Value: 0
	Storage size	0 (0 to 65504)
	Comment	Select 0 for automatic sizing
	Using 555-6020?	N

For GPS
Serial Port Support
- RSG232 Serial Interface

ID:	RS232 Interface	MODULE: RS 232 Serial Interface, H2.06
	Off after TX?	N
	Using 555-6020?	Y
	Port 3 RS422/485?	N

Interval Data Logging
Log Source Data

ID:	Log GPS Status	MODULE: Log Source Data, H2.02
	Start time (HMS)	00:00:00 (no to FAV)
	Interval (DHMS)	01-00:00:00
		FAV: GPS Scan Interval [note: add new field access val.]
		Parameter Name: GPS Interval

	Value: 01-00:00:00
Storage size	0 (0 to 65504)
Comment	Select 0 for automatic sizing
Source ID	GPS Receiver, #satellites used

When you are done, you should have set up the following Field Accessible Definitions and Values:

Field Accessible Time Definitions:

Instant Start Time	00:00:00 (00:00:00 to 23:59:59) ALTERABLE IN STOP MODE ONLY
Avg. Start Time	00:00:00 (00:00:00 to 23:59:59) ALTERABLE IN STOP MODE ONLY
WWV Start Time	00:00:00 (00:00:00 to 23:59:59) ALTERABLE IN STOP MODE ONLY
GPS Interval	01-00:00:00 (00:00:00 to 23:59:59) ALTERABLE IN STOP MODE ONLY
Hi/Low Start	00:00:00 (00:00:00 to 23:59:59) ALTERABLE IN STOP MODE ONLY

Field Accessible Value Definitions:

Current Rain	.00 (.00 to 99.99) ALTERABLE IN STOP & RUN MODE
Set BP Elevation	0 (0 to 15000) ALTERABLE IN STOP & RUN MODE
Clock Error	0.0 (-60.0 to 60.0) ALTERABLE IN STOP & RUN MODE
WWV Lock-ons	0 (0 to 65535) ALTERABLE IN STOP & RUN MODE
Solar Rad Calib	75.0 (20.0 to 150) ALTERABLE IN STOP & RUN MODE
GPS Acquisitions	0 (0 to 65535) ALTERABLE IN STOP & RUN MODE

When the program is complete:

- **return to Menu and select 'File'**
- **Select 'Save' and follow menus and name the file.**

- **Select 'Assemble' to prepare the program to put into the DCP.**

For more information about the Interagency RAWS program, contact USFS Program Manager Kolleen Shelley or BLM Remote Sensing Fire Weather Support Unit Herb Arnold.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #3

Programming the Handar 540

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for programming the Handar 540 data collection platform. This SOP was extracted from the Interagency RAWS web page (http://www.fs.fed.us/raws/book/vaisala/h540/540prog.html) under Field Guide and Tech Notes Forms without alteration, and is provided here to ensure accessibility. It is current as of 15 November 2004.

Handar 540 programming

208-387-5475 – HELP NUMBER

Handar 540 KEYS TO REMEMBER

M	CHANNEL	**L**	TELEPHONE
N	SENSOR TYPE	**S**	NEXT SCAN TIME
I	ID CODE	**T**	NEXT XMIT TIME
U	SCROLL UP	**Y**	RUN
V	SCROLL DOWN	**?**	PROGRAM MODE
J	TIME	**$**	FORCED SCAN
K	XMIT MODE	#	FORCED XMIT
Ctrl S	DATA DUMP	**X**	CLEAR
Ctrl D	PROGRAM DUMP	**D**	DELETE CHANNEL
SPACE BAR	VOICE	O	AFTER N …TAKES YOU TO MEASURE INTERVAL, DOWN ONE AND YOU CAN SET START OF MEASURE

SET LAPTOP AND WATCH TO GMT TIME – 303 499-7111

Connect Laptop/Programmer to DCP

Insure DCP is set to correct GOES transmit channel

If using voice – insure voice card is set to proper tone

[Turn on DCP]

SYSTEM PROG REQUIRED – PRESS ID **I**

Determine how many channels of data are to be programmed

Press **M** – Channel # Key 00

Press 1 then the Enter key 01

Enter remaining number of channels

After all channels are loaded scroll to Channel 01

Press **N** – Meas Key

CHANNEL #1 – PRECIP.

SENSOR TYPE 07

SENSOR NAME TAG 07

CARD SLOT # 06

VALUE PER TIP (XX.XX) 00.01

CURRENT VALUE ....00.01 (OR SET TO CURRENT RAIN YEAR AMOUNT)

MEAS INTERVAL 01:00:00

START OF MEAS..NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE................................001 (LOG)

XMIT 2 OR 3 BYTES 03

HIGH LIMIT ....NO LIMIT

LOW LIMIT ....NO LIMIT

HIGH DIFF LIMIT.......................................NO LIMIT

LOW DIFF LIMIT..NO LIMIT

CHANNEL NO 01

V TO SCROLL TO CHANNEL 02

N PRESS MEAS KEY

CHANNEL #2 – WIND SPEED

SENSOR TYPE 01

SENSOR NAME TAG 01

CARD SLOT # 06

SENSOR PWR ADV 00:00:02

SENSOR THRESHOLD 000

FREQ/VEL (XX.XXX) ....00.280 (1 ¾”) OR 00.262 (2")

MEAS INTERVAL 01:00:00

START OF MEAS..NO ENTRY AT THIS TIME (BACK UP 10 MIN)

LEVEL 1 MEAS TYPE................................002 (AVERAGE)

LEVEL 1 SAMP INTVL..............................00:00:01

LVL 1 DATA SET SIZE 00600

LEVEL 2 MEAS TYPE................................001 (LOG)

XMIT 2 OR 3 BYTES 03

HIGH LIMIT ....NO LIMIT

LOW LIMIT ....NO LIMIT

HIGH DIFF LIMIT.......................................NO LIMIT

LOW DIFF LIMIT..NO LIMIT

CHANNEL NO 02

V TO SCROLL TO CHANNEL 03

N PRESS MEAS KEY

CHANNEL #3 – WIND DIRECTION

SENSOR TYPE 02

SENSOR NAME TAG 02

CARD SLOT # 06

SENSOR PWR ADV 00:00:02

WD OUTPUT (0=POLAR, 1=RECT)...........0

FULL SCALE...359

ZERO SCALE 000

MEAS INTERVAL 01:00:00

START OF MEAS..NO ENTRY AT THIS TIME (BACK UP 10 MIN)

LEVEL 1 MEAS TYPE................................002 (AVERAGE)

LEVEL 1 SAMP INTVL 00:00:01

LVL 1 DATA SET SIZE 00600

LEVEL 2 MEAS TYPE................................001 (LOG)

SECONDARY CHANNEL 00

XMIT 2 OR 3 BYTES 03

CHANNEL NO 03

V TO SCROLL TO CHANNEL 04

N PRESS MEAS KEY

CHANNEL #4 – AIR TEMPERATURE

SENSOR TYPE 03

SENSOR NAME TAG 16

CARD SLOT # 06

SENSOR PWR ADV....................................00:00:02

TEMP INPUT (AIR TEMP)..........................01

TEMP SCALE 01

TEMP FORMAT 000

MEAS INTERVAL 01:00:00

START OF MEAS..NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE................................001 (LOG)

XMIT 2 OR 3 BYTES 03

HIGH LIMIT ....NO LIMIT

LOW LIMIT ....NO LIMIT

HIGH DIFF LIMIT.......................................NO LIMIT

LOW DIFF LIMIT..NO LIMIT

CHANNEL NO 04

V TO SCROLL TO CHANNEL 05

N PRESS MEAS KEY

CHANNEL #5 – FUEL TEMPERATURE

SENSOR TYPE 03

SENSOR NAME TAG 17

CARD SLOT # 06

SENSOR PWR ADV.....................................00:00:02

TEMP INPUT 02

TEMP SCALE 01

TEMP FORMAT 000

MEAS INTERVAL 01:00:00

START OF MEAS...NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE.................................001 (LOG)

XMIT 2 OR 3 BYTES 03

HIGH LIMIT ....NO LIMIT

LOW LIMIT ....NO LIMIT

HIGH DIFF LIMIT..NO LIMIT

LOW DIFF LIMIT...NO LIMIT

CHANNEL NO 05

V TO SCROLL TO CHANNEL 06

N PRESS MEAS KEY

CHANNEL #6 – RELATIVE HUMIDITY

SENSOR TYPE 04

SENSOR NAME TAG 04

CARD SLOT # 06

SENSOR PWR ADV 00:00:02

HUMIDITY CHAN 01

FULL SCALE...500

ZERO SCALE 000

MEAS INTERVAL 01:00:00

START OF MEAS..NO ENTRY AT THIS TIME (BACK UP 10 MIN)

LEVEL 1 MEAS TYPE................................002 (AVERAGE)

LEVEL 1 SAMP INTVL 00:00:01

LVL 1 DATA SET SIZE 00600

LEVEL 2 MEAS TYPE................................001

XMIT 2 OR 3 BYTES 03

HIGH LIMIT ....NO LIMIT

LOW LIMIT ....NO LIMIT

HIGH DIFF LIMIT.......................................NO LIMIT

LOW DIFF LIMIT..NO LIMIT

CHANNEL NO 06

V TO SCROLL TO CHANNEL 07

N PRESS MEAS KEY

CHANNEL #7 – BATTERY VOLTAGE

SENSOR TYPE 12

SENSOR NAME TAG 12

MEAS INTERVAL 01:00:00

START OF MEAS...NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE.................................001 (LOG)

XMIT 2 OR 3 BYTES 03

HIGH LIMIT ....NO LIMIT

LOW LIMIT ....NO LIMIT

HIGH DIFF LIMIT..NO LIMIT

LOW DIFF LIMIT...NO LIMIT

CHANNEL NO 07

V TO SCROLL TO CHANNEL 08

N PRESS MEAS KEY

NOTES

THE FIRST SEVEN CHANNELS WILL ALWAYS BE LOADED IN THE SAME

ORDER.

IF YOU HAVE BAROMETRIC PRESSURE– IT MUST BE LOADED IN CHANNEL #8.

THE FOLLOWING SENSORS MAY BE LOADED IN ANY OF THE REMAINING CHANNELS:

WIND DIRECTION (GUST)	FUEL MOISTURE 439A OR 439C
WIND SPEED (GUST)	SOLAR RADIATION
SOIL MOISTURE	
SOIL TEMP	

CHANNEL #8 – BAROMETRIC PRESSURE

YSI SETRA

SENSOR TYPE ....05...10

SENSOR NAME TAG ....05...05

CARD SLOT # ....06...06

SENSOR INPUT ADRS..F

SENSOR PWR ADV 00:00:02

SENSOR PWR ADR ....B

FULL SCALE...................................CALCULATE...........................500-1100 14.76–32.48

600-1100 17.72–32.48
800-1100 23.62–32.48

MEAS INTERVAL 01:00:00

START OF MEAS.......................................NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE..001 (LOG)

XMIT 2 OR 3 BYTES 03

HIGH LIMIT ....NO LIMIT

LOW LIMIT ....NO LIMIT

HIGH DIFF LIMIT..NO LIMIT

LOW DIFF LIMIT...NO LIMIT

CHANNEL NO 08

V TO SCROLL TO CHANNEL 09

N PRESS MEAS KEY

CHANNEL #_____ – FUEL MOISTURE

SENSOR TYPE 04

SENSOR NAME TAG 19*

CARD SLOT # 06

SENSOR PWR ADV 00:00:02

HUMIDITY CHAN 02**

FULL SCALE...500

ZERO SCALE 000

MEAS INTERVAL 01:00:00

START OF MEAS..NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE................................001 (LOG)

XMIT 2 OR 3 BYTES 03

HIGH LIMIT ....NO LIMIT

LOW LIMIT ....NO LIMIT

HIGH DIFF LIMIT.......................................NO LIMIT

LOW DIFF LIMIT..NO LIMIT

CHANNEL NO

V TO SCROLL TO CHANNEL

N PRESS MEAS KEY

* 4.Q SOFTWARE & UP

** 02 FUEL MOISTURE (439A) – 540
03 FUEL MOISTURE (439C)AND HAVE FIRMWARE 1.4 – 555

CHANNEL #_____ – WIND DIRECTION GUST*

SENSOR TYPE 02

SENSOR NAME TAG 02

CARD SLOT # 06

SENSOR PWR ADV 00:00:02

WD OUTPUT (0=POLAR, 1=RECT)...........0

FULL SCALE...359

ZERO SCALE 000

MEAS INTERVAL 01:00:00

START OF MEAS..NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE................................005 (MAXIMUM)

LEVEL 1 SAMP INTVL 00:00:01

LVL 1 DATA SET SIZE 03600

LEVEL 2 MEAS TYPE................................001

SECONDARY CHANNEL 00

XMIT 2 OR 3 BYTES 03

CHANNEL NO

V TO SCROLL TO CHANNEL

N PRESS MEAS KEY

* BE SURE AND CHECK START OF MEASURE

CHANNEL #_____ – WIND SPEED GUSTS ***

SENSOR TYPE.. 01

SENSOR NAME TAG....................................... 01

CARD SLOT #... 06

SENSOR PWR ADV 00:00:02

SENSOR THRESHOLD.................................... 000

FREQ/VEL (XX.XXX)...................................... 00.280 (1 ¾”) OR 00.262 (2")

MEAS INTERVAL.. 01:00:00

START OF MEAS .... NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE .... 005 (MAXIMUM)

LEVEL 1 SAMP INTVL 00:00:01

LVL 1 DATA SET SIZE.................................... 03600

LEVEL 2 MEAS TYPE .... 001 (LOG)

SECONDARY CHANNEL................................ ??*

XMIT 2 OR 3 BYTES.. 03

HIGH LIMIT... NO LIMIT

LOW LIMIT.. NO LIMIT

HIGH DIFF LIMIT .... NO LIMIT

LOW DIFF LIMIT .... NO LIMIT

CHANNEL NO

V TO SCROLL TO CHANNEL

N PRESS MEAS KEY

*THIS IS THE CHANNEL PROGRAMED FOR WIND DIRECTION GUSTS

*** BE SURE AND CHECK START OF MEASURE

CHANNEL #_____ – 12HR MAX AIR TEMPERATURE **

SENSOR TYPE.. 03

SENSOR NAME TAG...................................... 16

CARD SLOT #... 06

SENSOR PWR ADV 00:00:02

TEMP INPUT (AIR TEMP) 01

TEMP SCALE.. 01

TEMP FORMAT.. 000

MEAS INTERVAL 12:00:00

START OF MEAS .... NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE .... 005 (MAXIMUM)

LEVEL 1 MEAS INTERVAL 00:05:00

LVL 1 DATA SET SIZE.................................... 00144

LEVEL 2 MEASURE TYPE .... 001 (LOG)

SECONDARY CHANNEL............................... 00

XMIT 2 OR 3 BYTES....................................... 03

HIGH LIMIT .... NO LIMIT

LOW LIMIT.. NO LIMIT

HIGH DIFF LIMIT .... NO LIMIT

LOW DIFF LIMIT .... NO LIMIT

CHANNEL NO

V TO SCROLL TO CHANNEL

N PRESS MEAS KEY

** YOU WILL NEED TO DECIDE THE 1ST TIME OF MEASURE FOR A 12 HR PERIOD

AND ENTER THIS LATER – SEE PAGE 19.

CHANNEL #_____ – 12HR MIN AIR TEMPERATURE **

SENSOR TYPE.. 03

SENSOR NAME TAG....................................... 16

CARD SLOT #... 06

SENSOR PWR ADV 00:00:02

TEMP INPUT (AIR TEMP) 01

TEMP SCALE.. 01

TEMP FORMAT.. 000

MEAS INTERVAL.. 12:00:00

START OF MEAS .... NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE .... 004 (MINIMUM)

LEVEL 1 MEAS INTERVAL 00:05:00

LVL 1 DATA SET SIZE.................................... 00144

LEVEL 2 MEASURE TYPE .... 001 (LOG)

SECONDARY CHANNEL............................... 00

XMIT 2 OR 3 BYTES.. 03

HIGH LIMIT... NO LIMIT

LOW LIMIT.. NO LIMIT

HIGH DIFF LIMIT .... NO LIMIT

LOW DIFF LIMIT .... NO LIMIT

CHANNEL NO

V TO SCROLL TO CHANNEL

N PRESS MEAS KEY

** YOU WILL NEED TO DECIDE THE 1ST TIME OF MEASURE FOR A 12 HR PERIOD AND ENTER THIS LATER – SEE PAGE 19.

CHANNEL #_____ – 12HR MAX RELATIVE HUMIDITY**

SENSOR TYPE.. 04

SENSOR NAME TAG...................................... 04

CARD SLOT #.. 06

SENSOR PWR ADV 00:00:02

HUMIDITY CHAN (RH) 01

FULL SCALE 500

ZERO SCALE... 000

MEAS INTERVAL... 12:00:00

START OF MEAS .... NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE .... 005 (MAXIMUM)

LEVEL 1 MEAS INTERVAL 00:05:00

LVL 1 DATA SET SIZE................................... 00144

LEVEL 2 MEASURE TYPE .... 001 (LOG)

SECONDARY CHANNEL............................... 00

XMIT 2 OR 3 BYTES....................................... 03

HIGH LIMIT.. NO LIMIT

LOW LIMIT... NO LIMIT

HIGH DIFF LIMIT .... NO LIMIT

LOW DIFF LIMIT .... NO LIMIT

CHANNEL NO

V TO SCROLL TO CHANNEL

N PRESS MEAS KEY

** YOU WILL NEED TO DECIDE THE 1ST TIME OF MEASURE FOR A 12 HR PERIOD

AND ENTER THIS LATER – SEE PAGE 19.

CHANNEL #_____ – 12HR MIN RELATIVE HUMIDITY**

SENSOR TYPE.. 04

SENSOR NAME TAG....................................... 04

CARD SLOT #... 06

SENSOR PWR ADV 00:00:02

HUMIDITY CHAN (RH) 01

FULL SCALE 500

ZERO SCALE.. 000

MEAS INTERVAL.. 12:00:00

START OF MEAS .... NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE .... 004 (MINIMUM)

LEVEL 1 MEAS INTERVAL 00:05:00

LVL 1 DATA SET SIZE................................... 00144

LEVEL 2 MEASURE TYPE .... 001 (LOG)

SECONDARY CHANNEL............................... 00

XMIT 2 OR 3 BYTES.. 03

HIGH LIMIT .... NO LIMIT

LOW LIMIT.. NO LIMIT

HIGH DIFF LIMIT .... NO LIMIT

LOW DIFF LIMIT .... NO LIMIT

CHANNEL NO

V WILL SCROLL TO CHANNEL

N PRESS MEAS KEY

** YOU WILL NEED TO DECIDE THE 1ST TIME OF MEASURE FOR A 12 HR PERIOD

AND ENTER THIS LATER – SEE PAGE 19.

CHANNEL #_____ – SOLAR RADIATION

SENSOR TYPE 08

SENSOR NAME TAG 08

CARD SLOT # 06

SENSOR PWR ADV 00:00:02

FULL SCALE ...._ _ _ _ (CALL DEPOT– RCA PROGRAM

ZERO SCALE ....-_ _ _ _ W/CONSTANT FROM CALIBRATION ._ _ _ _ SHEET)

MEAS INTERVAL 01:00:00

START OF MEAS..NO ENTRY AT THIS TIME

LEVEL 1 MEAS TYPE................................001(LOG)

XMIT 2 OR 3 BYTES 03

HIGH LIMIT ....NO LIMIT

LOW LIMIT ....NO LIMIT

HIGH DIFF LIMIT.......................................NO LIMIT

LOW DIFF LIMIT..NO LIMIT

CHANNEL NO

V WILL SCROLL TO CHANNEL

AFTER ALL CHANNELS ARE PROGRAMMED

I PRESS ID KEY ....BE SURE IT IS CORRECT

K PRESS XMIT KEY TO CHECK GOES PRI XMIT MODE

GOES PRI XMIT MODE........................12 (SHORT PREAMBLE)

* 1ST GOES XMIT TIME...........................NO ENTRY AT THIS TIME

PRI XMIT INTERVAL...........................01:00:00 03:00:00

XMT WINDOW SIZE............................00:00:15 00:01:00

GOES SEC XMT MODE........................00

WWV SYNC TIME................................ENTER TIME FOR CLOCK TO TURN ON
1400 - 1700 GOOD RANGE TO CHOOSE
FROM

J PRESS TIME KEY

STATION TIME.....................................NO ENTRY AT THIS TIME - WILL
SHOW
....CURRENT DCP TIME

YEAR..NO ENTRY AT THIS TIME

JULIAN DATE.......................................NO ENTRY AT THIS TIME(SEE TIME

PAGE)

GMT TIME..SHOWS TIME BASED ON PC TIME

DIFF TIME...00:00:00

DCP LEADS=1 P/S LEADS= 2.............02

SCROLL THRU THE TIME KEY PROMPT AND ENSURE ALL DATA IS NOW

CORRECT

M SELECT CHANNEL #1

$ (SHIFT 4) FSCAN KEY

READ VALUE

DO THE SAME FOR ALL REMAINING CHANNELS ENSURING THAT THE DATA YOU ARE GETTING IS CORRECT FOR THAT SENSOR

IF ALL DATA IS CORRECT YOU ARE READY TO ENTER:
1ST GOES XMIT TIME AND 1ST START OF MEASURE

K SCROLL DOWN TO THE 1ST GOES XMIT TIME

1ST GOES XMIT TIME: PUT IN NEXT GMT THE STATION WILL TRANSMIT

M ENTER START OF MEASURE FOR EACH CHANNEL (BE SURE YOU HAVE ENOUGH TIME)

SCROLL TO CHANNEL #1

N SCROLL DOWN TO THE 1ST START OF MEASURE–ENTER CORRECT GMT TIME (THE NEXT START OF MEASURE – MAKE SURE THIS TIME HAS NOT PASSED).

DO THE SAME FOR ALL CHANNELS (ANSWER YES **(1)** TO CHANGE ALL CHANS.)

M O V – KEY COMBINATION TO MOVE TO CHANNEL'S MEASURE INTERVAL AND DOWN ONE TO START OF MEASURE

BACK UP AVERAGE'S 10 MIN. CH 2, 3, 6

CH ?????? (MAX & MIN AT, MAX & MIN RH) PICK THE TIME YOU WANT THE 12 HR PERIOD TO START. ENTER THE CORRECT GMT TIME.

BE SURE TO CHECK ALL CHANNELS

VOICE MODE???

SPACE BAR

VOICE OUTPUT MODE 01

Y RUN MODE

T CHECK TIME TO NEXT TRANSMIT (HOW LONG BEFORE NEXT TRANSMIT)

S CHECK TIME TO NEXT SCAN

AFTER STATION HAS TRANSMITTED GIVE BOISE RAWS FOLKS A CALL THEY WILL CHECK TO SEE IF THE STATION CAME IN AND IS WORKING CORRECTLY.

SENSOR TYPE

01 WIND SPEED
02 WIND DIRECTION
03 TEMPERATURE
04 RELATIVE HUMIDITY
05 BAROMETRIC PRESSURE
06 WEIGHTING GAGE
07 TIPPING BUCKET
08 SOLAR RADIATION
09 DEW POINT
10 ANALOG INPUT
11 INCREMENTAL ENCODER
12 BATTERY VOLTAGE
13 ADR INPUT
14 ABSOLUTE SHAFT ENCODER
15 SERIAL DATA INPUT

MEASURE TYPE
01 LOG
02 AVERAGE
04 MINIMUM
05 MAXIMUM

HUMIDITY CHANNEL (1,2,3)
01 RELATIVE HUMIDITY
02 FUEL MOISTURE (439A)
03 FUEL MOISTURE (439C)

BAROMETRIC SENSOR (SETRA)

500 – 1100	14.76 - 32.48
600 – 1100	17.72 - 32.48
800 – 1100	23.62 - 32.48

SENSOR NAME TAG (WHAT IT SAYS)

01 WIND SPEED
02 AT (WD)-RADIO SAYS WS 'AT' __ °
03 AIR TEMP (C)
04 RH
05 BAROMETRIC PRESSURE
06 RAIN
07 RAIN
08 S.R.
09 D.P.
10 A.I.
11 I.E.
12 BATTERY
13 A.D.R.
14 S.E.
15 FUEL TEMP (C)
16 AIR TEMP (F)
17 FUEL TEMP (F)
18 LEVEL
19 FUEL M

TEMP INPUT (1,8)
01 AIR TEMP
02 FUEL TEMP
03 SOIL TEMP

A QUESTION OF TIME ?????

1 Hour Xmit	
1st Quarter	00:XX:00
2nd Quarter	00:XX:15
3rd Quarter	00:XX:30
4th Quarter	00:XX:45

3 Hour Xmit		
00:XX:00	01:XX:00	02:XX:00
03:XX:00	04:XX:00	05:XX:00
06:XX:00	07:XX:00	08:XX:00
09:XX:00	10:XX:00	11:XX:00
12:XX:00	13:XX:00	14:XX:00
15:XX:00	16:XX:00	17:XX:00
18:XX:00	19:XX:00	20:XX:00
21:XX:00	22:XX:00	23:XX:00

A QUESTION OF DATE????

JULIAN DATE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1	32	60	91	121	152	182	213	244	274	305	335
2	2	33	61	92	122	153	183	214	245	275	306	336
3	3	34	62	93	123	154	184	215	246	276	307	337
4	4	35	63	94	124	155	185	216	247	277	308	338
5	5	36	64	95	125	156	186	217	248	278	309	339
6	6	37	65	96	126	157	187	218	249	279	310	340
7	7	38	66	97	127	158	188	219	250	280	311	341
8	8	39	67	98	128	159	189	220	251	281	312	342
9	9	40	68	99	129	160	190	221	252	282	313	343
10	10	41	69	100	130	161	191	222	253	283	314	344
11	11	42	70	101	131	162	192	223	254	284	315	345
12	12	43	71	102	132	163	193	224	255	285	316	346
13	13	44	72	103	133	164	194	225	256	286	317	347
14	14	45	73	104	134	165	195	226	257	287	318	348
15	15	46	74	105	135	166	196	227	258	288	319	349
16	16	47	75	106	136	167	197	228	259	289	320	350
17	17	48	76	107	137	168	198	229	260	290	321	351
18	18	49	77	108	138	169	199	230	261	291	322	352
19	19	50	78	109	139	170	200	231	262	292	323	353
20	20	51	79	110	140	171	201	232	263	293	324	354
21	21	52	80	111	141	172	202	233	264	294	325	355
22	22	53	81	112	142	173	203	234	265	295	326	356
23	23	54	82	113	143	174	204	235	266	296	327	357
24	24	55	83	114	144	175	205	236	267	297	328	358
25	25	56	84	115	145	176	206	237	268	298	329	359
26	26	57	85	116	146	177	207	238	269	299	330	360
27	27	58	86	117	147	178	208	239	270	300	331	361
28	28	59	87	118	148	179	209	240	271	301	332	362
29	29		88	119	149	180	210	241	272	302	333	363
30	30		89	120	150	181	211	242	273	303	334	364
31	31		90		151		212	243		304		365

Leap year

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1	32	61	92	122	153	183	214	245	275	306	336
2	2	33	62	93	123	154	184	215	246	276	307	337
3	3	34	63	94	124	155	185	216	247	277	308	338
4	4	35	64	95	125	156	186	217	248	278	309	339
5	5	36	65	96	126	157	187	218	249	279	310	340
6	6	37	66	97	127	158	188	219	250	280	311	341
7	7	38	67	98	128	159	189	220	251	281	312	342
8	8	39	68	99	129	160	190	221	252	282	313	343
9	9	40	69	100	130	161	191	222	253	283	314	344
10	10	41	70	101	131	162	192	223	254	284	315	345
11	11	42	71	102	132	163	193	224	255	285	316	346
12	12	43	72	103	133	164	194	225	256	286	317	347
13	13	44	73	104	134	165	195	226	257	287	318	348
14	14	45	74	105	135	166	196	227	258	288	319	349
15	15	46	75	106	136	167	197	228	259	289	320	350
16	16	47	76	107	137	168	198	229	260	290	321	351
17	17	48	77	108	138	169	199	230	261	291	322	352
18	18	49	78	109	139	170	200	231	262	292	323	353
19	19	50	79	110	140	171	201	232	263	293	324	354
20	20	51	80	111	141	172	202	233	264	294	325	355
21	21	52	81	112	142	173	203	234	265	295	326	356
22	22	53	82	113	143	174	204	235	266	296	327	357
23	23	54	83	114	144	175	205	236	267	297	328	358
24	24	55	84	115	145	176	206	237	268	298	329	359
25	25	56	85	116	146	177	207	238	269	299	330	360
26	26	57	86	117	147	178	208	239	270	300	331	361
27	27	58	87	118	148	179	209	240	271	301	332	362
28	28	59	88	119	149	180	210	241	272	302	333	363
29	29	60	89	120	150	181	211	242	273	303	334	364
30	30		90	121	151	182	212	243	274	304	335	365
31	31		91		152		213	244		305		366

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #4

Snow Survey Sampling Guide

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for recording snow measures on National Resource Conservation Service Snow Course sites. This SOP was extracted from the (http://www.wcc.nrcs.usda.gov/factpub/ah169/ah169.htm) without alteration, and is provided here to ensure accessibility. It is current as of 16 November 2004.

Snow Survey Sampling Guide

Agriculture Handbook 169

Introduction

The purpose of this guide is to promote efficient and accurate snow surveying and to establish uniform sampling procedures.

It is a training and reference guide designed for snow surveyors who use sampling equipment to measure snow accumulation. It explains sampling and recording procedures essential for accurate forecasts of the Nation's water supplies.

Importance of Accuracy

Accuracy is essential. A small error in snow sampling can produce a large error in the water supply forecast. An error in measurement affects not only current reports but also analyses of archival data in future years.

Care of Sampling Equipment

Taking good care of your sampling equipment can make the difference between a good survey and a poor one.

1. Handle the equipment carefully to prevent damage. A four-section sampling set costs more than $500.
2. Do not cling to sampling tubes while sampling on steep slopes.

3. Keep the sampling tubes clean and covered inside and out with a thin coating of spray silicone or wax. A coating keeps the snow from adhering to the tube and prevents corrosion.
4. Ice and rock feel and sound similar when struck by the sampling tube. Before you exert pressure, be sure you are striking ice.
5. Keep the cutter sharp and the orifice true to its original diameter. If the cutter is broken or badly worn, ask for a replacement.

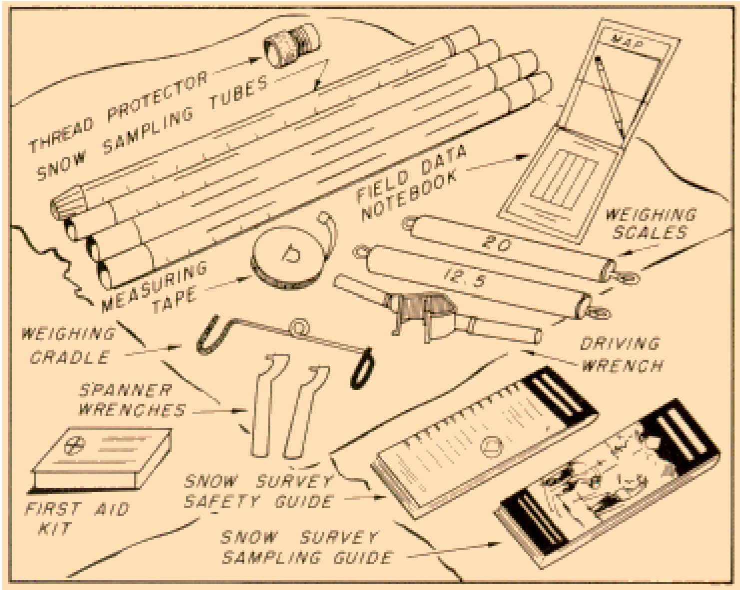
Take special care to avoid error while reading snow depth and tube weight. Be sure the core sample represents the full depth of the snow.

Checking Equipment

Before leaving headquarters --

1. See that tubes are properly siliconed or waxed.
2. Make sure the coupling threads are clean and that all the tube sections screw together without binding.
3. Check the sampling kit for the following items:
    - Sampling tube sections that match
    - Spanner wrenches
    - Thread protector
    - Driving wrench (optional)
    - Field data notebook (SCS-EN-708)
    - Pencil
    - Weighing scale and cradle
    - Snow course map
    - Measuring tape
    - Snow Survey Safety Guide
    - First aid kit
    - Snow Survey Sampling Guide

Snow Sampling Kit

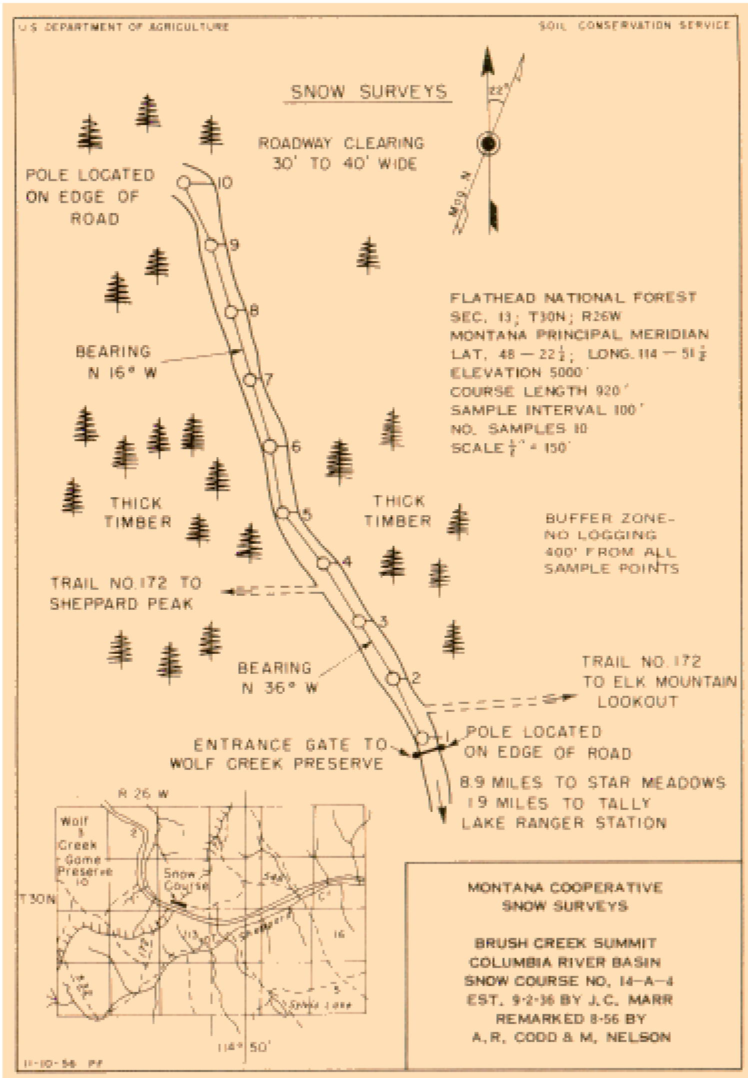


4. Check your oversnow traveling equipment for:
   - Goggles
   - Skis -- running surface, binding, poles, climbers
   - Snowshoes -- varnish coating, webbing, bindings
   - Oversnow vehicle -- fuel and oil (see operating manual)

5. Check your clothing and that of your companions. See Snow Survey Safety Guide.

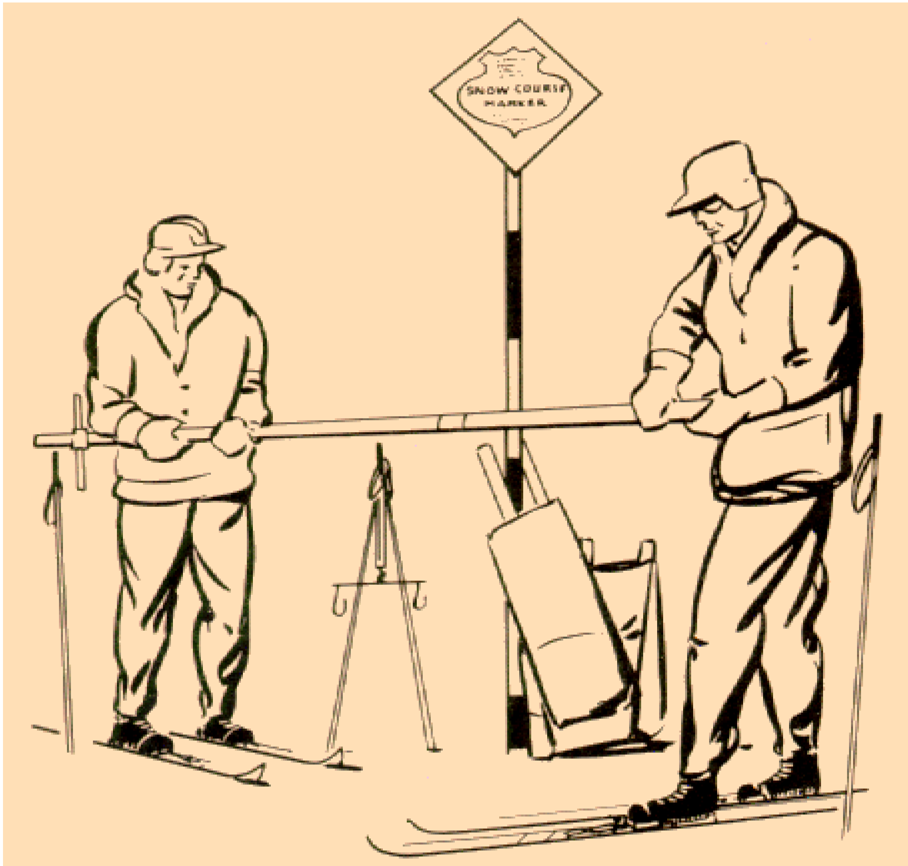
It is much easier to check these items at headquarters, where replacements are available, than at the snow course.

Snow Sampling Procedures - Step 1



Check the location sketch map of the snow course for sampling point No. 1. Do not drive the snow machine on the snow course. Do not walk on the snow course without snowshoes or skis. Keep walking to a minimum.

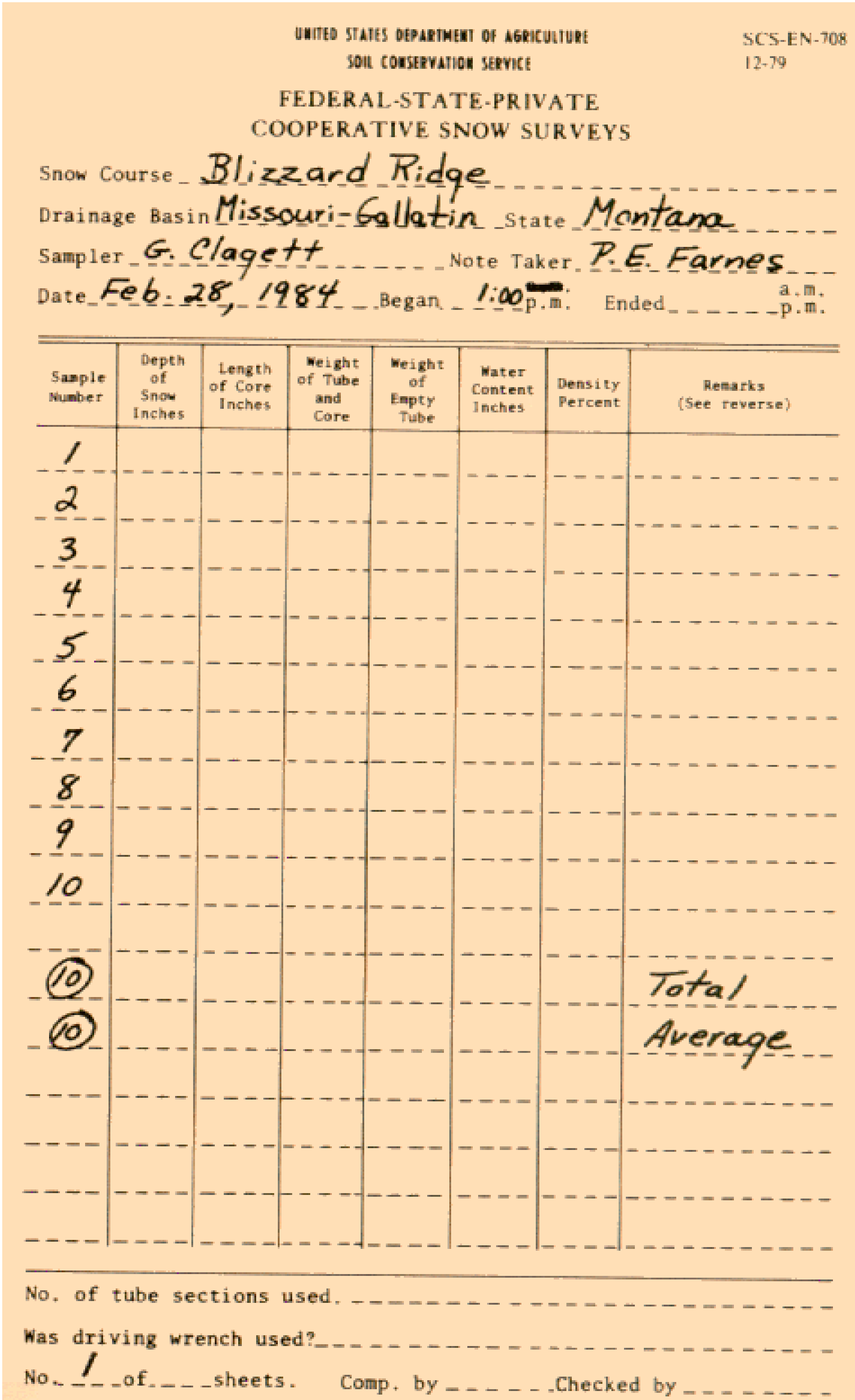
Snow Sampling Procedures - Step 2



Assemble sampling tube, screwing sections together handtight (no wrenches). Make sure the numbers run consecutively throughout the length. Use three or more sections of tubing unless the scale has been adjusted for light weights or accessory weights are added. Add thread protector to top section of tubing.

Snow Sampling Procedures - Step 3

Fill in heading on field note.



UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-EN-708
12-79

FEDERAL-STATE-PRIVATE
COOPERATIVE SNOW SURVEYS

Snow Course Blizzard Ridge

Drainage Basin Missouri-Gallatin State Montana

Sampler G. Clagett Note Taker P.E. Farnes

Date Feb. 28, 1984 Began 1:00 ~~a.m.~~ p.m. Ended a.m. p.m.

Sample Number	Depth of Snow Inches	Length of Core Inches	Weight of Tube and Core	Weight of Empty Tube	Water Content Inches	Density Percent	Remarks (See reverse)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
10							Total
10							Average

No. of tube sections used.

Was driving wrench used?

No. 1 of sheets. Comp. by Checked by

Snow Sampling Procedures - Step 4

If there is no marker at sampling point No. 1, find the point by measuring the correct distance from the snow course end marker, following directions shown on the snow course map.

One surveyor should carry the sampling tube and headend of tape. The second surveyor should carry the scale and notebook and hold the rear end of the tape. The second surveyor sights the first surveyor on line of the course with the next marker.

Snow Sampling Procedures - Step 5

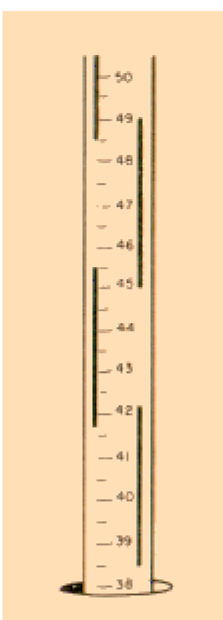
Before taking a sample, look through the tube to check for cleanliness. Hold the sampling tube away from your eye, cutter end up.

Snow Sampling Procedures - Step 6

Hold the sampling tube vertically (cutter end down) and drive it to the ground surface. Wear gloves to keep the tube cool and to make sampling easier. Be sure the cutter penetrates to the ground surface.

Snow Sampling Procedures - Step 7

Before raising the tube, read the depth of snow to the nearest one-half inch. Record the reading.



Snow Sampling Procedures - Step 8

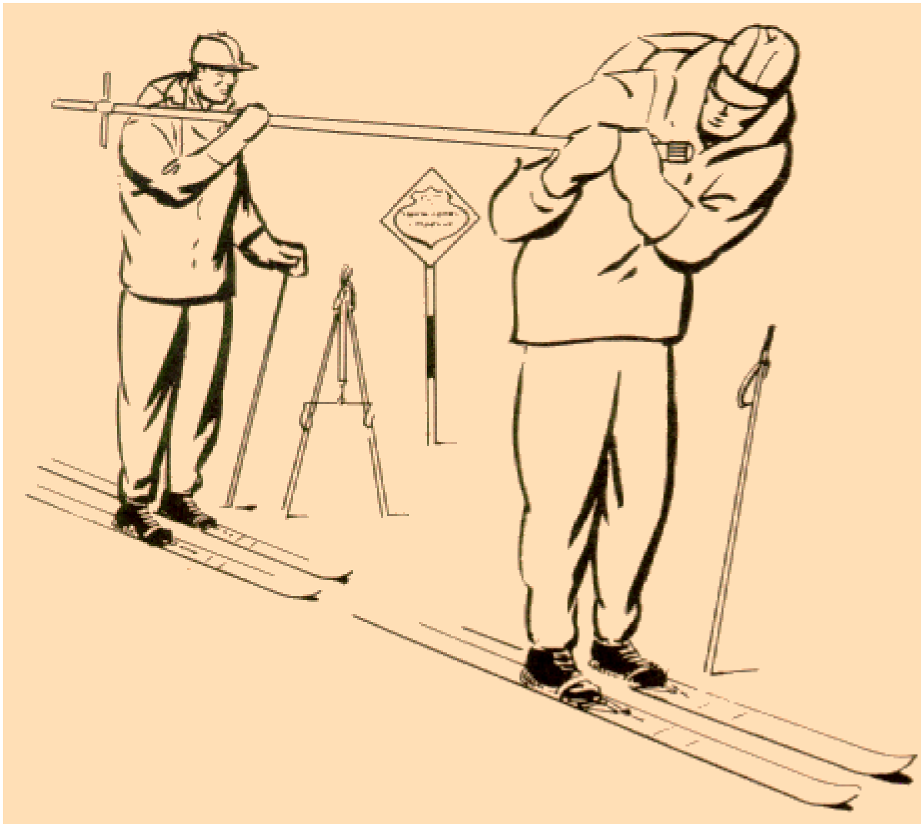
Turn tube at least one turn to right to cut core loose from earth. Carefully raise tube, look through slots, and read core length to the nearest one-half inch.

Call reading to the recorder.

Raise tube carefully out of snow.

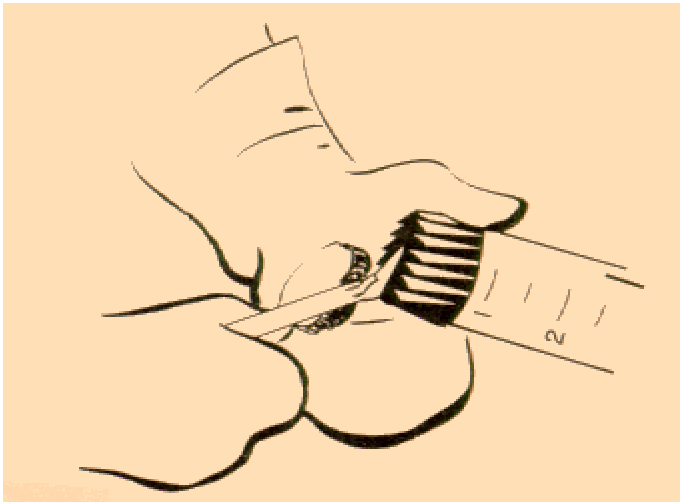
Note: Core length should be at least 90 percent of the snow depth except in snow of very low density or mushy snow. If it isn't, retake the sample or explain any deviation under "Remarks."

Snow Sampling Procedures - Step 9



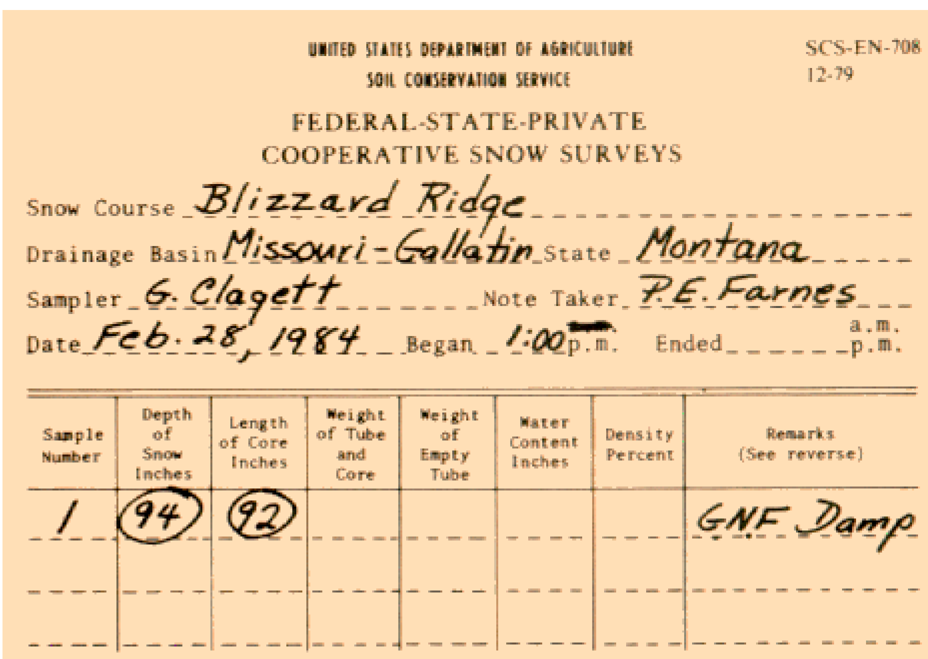
Inspect cutter end of tube for dirt or litter.

Snow Sampling Procedures - Step 10



With gloves on, use a knife, can opener, or other tool to carefully remove soil and litter from the cutter and tube. Throw the debris or litter several feet (15 feet or more) away from sampling point. This prevents the formation of melt holes at the sampling point.

Correct the reading for snow depth and core length by subtracting the distance driven into soil or litter.



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SOIL CONSERVATION SERVICE

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12-79

FEDERAL-STATE-PRIVATE
COOPERATIVE SNOW SURVEYS

Snow Course Blizzard Ridge
Drainage Basin Missouri-Gallatin State Montana
Sampler G. Clagett Note Taker P.E. Farnes
Date Feb. 28, 1984 Began 1:00 p.m. Ended a.m. p.m.

Sample Number	Depth of Snow Inches	Length of Core Inches	Weight of Tube and Core	Weight of Empty Tube	Water Content Inches	Density Percent	Remarks (See reverse)
1	94	92					GNF Damp

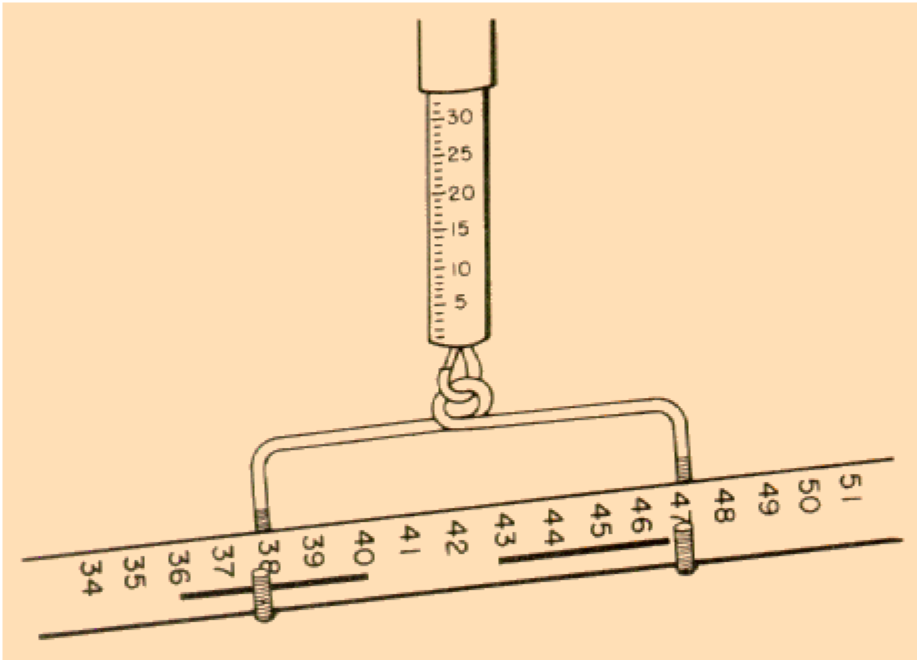
Record data as follows:

Record depth of snow to nearest one-half inch (94 inches, circled above).

If sampling point is bare, record a zero in snow-depth column. Do not move away from sampling point to find a spot with snow.

Record length of core to nearest one-half inch (92 inches).

Snow Sampling Procedures - Step 11



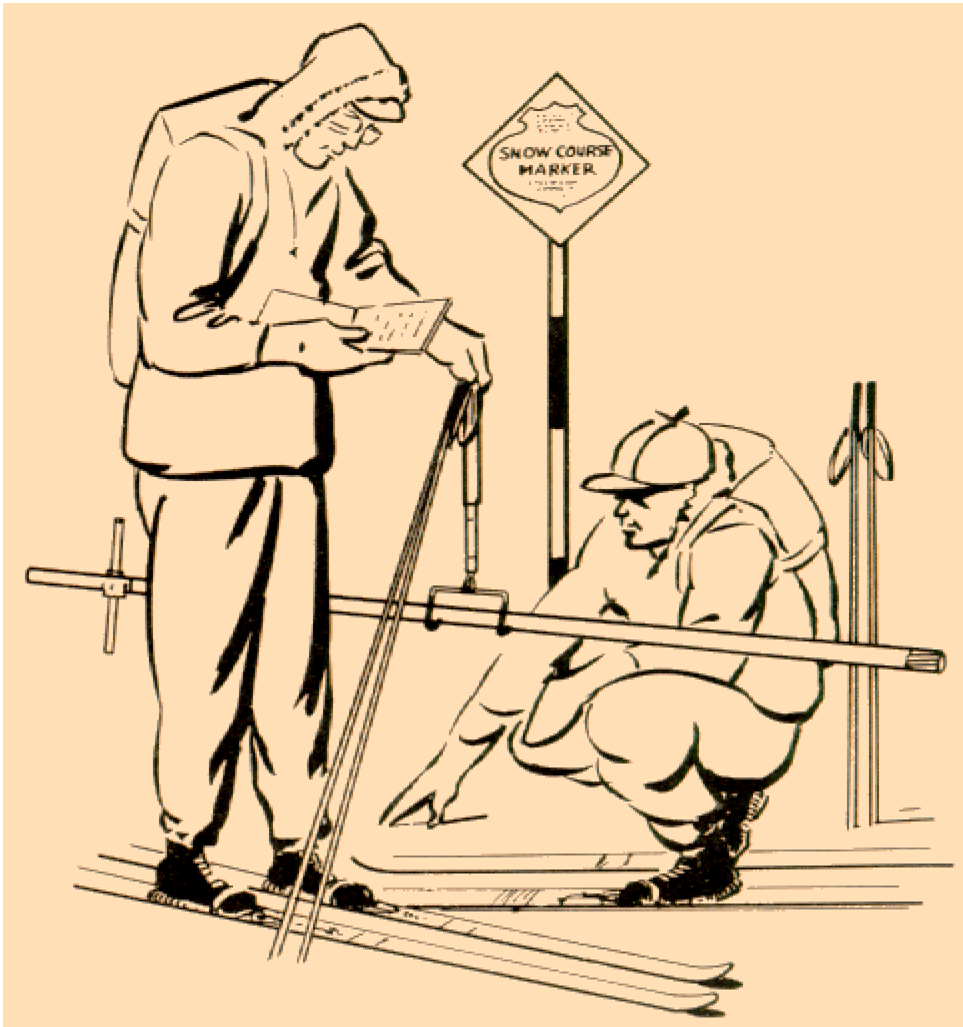
Carefully balance the sampling tube containing the core on the weighing cradle.

Never hold the weighing scale with hand around barrel. Suspend it like a pendulum from a ski pole.

If windy, point the tube into the wind.

To ensure an accurate reading, gently tap the scale to be sure it is not sticking or binding.

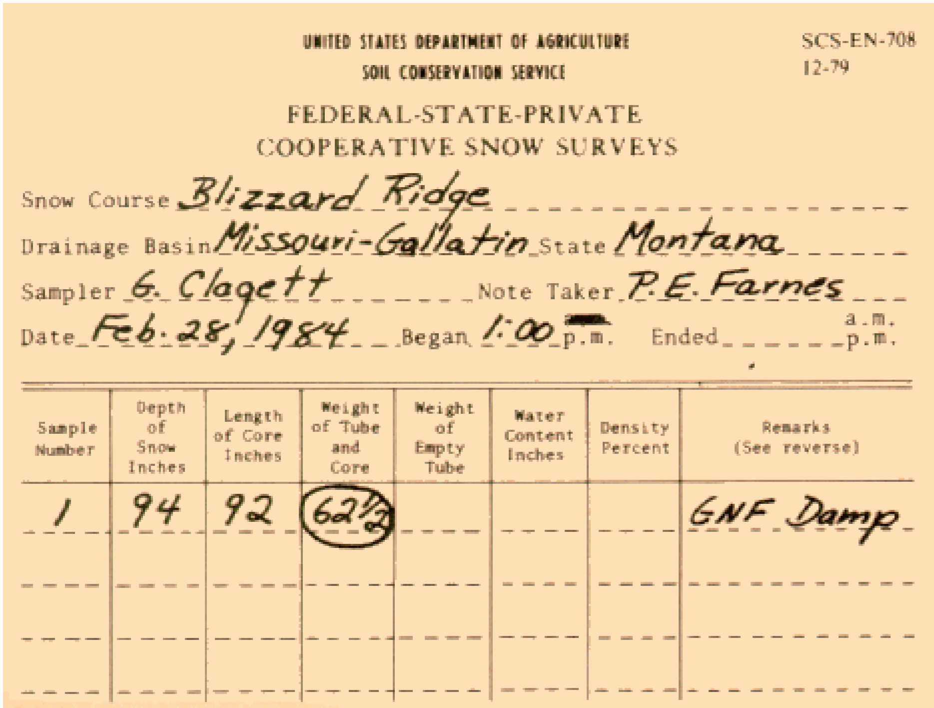
Snow Sampling Procedures - Step 12



Read the weight of tube and core from the graduations on the scale. The scale is marked in inches of water.

Caution: Scales of 12-1/2-foot-tube capacity have graduations equal to 1 inch. Scales of 20-foot-tube capacity have graduations equal to 2 inches.

Snow Sampling Procedures - Step 13



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FEDERAL-STATE-PRIVATE
COOPERATIVE SNOW SURVEYS

Snow Course Blizzard Ridge

Drainage Basin Missouri-Gallatin State Montana

Sampler G. Clagett Note Taker P.E. Farnes

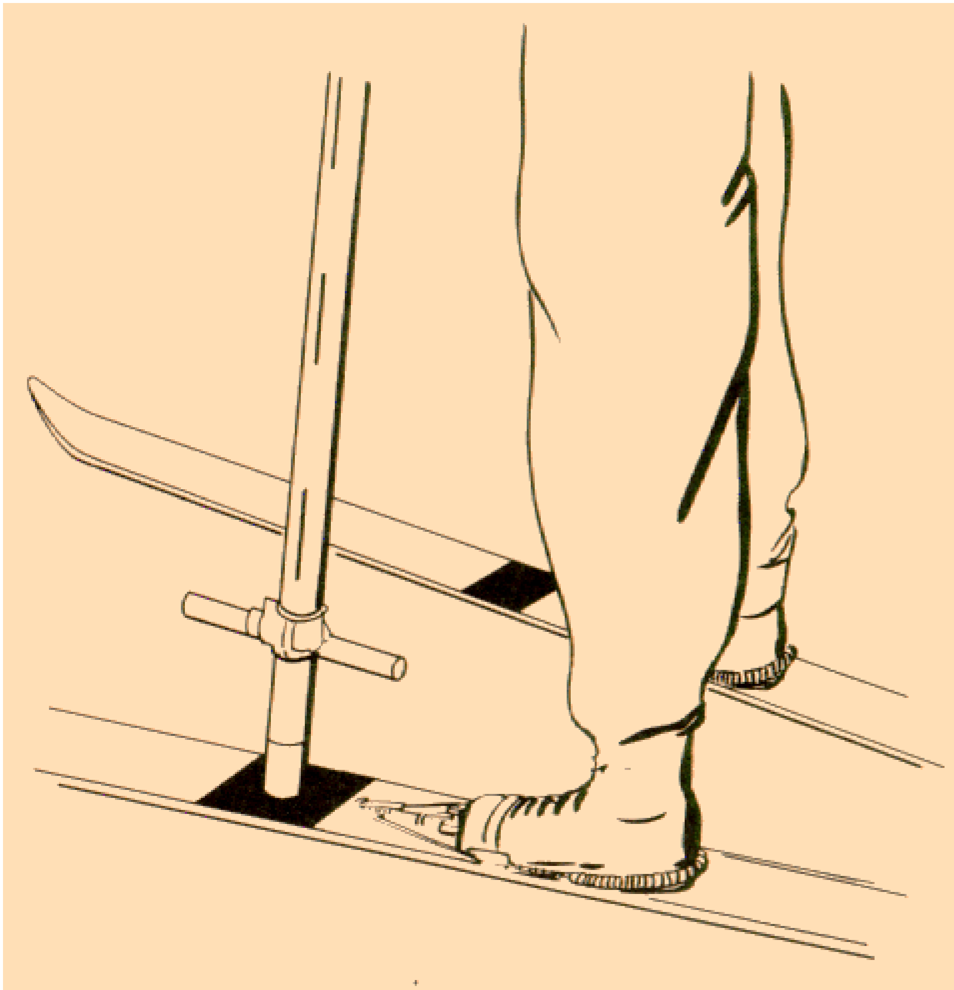
Date Feb. 28, 1984 Began 1:00 p.m. Ended a.m. p.m.

Sample Number	Depth of Snow Inches	Length of Core Inches	Weight of Tube and Core	Weight of Empty Tube	Water Content Inches	Density Percent	Remarks (See reverse)
1	94	92	62½				GNF Damp

Record the weight of the tube and core to the nearest one-half inch (62 1/2 inches) when using scales for 12-1/2-foot tubes and to the nearest inch when using scales for 20-foot tubes.

When the primary snowpack area of a watershed normally contains snow of low water content or very low density, or both, it is desirable to read the 12-1/2-foot scale to the nearest one-tenth inch.

Snow Sampling Procedures - Step 14



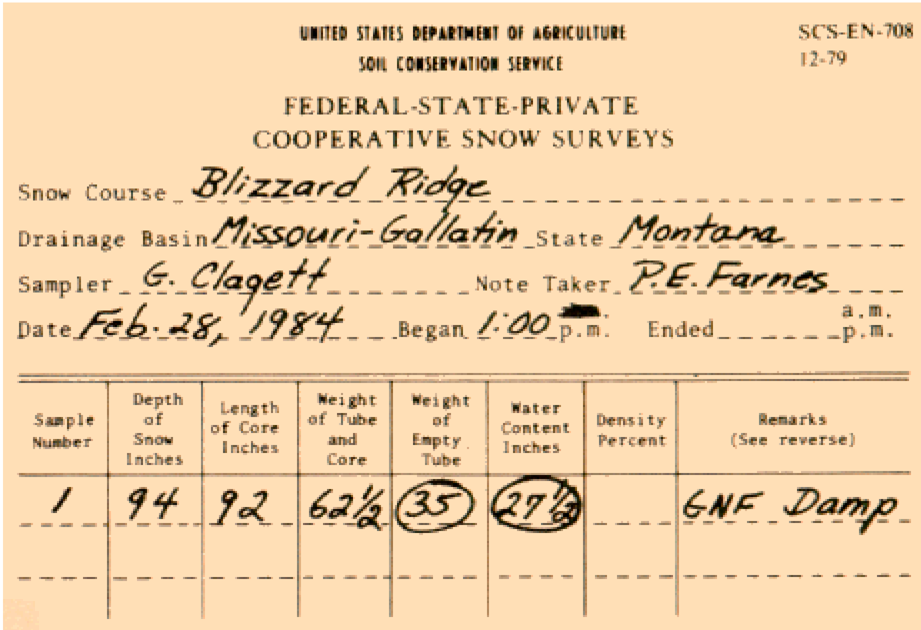
Lift the tube from the cradle and turn cutter end up. Tap the tube against a rubber pad on the ski or snowshoe to remove the snow core. Inspect the inside to see that all snow has been removed.

Note: A well-siliconed or waxed tube helps in removing the core.

Snow Sampling Procedures - Step 15

Weigh the empty sampling tube. The weight of the empty tube must read greater than zero on the scale. If using a driving wrench, be sure to leave it attached when weighing the empty tube and when weighing the tube and core of snow.

Snow Sampling Procedures - Step 16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SOIL CONSERVATION SERVICE

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12-79

FEDERAL-STATE-PRIVATE
COOPERATIVE SNOW SURVEYS

Snow Course Blizzard Ridge
Drainage Basin Missouri-Gallatin State Montana
Sampler G. Clagett Note Taker P.E. Farnes
Date Feb. 28, 1984 Began 1:00 [redacted] p.m. Ended ______ a.m. p.m.

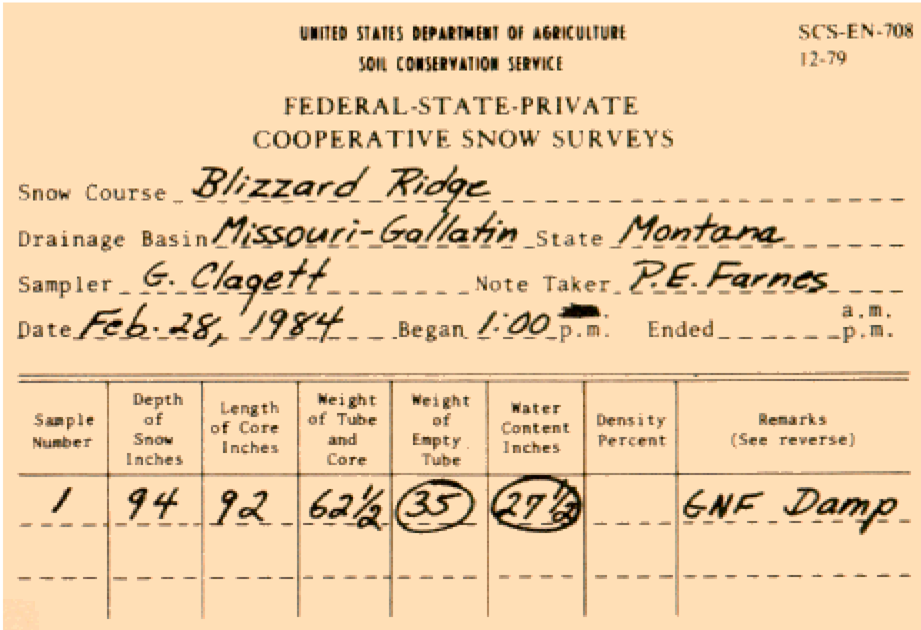
Sample Number	Depth of Snow Inches	Length of Core Inches	Weight of Tube and Core	Weight of Empty Tube	Water Content Inches	Density Percent	Remarks (See reverse)
1	94	92	62½	35	27½		GNF Damp

Record the weight of the empty tube to the nearest one-half inch or one-tenth inch for 12-1/2-foot tubes and to the nearest 1 inch for 20-foot tubes.

Check weight of the empty tube at least every fifth sample because small particles of water or snow often cling to the inside and outside of the tube. Checking helps make the sampling more accurate.

Whenever sections of tube are put on or taken off during the sampling, obtain a new empty weight.

Snow Sampling Procedures - Step 17



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FEDERAL-STATE-PRIVATE
COOPERATIVE SNOW SURVEYS

Snow Course Blizzard Ridge

Drainage Basin Missouri-Gallatin State Montana

Sampler G. Clagett Note Taker P.E. Farnes

Date Feb. 28, 1984 Began 1:00 p.m. Ended a.m. p.m.

Sample Number	Depth of Snow Inches	Length of Core Inches	Weight of Tube and Core	Weight of Empty Tube	Water Content Inches	Density Percent	Remarks (See reverse)
1	94	92	62½	35	27½		GNF Damp

Subtract the weight of the empty tube from the weight of the tube and core to obtain the water content.

Snow Sampling Procedures - Step 18

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FEDERAL-STATE-PRIVATE
COOPERATIVE SNOW SURVEYS

Snow Course Blizzard Ridge

Drainage Basin Missouri-Gallatin State Montana

Sampler G. Clagett Note Taker P.E. Farnes

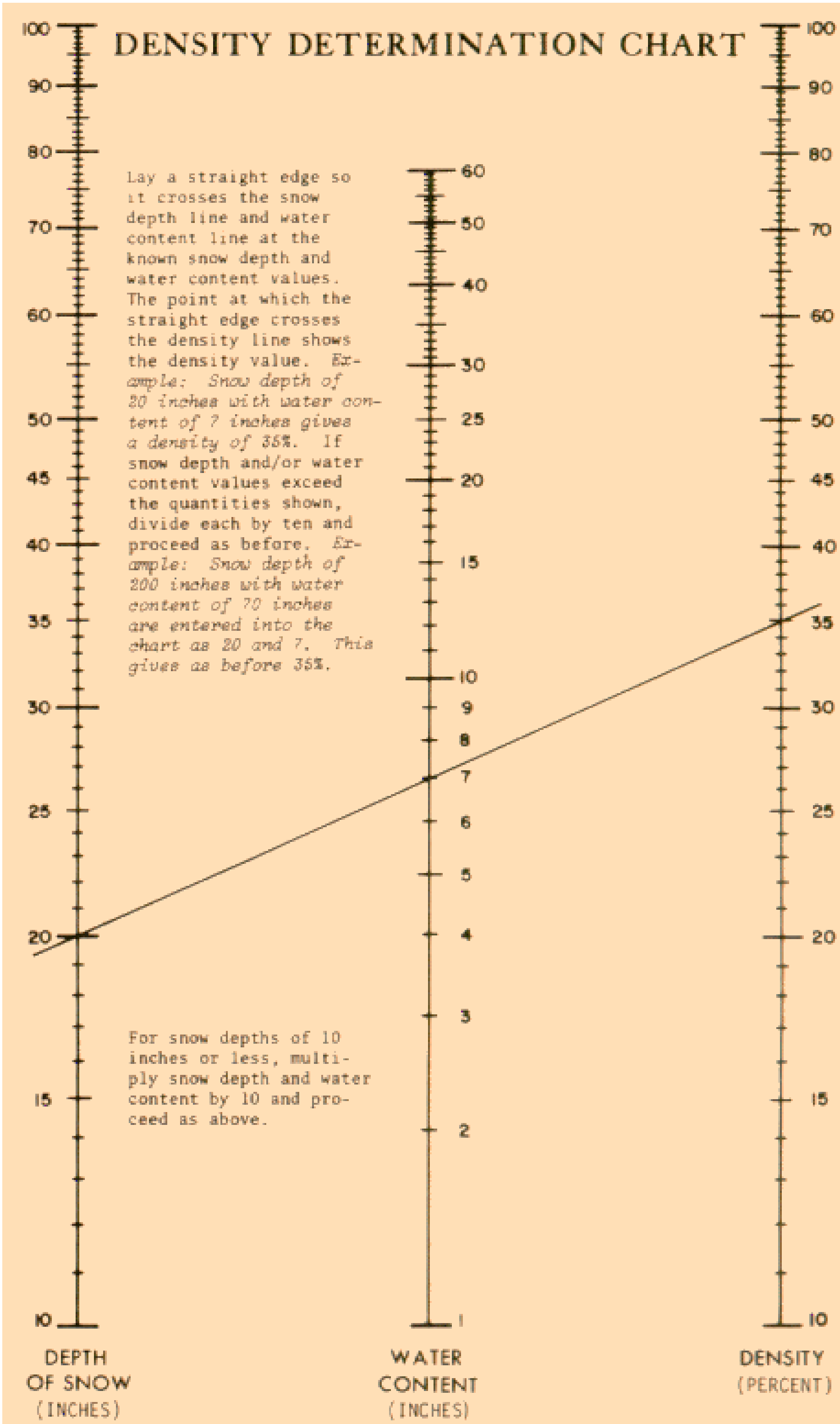
Date Feb. 28, 1984 Began 1:00 ~~a.m.~~ p.m. Ended ______ a.m. p.m.

Sample Number	Depth of Snow Inches	Length of Core Inches	Weight of Tube and Core	Weight of Empty Tube	Water Content Inches	Density Percent	Remarks (See reverse)
1	94	92	62½	35	27½	29	GNF Damp

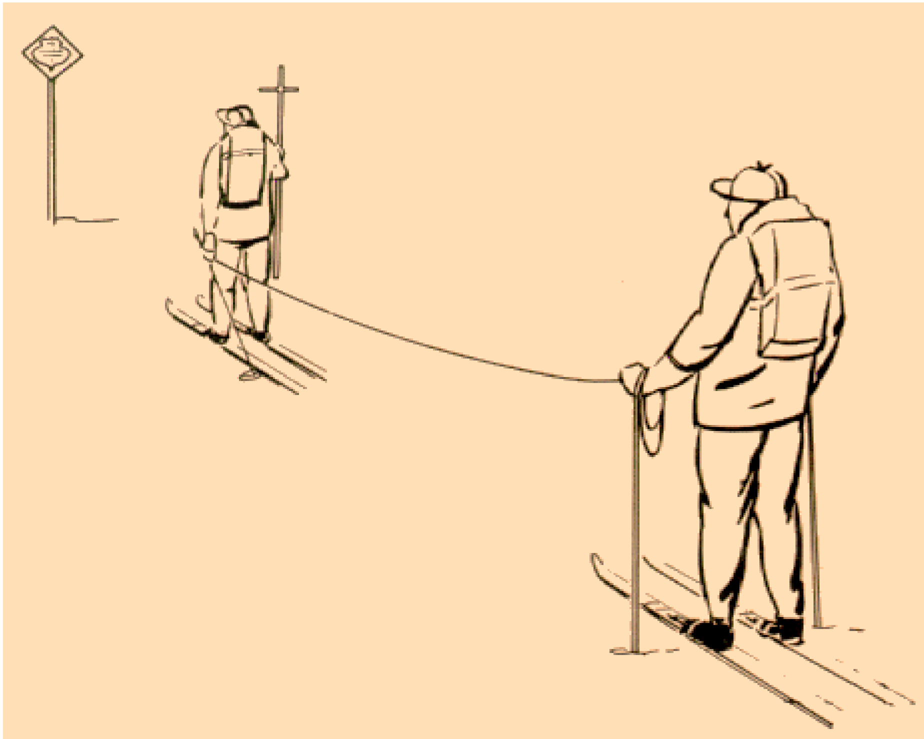
To obtain the density, divide the water content by the depth of snow or use the density determination chart below. Record density to nearest whole percent.

Ordinarily, density of individual samples should not vary more than 3 percent unless site conditions are not uniform. If the difference is more than 5 percent, take another sample.

If density varies because of ponded water, differential snowmelt, brush, and the like, note cause under "Remarks."


DENSITY DETERMINATION CHART
Lay a straight edge so it crosses the snow depth line and water content line at the known snow depth and water content values. The point at which the straight edge crosses the density line shows the density value. *Example: Snow depth of 20 inches with water content of 7 inches gives a density of 35%.* If snow depth and/or water content values exceed the quantities shown, divide each by ten and proceed as before. *Example: Snow depth of 200 inches with water content of 70 inches are entered into the chart as 20 and 7. This gives as before 35%.*
For snow depths of 10 inches or less, multiply snow depth and water content by 10 and proceed as above.
100
90
80
70
60
50
45
40
35
30
25
20
15
10
60
50
40
30
25
20
15
10
9
8
7
6
5
4
3
2
1
DEPTH OF SNOW (INCHES)
WATER CONTENT (INCHES)
DENSITY (PERCENT)

Snow Sampling Procedures - Step 19



Measure and sample the remaining points shown on the snow course map.

Snow Sampling Procedures - Step 20

Before leaving the snow course, both surveyors must inspect the notes. Add the figures in the depth-of-snow column and divide the total by the number of sampling points to get the average depth. Add the figures in the water-content column and divide the total by the number of sampling points to obtain the average water content to the nearest tenth of an inch.

Note: The number of sampling points includes those with zero depth. See completed notes below. Fill in checklist on back of field notes, adding comments about other conditions.

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SOIL CONSERVATION SERVICE

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FEDERAL-STATE-PRIVATE
COOPERATIVE SNOW SURVEYS

Snow Course Blizzard Ridge
Drainage Basin Missouri-Gallatin State Montana
Sampler G. Clagett Note Taker P.E. Farnes
Date Feb. 28, 1984 Began 1:00 p.m. Ended 2:35 p.m.

Sample Number	Depth of Snow Inches	Length of Core Inches	Weight of Tube and Core	Weight of Empty Tube	Water Content Inches	Density Percent	Remarks (See reverse)
1	94	92	62½	35	27½	29	GNF Damp
2	91	89	62		27	30	
3	92	86	62		27	29	
4	85½	79	60½		25½	30	
5	87	82½	60½	35	25½	29	Dry Soil
6	87	82	61½		26½	30	
7	83½	79	59		24	29	
8	84½	81½	60		25	30	Needles
9	85	76	80½	56	24½	29	
10	79½	71½	78½	56	22½	28	2 samples
10	869				255	29	Total
10	86.9				25.5		Average

No. of tube sections used. 4
Was driving wrench used? Yes, on samples 9 and 10.
No. 1 of 1 sheets. Comp. by P.E.F. Checked by G.C.

SAMPLING CONDITIONS

(Please check items descriptive of present conditions)

Weather at Time of Sampling

___ Clear, _✓_ Partly cloudy, _____ Overcast, ____ Raining,

_✓_ Snowing, ____ Blowing, _✓_ Freezing, ______ Thawing,

Snow Conditions at Snow Course

Snow samples obtained with _✓_ ease, _____ moderate difficulty.*

Snow samples obtained with _______ extreme difficulty.*

Ground under snow: _______ frozen, ____✓____ not frozen,

______ dry, ___✓___ damp, _________ wet (saturated).

Ice layer on ground None How thick? _______ inches.

How many inches of new snow at snow course? ___17____ inches.

Depth to first snow crust __17__ inches.

Are there ice layers in snow pack? Yes ____ No ✓______

If yes, show depth from surface ________________ inches

General Conditions

Snow on ground at Hdqtrs. office ___4____ inches.

Name and Location of Hdqtrs. office State office, Bozeman, MT

Air temperature (if known) ________________________

If at aerial marker, record snow depth ____________ inches

*Explain fully under remarks

PRECIPITATION DATA

Month	Day	Year	Precipitation	Readings	Reading Made by (check)	Dipstick	Weight
			Current				
			Previous				
Station name			Catch, inches		Scale adjusted to zero ___Yes ___No		
			After recharge				

Remarks: Heavy crust down 45-50 inches

Snowshoed last half mile to course.

For Special Conditions - Snow Freezing in Tube

If snow melts and freezes in the point of the sampler and the entire core does not enter the tube, it is probably because the tube is above freezing temperature and the snow below freezing. The following steps can help you meet this difficulty:

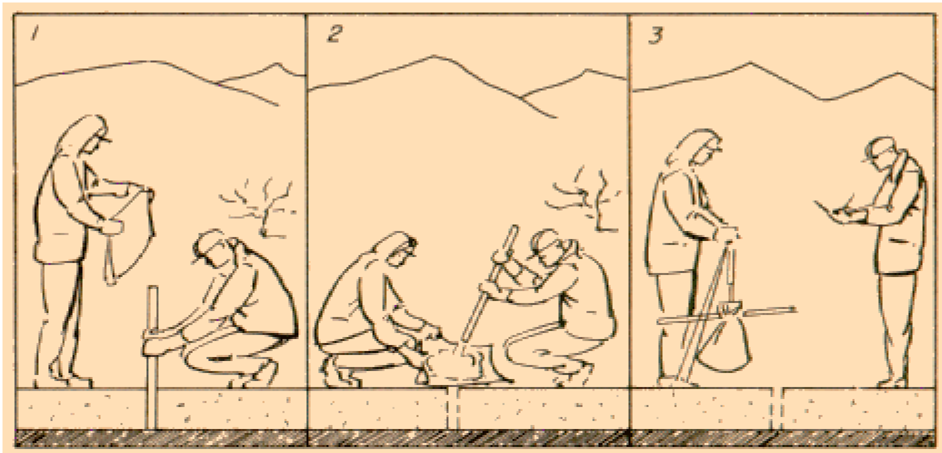
1. Cool the tube by setting it in the shade or burying it in the snow.
2. Clean the tube thoroughly, then push it rapidly through the snow without stopping until you reach ground surface.
3. Take samples in the early morning or evening when it is cool

If these precautions do not help, follow these steps:

1. Thrust the tube as deeply as possible without stopping.
2. Remove the tube carefully so as not to disturb the hole.
3. Record the core length and weight.
4. Empty the tube and return it carefully to the bottom of the hole.
5. Again thrust the tube deeper into the snow until it stops or reaches the ground.
6. Repeat as many times as necessary to reach the ground.

Record data as shown on sample note for "Tubes Too Short for Depth of Snow".

For Special Conditions - Sampling Very Shallow Snow



If water content of the snow is less than 2 inches, it is difficult to read the weighing scale accurately for single sample points. Do as follows:

1. Take a sample at the sampling point.
2. Empty the core into a bucket or any container that can be tied to the weight scale. (if the empty container is not heavy enough to record an empty weight on the scale, add more weight. Use sections of sampling tubes, driving wrenches, or anything handy.)
3. Record the depth of snow and length of core as shown on sample note below.
4. Weigh container and any added weights when all the sample cores have been accumulated.
5. Record this weight in the bottom of the column "Weight of Tube and Core."
   Empty snow from container. Weigh container and weights and record this figure at the bottom of the column "Weight of Empty Tube."
6. Subtract weight of empty container from weight of container and core. Record the difference at the bottom of the column "Water Content Inches." To obtain average water content on the snow course, divide total water content by total number of sampling points.
7. Total the snow depth and divide by number of sampling points to get average snow depth.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-EN-708
12-79

FEDERAL-STATE-PRIVATE
COOPERATIVE SNOW SURVEYS

Snow Course Suicide Park

Drainage Basin Gila State Arizona

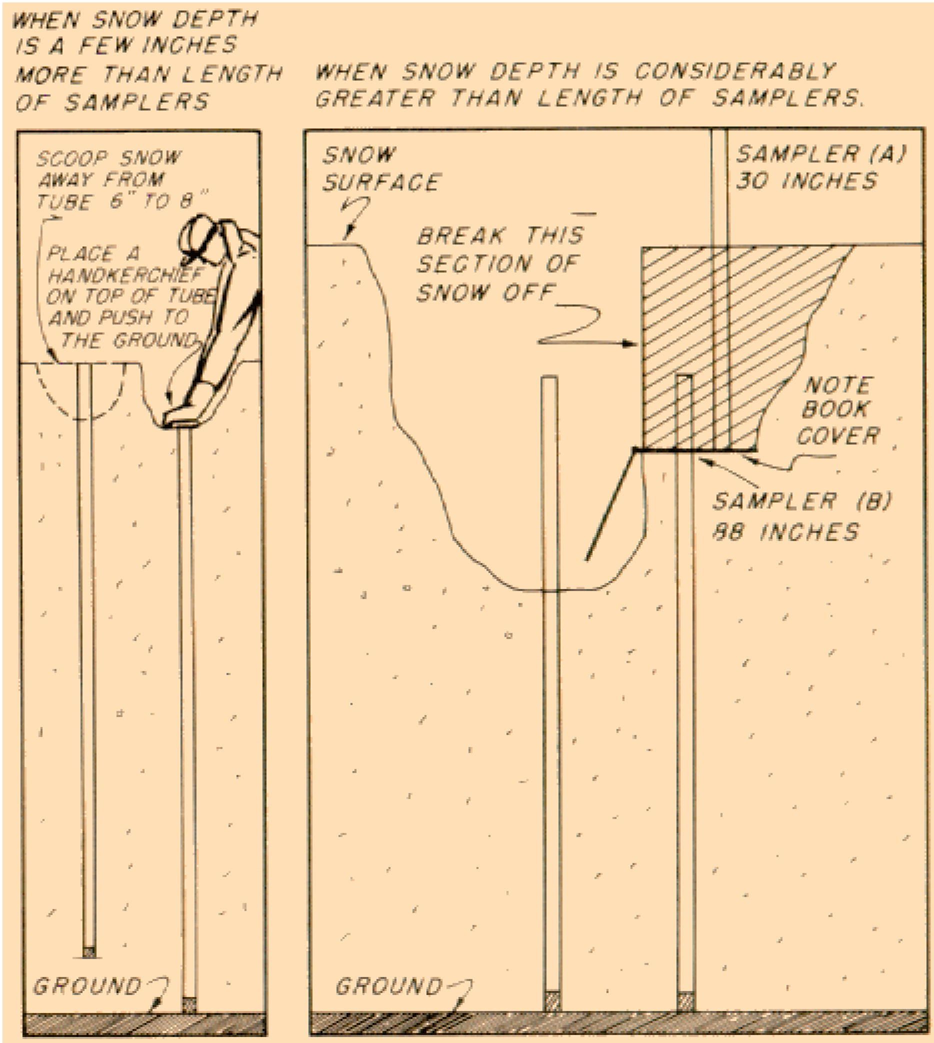
Sampler G. Watt Note Taker D. Enz

Date Feb. 15, 1984 Began 11:00 a.m. [redacted] Ended 11:30 a.m. [redacted]

Sample Number	Depth of Snow Inches	Length of Core Inches	Weight of Tube and Core	Weight of Empty Tube	Water Content Inches	Density Percent	Remarks (See reverse)
1	2	2					Dry
2	2½	2					
3	6	5					
4	3½	3					GDF
5	2	2					
6	6	5½					
7	8½	7					GDF
8	2	2					
9	3½	2½					
10	5	4½					
	//						
10	41		30.5	18	12.5	30	Total
10	4.1				1.3		Average

Bulk Sampled

For Special Conditions - Tubes Too Short for Depth of Snow



If the depth of snow is greater than the length of tubing at hand, do the following:

1. Drive the tube its full length into the snow.
2. Place a handkerchief or similar object over the top of the tube.
3. Dig down around the tube to a depth of about 1 foot.
4. Stand on tube and force it down farther.
5. Remove the wadding and observe the depth of the core. When the core reaches the top of the tube, you have reached the limit for this method of measurement.

The depth of the snow is the distance from the snow surface to the top of the tube added to the length of the tube.

If the snow is too deep to get a whole sample by this method, then do the following:

1. Dig a hole in the snow at the sampling point to a depth of 2 to 3 feet. Try sampler in bottom of hole. If you have not reached the ground surface, dig deeper. Use ski heel or tip of snow-shoe for a shovel if nothing else is available.
2. Slide a metal plate or firm, flat object (aluminum notebook cover) into side of pit at a depth below the top of the grounded sampler.
3. Drive sampler down to metal plate.
4. Measure snow depth and core length of the first section of snowpack.
5. Break off snow into pit down to metal plate.
6. Weigh and record weight of tube and core and weight of empty tube. (See sample note below)
7. Sample from metal plate down to the ground surface. Weigh and add depths and water contents for that sampling point. (See sample note below).
8. Be sure to fill the hole if the course is to be sampled at a later date. Make a note to bring additional sections of sampler tubing for future surveys.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-EN-708
12-79

FEDERAL-STATE-PRIVATE
COOPERATIVE SNOW SURVEYS

Snow Course Dead Man Creek

Drainage Basin Columbia-Willamette State Oregon

Sampler T. George Note Taker M. Vance

Date Apr. 1, 1984 Began 11:00 a.m. Ended ______ a.m./p.m.

Sample Number	Depth of Snow Inches	Length of Core Inches	Weight of Tube and Core	Weight of Empty Tube	Water Content Inches	Density Percent	Remarks (See reverse)
1a	30	29	31½	19	12½	42	Tube too short GNF
1b	88	88	58	19	39½	45	Damp
1	118	117			52	44	←
2a	38	36	34	19	15	39	GNF
2b	86	85	55	19	36	42	Wet
2	124	121			51	41	←
3a	22	20	28	19	9	41	GNF
3b	89	88	57	19	38	43	Grass Damp
3	111	108			47	42	

Example of note keeping for samples taken in sections.

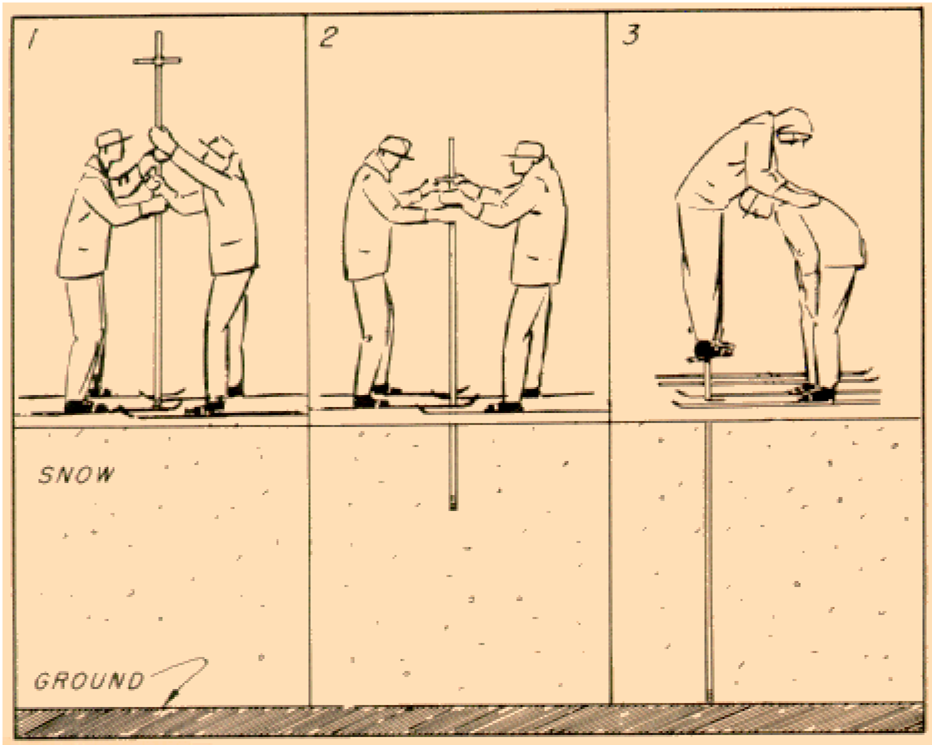
Totals are found by adding figures in rows 1, 2, 3, etc.

No. of tube sections used. 3

Was driving wrench used? Yes

No. 1 of 3 sheets. Comp. by M. V. Checked by T. G.

For Special Conditions - Driving Sampler Through Layers of Deep Snow



When sampling deep snow, drive the sampler rapidly. Keep it moving continuously until the ground surface is reached.

The following procedure is suggested:

1. Both surveyors drive the sampler with a hand-over-hand motion, keeping the sampler in motion.
2. Grab the driving wrench handle and push down.
3. If the tube stops, one surveyor steps on the handles and drives the tube down to the ground surface with a pumping action of the knees while balancing against his partner's shoulders.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #5

National Weather Service Observing Handbook No. 2

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for recording and reporting observations, and for equipment installation and calibration for National Weather Service (NWS) Cooperative Observer Program climate stations. This SOP was extracted from the NWS Cooperative Observer Program web site (http://www.nws.noaa.gov/om/coop/training.htm) without alteration, and is provided here to ensure accessibility. It is current as of November 16, 2004. To retain the pagination of the document, this page is not numbered.

National Weather Service
Observing Handbook No. 2

Cooperative Station Observations

Observing Systems Branch
Office of Systems Operations

Silver Spring, Md.
July 1989

U.S. DEPARTMENT OF COMMERCE
Robert Mosbacher, Secretary

National Oceanic and Atmospheric Administration
William E. Evans, Under Secretary and Administrator

National Weather Service
Elbert W. Friday, Jr., Director

This Handbook supersedes "Substation Observation Handbook No. 2," 1970

First Edition, 1989

Office of Systems Operations

Observing Systems Branch

Silver Spring, Maryland

PREFACE

John Companius Holm’s weather records, taken without the benefit of instruments in 1644 and 1645, were the earliest known observations in the United States. Subsequently such famous personages as George Washington, Thomas Jefferson, and Benjamin Franklin maintained weather records spanning many years.

The first extensive network of cooperative stations was set up in the 1890's as the result of an act of Congress in 1890 that established the Weather Bureau. Today, there are over 11,000 volunteer cooperative observers scattered aver the 50 states, taking observations seven days a week throughout the year.

The above observers regularly and conscientiously contribute their time so that their observations can provide the vital information needed to define the climate in their areas. The records are also used constantly to answer questions and guide the actions of public agencies, agricultural and commercial organizations, and individuals. Their records also form a basis for preparedness for national and local emergencies, such as flooding.

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SECTION 1: COOPERATIVE WEATHER OBSERVER PROGRAM

1.1 PURPOSE OF HANDBOOK

The purpose of this handbook is to provide guidelines for taking and reporting observations at cooperative stations. The instructions pertain to the exposure, operation, and maintenance of instruments and equipment used by the observer. Instructions also cover taking and reporting observations.

1.2 DEFINITION OF COOPERATIVE STATION

A cooperative station is a station at which observations are taken or other services rendered by private citizens, institutions (such as utilities and television stations), etc. Services rendered usually consist of taking instrumental or visual observations and transmitting reports.

The equipment used may be owned by the NWS, by an individual company, or by another governmental agency.

1.3 TYPES OF STATIONS

Although the majority of cooperative stations record precipitation amounts and maximum and minimum temperatures, there are several other types of stations. For example, one station may record precipitation only, while another station may record precipitation, temperature, and evaporation. One or more of the following parameters may be reported.

a) Precipitation	f) Soil temperature
b) Air temperature	g) Agricultural data
c) River stage	h) Atmospheric phenomena
d) Evaporation	I) Flash flooding
e) Wind movement	j) Road hazards

1.3.1 PRECIPITATION

Measurements are made of the amount of rainfall, depth of snow, and other forms of precipitation. Records are kept of the character, type, and time of occurrence. Each station is normally furnished with a nonrecording or a weighing-type recording gage.

1.3.2 AIR TEMPERATURE

Observations of the current air temperature, and of maximum and minimum temperatures between observations, are taken and recorded daily. The stations are provided with maximum and minimum thermometers and an instrument shelter for housing the thermometers, or a maximum-minimum temperature system (MMTS).

1.3.3 RIVER STAGE

Daily observations of river stages are taken. These stations generally also record precipitation, weather conditions, depth of snow or ice, and status of the river (rising or falling).

Each station is normally furnished with a river gage appropriate for the station.

1.3.4 EVAPORATION AND WIND MOVEMENT

Daily Measurements are made of the amount of evaporation from an open, freely exposed pan. Measurements are made of wind movement over the pan, temperature of the water, and at some stations, wet- and dry-bulb temperatures of the air. The stations are provided with:

a) An evaporation pan and measuring apparatus (stilling well and gage).

b) An anemometer and, when required, a wet- and dry-bulb psychrometer and storage tank.

1.3.5 SOIL TEMPERATURE

Selected stations record the soil temperature daily. The stations are provided with thermometers or sensing elements located in and under undisturbed bare or grass-covered soil at selected depths.

1.3.6 AGRICULTURAL DATA

At selected stations, observers forward weekly reports containing the effect of weather on crops and a description of current farming operations in the locality.

1.3.7 ATMOSPHERIC PHENOMENA

Weather occurrences such as rain, cloud cover, hail, and thunderstorms are considered to be atmospheric phenomena. Phenomena of severe enough nature to threaten life and property are usually reported when they take place, rather than waiting to report them at the scheduled time of observation.

1.3.8 FLASH FLOODING

In areas where flash flooding may occur, observations of the conditions which cause flash flooding are reported promptly. These conditions include heavy rainfall, river or creek stage, and the formation or breakup of ice jams.

1.3.9 ROAD HAZARDS

Road hazards are created by weather conditions such as drifting snow, flooding, and blowing dust or sand, and should be recorded.

1.4 ESTABLISHING, MAINTAINING AND INSPECTING STATIONS

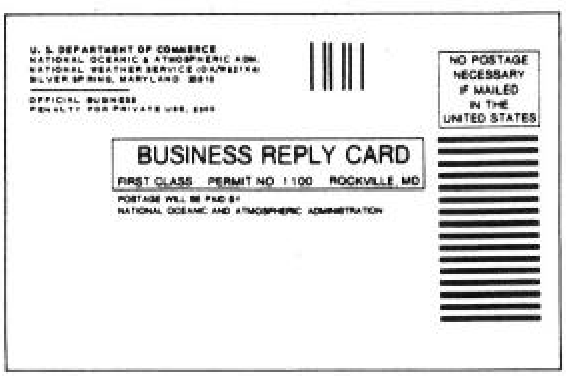
The NWS representative (i.e., your Cooperative Program Manager or service hydrologist) will be responsible for the installation of all furnished instruments. He will instruct the observer in techniques of weather observation, recording data, and caring for instruments and equipment. The NWS representative will visit the station periodically for reviews. He can then discuss problems with observing and recording weather data; also, for moving, inspecting, and maintaining the instruments and equipment.

1.4.1 MAINTENANCE

Instruments and equipment furnished to the station should be maintained in accordance with instructions for each instrument. Instruments should not be moved or relocated without the approval of the NWS representative. If immediate action is necessary to prevent damage, notify the NWS representative promptly. The observer may install replacement parts unless otherwise indicated. Be sure to inform the NWS representative when the growth of vegetation, trees, shrubs, or other changes affect the exposure of instruments.

1.4.2 REQUESTING SUPPLIES

Instruments, report forms, envelopes, and all other supplies will be furnished or ordered by the NWS representative. The observer should advise the NWS representative promptly when any forms, supplies, or services are needed. This may be done by letter or special card—WS Form B-27 (exhibit 1.1).


U. S. DEPARTMENT OF COMMERCE

OFFICIAL BUSINESS

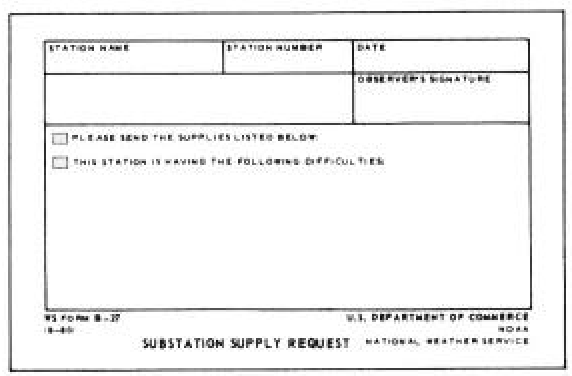
NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO 1100 ROCKVILLE, MD

POSTAGE WILL BE PAID BY

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION


STATION NAME | STATION NUMBER | DATE

OBSERVER'S SIGNATURE

PLEASE SEND THE SUPPLIES LISTED BELOW:

THIS STATION IS HAVING THE FOLLOWING DIFFICULTIES:

WS FORM B-27

U.S. DEPARTMENT OF COMMERCE

NOAA

SUBSTATION SUPPLY REQUEST

NATIONAL WEATHER SERVICE

Exhibit 1.1: WS Form B-27—Substation Supply Request/
Cooperative Station Supply Request

1.4.3 REPORTING DEFECTIVE INSTRUMENTS

Damaged or defective Weather Service equipment and instruments should be reported to the NWS representative, who will then inform the observer about arranging for the repair or replacement of the equipment and/or instruments. The boxes and material in which thermometers, clocks, and other delicate instruments are packed in should be saved. They can be used when returning defective units. The units should be carefully packed in the same manner as they were received.

1.5 PREFERRED TIME FOR TAKING OBSERVATIONS

Observations at precipitation stations should be taken at 7 a.m. local time, although you may usually choose any time between 6 a.m. and 8 a.m. Be sure, however, to take observations at the same time every day throughout the year if at all possible. Continue observing at the same time whether standard or daylight savings time is in effect; i.e., convert from 7 a.m. standard time to 7 a.m. daylight saving time when the latter takes effect.

Evening observations are best for temperature stations (6 p.m. is the preferred time). Stations reporting both parameters should report at a time agreed to with the NWS representative. Unless otherwise directed, temperature and precipitation should be observed at the same time of day. Evaporation stations should observe all elements in the morning when the evaporation rate is normally lowest. If an evening observation time is established, it should be as late as possible.

1.5.1 RESETTING INSTRUMENTS

Reset the maximum and minimum thermometers only once each 24 hours, immediately after they have been read. Nonrecording rain gages should be emptied after being read only once each 24 hours. Thermometers and gages should be reset only at the time of observation agreed to with the NWS representative. Instruments may be read at intermediate times, but they should not be reset.

1.6 FORMS

The National Weather Service (NWS) will furnish all forms you will need for recording weather data. The cover page for each pad of forms contains the reporting instructions. In the proper spaces, enter your station name (specified by your NWS representative), county, state, month and year , time of observation, etc.

1.6.1 LEGIBILITY

Legible records are very important. A form that is difficult to read loses value. Use a sharp, medium-hard pencil and good carbon paper. Replace the carbon paper when it no longer makes a legible copy. Draw a line through (do not erase) erroneous entries and write the correct values above, below, or to the right or left of the line.

1.6.2 DISPOSITION OF RECORDS

Mail the original and first copy of the report promptly at the close of the period of record (usually monthly). Keep an additional carbon copy for at least two months, in case the copies you mail are not received. In some cases, the NWS representative may ask you to prepare additional copies.

The NWS will furnish postage-paid envelopes for mailing your records, ordering supplies, and reporting defective instruments and equipments.

SECTION 2: PRECIPITATION

2.1 INTRODUCTION

There are two types of precipitation: liquid and solid. Liquid precipitation includes rain and drizzle. Since precipitation, by definition, falls to the ground, dew (which forms where it is found) is not precipitation. Solid precipitation includes snow, hail, ice pellets, etc. Precipitation is measured in terms of its depth:

a) Liquid (including the water equivalent of solid precipitation which has melted) to the nearest hundredth of an inch, and

b) Solid to the nearest tenth inch.

2.1.1 PRECIPITATION GAGES

In its simplest form, a precipitation gage is an open-mouthed can with straight sides, installed with the open end upward and sides vertical. Precipitation gages are also called rain gages. Improved gages record the amount of precipitation falling per unit time on a chart (usually a punch tape or rotating drum). See section 2.2 below.

2.1.2 EXPOSURE OF GAGES

The exposure of a rain gage is very important for obtaining accurate measurements. Gages should not be located close to isolated obstructions such as trees and buildings, which may deflect precipitation due to erratic turbulence. Gages should not be located in wide-open spaces or on elevated sites, such as tops of buildings, because of wind and the resulting turbulence problems. The best location is where the gage is uniformly protected in all directions, such as in an opening in a grove of trees. The height of the protection should not exceed twice its distance from the gage. As a general rule, the windier the gage location is, the greater the precipitation error will be.

Wind shields (exhibit 2.1) may be used to minimize the loss of precipitation. This loss is much greater during snowfall than rainfall, so shields are seldom installed at cooperative stations unless at least 20 percent of the annual precipitation falls in the form of snow.

In areas where heavy snowfall occurs; e.g., mountainous areas in the western U.S., gages are mounted on towers at a height considerably above the maximum level to which snow accumulates, at or somewhat below the level of tree tops. See exhibit 2.2.

Good exposures are not always permanent. Man-made alterations to the area and the growth of vegetation may change an excellent exposure to an unsatisfactory one in a very short time, necessitating the moving of precipitation gages to sites having better exposures.

PRECIPITATION

Exhibit 2.1: Snow Tower

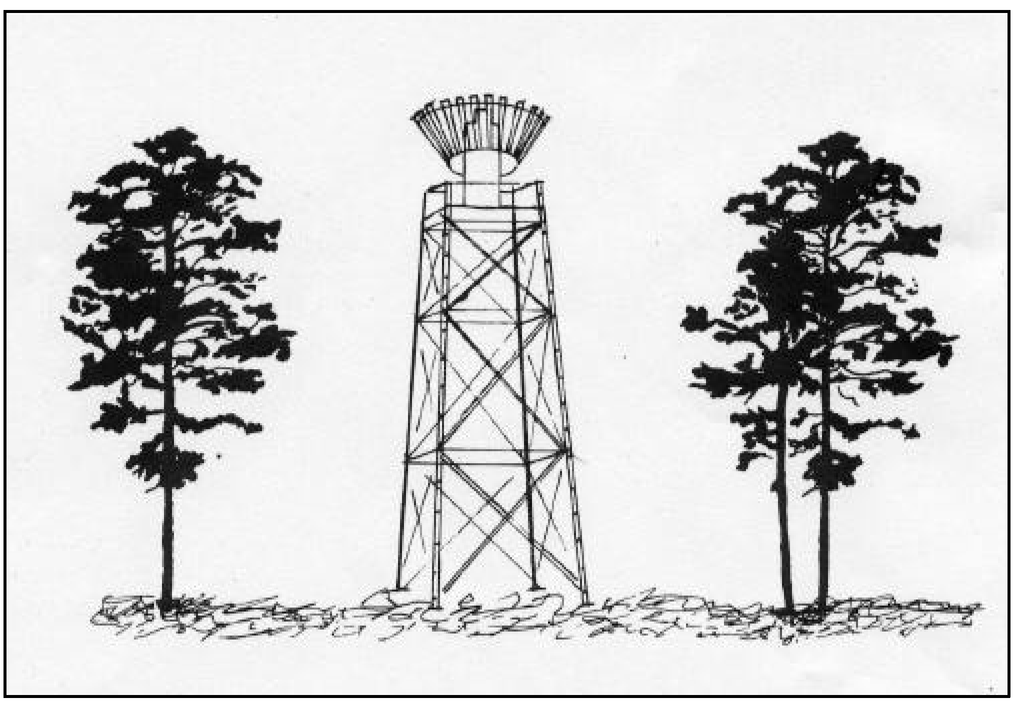


Exhibit 2.2: Snow Tower

PRECIPITATION

2.2 TYPES OF PRECIPITATION GAGES

The specific types of gages now being used for measuring precipitation are:

a) Nonrecording
   1) 8-inch gage
   2) 4-inch gage

b) Recording (weighing type)
   1) Belfort (Fischer & Porter) gage
   2) Universal gage

These are described below.

2.2.1 EIGHT-INCH NONRECORDING GAGE

This gage (exhibits 2.3 and 2.4) consists of the large diameter outer can (in the left-center of exhibit 2.4), a smaller diameter measuring tube inside it (right-center), a funnel that connects the above two (right), a measuring stick (bottom), and a support (left in exhibit 2.4). The outer can and top of the funnel are 8 inches in diameter. The funnel directs precipitation into the measuring tube, which is 20 inches tall and holds exactly 2 inches of rainfall (additional rainfall will flow into the overflow can). This ten-to-one ratio makes it possible to read rainfall amounts to the nearest hundredth of an inch. The measuring stick is marked at .01 inch intervals.

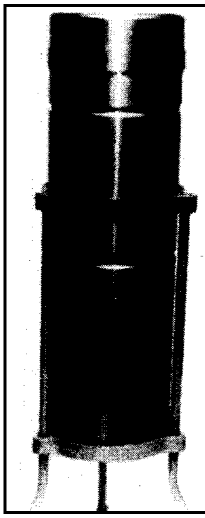


Exhibit 2.3: Eight-Inch Nonrecording Gage, Assembled

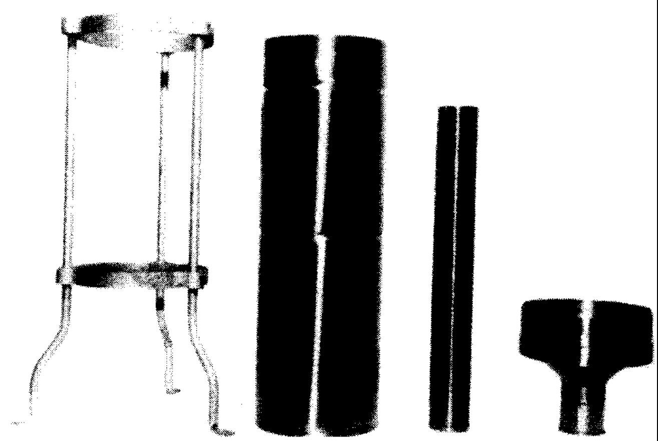


Exhibit 2.4: Eight-Inch Nonrecording Gage, Unassembled

2.2.1.1 INSTALLATION AND MAINTENANCE

The metal support (exhibit 2.4, left side) must be firmly mounted on a horizontal platform to prevent it from being blown or knocked over. The top of the gage must be horizontal. This should be checked by laying a carpenter I s level across the open top of the gage in two directions, one crossing the other at right angles. If the top is not level in both directions, report this to the NWS representative. If you level the gage, please add a note to the observation form giving the date the defeat was discovered and the date corrected.

Leaks in the tube or overflow can and should be reported promptly to the NWS representative.

2.2.2 FOUR-INCH NONRECORDING GAGE

The four-inch gage (exhibit 2.5) consists of the outer overflow can (lower left), measuring tube (center), a funnel (top) that catches the precipitation and directs it into the tube, and a mounting bracket with screws (lower right). The gage is made of clear plastic. No measuring stick is needed because the measuring tube is graduated to hundredths of an inch. This tube holds exactly one inch of precipitation. Any additional amount will fall into the overflow can and can be measured as with the eight-inch gage (section 2.2.1).

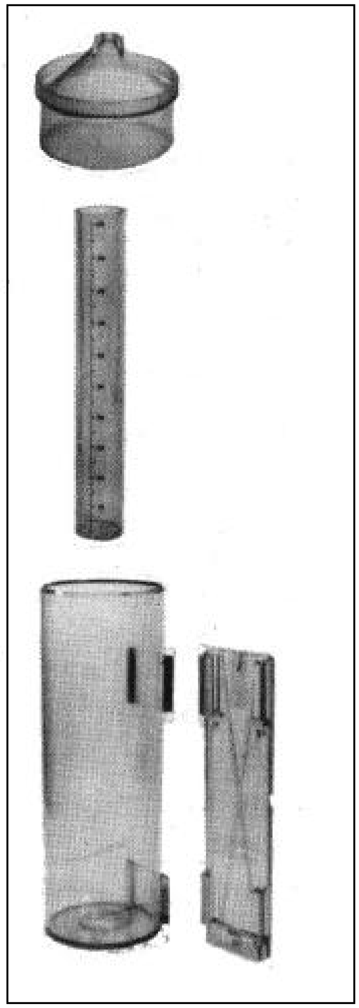


Exhibit 2.5:
Four-Inch
Nonrecording Gage

2.2.3 WEIGHING-RECORDING GAGE

The weighing-type recording gage is designed to record the rate and amount of precipitation. The precipitation rate is measured in hundredths or tenths of an inch per unit time. The amount is measured in hundredths or tenths of an inch. These gages consist of a receiver with an inside diameter of exactly 8 inches that funnels precipitation into a collector mounted on a weighing mechanism.

There are two types of weighing gages used by the NWS:

a) The punched tape type, manufactured by Belfort Instruments or Fischer & Porter (exhibit 2.6), and:

b) The universal type (exhibit 2.7).

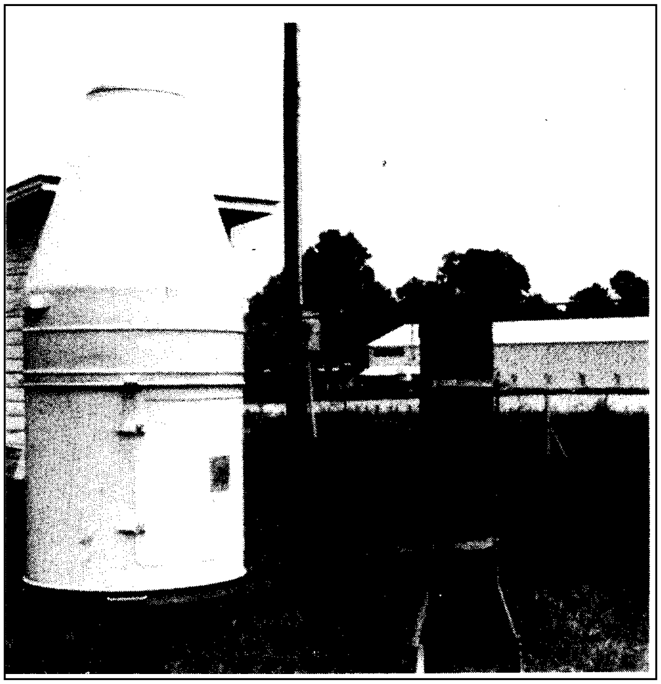


Exhibit 2.6: Belfort (Fischer & Porter) Recording Gage

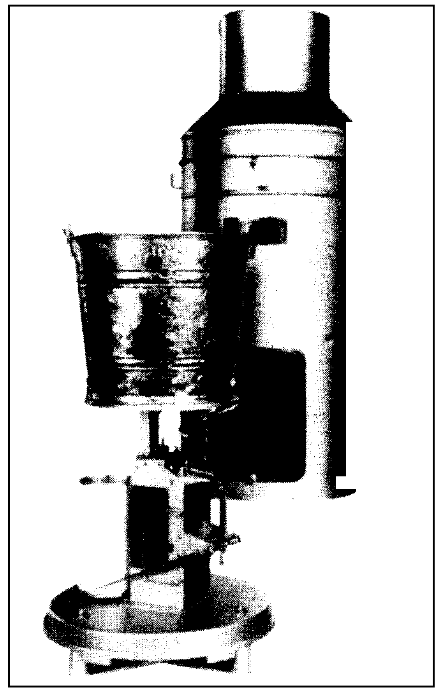


Exhibit 2.7: Universal Recording Gage

2.2.4 UNIVERSAL GAGE

Precipitation falls into the universal gage receiver, where it is funneled into a collector mounted on a weighing mechanism. The weight of the precipitation in the collector compresses a spring, which is connected to a pen (ink) arm. Ink from the pen leaves a trace on a paper chart, which is wrapped around a clock-driven cylinder. The cylinder rotates continuously, making one revolution every 24 hours. Ink tracings on the chart provide a "history" of precipitation rates and amounts.

Charts are graduated to the nearest .05 inch and may be read to the nearest .01 inch by interpolating between the graduations. The total capacity of the gage is 12 inches, although the chart is graduated to only 6 inches. When the 6-inch mark is reached, the pen of the chart reverses direction. The reverse in pen direction is commonly referred to as "dual traverse."

PRECIPITATION

2.2.4.1 CALIBRATION AND EQUIPMENT PROBLEMS

The gage requires occasional calibration and other adjustments to maintain its accuracy. This will be done by inspectors with special equipment. clock failure, or any trouble that cannot be corrected as described below, should be reported immediately to the NWS representative.

2.2.4.2 GAINING ACCESS TO BUCKET AND CHART MECHANISM

You will need access to the chart and bucket in order to read or change the chart, wind the clock, or empty the bucket. Most universal gages have an inspection door large enough to provide access to the clock and chart. On gages with inspection doors too small for this, you can remove the receiver (top) and outer shield to gain access.

2.2.4.3 PREPARATION OF CHARTS

Enter the following information in the spaces provided on the chart before putting the chart on the cylinder:

a) Station name as specified by the NWS representative.

b) Date and local time, to the nearest minute, that the pen will be placed on the new chart.

Cross out P.M. when it is morning or A.M. when it is afternoon. When Daylight Saving Time is in use locally, enter I'D" following A.M. or P.M. For example, if the chart is changed in the morning, enter A.M.D.

2.2.4.4 INSTALLING AND REMOVING CHARTS

Charts should be changed on all of the following occasions.

a) At least once a week.

b) On the first day of each month.

c) Within 24 hours after precipitation has ended.

Do not change the chart during rain that is heavy enough to wet the trace and cause the ink to spread. Rather than change the chart, empty the bucket during heavy rain when the bucket may overflow or the capacity of the chart may be exceeded.

When installing and removing charts, make a vertical mark about 1/4 inch long on the chart (trace) by gently touching the weighing mechanism which moves the pen. This mark will serve as a time check for the office receiving the chart. If the pen is not making a trace on the chart, place a small dot on the chart.

to mark the position of the pen. Draw a circle around the dot to identify it, and enter a note of explanation on the chart (e.g., "chart removed").

2.2.4.5 CHANGING CHARTS ON GAGES WITH LARGE INSPECTION DOORS

a) Open the inspection door and make a time check on the chart.

b) Remove the pen from the chart by shifting the pen bar forward.

c) Remove the receiver.

d) Empty and replace the bucket except when charged with antifreeze or when oil has been used to retard evaporation

e) Raise the outer shield (if so equipped) and rest it on the vertical guides.

f) Grasp the cylinder at the top with one hand and, with the other, gently lift it over the spindle.

g) Release the clip holding the chart. Avoid touching or storing the chart in a way that will cause the trace to be smeared before it dries.

h) Wind the clock. Caution: the clock may stop if wound too tightly.

I) Wrap the new chart around the clock cylinder so the time reads left to right, and so the chart fits smoothly and snugly on the clock cylinder. The chart base must uniformly contact the flange or cylinder.

j. Replace the clip. Check to be sure that corresponding ends of each "inch" line coincide where they meet. The exposed end of the chart must extend 1/4 inch to the right of the clip.

k. Replace the cylinder. Lower it gently aver the spindle until the gears mesh.

1. Re-ink the pen. Return it almost to the surface of the chart. Make sure it reads within .025 inch of the last reading on the previous chart. It should read zero, however, if you have emptied the bucket, unless the NWS representative specified some other value.

m. With the pen almost touching the chart, turn the cylinder until it reads three hours fast, then turn it back so it reads the correct time. Be sure the time is correctly written on the chart.

n. Return the pen to the chart. Touch the weighing mechanism to make a vertical time check on the chart. Replace the shield and receiver.

2.2.4.6 CHANGING CHARM ON GAGES WITH SMALL INSPECTION DOORS

Use the following method on gages having small inspection doors.

a) Remove the receiver and shield (exhibit 2.6).

b) Make a time check or identify the pen position on the chart by touching the weighing mechanism.

c) Shift the pen bar forward and lift the pen from the chart.

d) Empty and replace the bucket, except when charged with antifreeze.

e) Grasp the chart cylinder at the top with one hand, and with the other, gently lift it aver the spindle. Release the clip holding the chart, taking care not to smear the ink.

f) Wind the clock. Wrap the new chart around the clock cylinder so the time reads from left to right, and so the chart fits smoothly and snugly. The chart base must uniformly contact the flange of the cylinder.

g) Replace the clip. Check to be sure that corresponding ends of each "inch" line on the charts coincide. The exposed end of the chart must extend 1/4 inch to the right of the clip.

h) Replace the cylinder. Lower it gently over the spindle until the gears mesh.

I) Re-ink the pen and return it almost to the surface of the chart. Note the amount the pen indicates on the chart. It should indicate the same value (within .025 inch) as before the chart was changed. It should read zero if the bucket was emptied unless the NWS representative has specified that it read some other value at the time of the last calibration.

j) Return the pen to the chart. Touch the weighing mechanism to make a vertical time check on the chart.

k) Replace the shield and receiver.

2.2.4.7 COMPLETING THE CHARTS

After removing the chart from the gage, enter the following.

a) The local time and date of removal, as, in section 2.2.4.3.b.

b) An arrow (\) with the word "on" at the place the timecheck was made when the chart was installed.

c) An arrow ([) with the word "off" at the place the timecheck was made when the chart was removed.

d) Notes that will explain unusual or missing parts of the trace. Inspect the weighing gage daily to be sure the clock is running and the pen is raking a trace. If the clock has stopped and cannot be restarted, turn the cylinder forward ½ inch each day until the clock is replaced. The chart need not be replaced until the time or precipitation range has been used or the clock is replaced. Contact the NWS representative promptly for a replacement clock.

2.2.5 BELFORT (FISCHER & PORTER) PUNCH TAPE GAGE

Belfort Instrument Co. took over manufacturing of this gage in the early 1980's. It is gradually replacing the universal weighing gage. Precipitation amounts are recorded at 0.10 inch increments. The maximum capacity is 19.5 inches. A machine punches holes in a paper tape on a moving scroll every 15 minutes. Although the punch tape is designed for automatic machine processing, it may be read visually by summing the values of the holes punched. Punches are made for the following values: 0.1, 0.2, 0.4, 0.8, 1.0, 2.0, 4.0, 8.0 and 10.0 inches. For a precipitation amount of 3.7 inches, the following pinches would be made: 2.0, 1.0, 0.4, 0.2 and 0.1 inches, the sum of which equals 3.7 inches.

An illustrated instruction bulletin is provided with each instrument. It should be consulted for details on any specified model. The following sections refer to the Model #35B155911XX1 with an electronic timer—the most recent model produced.

The Belfort gage shown in exhibit 2.7 is powered by a 6.75 volt DC battery. The measuring device consists of:

a) a collection bucket for receiving and storing precipitation,

b) a weighing device for measurement, and

c) an indicator dial showing the amount of precipitation collected to the nearest whole inch.

2.2.5.1 OPERATION AND MAINTENANCE

The NWS representative will place the gage in operation and explain its operation to the observer. The observer should do the following.

a) Inspect the gage weekly to assure that the tape is at the proper time. Red figures on the left side of the tape indicate the days. Make a dial reading and enter it on the observer form. If the tire indicated on the tape is in error by more than an hour (4 spaces), reset it to the correct time. Make a notation of this on the tape. Refer to section 2.2.5.2 for Instructions on setting the tape to the correct time. Do not make manual punches before adjusting or removing the tape.

b) If the reading on the indicator dial is near or exceeds 10 inches, either remove and empty the collector or unhook the plastic drain tub from the rim and lower to the drainage position, diverting the stream away from the instrument. CAUTION: do not spill or empty where oil and antifreeze will damage the grass or other vegetation. Replace the collector on the force post. Fasten the drain tube hook firmly aver the edge of the collector. Rotate the zero adjustment knob until the code disk pointer is at the exact "zero" position. Add one pint of oil (supplied by the NWS representative) to the collector. During the time of year when snow or freezing weather may be expected, you must remove the funnel and you must add antifreeze to the collector. Replace the hood.

c) As soon as possible after the beginning of each month (or as requested), remove the recorded portion of the tape. Advance the tape so about 20 inches of blank tape are included following the punched portion. Remove the tape by slipping it off the end of the take-up spool. Mark the date, time of removal (indicating standard or daylight time), and station name and number on the recording tape. Include any other information that may be helpful -in processing the tape.

d) Check the amount of tape remaining on the spool. If there is enough for the next entire month, rethread the loose end of the tape from the supply roll onto the take-up spool. Install a new roll of tape when necessary. Make sure that the printed side of the tape is right-side-up when facing the front of the instrument and that the tape is threaded through the punch arm assembly and paper guide.

e) Set the tape to the correct time (section 2.2.5.2) and mark the day and month on it.

f) Remove and empty the chad tray.

g) Put the punched tape for the past month in one of the mailers supplied by the NWS representative and mail. Be certain that a mailing address has been stamped on the mailer. If not, obtain the address from the NWS representative and request new mailers that are properly addressed.

h) Close and fasten the door with both latches to keep out dust and moisture. Insert the latch cover in its retainer on the base of the gage. The slot near the top should be over the padlock eye on the hood. The latch cover need not be installed if it is not necessary to lock the gage.

2.2.5.2 SETTING THE TAPE TO THE CORRECT TIME

The electronic timer will trigger the gage to punch every 15 minutes. The power switch must be "ON." When the leads from the timer are connected to the battery, the recorder will punch 33 seconds after pushing the manual punch button. The best time to change the tape is immediately after a routine punch-out. This will allow 15 minutes to change the tape without missing any readings.

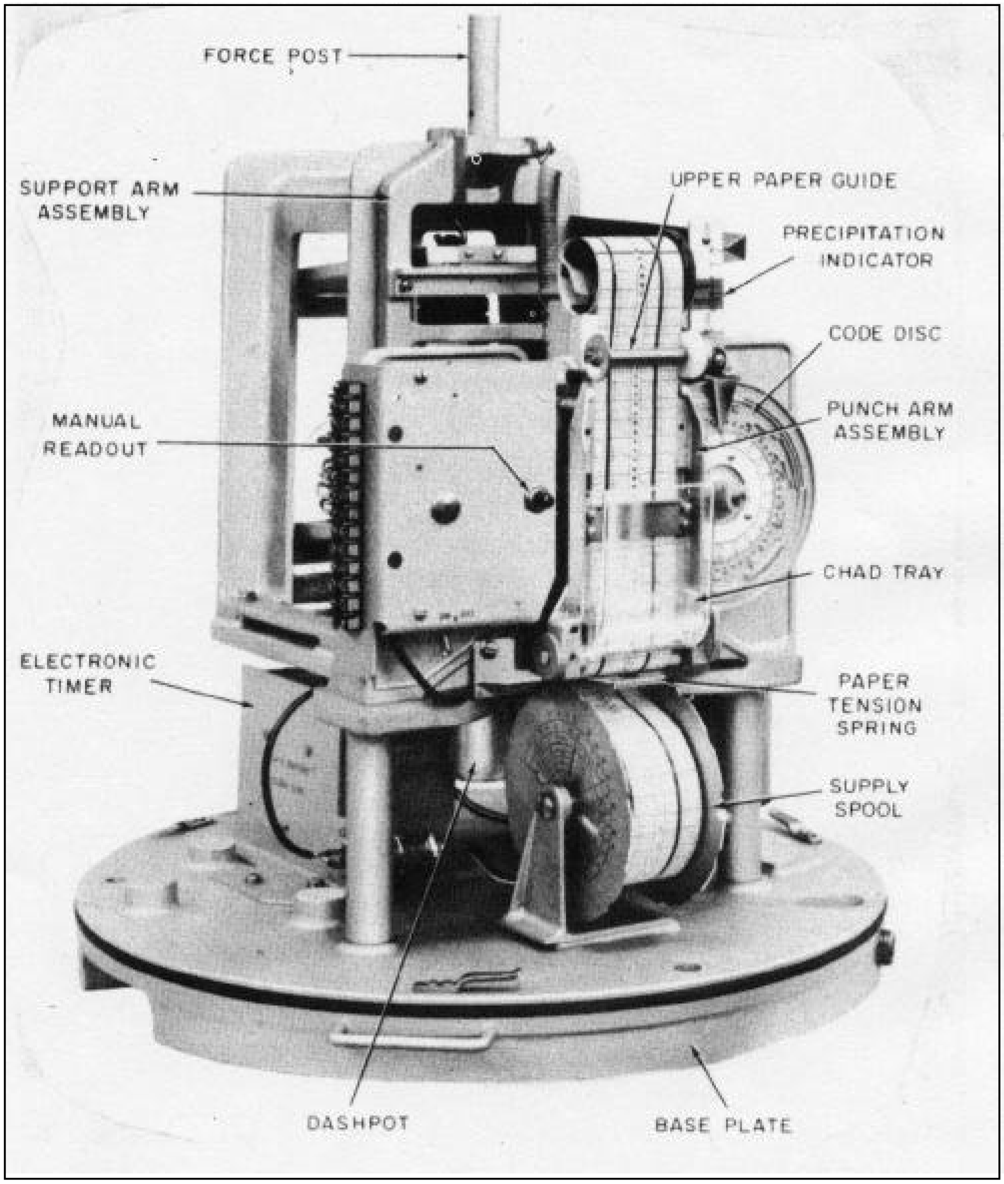


Exhibit 2.8: Belfort Recorder—Front View with Cover Removed

Set the tape to the correct time, as follows.

a) With the power switch "OFF," feed the tape through the die block onto the take-up spool. Continue feeding the tape until the first time line to appear above the die block reads two hours before the current tine. See exhibit 2.8.

b) Turn the power switch to the "ON" position and push the button to advance the tape at least 8 lead punches or until the time line on the tape corresponding to the next 15-minute time interval is lined up with the holes in the punch block. Next, draw a line across the tape just above the punching block, using a felt tip pen. Write the date and time on the tape. This reference will determine the actual start of the record. The **next punch** should occur at the next 15-minute clock interval and it should agree with the time shown by the tape within 15 minutes. Hold the button down 5 seconds for each punch.

2.2.6 WINTER OPERATION

During the season when frozen precipitation (except hail) or freezing temperatures are likely to occur, both of the above types of gages need to be winterized, as described below.

a) At the start of winter, remove the funnel from the collector. Snow rings (on some universal gages) should be installed in place of the funnel.

b) Empty the bucket or collector and replace it in the gage. Remove and replace the collector very slowly on Belfort gages to avoid breaking a cable in the mechanism.

c) On the universal gage, turn the adjusting knob so the pen reads zero on the chart. On the Belfort gage, rotate the zero adjusting knob until the code disk pointer is at the exact position.

d) On the universal gage, pour one quart of antifreeze (supplied by the NWS representative) into the bucket. Do not use commercial antifreeze or add water.

On the Belfort gage, pour two quarts of the above antifreeze into the collector. Do not add water.

e) Make no adjustments to the gage after antifreeze has been added. The pen should rest between the 1 and 2 inch lines after antifreeze has been added to the universal recorder. The dial on the Belfort gage should read between 2 and 3 inches.

f) Enter a note on the chart or tape identifying the time and date the gage was charged with antifreeze.

2.2.7 ROUTINE MAINTENANCE

Take the following actions during the year.

a) Stir the antifreeze solution occasionally during the winter, especially after rain or snow, to help maintain a uniform mixture.

b) Equity the universal recorder bucket when the pen reaches approximately the 5-inch level. Empty or drain the Belfort gage when the 10-inch level is reached. Do not adjust the pen in either case.

c) Change charts on universal gages, as follows:

1) On the first day of each month.
2) After each measurable rain or snow.
3) Once each week.

Change tapes on the Belfort gage on the first of each month.

d) Notify your NWS representative when additional antifreeze materials are needed.

e) Mail recorded data as instructed by the NWS representative.

2.3 HOW TO MEASURE RAINFALL

2.3.1 BELFORT GAGE

See section 2.2.5 for instructions on reading the Belfort gage.

2.3.2 UNIVERSAL GAGE

The universal gage may be read directly from the trace on the drum. If the gage did not read zero at the last observation time, subtract the previous reading from the current reading.

2.3.3 FOUR-INCH NONRECORDING GAGE

The four-inch clear plastic gage may be read directly by observing the marks etched in the measuring tube. This tube holds up to one inch of water. If more than an inch of rain has fallen, empty the water in the measuring tube, pour the water in the overflow cylinder into the tube, measure it, and add this to the amount originally in the measuring tube. Repeat this if more than two inches have fallen. When finished, put the emptied measuring tube back inside the empty outer cylinder and replace the funnel on top.

2.3.4 EIGHT-INCH NONRECORDING GAGE

Remove the funnel and insert the measuring stick into the bottom of the measuring tube, leaving it there for two or three seconds. The water will darken the stick. Remove the stick and read the rainfall amount from the top of the darkened part of the stick. Example: if the stick is darkened to three marks above the 0.80 inch mark (the longer horizontal white line beneath the 0.80), the rainfall is .83 inch.

If the measuring tube is full (indicating at least two inches of rain), empty the tube carefully to avoid spilling any water back into the overflow can. Allow a few seconds for all the water to drain from the tube. Then pour the water from the overflow can into the measuring tube. Measure this amount and add it to the two inches already emptied from the tube. If more than four inches of rain has fallen, the measuring tube will be filled at least twice.

When finished, put the emptied measuring tube back inside the empty outer can and replace the funnel on top.

2.4 MEASURING THE WATER EQUIVALENT OF SNOWFALL

The Belfort and universal gages measure precipitation by weighing it. Thus, snow falling into these gages is automatically measured, and no melting is required. This value is the water equivalent. If snow or ice is stuck to the inside of the funnel, it should be scraped loose and allowed to fall into the antifreeze solution before taking a reading.

For nonrecording gages, remove the funnel and measuring tube from the outer can during winter or whenever snow is likely to fall. The water equivalent of frozen precipitation that has fallen into the gage can be determined by following these steps.

a) Bring the overflow container that contains the snow into a warm building.

b) Wait for the snow to melt.

c) Pour the melted snow into the measuring tube.

d) Measure this as you would measure rain.

Melting the snow can be accelerated by carefully measuring an amount of warm water in the measuring tube, pouring this in the overflow can with the snow, letting the snow melt, measuring the total amount of melted precipitation, then subtracting the amount of water added.

Take care not to leave water standing in the gage if the temperature is expected to drop below freezing, as this can bend and crack it, causing leaks.

2.4.1 OBTAINING CORE SAMPLES OF SNOW

In cases where strong winds or drifting snow prevent the gage from receiving the correct amount of snow, or when snow overflows the gage or clings to the top to block snow from falling inside, direct measurements can be very inaccurate. Often the best solution in these cases is to take a core sample. Do this as follows.

a) Find an area where drifting is minimal. This will usually be a flat area away from obstructions such as trees and buildings, although obstructions at some distance can help minimize drifting.

b) Invert the overflow can and force it down through the snow. The rim will cut a cylindrical vertical sample. If the snow is very deep, it may be necessary to push the can part way to the ground. Then, remove and empty the snow into a container, and insert the can in the same hole to obtain the rest of the snow.

Caution! Do not push the can through snow that was measured at the previous observation, or its water equivalent will be counted in both measurements.

c) Slip a piece of sheet metal or thin wood beneath the mouth of the can to prevent the snow from falling out.

d) Take the snow indoors, melt it, and obtain the water equivalent as described in section 2.4.

e) If there is a question about the accuracy of the water equivalent of snow measured directly in the can, compare it with the amount determined by a core sample and use the larger of the two readings.

2.5 MEASURING THE DEPTH OF FROZEN PRECIPITATION

2.5.1 DEFINITION

Although frozen precipitation includes snow, ice pellets, glaze, hail, and sheet ice formed directly or indirectly from precipitation, the following text will use the word "snow" for all of the above.

Two types of snow depth are reported:

a) The depth of newly fallen snow (snow having fallen since the previous scheduled time of observation), reported in inches and tenths.

b) The total depth of snow on the ground (new and old), reported to the nearest whole inch.

2.5.2 MEASURING WITH A MEASURING STICK

Find a location where the snow appears to be near its average depth. This may be difficult if the snow has drifted. Look for a flat, somewhat open area away from buildings and trees. Some trees in the distance may be helpful in breaking the wind, preventing drifting, and thus providing for a more even distribution of the snow.

Measure the depth with a sturdy measuring stick, such as that used with the 8-inch nonrecording gage, a ruler, or a yardstick. Convert readings to the nearest tenth inch. If using the 8-inch gage stick, multiply the scale reading by 10; i.e., if it reads 1.15 inches, the snow depth is 11.5 inches. Measure the depth at several locations and use an average depth if drifting has occurred.

When snow has fallen between observation times and has been melting, measure its greatest depth on the ground while it is snowing, or estimate the greatest depth. If all snow melted as it fell, enter a trace for the snowfall.

2.5.3 MEASURING NEW SNOW FALLING ON TOP OF OLD SNOW

When fresh snow has fallen on old snow, it is necessary to measure the depth of the new snow (tenths of inches) and the total depth of all snow (whole inches). Snow boards (section 2.5.4) provide the best method of taking measurements in this case. If you do not have a snow board, and if the old snow has settled or partially melted enough to develop a crust or to be noticeably denser than the new snow, it may be possible to insert the snow stick until it meets the greater resistance of the crust of old snow, and to use this depth as the amount of new snow having fallen. Sometimes pollution or partial melting will give the old snow a darker color than the new. If so, cut a vertical core through the snow down to the ground. Measure the new (whitest) snow depth to the nearest tenth inch, and the total snow depth to the nearest inch.

2.5.4 SNOW BOARDS

Snow boards (exhibit 2.9) are laid on top of the old snow when there is any possibility of new snow falling. They may be made of thin lumber or other light material (Styrofoam) that will not sink into the snow, yet be heavy enough not to blow away. They should be painted white. Push them into the snow just far enough that the top of the board is level with the top of the snow. A 16" X 16" snow board will allow cutting more than one snow sample.

After each observation, boards should be cleaned and placed in a new location. Because of evaporation or drifting, they may need adjusting daily to assure that the top of the board remains flush with the old snow.

2.5.5 SNOW STAKES

Snow stakes are used in geographical areas frequently having deep snowfalls, as in the western mountains and to the lee of the Great lakes. Stakes should be graduated in whole inches, with numerals inscribed at 10-inch intervals; i.e., “20" for 20 inches. Stakes should be sturdy, water-resistant, and painted white to minimize snow melt around them. If possible, they should be located on level ground where the snow depth is typical of the area. In hilly areas, select a northerly exposure Northern hemisphere). The area around the stake should be free from trees, buildings and other obstructions that could seriously affect the wind flow around the stake. Low, leafless bushes, however, can be beneficial in reducing drifting. The stakes may be mounted on a securely anchored vertical post or other support.

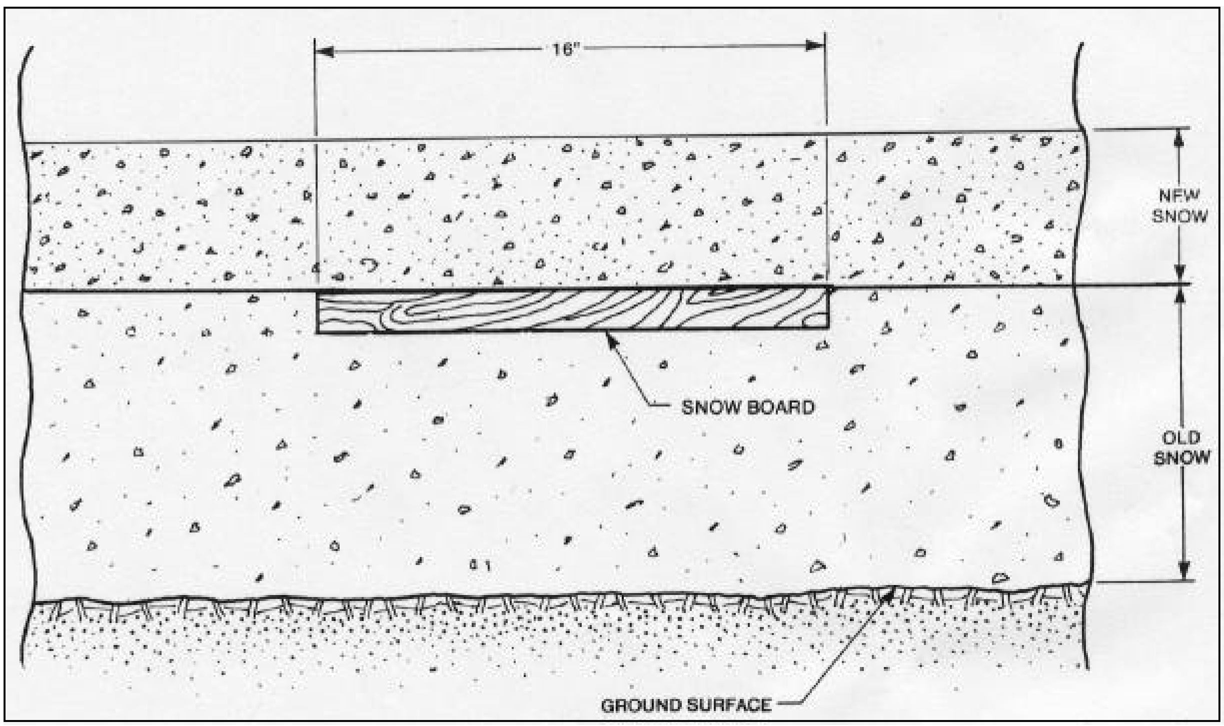


Exhibit 2.9: Snow Board

2.6 KEEPING AND MAILING RECORDS

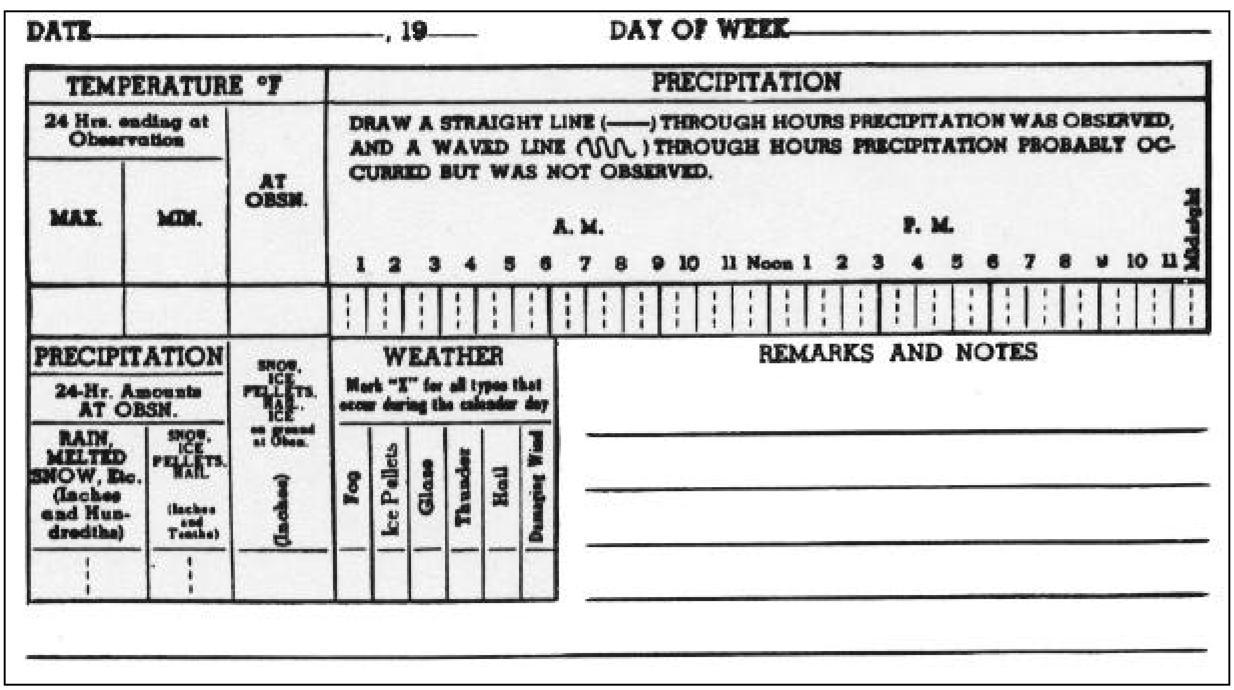
2.6.1 PURPOSE

One of the most important tasks of the cooperative observer is to record precipitation and other data on forms that are mailed, either directly by the observer or through the NWS representative, to the National Climatic Data Center (NCDC) . NCDC archives and publishes these records, which comprise the major part of our information on the climatology of the U.S. The monthly reports sent to the NWS representative or directly to NCDC, as well as hazardous weather events (heavy rain, flooding, severe storms, etc.) reported immediately to weather offices by designated observers, are the real payoff of the cooperative observer program.

The forms used most often by cooperative observers are WS Form B-82 (formerly Form F-7) and Form B-91 (formerly WS Form E-15). These are described below.

2.6.2 WS FORK B-82 (FORMERLY WS FORM F-7), "OFFICIAL WEATHER OBSERVER'S RECORD"

The purpose of this handy pocket-sized pad of forms (exhibit 2.10) is to record observations while reading the instruments. Information recorded on Form B-82 is then transferred to the official permanent record, WS Form B-91. Each pad of B-82 forms is intended to last one month. Form B-82 contains complete instructions for recording observations. This form is not to be mailed and may be retained by the observer.


DATE ________, 19___ DAY OF WEEK ________

TEMPERATURE °F

24 Hrs. ending at Observation

MAX. MIN. AT OBSN.

PRECIPITATION

DRAW A STRAIGHT LINE (——) THROUGH HOURS PRECIPITATION WAS OBSERVED, AND A WAVED LINE (∿∿) THROUGH HOURS PRECIPITATION PROBABLY OCCURRED BUT WAS NOT OBSERVED.

A. M. 1 2 3 4 5 6 7 8 9 10 11 Noon P. M. 1 2 3 4 5 6 7 8 9 10 11 Midnight

PRECIPITATION

24-Hr. Amounts AT OBSN.

RAIN, MELTED SNOW, Etc. (Inches and Hundredths)

SNOW, ICE PELLETS, HAIL (Inches and Tenths)

SNOW, ICE PELLETS, HAIL, ICE on ground at Obsn. (Inches)

WEATHER

Mark "X" for all types that occur during the calendar day

Fog Ice Pellets Glaze Thunder Hail Damaging Wind

REMARKS AND NOTES

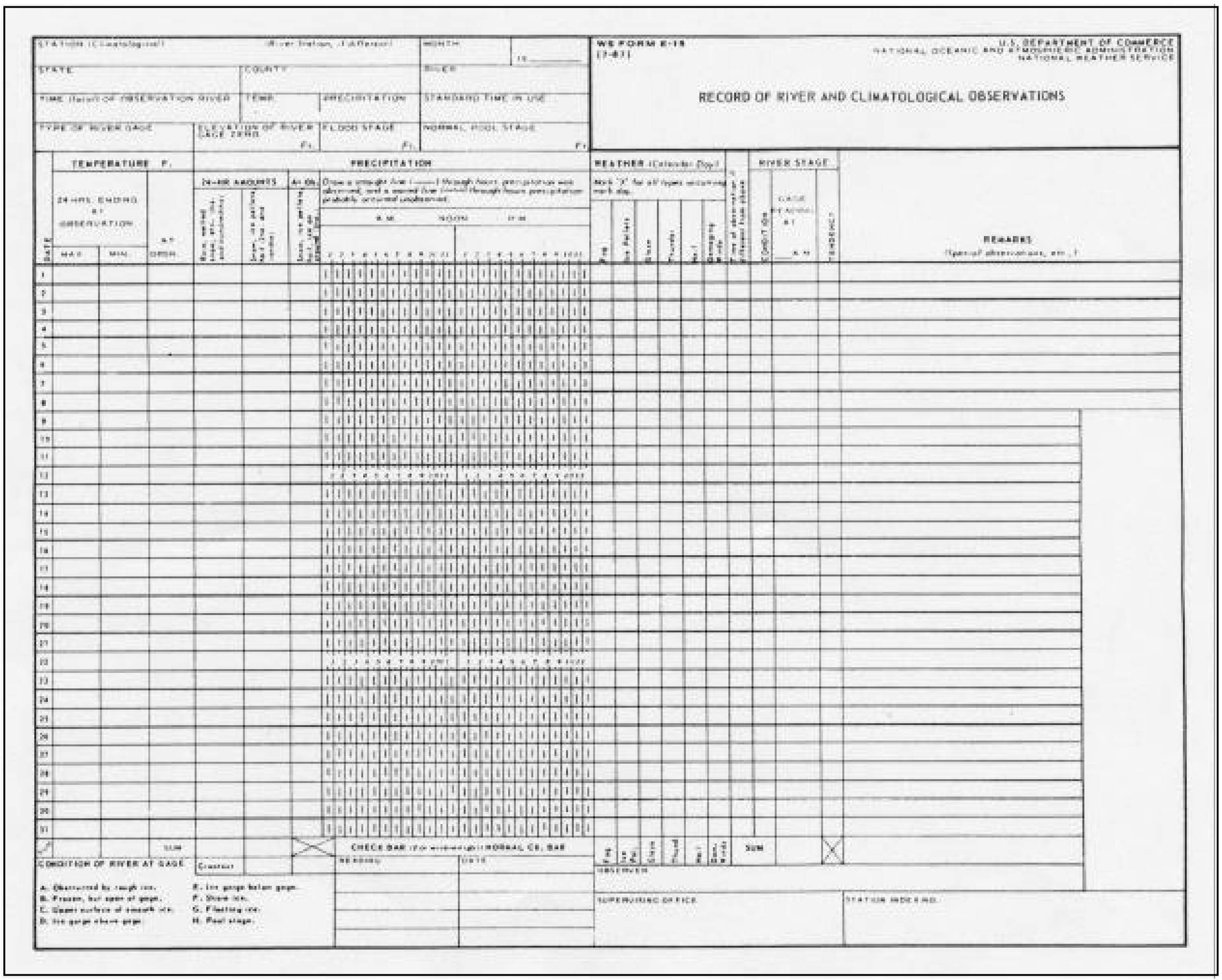
Exhibit 2.10: WS Form B-82—Official Weather Observer's Record

2.6.3 WS FORM B-91, "RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS"

The information on one of WS Form B-82 is transferred to one line of Form B-91 (exhibit 2.11). For example, information for March 23 on Form B-82 is transferred to the line designated for the 23rd day of the month on the B-91. Each B-91 contains space for an entire month's observations. The NWS representative will instruct you as to how many carbon copies are required, and to whom to send them.

PRECIPITATION

Forms should be mailed as soon as possible, but no later than the fifth day of the following month. Complete instructions for filling out the B-91 are contained on the cover pages of the form.


WS FORM E-15

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION | MONTH | STATE | COUNTY | RIVER | TIME OF OBSERVATION | STANDARD TIME IN USE | TYPE OF RIVER GAGE | ELEVATION OF RIVER GAGE ZERO | FLOOD STAGE | NORMAL POOL STAGE

TEMPERATURE F. | PRECIPITATION | WEATHER (Calendar Day) | RIVER STAGE | REMARKS

Exhibit 2.11: WS Form B-91 (Formerly WS Form E-15)
Record of River and Climatological observations

2.7 REAL-TIME REPORTING OF PRECIPITATION, TEMPERATURES AND HAZARDOUS WEATHER EVENTS

You may be among the many observers requested to report precipitation (and in sane cases, temperature) values to an NWS office every day or whenever a certain minimum amount of precipitation has fallen. If you agree to do this, your information will be vital to the NWS river and flood forecast and warning program. During the winter, you may be requested to measure and report the water content (water equivalent) of snow on the ground twice a week. This information helps the NWS forecast the amount of runoff and potential flooding from snow melt during warm spells or the spring thaw. Some observers maintain precipitation gages from which the data are automatically interrogated by telephone or satellite.

The NWS may also ask you to report immediately by telephone any severe weather event that may endanger life and property. This information will aid in determining the need for warnings of severe weather. If you participate in this program, you will be asked to report one or more of the following types of events.

a) Flash flooding (give the time of your observation and state if the water level is rising or falling).

b) Severe thunderstorms with damaging winds (50 mph or stronger) or 3/4 inch or larger hail.

c) Excessive rain; i.e., 0.50 or 1.00 inch or more per hour.

d) Unusual snow accumulation (4 inches or more, or as instructed).

This special reporting is entirely voluntary and is not intended to interfere with the regular weather duties you agreed to do for the NWS. However, these extra reports can be valuable means of saving lives and minimizing the destruction of property.

SECTION 3: AIR TEMPERATURE

3.1 DEFINITIONS

The word temperature as used in Section 3 refers only to the air temperature. Temperature readings are taken from maximum and minimum thermometers, or from the digital displays of maximum-minimum Temperature systems (MMTS).

The minimum temperature is the lowest temperature to have occurred since the minimum thermometer or MMTS was last read and reset.

The maximum temperature is the highest temperature since the maximum thermometer or MMTS was last read and reset.

The current temperature is the temperature at the time the thermometer or MMTS is read. This is read from the maximum thermometer while in a vertical position after it has been whirled.

3.2 TYPES OF THERMOMETERS

There are two types of temperature sensors in common use at cooperative stations: the liquid-in-glass maximum and minimum thermometers (exhibit 3.1) and the MMTS (exhibit 3.2). Exhibit 3.1 shows the liquid-in-glass maximum and minimum thermometers in their correct "set" positions.

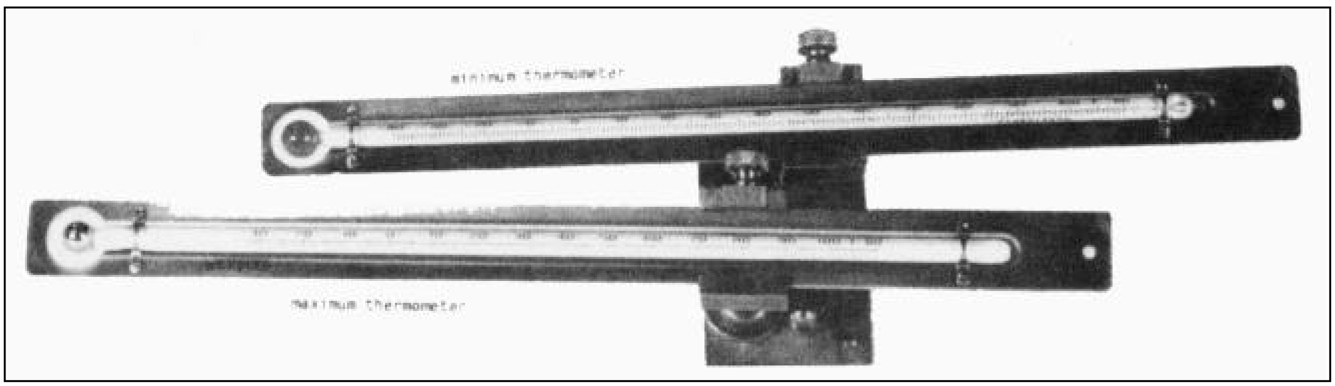


Exhibit 3.1: Liquid-in-Glass Maximum and Minimum Thermometers

3.3 INSTRUMENT SHELTERS

Thermometers must be enclosed in shelters, which act as shields from the sun, rain, snow, and other sources of light, heat, or cold which can cause erroneous readings. Shelters are designed to allow the maximum possible free flow of air while providing protection from heat and light. This is accomplished with louvers which slope downward from the inside to the outside of the shelter and with a double top. The VMS shelter is shown in exhibit

Exhibit 3.3 shows the medium-sized shelter used most often for liquid-in-glass maximum and minimum thermometers.

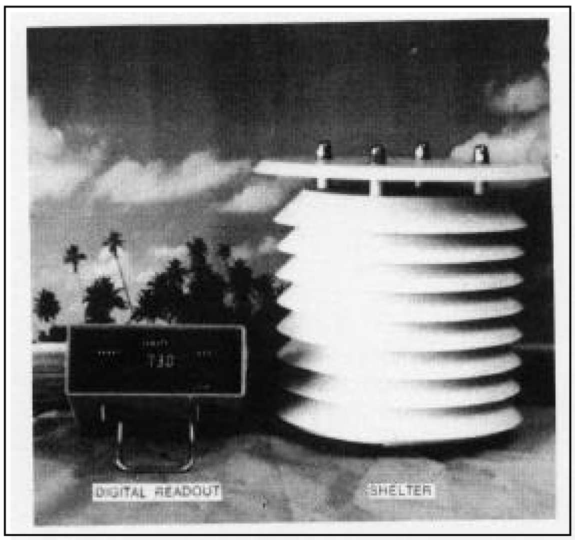


Exhibit 3.2:
MMTS Outdoor Shelter
with Indoor Digital Readout

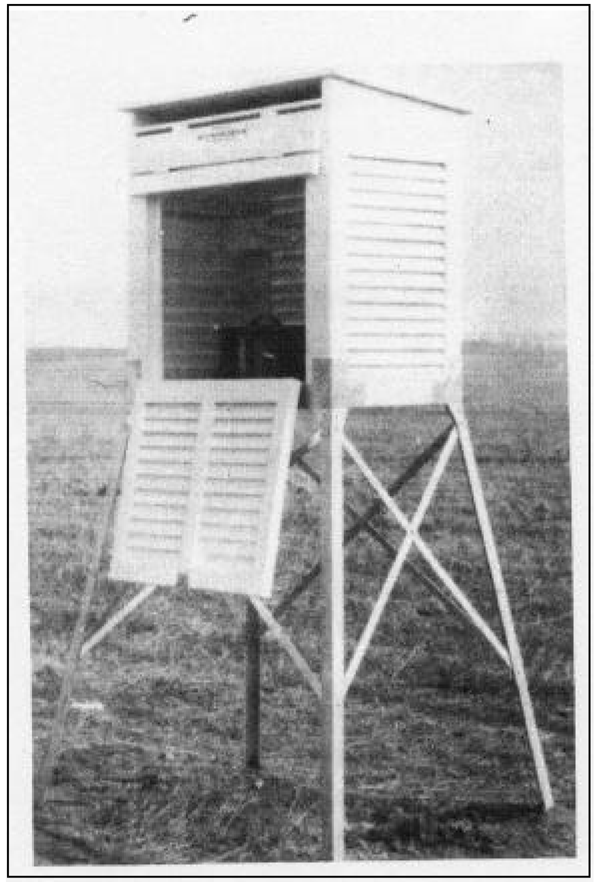


Exhibit 3.3.:
Medium-Sized Instrument Shelter

Liquid-in-glass thermometers are mounted on a horizontal board located in the upper middle part of the shelter.

3.3.1 SHELTER PLACEMENT

The ground over which the shelter is located should be typical of the surrounding area. A level, open clearing is desirable so the thermometers are freely ventilated by the flow of air. Do not install on a steep slope or in a sheltered hollow unless it is typical of the area, or unless data from that type of site are desired. When possible, the shelter should be no closer than four times the height of any obstruction (tree, fence, building, etc.). It should be at least 100 feet from any paved or concrete surface.

All shelters should be mounted securely enough into the earth or a concrete slab to eliminate vibrations. Strong winds can cause vibrations that will displace the indices on maximum and minimum thermometers, causing erroneous readings. The wooden shelter door must face north to prevent the sun from shining on the thermometers when the door is open.

3.3.2 SHELTER MAINTENANCE

Dust the inside of wood shelters occasionally with a dry cloth. Inspect supports for secure mounting. Report any defects or changes to the NWS representative. The NWS representative will paint the shelter when needed.

Remove insect nests and other matter restricting air flow through the MMTS shelter now and then. If this is not possible, report the condition to the NWS representative.

3.4 LIQUID-IN-GLASS MAXIMUM AND MINIMUM THERMOMETERS

3.4.1 MAXIMUM THERMOMETER—HOW IT WORKS

The maximum thermometer has a mercury-filled bulb (sensing element). It is exposed in a nearly horizontal position (exhibit 3.1). Graduations at 10 intervals are etched on the stem. The bore is constricted between the graduated portion of the stem and the bulb, as shown in exhibit 3.4. As the temperature rises, some of the expanding mercury in the bulb is forced to pass through the constricted portion into the graduated portion. When the thermometer is lowered for reading, the top of the mercury column indicates the highest temperature reached.

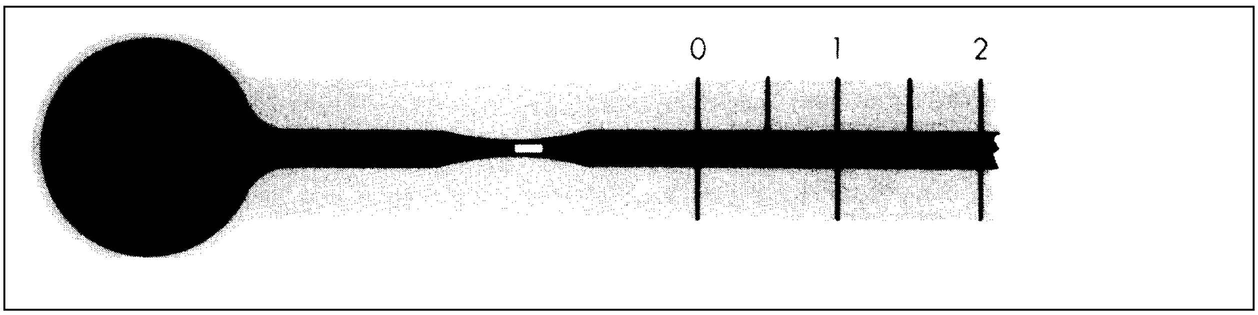


Exhibit 3.4: Liquid-in-Glass Maximum Thermometer

3.4.2 MINIMUM THERMOMETER—HOW IT WORKS

The minimum thermometer has an alcohol-filled bulb, graduated at 10 intervals, and exposed as shown in exhibit 3.1. The alcohol is often colored to make it easier to read. The bore contains a dark dumbbell-shaped object called an index 3.5). As the temperature rises, the alcohol expands and flows around the index without displacing it. Part A of exhibit 3.5 shows the top of the alcohol column some distance to the right of the index. In Part B, the alcohol column has retreated with falling temperature until the top just touches the index. Further cooling moves the index nearer the bulb (to the left). As the temperature rises again, the alcohol column moves toward the right without moving the index. Part C shows an incorrect reading with the index trapped in the broken alcohol column. Correcting this problem is described in Section 3.4.6.2.

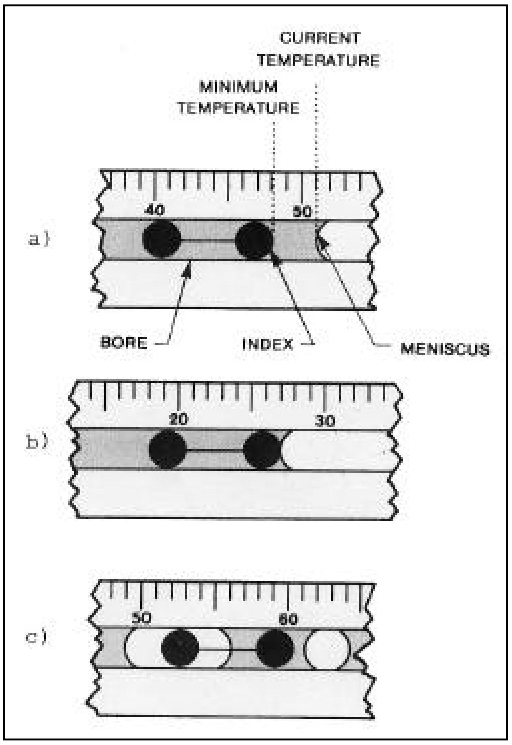


Exhibit 3.5: Index on Minimum Thermometer

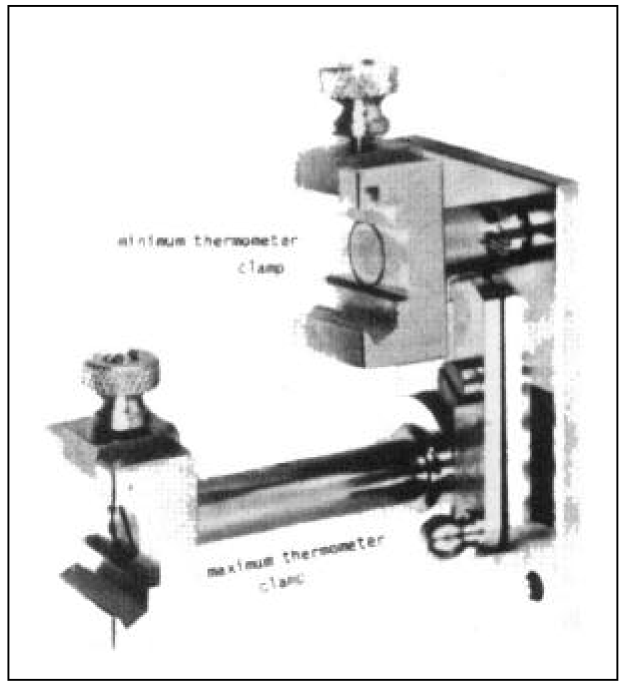


Exhibit 3.6: Supports for Maximum and Minimum Thermometers

3.4.3 MOUNTING AND MAINTAINING THE THERMOMETER SUPPORT

Thermometers are mounted in instrument shelters on supports such as the one shown in exhibit 3.6. The support makes it easy to read and reset the thermometers to the current temperature at the time of observation.

The support consists of two metal shafts fastened to a metal base plate. Clamps, which hold the thermometers, are attached to the end of the shafts. The longer shaft holds the maximum thermometer, while the shorter holds the minimum. The maximum thermometer may be spun (rotated) by hand to reset the mercury column to the current temperature. A pin in the minimum thermometer shaft prevents it from rotating more than a quarter turn (about 90˚). It is reset by rotating it to the vertical position.

The thermometer support should be mounted with screws near the center of the shelter, where the bulbs will be exposed to the freest possible flow of air through the shelter. The longer shaft should be at the bottom, and the longer sides of the base plate should be vertical.

Oil the longer shaft of the support occasionally with a thin motor oil (exhibit 3.6). Wipe any visible oil from the surface of the support.

3.4.4 MOUNTING THE THERMOMETERS

Clamp the metal back of the maximum thermometer to the lower (longer) shaft of the support at a point 3.5 inches from the high-temperature end of the back. The bulb end will be to the left when the thermometer is set.

Clamp the metal back of the minimum thermometer to the upper (shorter) shaft. The back should be clamped at a point slightly closer to the high temperature end than the bulb end. The bulb end should be to the left when the thermometer is set.

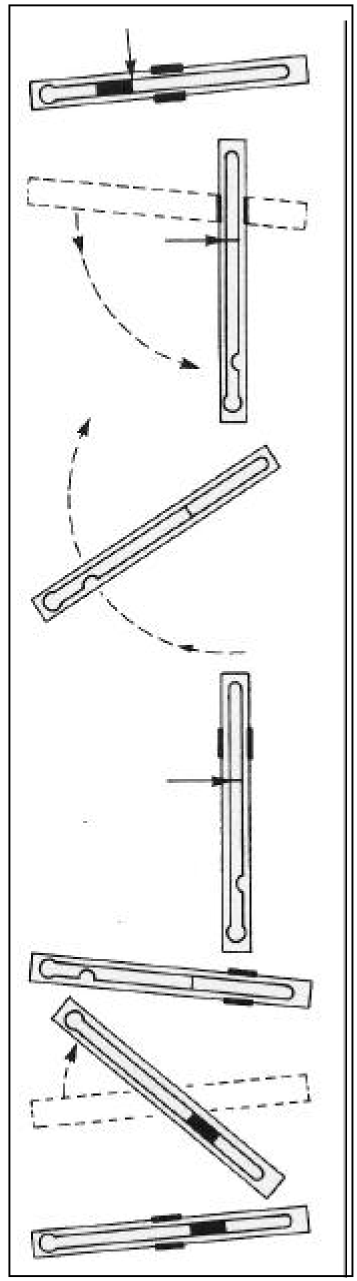
Be certain that the bulbs will not touch any object when rotated or tilted vertically. If properly installed and set, the bulb end of the minimum thermometer will be slightly (about 5˚) above the horizontal (exhibit 3.1).

3.4.5 HOW TO READ AND RECORD I TEMPERATURES

Thermometers are read and recorded to the nearest whole degree. Readings should usually be recorded on WS Form B-82 (optional) and B-91 (see sections 2.3.2 and 2.3.3). Below zero temperatures are recorded with a minus (-) sign to the left of the digits; i.e., -15 for 15˚ below zero. The thermometers should be reset after they are read, as described in sections 3.4.5.1 and 3.4.5.2. and exhibit 3.7.

CAUTION! Stand as far from the thermometers as possible to prevent body heat from changing the readings. This is particularly important in cold weather. Do not touch the bulbs of the thermometers.

Be sure that the line of sight from your eye to the top of the mercury or alcohol column is level. If not, your reading will be too high or too low, as illustrated in exhibit 3.8.



a) Read right end of index in minimum thermometer.

b) Unlock and slowly lower maximum thermometer; read top of mercury column.

b) Whirl maximum thermometer until its reading agrees (within 1°) with reading at top of alcohol column on minimum thermometer. When the two thermometers differ by more than 1° report to supervising office.

c) Read this temperature from maximum after it has been whirled, except at evaporation stations (Section 5, para 4.1).

d) Lock maximum thermometer in its set position.

f) Invert minimum until index drops to end of alcohol column.

g) Return minimum to its nearly horizontal position.

Exhibit 3.8: Reading and Setting Thermometers

3.4.5.1 READING AND SETTING THE MAXIMUM THERMOMETER

The highest temperature occurring since the maximum temperature was previously set is the reading at the top of the mercury column, taken with the bulb end lowered. Carefully release the support catch back of the clamp to lower the bulb end of the thermometer. See exhibit 3.9.

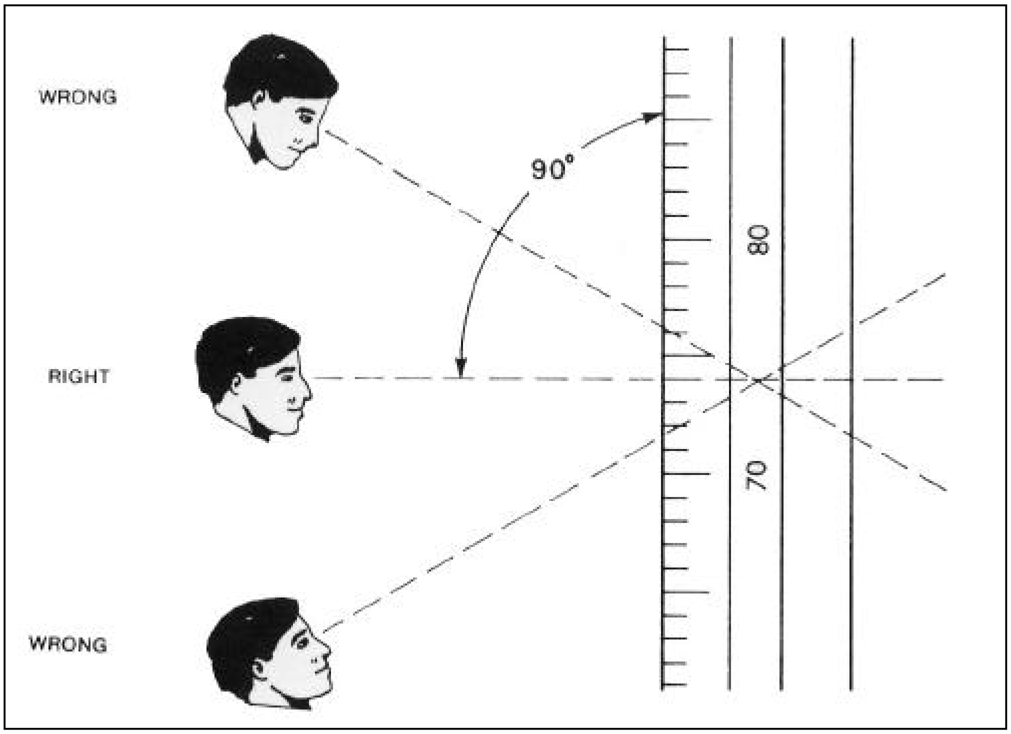


Exhibit 3.8: Reading Thermometers

To set (reset) the maximum thermometer, start with the bulb end lowered (as above) and whirl it rapidly, allowing it to spin freely until it comes to rest. Repeat the whirling if necessary until the mercury will not retreat farther into the bulb; that is, until the column is no longer separated at or below the constriction. See exhibit 3.10.

Now move the catch on the support until it touches the longer shaft. Carefully elevate the bulb end of the thermometer until the catch locks the shaft in place on the support. The thermometer is now "set." It is ready to indicate the maximum temperature that occurs before it is set again in the same manner.

3.4.5.2 READING AND SETTING THE MINIMUM THERMOMETER.

The minimum temperature is the reading at the end of the index farthest from the bulb (not the reading on the alcohol column). Read the thermometer before moving it from the almost horizontal position in which it was set at the time of the last observation.

To set the minimum thermometer, point the bulb end upward (exhibit 3.11). Allow the index to fall to the end of the alcohol column. Then turn the thermometer counterclockwise until it stops. The bulb end will now be slightly lower than horizontal.

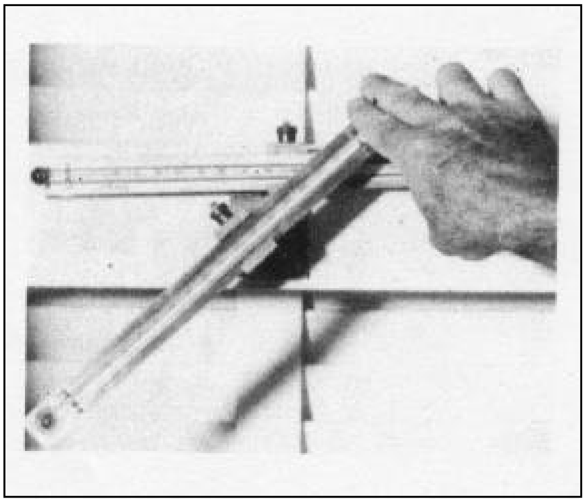


Exhibit 3.9: Maximum Thermometer in Reading and Whirling Position

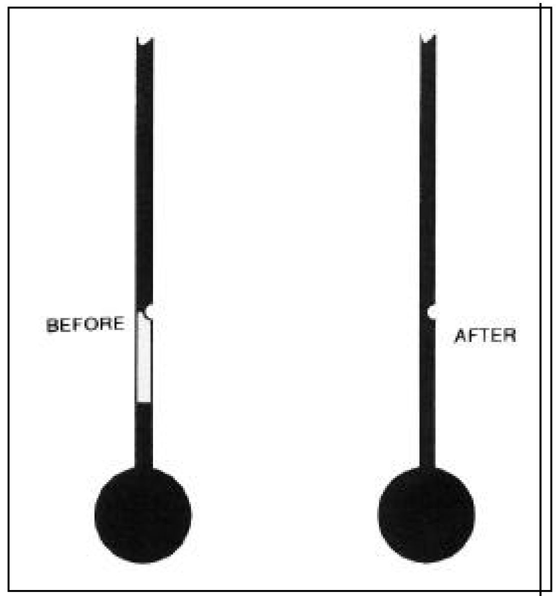


Exhibit 3.10: Maximum Thermometer Before and After Whirling

3.4.5.3 READING THE CURRENT TEMPERATURE

Read the current temperature from the maximum thermometer while it is in a vertical position after spinning. Read the temperature at the end of the mercury column farthest from the bulb. Read it immediately after setting it.

3.4.6 CORRECTING THERMOMETER ERRORS

Sometimes there may be breaks in the mercury or alcohol columns, the thermometer may be too difficult to reset, or it will reset itself between readings. The following instructions tell how to correct some of these problems. If correction is impossible, request a replacement from your NWS representative immediately.

3.4.6.1 CORRECTING MAXIMUM THERMOMETERS

The constriction shown in exhibit 3.4 may not be small enough in some thermometers to prevent the mercury from withdrawing into the bulb when the temperature falls after reaching its maximum value. Sometimes rough handling will cause this problem. To test for this defect, place the thermometer in a vertical position. If the mercury withdraws into the bulb without spinning the thermometer, it must be replaced. Please report this to the NWS representative promptly.

If the constriction is too small, it may require many spins of the thermometer to get the mercury to return to the bulb, especially at low temperatures. If so, report this to the NWS representative.

Sometimes a small amount of mercury will lodge in the upper end of the bore. If so, hold the thermometer vertically with the bulb upward. Tap the metal back of the thermometer gently with a finger until the column joins the mercury at the bottom. Lower the bulb, allowing the column to slide slowly down the bore to the constriction.

When the mercury cannot be united as above, remove the thermometer from its support and whirl as in Method II of section 3.4.6.2.

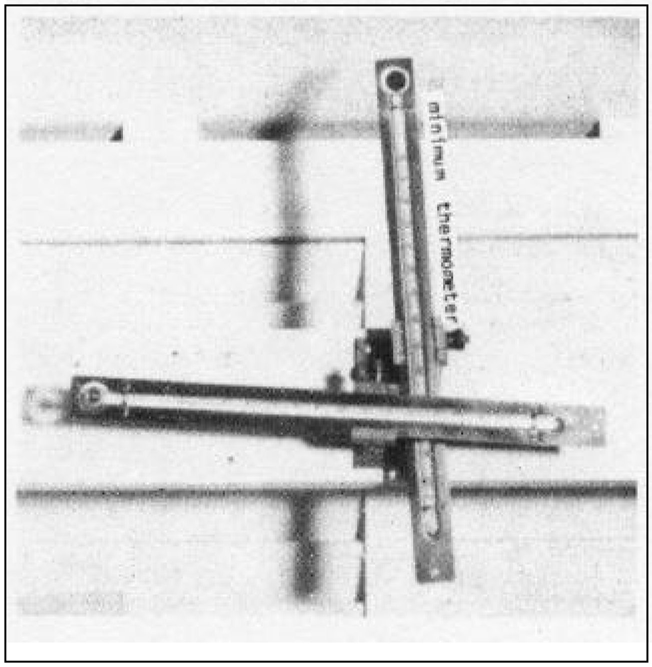


Exhibit 3.10: Minimum Thermometer in Vertical Position During Resetting of Index

3.4.6.2 CORRECTING MINIMUM THERMOMETERS

Sometimes the alcohol column of a minimum thermometer separates into small parts, causing incorrect readings. Separations may appear as small bubbles, making the column too long and readings too high, and trapping the index. Some alcohol may separate completely and remain in the upper portion of the bore, resulting in readings too low. The thermometer should be inspected regularly for these problems. The methods described below may have to be repeated several times, taking 15 to 20 minutes, before the column can be joined. The thermometer should be kept in a vertical position for several hours after parts of the column have been joined, in order that alcohol clinging to the sides of the bore will drain down. When repeated attempts fail to join the alcohol column, request a new thermometer from the NWS representative.

METHOD I: TAPPING

Grasp the thermometer slightly below the middle with the bulb end down. Strike the edge of the metal back sharply against the palm of your hand as shown in exhibit 3.12. Repeat this procedure several times. The thermometer must not be held so that your fingers or any part of your hand presses against the stem.

The bulb end may also be tapped on an open book.

METHOD II: CENTRIFUGAL FORCE

A short, quick swing of your arm is often effective in forcing the index toward the bulb and reuniting segments of the alcohol column. Grasp the thermometer firmly by the edges of the metal back a little above the midpoint. Avoid pressure on the back. With your arm extended upward, quickly swing the thermometer downward through an arc of 3 or 4 feet, stopping the motion suddenly when the thermometer is vertical. Sometimes it will be necessary to repeat this operation several times. See exhibit 3.13.

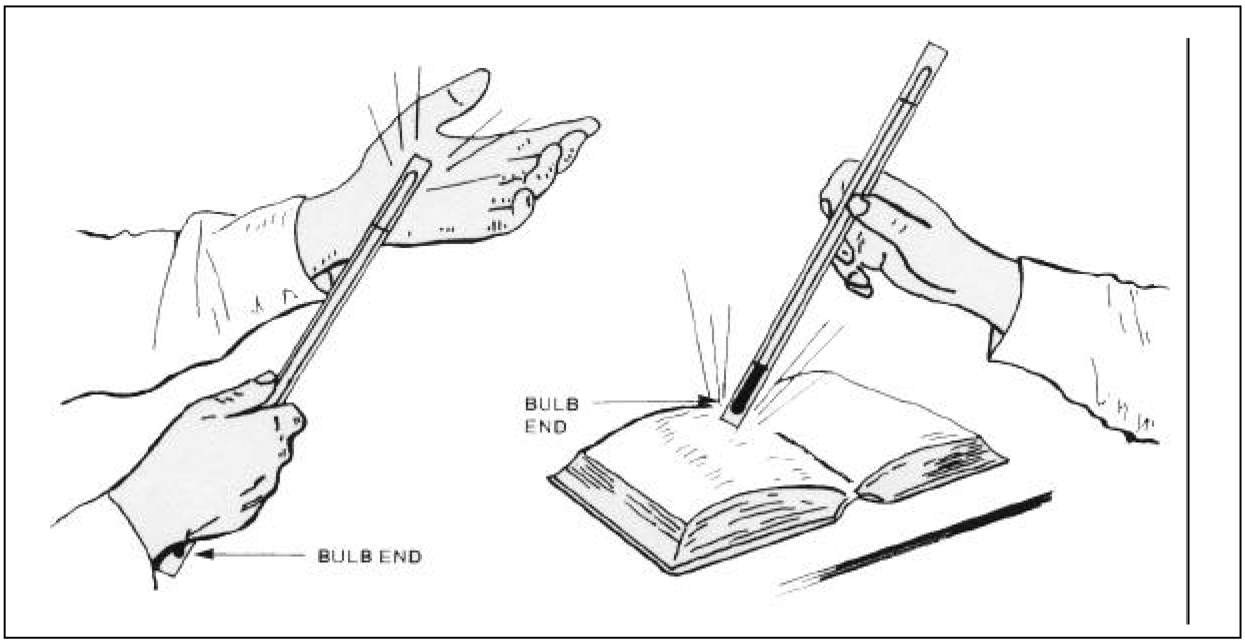


Exhibit 3.12: Joining the Alcohol Column Tapping Method

The thermometer can also be whirled on a short cord. Pass a strong cord through the hole in the top of the metal back of the thermometer. Firmly grasp the cord 6 to 8 inches from the thermometer and whirl it rapidly. Stand clear of all objects the thermometer might strike while whirling. It may take considerable practice to spin the thermometer rapidly and stop it safely. This method will often bring down an entrapped index and unite detached segments of the column. Make sure the cord is not cut by the thermometer back as it is whirled.

3.5 MAXIMUM/MINIMUM TEMPERATURE SYSTEM (MMTS)

The MMTS measures the current temperature average range from -55o to +1250F and compares it to the highest and lowest values stored in the memory of a microcomputer. If the current temperature exceeds the previous highest or lowest reading, then it becomes the newest maximum or minimum temperature.

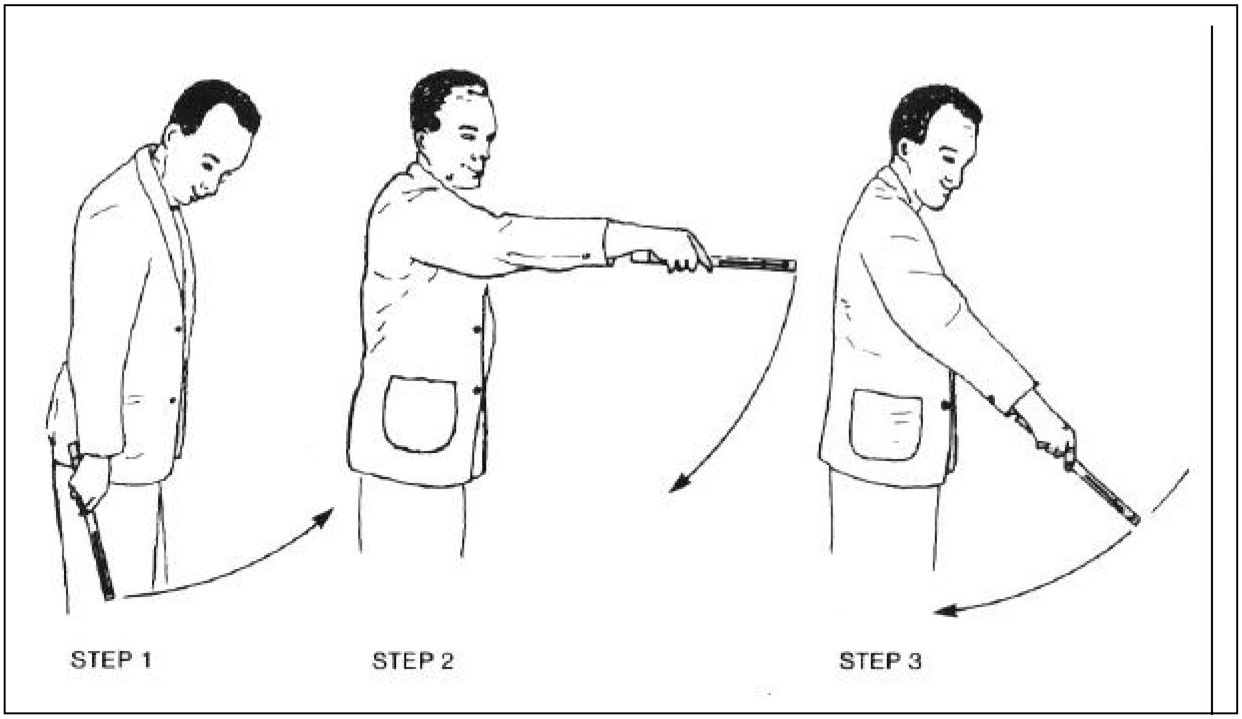


Exhibit 3.13: Joining Alcohol Column—Centrifugal Force Method

3.5.1 INITIAL CHECKOUT OF INSTRUMENT

Important: always turn the electronic display unit power switch off when not in use. With the power switch on and the unit unplugged, the battery supplying the emergency backup power will severely discharge, permanently damaging the system.

a) Connect the instrument shelter to the display unit with the fabricated cable.

b) Plug the AC power cord of the display unit into an AC outlet.

c) Turn on the power switch located on the rear panel of the display unit.

d) Allow one hour for the backup nickel cadmium battery to charge and then turn the display unit off and back on to reset it.

e) Observe that the display shows the message "HELP." This indicates the microcomputer is functioning properly. Exhibit 3.14 shows the display reading.

f) Depress the button labeled "RESET." The :message "HELP" will be replaced by the current temperature; e.g., 66.3.

g) Press and hold the “MAX” and “MIN” buttons simultaneously to test the fluorescent display for missing segments. All segments that are not already illuminated will flash intermittently.

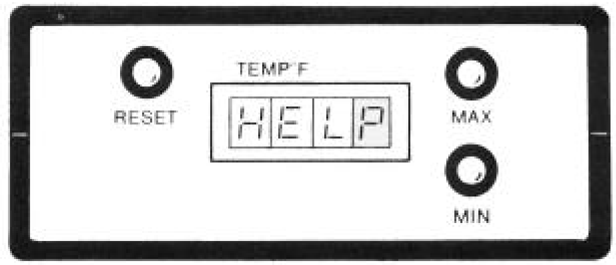


Exhibit 3.14: MMTS Display Panel Showing "HELP"

h) The message "LO" or "HI" may appear indicating an open or shorted sensor, or less likely, a temperature colder than—55° or hotter than +125° F.

3.5.2 CALIBRATION

Often, no calibration is necessary due to the design of the MMTS. Due to possible errors caused by power surges, some observers may be given calibration equipment by the NWS representative, who will provide instructions on its use. Temperature sensors are accurate within 0.4°F between -40° and +104°, and within 0.7° for temperatures between -40° and -55° and between +104° and 125°.

3.5.3 OPERATION

The current temperature is displayed if no -buttons are pressed. Depress the "MAX" button to display the maximum temperature that occurred since the MMTS was last reset. Depress the "MIN" button to do the same for the minimum temperature.

Simultaneously press the "RESET" and "MAX" buttons to reset the stored maximum temperature. Do the same with the "RESET" and "MIN" buttons to reset the minimum temperature.

Do not reset the maximum or minimum temperatures between the scheduled times of observation. Resetting at unscheduled times is the most frequent cause of errors.

Record the maximum, minimum, and current temperatures on WS Form E-15. Record to the nearest whole degree, even though the readings are displayed to the nearest tenth degree. If the last digit is a 5 (e.g., 43.5), round the temperature upward to the next higher whole degree (i.e., 44).

3.5.4 IDENTIFYING AND CORRECTING ERRONEOUS MAXIMUM AND MINIMUM TEMPERATURES

Today's maximum temperature must be at least as high as the higher of today's or yesterday's temperatures at the time of their respective observations temperatures were 64° and 52°, and today's maximum temperature is displayed as 62°, you must raise today's MAXIMUM to 64°. See section 3.5.7 for a description of the most frequently occurring errors.

Similarly, today's minimum temperature must be at least as low as the lowest of today's or yesterday's current temperatures. If not, lower it to the lowest of the two readings. Unauthorized resetting between observation times creates more errors than all other causes combined. Persistent errors from other causes (i.e., vibrations) should be reported to the NWS representative.

3.5.5 "HELP" AND BLINKING DISPLAYS

If the "HELP" message appears on the display, press the "RESET" button to clear it and to show the current temperature. "HELP" indicates an interruption to the A.C. line voltage has occurred. Me microcomputer enters a "power down" condition in which the internal backup battery is used to preserve the maximum and minimal values stored in memory. These values are stored up to two hours without power. However, no updating of new maximum and minimum temperatures occurs during or after the power interruption until the "RESET" button has been pressed.

Blinking of the tenths (right-most) digit on the display indicates that the internal backup battery is charging. If the blinking persists and is not caused by power outages, the battery is probably defective, and the NWS representative should be informed.

3.5.6 ENTRY OF TEMPERATURE READINGS ON WS FORM B-91

Maximum, minimum and current temperatures are recorded to the nearest whole degree on WS Form B-91. See exhibit 2.10. WS Form B-82 (exhibit 2.9) is designed to record readings taken outdoors, so as not to forget values between the time the instruments are read and the readings are recorded on WS Form B-91. Since the MMTS is read indoors, Form B-82 may be needed only for recording precipitation.

3.5.7 COMMON ERRORS TO AVOID

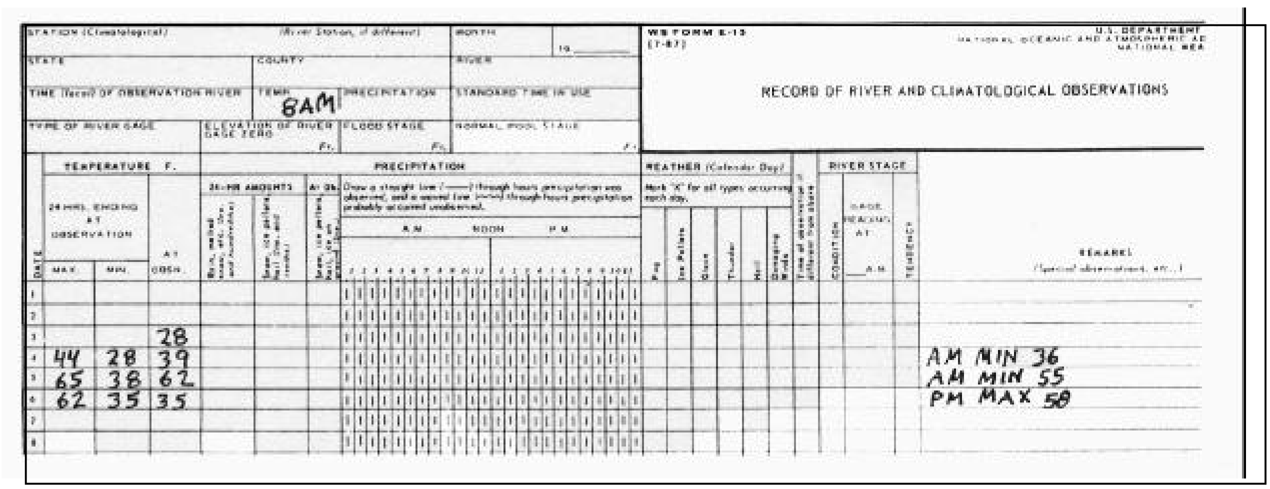
Maximum and minimum temperature data are keyed into computers at NCDC. Data which are inconsistent must either be rejected or corrected (estimated) . observations are flagged most commonly for the following types of errors.

a) Maximum temperature lower than the time-of-observation temperature at the previous observation (24 hours earlier). This error is most frequently committed by people taking observations in the afternoon or evening.

b) Minimum temperature higher than the time-of-observation temperature at the previous observation (24 hours earlier). This error is most frequent among morning observers.

c) Maximum (and occasionally the minimum) temperature entered on the B-91 on the day it Occurred rather than on the day the thermometers were read and reset. For example, a morning observer records high and low temperatures for the past 24 hours at 7 a.m. on the 25th as being 88 and 62. He knows the maximum of 88 occurred on the 24th (the previous afternoon), so he records it on his B-91 on the 24th. This should be recorded on the 25th, since that is the day he read and reset his instruments.

The most common cause of errors (a) and (b) is resetting the MMTS or the maximum and/or minimum thermometers between times of observation. The maximum temperature for the past 24 hours must be at least as high as the time-of-observation temperature both today and 24 hours earlier, and the minimum at least as low as today's and 24 hours ago. This error appears to be committed because, for example, the afternoon observer wants to record this afternoon's maximum temperature when it is lower than yesterday afternoon's maximum. This situation usually arises when it was warmer yesterday than today. Today's maximum should be recorded in the REMARKS column as, for example, "p.m. max 48" or "today's max 48," and last night's minimum as "a.m. min 36." Exhibit 3.15 shows the correct method of recording minima for the past night that are higher than the 24-hour minima (see the REMARKS entries on the 4th and 5th) and 24-hour maxima that were lower than the previous afternoon's maximum (see the REMARKS entry on the 6th).


WS FORM B-91
RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

TIME (local) OF OBSERVATION TEMP. 8AM

DATE	TEMPERATURE F. MAX.	MIN.	AT OBSN.	REMARKS
1				
2				
3			28	
4	44	28	39	AM MIN 36
5	65	38	62	AM MIN 55
6	62	35	35	PM MAX 58
7				
8				

Exhibit 3.15: WS Form B-91 Showing Correct Procedures
for Recording Maximum and Minimum Temperatures

SECTION 4: RIVER STAGES AND RELATED PRECIPITATION OBSERVATIONS

4.1 INTRODUCTION

The stage of a river or lake is the height of the water surface above some established datum or reference elevation. The term "gage height" is used for readings from a gage, but river stage and gage height are often used interchangeably. The datum may be a recognized elevation such as mean sea level or an arbitrary datum chosen for convenience. In either case, the gage is adjusted so that only positive gage heights are possible and these are relatively low numbers. This is done by setting the lowest possible gage height (the case of no strewn flow) to a value of zero. The elevation of the zero gage height is referenced to the datum by running levels to a reference mark which has a known elevation relative to the datum. It is important that an elevation reference mark for the datum be located (or established) that is permanent even if the gage is destroyed.

The depth of inundation of a flood can be determined by plotting the indicated elevation contour on a topographic rap. Determining the elevation above sea level of high water is especially significant during a flood of record.

River stages are affected by many factors. Precipitation and temperature are the most commonly known causes of rises and falls in river stages. However, there are other factors, such as snow melt and glacial runoff into stream, and the release of water from any upstream reservoirs.

Precipitation readings at river cooperative stations are taken with the four-or eight-inch nonrecording gage (section 2.2). River stages are read using a staff, wire weight, or profile gage, as described below.

4.2 STAFF RIVER GAGE

The staff river gage (exhibit 4.1) is a fixed scale that can be in the form of porcelain-enameled iron sections, a wooden plank, or may be printed on available structures such as a bridge, pier, or wall. The gage may be mounted vertically or inclined with graduations for vertical depth. The inclined gage is used where ice or debris will not permit a permanent vertical staff to be installed. It usually consists of a heavy timber installed on the incline of the bank. The scale of the staff gage must be set so that a reading can be taken at zero flow in the low-water channel. Readings are made to the nearest tenth of a foot. The staff gage will usually have a gage datum that will be the elevation of its zero reading above mean sea level. The gage sections should be set so the readings are heights above the datum.

If vertical movement of the supporting structure occurs, such as settling, erroneous observations from the staff gage will result unless levels are run from a reference of known elevation and the staff scale is reset.

If the gage has been set with a scale that has graduations above and below zero (exhibit 4.2), the below zero readings must be recorded on the report form with a minus sign; e.g., -0.3. If possible, the gage should be set so as to avoid negative values.

4.3 WIRE WEIGHT GAGE

The wire weight gage (exhibit 4.3) is permanently mounted inside a case that is attached to a bridge or similar structure. The gage consists of a drum wound with cable, a bronze or brass weight attached to the end of the cable, a check bar, a graduated disc, and a counter.

Take readings as follows.

a) Unlock the case at (1) and gently open the cover (2). If the cover jams and will not swing freely, do not force it open. Close, relock, and submit a repair order. Inspect the wire (7) on the drum (8) for even windings that touch each other.

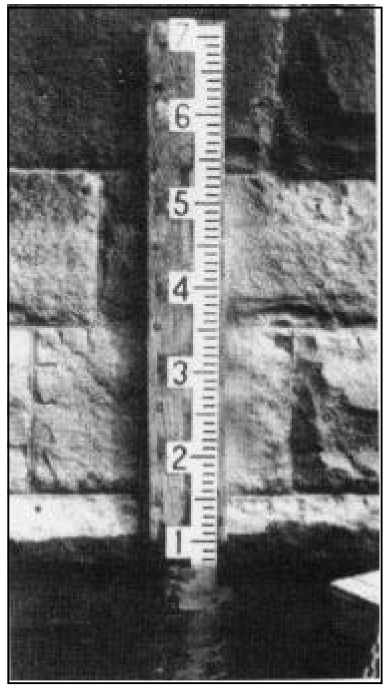


Exhibit 4.1: Staff River Gage

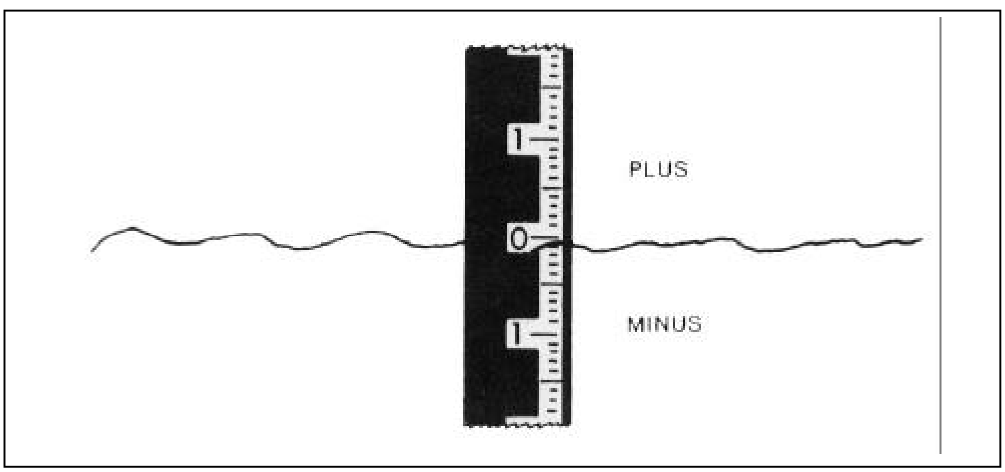


Exhibit 4.2: Staff River Gage Installation

b) Grasp the crank handle (3) and release the pawl (4). Lower the weight (5) to just touch the check bar (6), which is read while in the forward position.

Read the check bar elevation and record it. Enter this reading at the beginning, middle, and end of each month in the lower left corner of WS Form E-15. The feeder counter (9) displays units of feet. The index wheel (10) displays units of tenths and hundredths of a foot and is read at the pointer (11) .

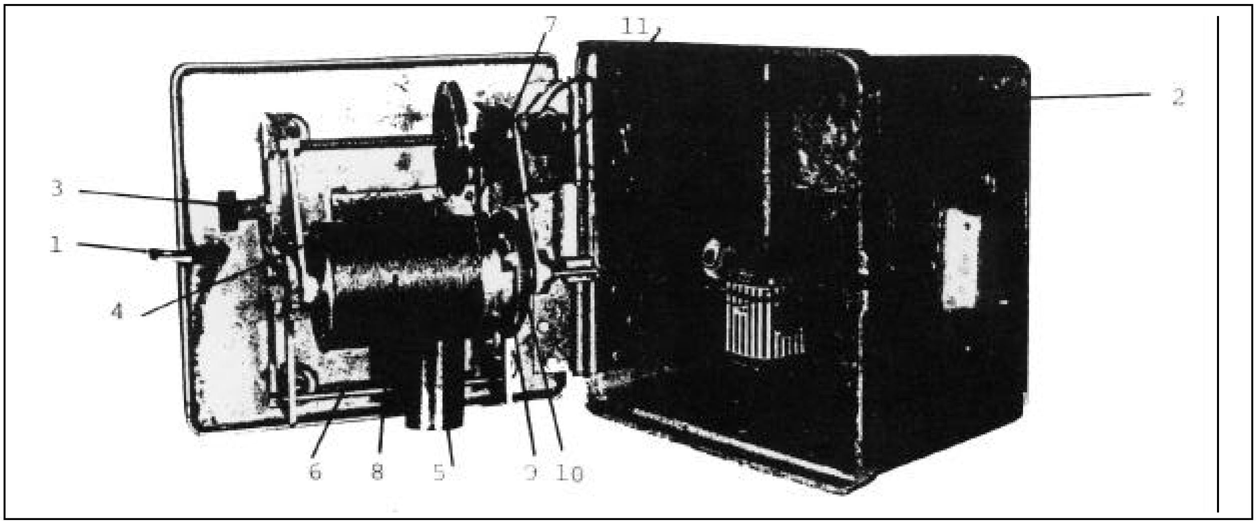


Exhibit 4.3: Wire Weight Gage

c) Raise the weight and slide the check bar to the rear position. Lower the weight to the water surface and

read this elevation just as the weight touches the water while descending. Average the peaks and troughs of elevation if the water surface is rough. You should repeat this process at least once. If the point of contact with the water surface is difficult to determine, it may be necessary to strum the cable or to swing the weight in a pendulum motion up and downstream to obtain an accurate reading.

d) Every day, record the reading obtained in step © in the "GAGE READING AT" column on WS Form E-15.

e) Engage the pawl and crank the weight to its original position within the gage. Slide the check bar to the for-ward notch. The crank handle should now be located in the rear position. This will allow the cover to close without touching the cuter tip of the crank handle.

f) Close the cover and lock the case as you originally found it.

4.4 PROFILE GAGE

On some rivers, especially where man-made structures such as bridges are rare and where vertical or staff gages can be damaged by ice Jams and breakup, profile gages are used. These consist of a marker, usually a brass cap benchmark, anchored in the bank above the levels of ice movement. The profile of the bank is surveyed to determine elevations to the nearest tenth of a foot and plotted on a graph. The cooperative observer, using a long surveyor's tape measure, determines the distance from the reference marker to the water's edge. From the graph, the slope distance is converted to a vertical stage. The observer always reports the slope distance to the NWS office.

4.5 RIVER GAGE LOCATION

Consider the following factors when selecting a site for the river gage.

a) The gage should be located so that stages will best reflect flooding in the area of maximum damage potential.

b) There should be access to the gage during high water, if at all possible.

c) The gage should not be located in the backwater of a reservoir or of a main stem river, if possible.

d) The river banks at the gage site should be stable.

4.6 RELOCATING RIVER GAGES

A river gage should be moved only after all other options have been exhausted. A different river gage location is likely to change such forecast components as the relationship of the gage reading to the discharge rate, flood wave travel time, and the attenuation, as well as changing the flood stage. Moving the gage may add or exclude a significant tributary from the drainage area. All users of the stage data would need to be informed of the change.

A new or moved river gage location will mean establishing a new gage datum if an arbitrary datum is used. If mean sea level is the datum, a bench mark or a new reference mark with known mean sea level will have to be located. It will then be necessary to run levels fruit the known elevation to the new gage site.

A wire weight gage will require that a new check bar elevation be determined, while a staff gage will require that the individual gage sections be set to given elevations above the datum.

If moving the gage is ultimately indicated, observers should contact their NWS representative.

4.7 TIMES OF RIVER STAGE AND PRECIPITATION OBSERVATIONS

Observations of river stage and precipitation should be taken at 7 a.m. each day unless otherwise specified by or agreed upon with the NWS. Special observations are taken at 1 p.m., 7 p.m., and 1 a.m. <u>only</u> when a report is required (section 4.8) or when the observer believes an emergency situation has occurred.

RIVER STAGES AND RELATED PRECIPITATION ON OBSERVATIONS

4.8 WHEN TO REPORT

There are two types of reporting stations, daily and criteria. Criteria stations are sometimes called Occasional stations. In many areas of the country, criteria stations are being converted to daily stations.

At a daily reporting station, reports are to be sent immediately after the 7 a.m. observation. Send extra reports at 1 p.m., 7 p.m., and 1 a.m. when the river stage reaches a level designated by the NWS representative (the criteria level) .

The reporting station should send its first report when the river stage reaches the criteria level specified by the NWS. Reports should continue daily until the stages fall below this level. If the river stage goes above a second criteria level, extra reports are to be made at 1 p.m. , 7 p.m., and 1 a.m., until the stage falls below this level.

Observations of both precipitation and river stage should be recorded on the reporting form at 7 a.m. every day at criteria reporting stations, even if stages are below criteria and are not sent. Always report river stage and precipitation together.

If no precipitation has occurred, the daily record from both types of stations should indicate 0 or 0.00.

When the rain gage measurement reaches a criteria value (usually 0.50 inch), an initial report must be made at 7 a.m., 1 p.m., 7 p.m., or 1 a.m. Reports should continue at all of these times until precipitation has not been reported for 24 hours. For example, if 1.05", 0.22", 0, and 0 precipitation fell during the six-hour periods ending at 1 p.m., 7 p.m., 1 a.m., and 7 a.m., report 1.05" at 1 p.m. and 1.27" at the other three times. See section 4.9b below.

4.9 WHAT TO REPORT

The report should contain the following information.

a) Location (station name or number), date, and time of observation.

b) The amount of precipitation having fallen since the previous 7 a.m. observation (inches and hundredths).

c) Character of the precipitation (rain, snow, ice pellets, etc.).

d) The weather at the observation time (clear, cloudy, rain, snow, etc.).

e) The depth of snow or ice on the ground (nearest whole inch).

f) The water equivalent of the above snow and ice (nearest tenth inch), if agreed to with the NWS.

g) The river stage at the observation time (feet and tenths).

h) The tendency of the river stage (rising, falling or stationary).

I) The river stage at the previous 7 a.m. observation,. if not previously reported

j) In the remarks section, enter special comments such as snow melting slowly or rapidly, unusually heavy rainfall in a short period of time (e.g., 1.54" in 30 minutes), ice breaking up or an ice jam forming on the river, etc.

Make a special effort to obtain a stage Measurement at the river crest, recording the approximate time of occurrence. It is also very helpful to take observations, both as the river begins a significant rise and as it recedes from a crest. These reports, even when not transmitted, will be valuable input to computer models that relate precipitation to river stage, and which determine the relationships of river stages at different points on the river.

When the water surface is disturbed due to turbulence or waves, record the stage as the average of the peaks and troughs.

4.10 REPORT FORMS

All necessary forms are furnished by the NWS. Each pad of forms contains detailed instructions. A sample of WS Form B-91 is shown in exhibit 2.11.

SECTION 5: EVAPORATION STATION OBSERVATIONS

5.1 INTRODUCTION

Observations are made of the amount of evaporation to the nearest hundredth inch from an open pan. other elements recorded include wind movement, water and air temperatures, and precipitation. At some sites, additional parameters will be required, such as dry and wet bulb temperatures, humidity, and the temperature and moisture content of the soil. Section 6 contains instructions on soil temperature measurements.

5.2 SETTING UP THE OBSERVING SITE

5.2.1 EXPOSURE OF EQUIPMENT

The equipment site should be fairly level, sodded, and free from obstructions (exhibit 5.1). It should be typical of the principal natural agricultural soils and conditions of the area.

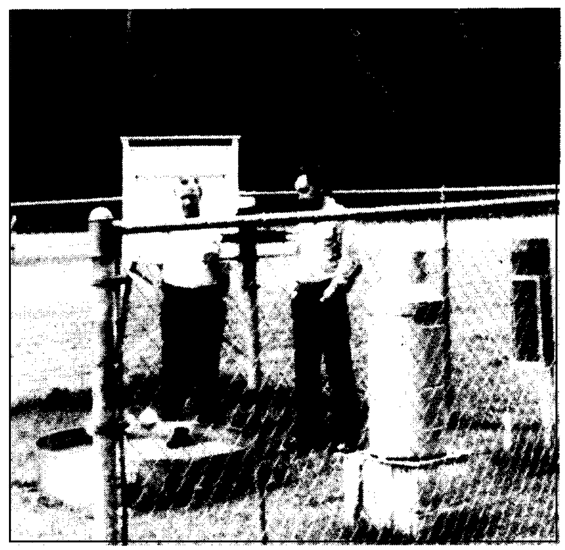


Exhibit 5.1: Evaporation Station Sites

Neither the pan nor instrument shelter should be placed over heat-absorbing surfaces such as asphalt, crushed rock, concrete slabs or pedestals. The equipment should be in full sunlight during as much of the daylight hours as possible, and be generally free of obstructions to wind flow. Obstructions that cannot be moved, such as trees, buildings, and nearby shrubs, should not be closer to the instruments than four times their heights. Shadows are permissible only near sunrise and sunset. Avoid areas subject to flooding or lawn sprinkling.

EVAPORATION STATION OBSERVATIONS

At reservoirs (flood control, water supply, and irrigation projects) the pan should be placed on the upwind side of the water. This is based on the prevailing direction of the strongest winds. The pan site should be far enough from the water to avoid the chance that water or spray carried from a spillway, or picked up from the reservoir by a strong wind, will be deposited in the pan.

The layout of equipment on the plot is shown in exhibit 5.2. The orientation N of the layout should be as indicated by the North arrow. If necessary, the layout can be rotated as much as 45˚.

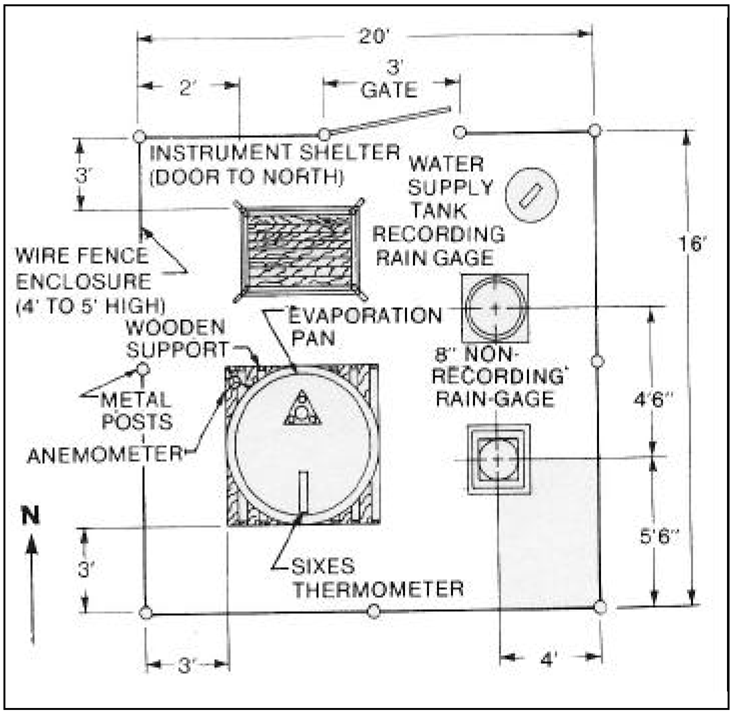


Exhibit 5.2: Evaporation Plot Layout

5.2.2 PLOT LAYOUT

Note that the layout is designed to eliminate shadows from instruments at stations in the northern hemisphere. Shadows from small diameter fence posts will occur only briefly in the late afternoon. The minimum distances between instruments are shown in exhibit 5.2.

The 10- by 16-foot plot shown is the minimum size. If other equipment is installed, the plot should be enlarged accordingly.

5.2.3 ENCLOSURE

The plot must be enclosed by a fence that will keep out animals. A steel chain link fence (9 or 11 gauge), at least four feet high, with steel posts set in concrete is recommended. Fences of wood or other solid material shall not be used. It may be necessary to bury a barrier under the fence for protection from burrowing animals, or add 18 to 24 inches of one inch galvanized chicken mesh fence along the bottom of the chain link fence to keep out small animals.

5.3 EVAPORATION EQUIPMENT

This section describes the installation, maintenance, and method of taking observations from each instrument. Evaporation measurements are made with an evaporation pan and a fixed-point gage with a measuring tube. Evaporation stations have the following additional instruments:

a) An anemometer to determine the daily wind movement over the pan and a display stand pintle (subsection 5.3.4).

b) An Clinch nonrecording precipitation gage with appropriate measuring stick or in some cases, a weighing-type recording precipitation gage.

c) A water temperature thermometer or thermograph to provide maximum, minimum, and current temperatures of the water in the evaporation pan (subsection 5.3.6).

d) Maximum and minimum thermometers or a thermograph for measuring the air temperature. Some stations have a hygrothermograph in place of these for measuring air temperature and humidity (subsection 5.3.5).

e) An instrument shelter for housing the temperature and humidity measuring instruments.

f) A water storage tank (if necessary) to provide a reserve water supply for the pan (subsection 5.3.3).

5.3.1 EVAPORATION PAN

The pan is circular, 10 inches deep, and 47.5 inches in diameter (inside diameter). It is constructed of monel metal. See exhibit 5.3. Also shown in exhibit 5.3 are the pan support and an anemometer.

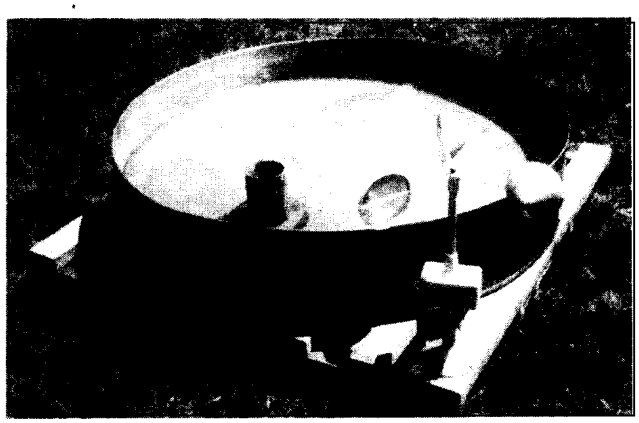


Exhibit 5.3: Evaporation Pan

5.3.1.1 INSTALLATION

The pan must be centered on supports resting on leveled ground. Take care to locate the pan in an area that is free from flooding even in heavy rains, or where runoff could wash away the support. If fill dirt is required to level the ground, it should be tamped firmly. The top of the support should be .5 inch above the dirt. This will leave an air space between the bottom of the pan and the fill dirt to simplify inspecting the pan for leaks.

5.3.1.2 MAINTENANCE

Carefully inspect the pan for leaks at least once a month (leaks make measurements useless). Report any leaks immediately to the NWS representative. Record the date the leak was discovered and the date the pan was repaired or replaced.

Clean the pan as often as necessary to keep it free from any substance that will alter the evaporation rate, such as sediment, SCUM algae, and oil films. Oil films greatly reduce evaporation.

The pan should never be painted. This would alter the evaporation characteristics. In order to compare measurements between sites, all pans must have identical characteristics.

Under no circumstances should the pan be lifted and emptied with a significant amount of liquid in it, as such action can split or bend the pan. Most of the water should be syphoned or dipped out first.

During months when freezing conditions are likely, empty, clean, and store the pan, preferably indoors. If left in the fenced enclosure, it should be turned upside down and secured to the support with a strong rope.

5.3.1.3 CONTROL OF ALGAE

A small amount of copper sulphate may be added to the water to discourage algae growth. The NWS representative will supply the copper sulphate. If algae are already present, they must be removed by thoroughly cleaning the pan

5.3.2 FIXED POINT GAGE

The fixed point gage consists of a pointed rod mounted in a tube called the stilling well. It is placed inside the evaporation pan, one foot from the north edge. The stilling well makes readings more precise by eliminating wind-caused surges in the water level and ripples.

The stilling well is 2.5 to 3.5 inches in diameter and 10 inches tall, and is attached to a base. All parts are made of non-corrosive metal. The base must be heavy enough to resist being moved by the wind. The stilling well has two small openings, 1/8 inch in diameter, located opposite each other near the base. They permit the flow of water in and out of the stilling well.

The pointed rod is 1/8 inch in diameter. It is attached to the center of the base inside the well. The point is 7.5 inches above the bottom of the evaporation pan when in position.

Evaporated water must be replaced. This is done by using the transparent measuring tube, shown beside the stilling well in exhibit 5.4. It is 15 inches deep with an inside diameter of 4-3/4 inches, which is one-hundredth of the surface area of the evaporation pan. The tube is graduated at one-inch intervals, with the zero mark at the top. One inch of water in the measuring tube is equivalent to .01 inch in the evaporation pan.

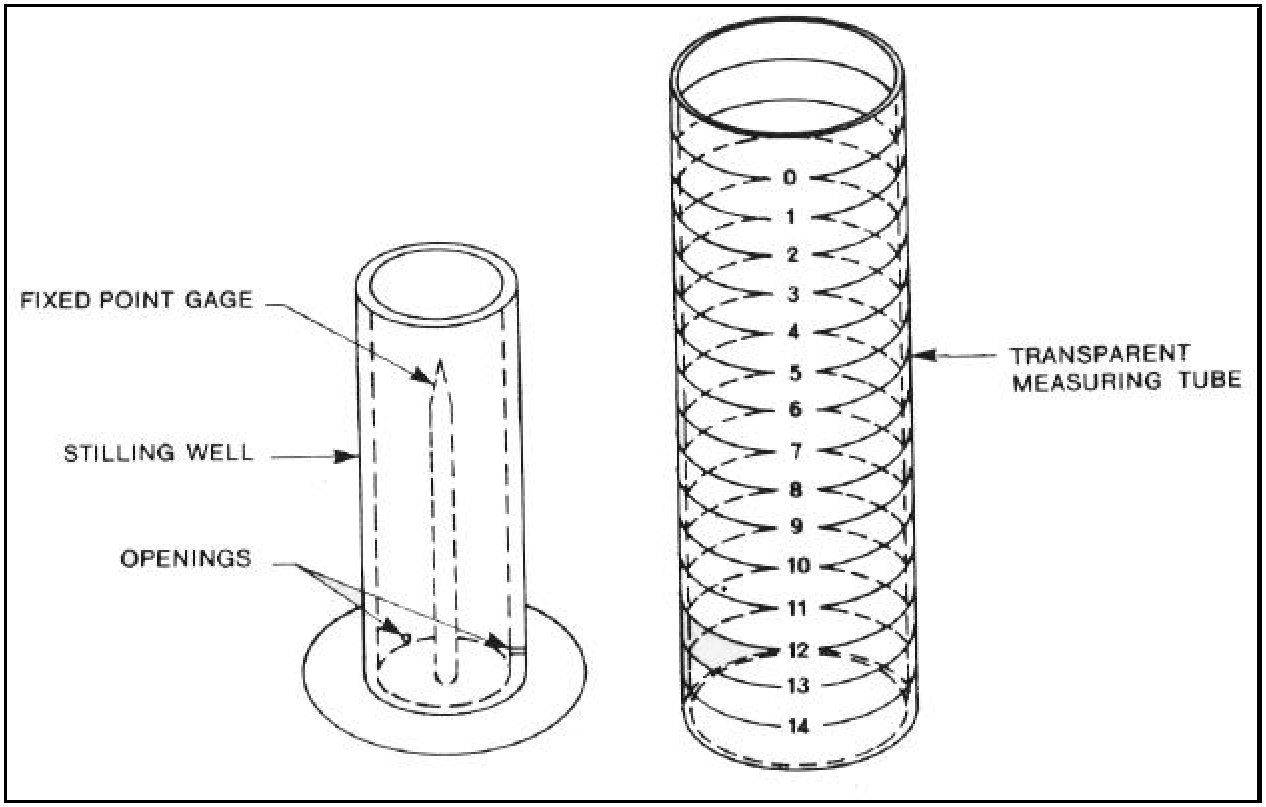


Exhibit 5.4: Stilling Well, Fixed Point Gage, and Measuring Tube

5.3.2.1 MEASURING THE AMOUNT OF EVAPORATION

Evaporation is measured by determining the amount of water required to bring the water level in the stilling well exactly to the tip of the pointed rod. Use the transparent measuring tube to add or remove water from, the evaporation pan. Mien water must be added, fill the measuring tube to the zero mark (the top mark on the tube), then pour (slowly) exactly enough water into the evaporation pan (not in the stilling well) to bring the water level to the tip of the fixed point. Next, read the level of water remaining in the measuring tube. If this reading is closest to the 12 mark, for example, 0.12 inches of water has evaporated (or else evaporation has exceeded precipitation by 0.12 inches). See exhibit 5.5.

If precipitation has occurred since the previous observation, the water level may be above the tip of the fixed point. In this case, remove water by filling the measuring tube up to the zero level with water from

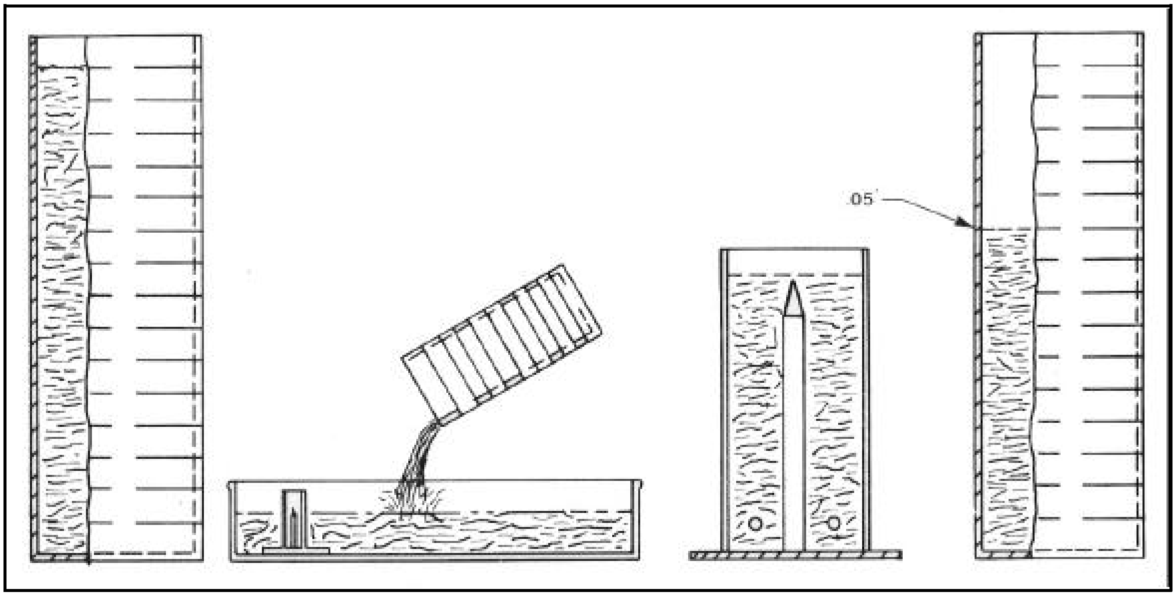


Exhibit 5.5: Evaporation Measurements

the evaporation pan as many times as necessary to bring the water level to the fixed point. Be sure to keep track of the number of times the tube is filled. Each filling represents 0.15 inches of water. When enough water has been removed to bring the water level below the fixed point, fill the measuring tube with water from the storage tank (subsection 5.3.3) to the zero level, and pour enough water back into the pan to bring the level to the tip of the fixed point. Deduct this amount from the total removed.

An alternative to bringing the water level below the fixed point is to remove enough water from the pan into the measuring tube to bring the water exactly to the fixed point, measuring the amount in the tube, and subtracting this from 0.15 inch. For example, if the tube is filled to the "5" level (0.05 inch), subtract 0.05 from 0.15. The amount removed by dipping is thus 0.10 inch. This is added to the amount removed (if any) by filling the tube from the pan as described in the previous paragraph.

For recording purposes, water added is positive and water removed is negative. For example, if 0.24 inches of water mist be added, record this as +0.24. On the other hand, if rain has fallen and the measuring tube must be filled three times to bring the level below the fixed point, 0.45 inch is deducted. If 0.06 inch of water is then added to bring the level back to the fixed point, enter the sum of -0.45 and +0.06, or -0.39, on the recording form (WS Form B-92).

5.3.3 WATER STORAGE TANK

If clean water is not available at the site, a storage tank should be located there. The tank should be placed where it will not shade or reduce wind flow over the pan. It should be thoroughly cleansed at the beginning of the evaporation measuring season. The water must be completely free of oil.

Exhibit 5.6: 5-Digit, 3-Cup Anemometer

When the season ends, empty and secure the tank to prevent freeze and wind damage.

5.3.4 ANEMOMETER

A standard 3-cup, 5 digit counter anemometer (exhibit 5.6) is mounted on a wooden pan support.

5.3.4.1 INSTALLATION

The anemometer is mounted on a specially designed display stand pintle on the northwest projecting corner of the pan support. The center of the cups should be 6 to 8 inches above the rim of the pan. In this position, the shadow of the cup falls on the pan only during the late afternoon. The anemometer retaining screw (the knurled head set screw located in the adaptor at the bottom end of the anemometer housing) is used to attach the anemometer to its support base. This screw should be turned only hand-tight.

5.3.4.2 MAINTENANCE

The NWS representative will service and clean the anemometer on his routine inspection trips, normally twice a year. Bearings of an anemometer that lacks oil will squeak and wear badly within a few hours. A squeaking anemometer should be removed immediately from its support and examined carefully. If it is not seriously damaged, clean and oil it. Otherwise, report the problem to the NWS representative immediately. If service is required between NWS representative visits, use the following procedure.

a) Loosen the set screw near the bottom end of the housing.

b) Remove the anemometer from its support base with a slight twisting motion.

c) Remove the nut on top of the spindle above the cups.

d) loosen the screw on the hub side of the cups and remove the cups from the spindle.

e) Remove the spindle bearing. To do this, loosen the retaining screw on the back near the enlarged portion of the housing. The spindle and ball bearings can then be removed. Take care not to lose any ball bearings.

f) Remove all dirt and used lubricant from the spindle with a clean cloth. If necessary, wash the spindle and upper bearings in kerosene or a similar petroleum-based solvent. Noticeable amounts of dirt in the anemometer should be reported to the NWS representative.

    1) Where a sleeve-type bearing is used, roll a piece of cloth into a small rope and run it through the spindle bearing until it is bright and clean.

    2) For a ball-type spindle bearing, clean the bearing with petroleum based solvent. Use a cloth to clean the outer race of the bearing (in the top end of the housing).

    3) If an oil-reservoir type retaining nut is used, loosen the knurled cap at the top and refill it with oil. Make sure the wick enters the small hole in the end of the spindle when replacing the nut.

g) Apply a drop of oil to the worm threads and two or three drops to the bearing before reassembling the anemometer. Remove excess oil so it will not become a trap for dust and abrasive particles.

h) Under "Remarks" in WS Form E-22, enter "anemometer cleaned" with date.

5.3.4.3 WIND MOVEMENT READINGS

Read the anemometer counter daily at the scheduled time of observation, to the nearest whole mile. For example, if the counter shows a total wind movement of 9291.3 miles, enter 9291.

5.3.4.4 DATA FROM 5-DIGIT-COUNTER TYPE ANEMOMETERS

The five digits appearing in the window of the meter indicate the total wind movement in tenths of a mile for any total from zero to 10,000 miles. The right hand digit indicates tenths of a mile.

Generally, you will not have to compute the number of miles of wind movement since the previous reading. When asked to compute the miles of wind travel, subtract the previous day's reading from the number currently on the counter. When 10,000 miles have accumulated, the reading starts over at zero. Thus, when the current day's reading is less than the preceding reading, compute the 24-hour wind movement by adding 10,000 to the current reading. Subtract the preceding reading from this total. For example, if today's reading is 10,109 and the previous reading 9,986, subtract 9,986 from 10,109. The movement will thus be 123 miles.

5.3.5 DRY- AND WET-BULB TEMPERATURES

Dry- and wet-bulb temperatures are read in order to compute a measure of humidity. The NWS representative may request that the wet and dry bulb temperature data be used to compute the dew point or relative humidity. The dry-bulb thermometer of the psychrometer gives the current air temperature. The wet-bulb temperature is the lowest temperature obtained from the moistened wick-covered temperature-sensing element of the psychrometer that has been cooled by evaporating water.

5.3.5.1 TYPES OF PSYCHROMETERS

The psychrometer in general use consists of two identical mercury-in-glass thermometers, shown hanging from a hook to the left of the ventilating fan in exhibit 5.7. The lower one of the two (the wet-bulb thermometer) has a close fitting, loosely woven muslin wick covering the bulb. The fan is operated with a hand crank to provide forced ventilation of the thermometers.

Another type of psychrometer, called the sling psychrometer, is shown in exhibit 5.8. On this instrument, evaporation frat the wet-bulb, wick is enhanced by whirling the thermometer through the air around the sling handle.

5.3.5.2 MAINTENANCE

The only additional maintenance which the wet-bulb thermometer requires over other liquid-in-glass thermometers (subsection 3.4) concerns the muslin wick. This wick must be close-fitting and tubular, so it holds tightly to the thermometer bulb. Slip about 3 inches of wicking aver the bulb until it extends beyond the narrow part of the stem. Change the wicking frequently to keep it clean. A dirty wick, or one filled with mineral salts (often invisible) from evaporated water, will not allow water to evaporate as readily as a clean wick and will result in readings being too warm.

5.3.5.3 MOISTENING THE WET BULB

The wet-bulb should be moistened just prior to ventilating it, with the following two exceptions.

a) HIGH TEMPERATURE AND LOW HUMIDITY

In hot, dry weather, moisten the wet-bulb wick thoroughly several minutes before reading it, leaving a drop of water on the end. Natural ventilation will cause partial evaporative cooling before it is ventilated. The drop of water is necessary to prevent the wick from drying before the lowest wet-bulb reading can be obtained. Nevertheless, under very low humidity conditions the wet-bulb must be pre-cooled by one of the following methods to prevent premature drying.

1) Store the moistening water in a porous jug in the shelter.

2) Equip the wet-bulb with a longer wick, and insert the end of the wick in a water container placed a few inches below the bulb. Move the container away before ventilating the wet-bulb.

b) DRY-BULB TEMPERATURE BELOW 37˚

Moisten the wick throughly 10-15 minutes before reading. This time interval will allow the latent heat released by the freezing of the wet bulb wick to escape before ventilation is started, use waster at room temperature to melt any accumulation of ice. A thin coating of ice will form during the above 10 to 15 minute wait or during ventilation. The

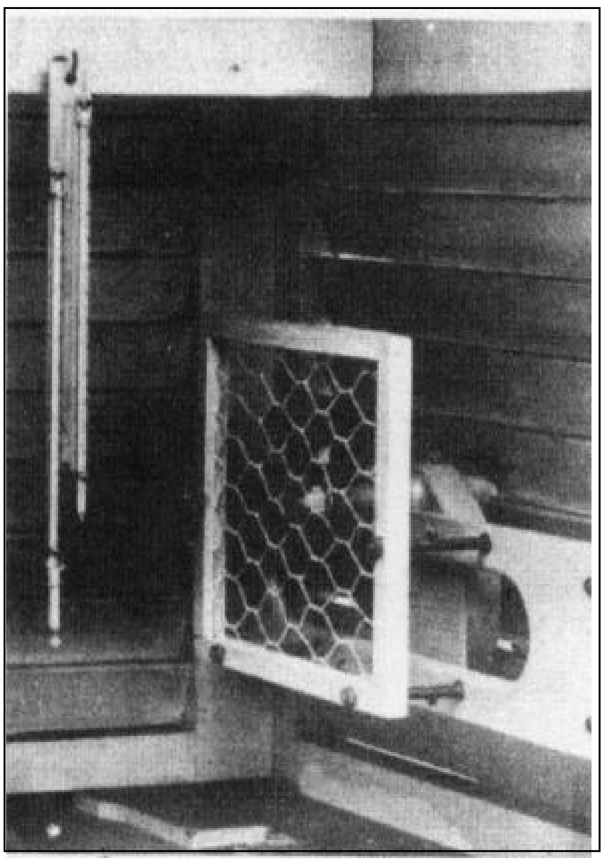


Exhibit 5.7:
Psychrometer with Fan

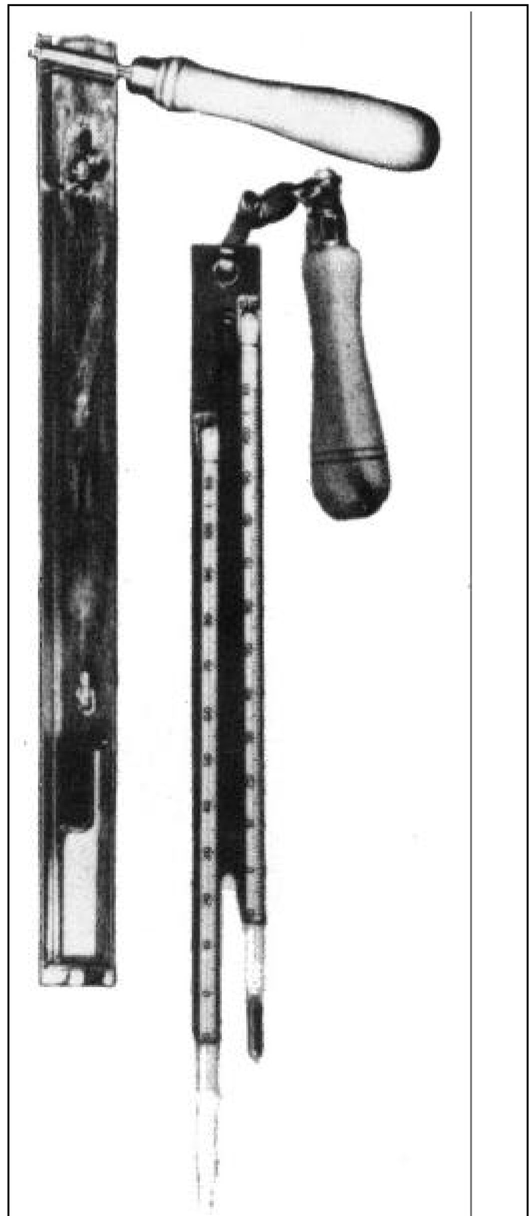


Exhibit 5.8:
Sling Psychrometer

ice coating must be thin in order to get accurate readings at these wet-bulb temperatures If water remains unfrozen at wet-bulb temperatures below 32° in spite of ventilation, freezing my be induced by touching the wick with snow or ice.

5.3.5.4 TAKING PSYCHROMETER OBSERVATIONS

Moisten the wick as above. For psychrometers with hand-cranked fans, turn the crank at least 3.5 revolutions per second to ventilate properly.

For sling psychrometers (exhibit 5.8), select a shady spot that has plenty of room for whirling the psychrometer. Face into the wind. Whirl the psychrometer at least two revolutions per second, as far in front of the body as possible, for at least 10 to 15 seconds between each reading. Ventilate longer if the temperature is near or below freezing.

For both of the above types of psychrometers, read both thermometers to the nearest tenth degree two or more times immediately following each period of ventilation. Repeat the ventilation operation until two successive readings of the wet-bulb are the same. Record the lowest wet-and dry-bulb readings. Follow the procedures given in subsection 5.3.5.3 if the air is very dry or the temperature is below 37°.

5.3.6 WATER TEMPERATURES

Other factors being equal, the rate of evaporation increases rapidly with increasing water and air temperature, approximately doubling with each rise in temperature.

Maximum and minimum water temperatures are determined from. Sensing elements placed beneath the surface of the water in the evaporation pan. Evaporation occurs from the immediate surface of the water. Since warmer water is lighter than colder (if above 39°F), it will rise to the top and tend to stratify there during the day, especially with the sun shining. Therefore, the thermometer should measure the water temperature as close to the surface as possible without being exposed to the air (Section 5. 3. 6.1.1 below).

Water temperatures are measured with the recording or (more frequently) the maximum-minimum (Six's) thermometer, 20°F as shown in exhibit 5.9.

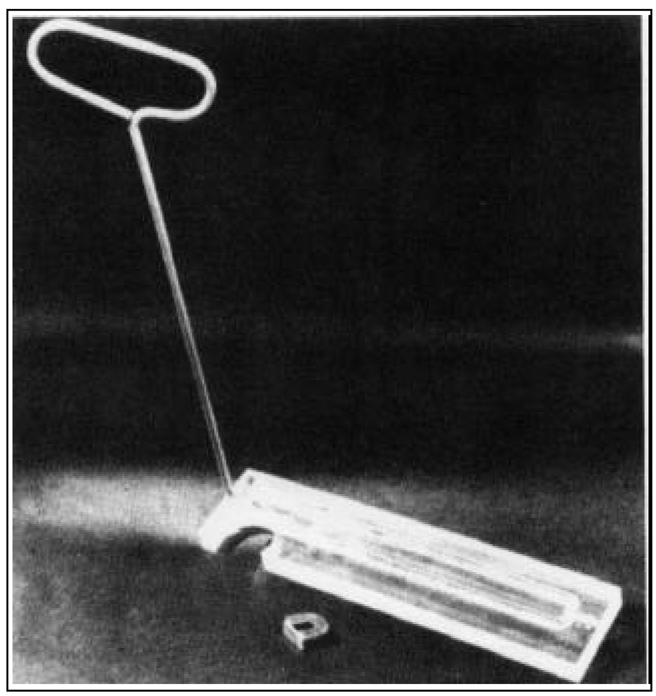


Exhibit 5.9: Six’s Water Thermometer, Submerged-Mount

Some Six's thermometers are provided with a float-mounted frame. This is being replaced with the submerged mount.

5.3.6.1 INSTALLATION

5.3.6.1.1 FLOAT-MOUNTED INER43KETM

The float-mounted thermometer is provided with a shield to prevent sunlight from striking the bulb. It is mounted horizontally on a float-supported nonmagnetic frame. The frame supports the thermometer which can be set to ride approximately 1/4 inch below the water surface. This is done by adjusting the screws holding the bulb end. Attach the float to an anchor using flexible lines at least 10 inches long, but short enough to keep the unit one foot from the edge of the pan and gage. Two lines may be used, one attached to each end of the frame.

5.3.6.1.2 SUBMERGED

The submerged-mount thermometer is mounted horizontally on a plastic holder which rests on the bottom of the pan. A non-magnetic metal handle is fastened to the bulb end of the holder and hooks over the edge of the pan, as shown in exhibit 5.10. The holder should be located on the inside bottom (south side) of the pan. The thermometer bulb should be shaded as much as possible from direct sun rays. Submerge the thermometer gently to prevent the small indices inside the tube from jarring away from the mercury column.

5.3.6.1.3 RECORDING THERMOMETERS

Any recording thermometer with an immersible sensing element may be used. Examples are electrical resistance, mercury-in-steel, and gas-filled steel elements.

The line connecting the thermometer to the recorder should be long enough to permit installation of the recorder where it will not cast a shadow on the pan, and more than four feet from any instrument. It should be in a low housing along a fence in the northern half of the enclosure (northern hemisphere). The thermometer should be mounted on an adjustable float mechanism in a horizontal position. It must be shielded from direct solar and sky radiation and from possible physical damage. The float mechanism should be adjusted to support the thermometer about 1/4 inch beneath the surface of the water near the center of the pan.

5.3.6.2 MAINTENANCE

Follow the manufacturer's instructions for maintaining the recording thermometer and for changing its charts.

Keep the Six's thermometer assembly (floats, shield, and plastic holder) free from dust and sediment. Use a soft wet cloth for cleaning the unit. A very fine grade steel wool or SOS-type pad can be used to clean salt deposits from the thermometer bulb and tube.

5.3.6.3 ACCURACY CHECKS

Check the accuracy of the water temperature readings once a month when the pan is cleaned by removing the Six's thermometer from the pan and placing it in the instrument shelter. Allow enough time for the thermometer to dry and reach the air temperature. Read the current air temperature from the minimum thermometer without re-setting. Then read the temperature from the Six's thermometer. Enter the readings in the "Remarks" column. If readings differ by 20 or more, notify the NWS representative.

5.3.6.3.1 REJOINING SEPARATED MERCURY COLUMNS

The mercury columns in Six's thermometers are subject to separation, causing inaccurate readings. The columns should be joined as soon as possible. Remove the thermometer and holder frat the pan. Do not remove the thermometer from either its plastic holder or float frame. Hold the thermometer near its bulb end and swing rapidly in an arc until the mercury column is rejoined. Take care to avoid striking any objects and breaking the thermometer.

5.3.6.4 READING AND RESETTING THE SIX’S THERMOMETER

Read temperatures to the nearest whole degree, as indicated by the end of the metal indices nearest the mercury columns in each tube. If possible, read while submerged. Then, remove the thermometer from the pan to reset the indices.

Th reset the thermometer, place a horseshoe magnet (open end down and parallel to the thermometer tube) directly above one metal index. Move the magnet slowly toward the mercury column until the index touches the mercury. Gently lift the magnet away from the tube so the index will not spring away from its contact with the mercury. Repeat this procedure for the other index.

The submerged-mount thermometer comes with a small metal strip for storing the magnet when not in use. If the strip is lost, a nail or small metal piece may be used.

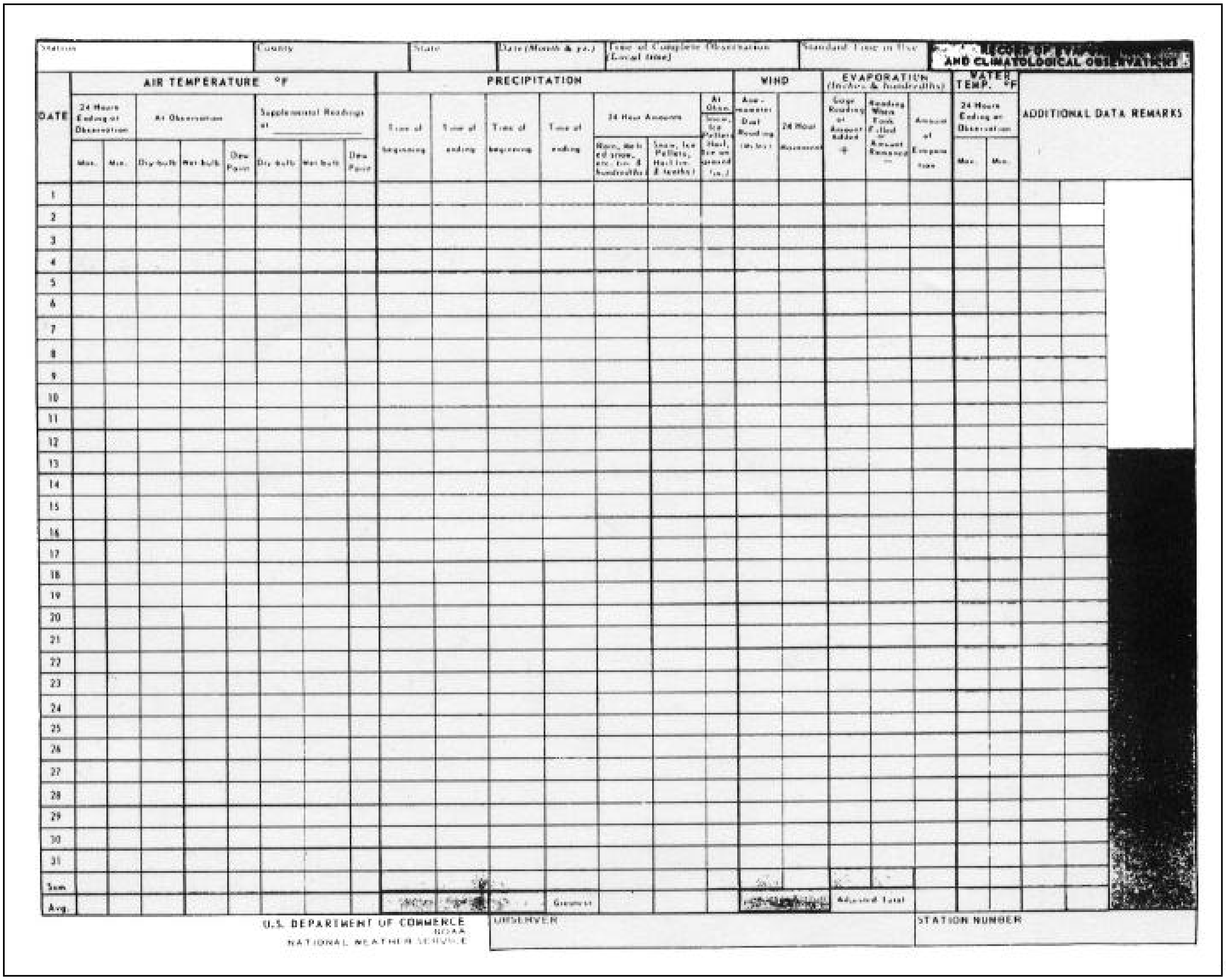
Readings from recording thermometers need not be recorded on a form unless instructed to do so by the NWS representative. Enter the date, time, and station name on the chart when changing it.

5.4 READING OBSERVATIONS FROM EVAPORATION STATIONS

Record observations on WS Form B-92 (formerly WS Form E-22), "Record of Evaporation and Climatological observations," unless instructed otherwise by the NWS representative. The cover of Form B-92 contains instructions for recording observations.

EVAPORATION STATION OBSERVATIONS

Exhibit 5.10 shows sample entries on this form for a station equipped with a fixed-point gage. Note that you do not have to fill in the columns for the dew point, 24-hour wind movement, and the amount of evaporation. These values are computed by the office processing your data.



Station | County | State | Date (Month & yr.) | Time of Complete Observation (Local time) | Standard Time in Use

RECORD OF EVAPORATION AND CLIMATOLOGICAL OBSERVATIONS

DATE | AIR TEMPERATURE °F | PRECIPITATION | WIND | EVAPORATION (Inches & hundredths) | WATER TEMP. °F | ADDITIONAL DATA REMARKS

U.S. DEPARTMENT OF COMMERCE
NOAA
NATIONAL WEATHER SERVICE

OBSERVER

STATION NUMBER

Exhibit 5.10: WS Form B-92 (formerly WS Form E-22)
Record of Evaporation Climatological Observations

SECTION 6: SOIL TEMPERATURE STATIONS

6.1 INTRODUCTION

Knowledge of the soil temperature is very important to the agricultural industry. All species of plants have a specific range of temperatures in which they will grow. Most seeds require a certain amount of warmth in order to germinate. Some vegetation will suffer if the soil temperature is too warm. Information collected from soil temperature stations is used for general weather purposes as well as for agriculture.

Many stations measuring soil temperature transmit their readings over nationwide communications circuits, especially during the beginning and middle portions of the growing season. Nationwide weekly average soil temperatures are published during the growing season in the Weekly Weather and Crop Bulletin, and daily readings for one or more levels are published in *Climatological Data* by the National Climatic Data Center.

Soil temperature station may have the following additional instrumentation: precipitation gage, air temperature thermometer with shelter, evaporation pan, and anemometer.

6.2 EXPOSURE AND PROTECTION OF EQUIPMENT

Soil thermometers should have an exposure typical of the principal natural agricultural soils and conditions of the area. The site should not be subject to irrigation, overflow, or unusual ground-water conditions. The site should be open to full sunshine, with the exception of certain designated sites or where partial shade is considered typical of the area.

The observing plot should be fenced or have other protection from humans and animals.

6.2.1 SIZE OF PLOT

The plot should be 10 by 1-foot or larger, with the thermometers centrally located. Where both sod and bare plots are maintained, the bare plot should also be at least 10 by 10 feet. If the location is not typical of the surroundings, the plot should be larger—at least 30 by 30 feet.

6.3 MAINTENANCE OF PLOTS

6.3.1 SOD-COVERED PLOTS

Sod-covered plots should be under bluegrass, alta fescue, perennial rye, or other grasses used for lawns or pastures in the areas. The area should bed trimmed and otherwise maintained at a uniform 2 or 3 inch height. No irrigation should be applied, except to start cover before beginning observations. If, during extreme drought, it is necessary to irrigate, the soil temperature should be noted as not being typical and should be excluded from published data.

6.3.2 NATURAL COVER

At some locations, normal climate and soil do not permit maintenance of a sod cover. Then, maintain the cover like the natural cover common to the area.

6.3.3. BARE SOIL

Bare soil plots should be kept free of weeds and other vegetation all times. This can be done by scraping with a hoe or by chemical treatment. Chemicals are often easier to use, longer lasting, and will cause less change in the soil structure. Shallow raking to avoid heavy crusting after precipitation is recommended. Avoid deep cultivation.

If chemical treatment is used, be aware that the effects of some sterilants on the physical properties of soil are not completely understood. Over dosages have been reported to increase crusting, with a loss of structure. Follow carefully the manufacturer’s recommendations on the method, quantity, and time of application.

Some chemicals can wash away during heavy rain, seriously injuring desirable vegetation in adjoining plots, while the more soluble products tend to move down into the soil. The following products have been suggested.

a) Sodium chlorate (this comes in several forms, including pellets).

b) Boron (brand name Barascu).

c) Meth-lurea compounds (Monuron and Diuron, under the brand names of Telva and Karmex)

d) Erbon and Simazine.

Many factors, including soil type and climate, influence the effectiveness of these chemicals on vegetation and the soil. Boron has been found more favorable in arid regions, and chlorates better in humid areas. Get recommendations from local soil an weed experts for the best sterilant to use.

6.3.4 SNOW COVER

Snow cover should remain natural and undisturbed. The observation site should be located so that snowfall is normal and free of obstructions that can cause artificial drifting or wind scouring.

6.4 TYPES OF THERMOMETERS AND READINGS

Dial-type or digital thermometers may be used. Maximum, minimum, and current temperatures are generally recorded at lesser depths. At greater depths where temperature changes are slower (generally, below the 8-inch level), only the current temperature is usually recorded. At most observing sites, maximum and minimum air temperatures are read and recorded at the same time and location as the soil temperatures. See Subsection 6.9 for a description of the Palmer soil and other types of thermometers in use.

6.4.1 INSTALLATION OF THERMOMETERS

Sensing elements should be located in and under undisturbed soil. They should be in close contact with the ambient soil, with no insulating air spaces or pockets, and without artificial channels for the entry of water. They should be in or very near the center of the observation plot. Readouts should be mounted high enough above gro8nd to make it easy and convenient to read and reset the thermometers.

Dig a small trench just to the north of the spot where the sensors will be imbedded in the earth. This should be as small as possible without hindering the necessary work. Remove the sod carefully and set it aside on boards or a tarpaulin (you will replace this later). This should be removed in layers, as it can be replaced as close to its original condition as possible.

The trench should be slightly deeper than 6the lowest depth for the sensor. This allows enough working space and permits a slight looping of the flexible cables to be installed. Make a hole for the sensing elements with a rod 18 inches long and 5/16 inch in diameter for installing the 13-inch long mercury-in-steel sensors used with the Palmer soil thermometer (subsection 6.9). The rod should be pressed into the face of the south end of the pit at the proper depth and be driven into the soil nearly its full length. It should remain parallel to the surface above it so that it is the same depth throughout its full length. If smaller sensors (such as thermistors or thermocouples) are used, a rod with a diameter equal to or only slightly larger than the sensor should be used. See exhibit 6.1, which shows the instrument trench (unshaded area) as it would appear before replacing the soil.

Press the sensing element into the hole with the least force possible. If too much resistence is met, withdraw the element and clear the hole with the rod.

6.5 SHELTERS

6.5.1 THERMOMETERS HEAD SHELTERS

Soil temperature thermometer heads or recorders must be protected from the wea6her by a shelter, such as that shown in exhibit 6.2., in which the access door opens from the side or top., The length of the shelter depends on the number of thermometers installed.

Soil temperatures measured with an MMTS will have the display mounted in or near a shelter housing the air temperature sensor. A multiple positions switch on the display is used to read and reset temperatures from all sensors.

SOIL TEMPERATURE STATIONS

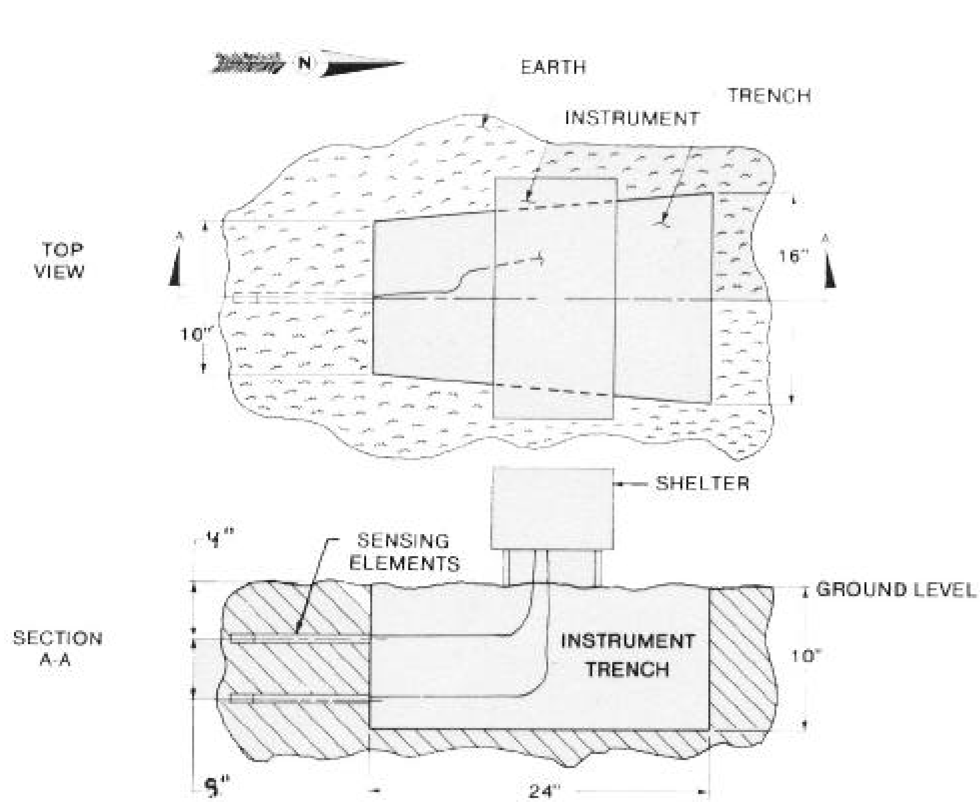


Exhibit 6.1: Installation of Soil Thermometers

6.5.2 LOCATION OF SHELTER

The shelter should be located about one foot north of the south edge of the trench. Set the supports for the shelter in the trench before replacing the soil. The 5-foot cable will permit the shelter to be about three feet above ground. This will allow for a slight loop of the cable in the trench floor for sensors as deep as eight inches.

If electric wires connect the sensors to the recorders (as with the MMTS), the shelter may be located outside and to the north of the trench, where no shadows will affect the soil above the sensors.

6.5.3 REPLACING SOIL IN TRENCH

The soil should be replaced as nearly as possible in tits original condition. This will usually require firm packing as each layer is replaced. Soak soil as it is returned to the trench, then replace the sod. Excess moisture will assist in renewing sod growth.

6.6 DEPTH OF SOIL TEMPERATURE MEASUREMENTS

The following dfep5ths (in inches) have been recommended by the Commission for Climatology (CC1) and the Commission for Agricultural Meteorology (CagM) of the World Meteorological Organization (1kM) for observing soil temperature: 2, 4, 8, 20, 40, 60, and 120.

The two-inch depth was suggested only by the CAgM, for agricultural purposes. This depth is extremely sensitive to microscale differences in soil type and color, moisture, and vegetative cover. It has been found difficult to maintain an accurate two-inch depth, especially with a bare soil cover. The 60- and 120-inch depths were recommended only by the CC1, for climatological purposes-

Where a choice of depths must be made due to sensor limitations, the following order of priority is recommended:

Priority	1	2	3	4	5	6	7
Depth (inches)	4	8	20	40	2	60	120

Many soil temperature measuring stations record temperatures only at the four-inch depth.

6.7 OBSERVATIONS

6.7.1 TYPE AND FREQUENCY

Readings are usually taken daily. At stations closed aver weekends that do not have recording thermometers, the Monday maximum and minimum temperature readings cover the preceding 72 hours.

Daily ranges in the soil temperature can exceed air temperature ranges in the shallow layers. This amplitude diminishes rapidly to about 1° at depths of 18 to 24 inches. Therefore, maximum and minimum temperatures are normally recorded at depths through 20 inches, while only the current or daily average temperature is recorded at greater depths.

6.7.2 TIME OF OBSERVATION

Because nearly all soil temperature stations also record daily maximum and minimum air temperatures, all readings should be taken at the same time of day. Generally, this will be between 7 and 8 a.m. or between 5 and 8 p.m. Pick a time that is convenient and adhere to this as closely as possible.

If recording instruments are used, they should be checked daily to be sure they are operating properly.

6.8 ENTRY OF READINGS ON PERMANENT RECORD FORMS

WS Form B-83a (formerly WS Form F-10a), "Supplementary Record of Climatological observations," is designed for recording soil temperatures at up to 6 depths. Temperatures should be recorded to the nearest whole degree. For levels at which you are recording both maximum and minimum temperatures, enter these in the appropriate depth columns under soil temperatures and label ,max,, and "Min" under inches as shown on the inside of the WS Form B-83a cover. At levels where you record only the current temperature, enter only the one value.

SOIL TEMPERATURE STATIONS

6.9 PALMER SOIL THERMOMETER

This subsection describes the operation, maintenance, and calibration procedures for the Palmer soil thermometer. This thermometer has been in general use for many years. See exhibit 6.2. Subsections 6.4 and 6.5 describe installation procedures.

6.9.1 RESETTING MAXIMUM AND MINIMUM POINTERS

After recording the maximum and minimum temperatures, carefully reset the red(maximum) and green (minimum) pointers reset the red pointer first by bringing it into contact with the black (current temperature) pointer- Next, gently rotate the green pointer to the opposite side of the black pointer. Do ***not*** press down on the green pointer knob, as this will result in tension loss in the pressure washer and cause loose pointers.

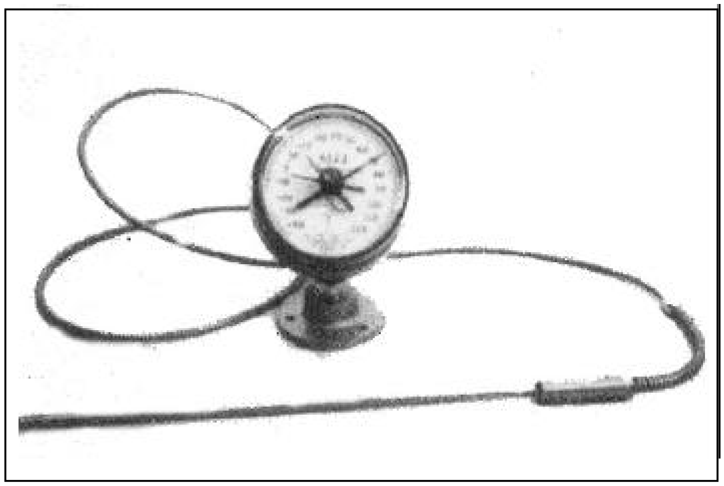


Exhibit 6.2: Palmer Soil Thermometer

During the above resetting, check the flex of the black pointer. It should flex or move less than 10 in response to pressure from the red and green Thermometer pointers. Movement in excess of this indicates either a loss of tension in the sensor system or too much drag tension in the maximum and/or, minimum pointers. If lubrication does not correct the situation, the instrument must be replaced.

6.9.2 MAINTENANCE

The most common maintenance needs of the Palmer soil thermometer are as follows: loose or frozen pointers, moisture in the head, broken covers, and calibration errors.

6.9.2.1 LOOSE POINTERS

This usually results from improper resetting procedures. Th correct this, remove the bezel ring and glass cover (the red and green pointers are mounted in the glass cover). Remove the allen set-screw embedded in the green knob. The tightness of this knob controls the tension on both pointers. With your thumb on the bottom of the connecting shaft (inside the glass cover), carefully reset the green knob to the desired tension. Clockwise rotation increases the tension. Replace the allen set-screw in the green knob and reassemble. You may find it necessary to replace the tension washer under the green knob.

6.9.2.2. FROZEN PRINTERS

Frozen pointers can often be corrected by cleaning and lubricating. Use a good silicone lubricant, preferably in a pressure spray applicator. In some case you may have to remove the bezel ring and glass cover to perform adequate cleaning and lubrication

6.9.2.3 MOISTURE IN THE HEAD

This indicates the need for a new gasket. Remove the bezel ring and glass cover. Replace the sealing gasket on a day with as low humidity as possible.

6.9.2.4 BROKEN COVER

A file or hacksaw may be required to remove the bezel ring. Make a cut across the outside edge of the ring and use a screwdriver to press downward and outward to snap it off. Request a new cover and ring from the NWS representative. This will be sent complete with a connecting screw to fasten it in place.

6.9.3 CALIBRATION ERRORS

Calibrate the thermometers at least twice a year. Without this, the thermometers are likely to drift upward or downward. This subsection describes calibration procedures.

6.9.3.1. IN-PLACE CALIBRATION CHECKS

Incorrect date resulting from long-term calibration drifts can be eliminated with careful routine periodic calibration checks. The following three procedures may be used to accomplish this.

a) A bi-metal or similar type of thermometer of known accuracy can be used for comparison. It is imperative that the sensor of the bi-metal be pushed to the same depth as the Palmer soil thermometer sensor bulb and left there long enough to stabilize at the soil temperature (4 to 5 minutes).

b) A more desirable technique for the shallow depths is to remove soil to the level of the base of the Palmer 13-inch sensor bulb. The comparison thermometer sensor should then be inserted along the 13-inch sensor bulb, 2 to 3 inches from the base, and the soil replaced above it. The thermometer must remain imbedded long enough for the removed and replaced soil to regain the temperature of adjacent undisturbed soil at the same depth. When the soil has been removed, check to be certain the soil thermometer is still at the prescribed depth.

c) If the soil at the depth of a soil thermometer is in the process of freezing, the temperature will often remain at the 32°F ice-water equilibrium point for several days. Check the temperature during this period to determine the accuracy of the thermometer.

6.9.3.2 CALIBRATION OF PALMER MODEL 35B

A calibration check of Palmer model 35B should be performed at least twice a year.

Methods (a) and (b) above should not be used on model 35B soil thermometers between about 9 a.m. and 6 p.m. on bright, sunny days, as sensitivity to heat penetration under these conditions can make it read higher.

Make the following two allowances for discrepancies between the Palmer model 35B and the check thermometer.

a) The tolerance of the Palmer (about 2 °F) and the check thermometer (generally 1 percent of the scale) may be additive.

b) A seemingly slight difference in exposure between the two may contribute to a variation in readings. A spread of up to 4 °F between the two readings should be considered satisfactory. For method © above, a reading between 29 °F and 35 °F should be considered sufficiently accurate at the icepoint.

Note: Never apply any allowable difference as a correction to future observations.

6.9.3.3 THE CALIBRATION

If the above checks indicate a calibration offset, calibrate the thermometer as follows.

a) Place both the probe and the reference thermometer in the shelter housing the dial indicator and close the door.

b) After 10 minutes, open the door and record both readings.

c) Immerse both the reference thermometer and the entire probe of the Palmer thermometer in a slushy ice bath.

d) After 10 minutes, record the temperatures. Leave the sensors in the ice bath, in case step (f) below must be used.

e) If the difference in the readings of the two thermometers is approximately the same in steps (b) and (d), an offset is indicated. See step (f) below. If the differences are not approximately the same, the Palmer must be considered inoperative and replaced.

f) If an offset is indicated, turn the "reset" screw on the back of the dial head until the thermometer reads 32° while the probe is still in the ice bath.

g) On some older instruments, an access screw in back of the dial head must be removed first. The adjustment on these models is limited to about two degrees. If a greater adjustment is needed, remove the bezel ring and glass cover. Place a screwdriver in the center screw of the black pointer hand and loosen it. Rotate the pointer hand gently to the desired setting. Re-tighten the center screw. If the instrument is equipped with a non-reusable bezel ring, the ring may be removed with a file. Obtain a replacement from the NWS representative.

SECTION 7: ATMOSPHERIC PHENOMENA

7.1 INTRODUCTION

The following atmospheric phenomena should be observed and recorded on your WS Form E-165 or other form designated by your NWS representative: Tornadoes, waterspouts, thunderstorms, damaging winds (including squalls), fog, haze, smoke, dust, frost, and any form of precipitation. Recording haze, smoke, dust and frost is optional, except when dangerous, i.e., to travelers or crops. Damaging and life-threatening phenomena, especially tornadoes, would be reported immediately to the state police, the designated NWS office or forecast office or as directed by your NWS representative.

Observations of the above phenomena are an important part of the record from climatological stations, and they are often the only written account of these occurrences from the observer's are that will be sent to NCDC. Except for precipitation, no instruments are required to record these phenomena.

7.2 TORNADOES, WATERSPOUTS AND FUNNEL CLOUDS

Tornadoes and funnel clouds are nearly always associated with intense thunderstorm activity, While some waterspouts may develop in the absence of thunderstorms and often be much less destructive, others are tornadoes that have formed or moved over water, as they are just as dangerous over water as land.

7.2.1 TORNADO

Tornadoes are local storms usually of short duration, consisting of violently rotating winds, nearly always turning counterclockwise in the northern hemisphere. A tornado will usually appear hanging from the bottom of the storm cloud, generally close to but outside the area in which rain is falling. Part or all of the funnel may be invisible if the air is dry, but the tornado can still often be identified by the rotating particulate matter, especially near the ground, and in Intense tornadoes, by a loud roaring sound. Rotating debris not associated with clouds are whirlwinds (dust devils) rather than tornadoes.

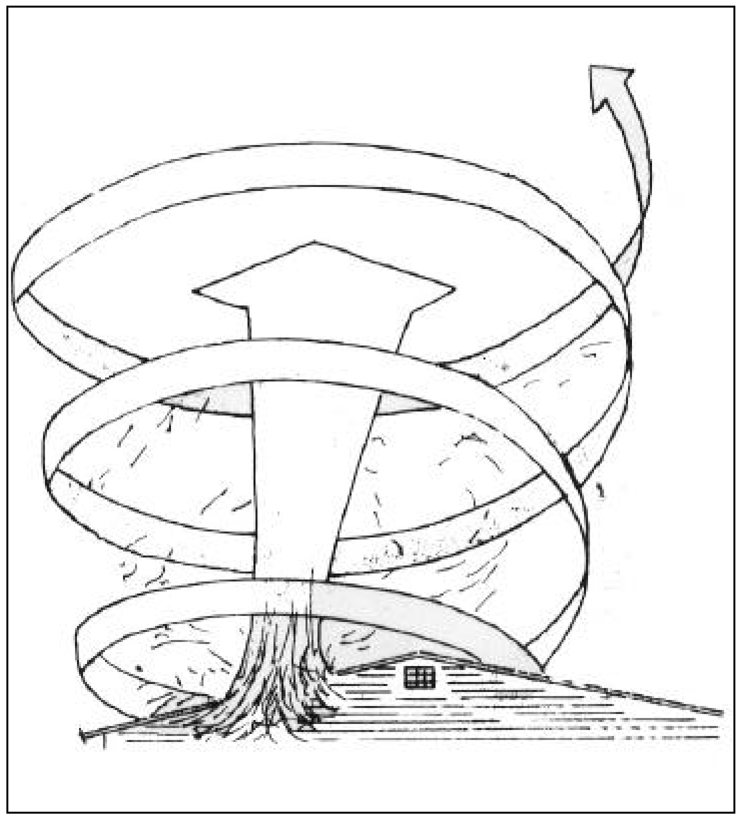


Exhibit 7.1: Winds Associated with a Tornado

Tornadoes do their destructive work through the combined action of their strong rotary winds and the partial vacuum in the center of the vortex. As a tornado passes over a building, the winds twist and rip from the outside at the same time the abrupt pressure reduction in the tornado's "eye" causes explosive aver-pressure inside the building (exhibit 7.1) (this exhibit will be re-drawn to show winds rotating counter-clockwise). Walls collapse or topple outward, windows explode, and the debris of this destruction is driven through the air with dangerous force. Heavy, objects like machinery and railroad cars can be lifted and carried by the wind for considerable distances.

7.2.2 FUNNEL CLOUD

A funnel cloud is a tornado that does not reach the ground. Nearly all tornadoes start as funnel clouds, forming at the base of dark, heavy cumulonimbus clouds and developing downward. Some never reach the ground. Others reach the ground (becoming tornadoes), then rise again or dissipate.

7.2.3 WATERSPOUT

Over a large body of water, a tornado is called a waterspout. It rises from the water into the cloud in an upward spiral. With some exceptions, they do not develop into dangerous storms, and diminish rapidly when moving over land.

7.3 THUNDERSTORM

For record purposes, a thunderstorm is considered in progress when thunder is heard, whether or not rain is falling or lightning is seen. The intensity may vary from occasional distant thunder to very frequent, sharp thunder with heavy rain, sometimes associated with strong winds and hail.

7.4 HYDROMETEORS

Winds are considered "damaging" when vegetation, buildings, or other property has been injured, damaged, or destroyed.

A squall is a sudden, violent wind, often accompanied by rain or snow. Gusty winds are characterized by sudden, periodic increases in speed. There are noticeable differences in speed between the peaks and lulls. All of these often occur with thunderstorms, or they can occur alone.

7.5 HYDROMETEORS

A hydrometeor is any form of atmospheric water (liquid or frozen) or water vapor that (a) falls through the atmosphere, such as rain or snow; (b) is suspended in the atmosphere, such as fog; © is blown from surfaces by the wind, such as blowing snow or blowing spray; or d) is deposited on objects, such as freezing rain (glaze).

ATMOSPHERIC PHENOMENA

7.5.1 FORMS OF PRECIPITATION

Hydrometers include precipitation in all its forms. It may be continuous, intermittent, or showery. The intensity is classified as light, moderate, heavy or excessive. Precipitation is observed in the following forms.

a) Rain: Drops of water in liquid from falling from the sky, larger than .02 inch in diameter.

b) Drizzle: Fairly uniform precipitation composed exclusively of fine droplets (less than .02 inch in diameter), uniformly dispers3ed, that may appear to float with the air currents.

h) Ice pellets: Round or irregularly-shaped pellets of ice with a diameter of 1/5 inch or less, either transparent or translucent. Pellets usually rebound when striking hard surfaces, making a sound on impact. The following two types of ice pellets are observed.

(1) Hard grains of ice consisting of frozen raindrops ro melted and refrozen snowflakes (often called sleet).

(2) Pellets of snow encased in a thin layer of ice. These are softer than sleet and rarely bounce on impact.

The first type falls as continuous precipitation, while the second is associated with showers.

d) Glaze: Rain or drizzle that falls in liquid form but freezes to objects and/or on the ground. It forms a smooth coating of transparent ice layers, as seen in exhibit 7.2. Ice storms results from heavy coatings of glaze and may do great damage to trees, shrubs, and telephone and power lines, creating unsafe condition such as those shown in exhibit 7.3.

e) Hail: Pieces of ice, often round or in irregularly shaped lumps, falling individually or several pieces frozen together. They range from 1/5 inch to two or more inches in diameter. Exhibits 7.4. and 7.5 show examples of hail.

Hail usually consists of alternate opaque and clear layers of ice. It is normally associated with thunderstorms and temperatures above freezing.

Hail can cause serious damage to anything it strikes. Crops may be destroyed (exhibit 7.5) kind livestock injured.

f) Snow: White or translucent ice crystal, mostly in six pointed star form often mixed with simple crystals. Snow occurs under conditions similar to those of rain, but the air temperature aloft must be freezing or lower.

Exhibit 7.2: Glaze

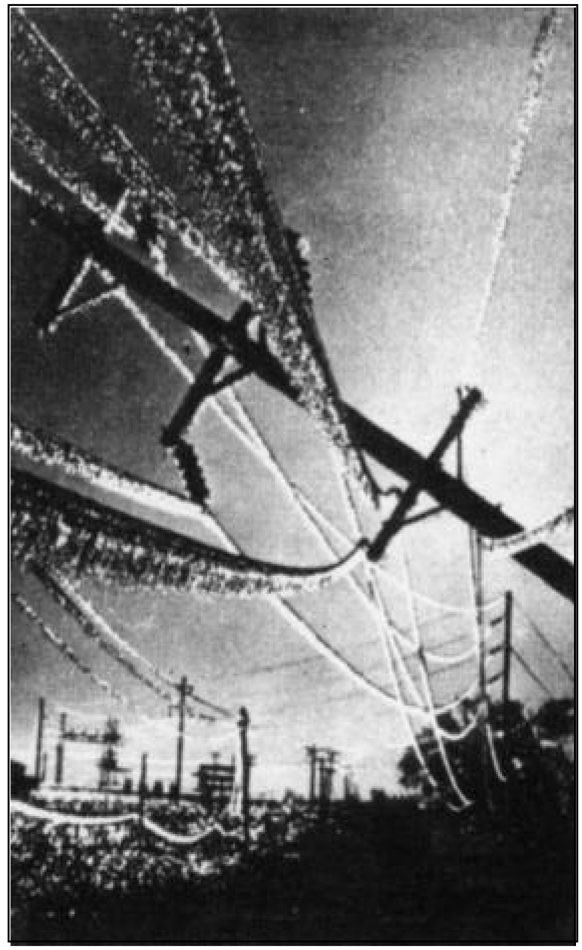


Exhibit 7.3: Road Hazard
Caused by Glaze

g) Snow pellets: White, opaque grains of ice, round or conical, 1/16 to 1/4 inch in diameter. They are crisp and easily compressed and may bounce or burst when striking hard surfaces.

h) Snow grains (granular snow): Minute opaque, branched, starlike snowflakes or very fine simple crystals. They are smaller than snow pellets and usually fall in small quantities from low stratified clouds. They do not bounce or shatter on impact.

Both snow pellets and snow grains should be recorded as snow.

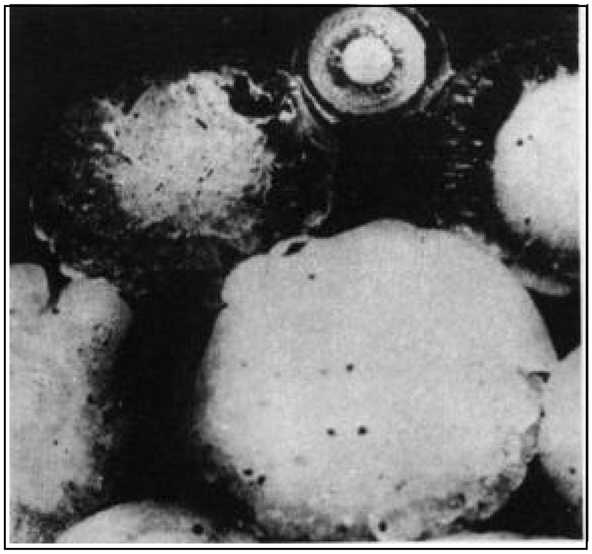


Exhibit 7.4: Closeup View of Hail Exhibit

Exhibit 7.5: Hail Accumulated on the Ground, having Damaged Crops

7.5.2 HYDROMETEORS OTHER THAN PRECIPITATION

a) Fog: Minute water droplets suspended in the atmosphere to form a cloud at the earth's surface. There is no visible downward motion. The horizontal visibility is usually less than 3 miles. It is called ground fog if the depth is less than 20 feet. Fog differs from haze by its dampness, and gray color.

b) Ice fog: Minute suspended particles in the form of ice crystals and/or needles. It occurs at very low temperatures (-20 ˚F or colder), usually in clear, calm weather at high latitudes. It does riot produce rime or glaze on objects.

c) Dew: Liquid water that has condensed on objects on or near the surface of the earth with above freezing temperatures. Dew occurs on calm, clear nights.

d) Frost: Thin ice crystals shaped like scales, needles, feathers or fans, that form on objects with a temperature of 32˚ or lower. Frost can occur on the ground when the air temperature at the instrument shelter level is several degrees above freezing. It is the same as hoarfrost.

e) Freeze: The condition of the lower atmosphere when the temperature of surface objects is 32˚ or lower. A freeze may or may not be accompanied by a deposit of frost. When vegetation is injured by a relatively low temperature (with or without a frost), the condition is termed a freeze.

ATMOSPHERIC PHENOMENON

During a freeze, the air at the instrument shelter level may be above 32°, although the ground is 32° or colder. This occurs most frequently during calm, clear nights, with the greatest temperature difference near sunrise.

Freezes are classified as follows.

1) Light freeze: little destructive effect on vegetation, except to tender plants and vines. Shelter level temperatures are often above freezing but drop below freezing for a short period at the surface.

2) Killing freeze: widely destructive to vegetation. It is often defined as a sufficiently severe freeze to cut short the growing season. Temperatures at thermometer level are generally below freezing. This is sometimes called a "killing frost."

3) Hard freeze: staple vegetation is destroyed. The ground surface is frozen solid under foot, and heavy ice forms on puddles and other exposed water surfaces. It is colder and more prolonged than a killing freeze.

f) Rime: a white or milky and opaque granular deposit of ice formed by the rapid freezing of supercooled water droplets of fog, as they impinge on exposed objects. It is denser and harder than hoar frost, but lighter and softer than glaze.

g) Blowing snow: snow particles raised from the surface by strong turbulent winds to eye level (six feet) or above. It is blown about in sufficient quantities to restrict the horizontal visibility. It is called "drifting snow" if raised to a height below eye level.

Blowing and drifting snow should be recorded when causing damage, such as blocking -roads or exposing seeded fields.

7.6 LITHOMETEORS

Lithometeors are visible phenomena suspended in the air that are not associated primarily with water vapor. Examples are dry haze and smoke.

7.6.1 DRY HAZE

Dry haze consists of fine dust or salt particles suspended in the air in sufficient quantity to reduce the visibility. It resembles a uniform veil that subdues all colors. Dark objects have a bluish tinge. Bright objects (the sun or distant lights) appear a dirty yellow or have a reddish hue.

Dry haze may be caused by a variety of substances, including dust, salt, residue from distant fires or volcanoes, or pollen.

7.6.2 SMOKE

This is suspended particulate matter resulting from combustion. Smoke will cause the disk of the sun at sunrise and sunset to appear very red or to have a reddish tinge at other times of day. Smoke coming from a great distance, such as from forest fires or volcanoes, usually has a light grayish or bluish color.

As this smoke continues traveling from its source, the larger particles drop out, leaving haze.

7.6.3 DUST

Fine particles of dust or sand suspended in the air, often as the result of a dust storm or sand storm that may have occurred at or far away from the observing site. It imparts a tan or gray hue to distant objects. The sun's disk is pale, colorless, or tinged yellow. Dust manifests itself in the following additional forms.

a) Blowing dust: dust picked up locally from the surface and blown about in clouds or sheets, reducing the horizontal visibility to 6 miles or less.

b) Dust storm: blowing dust reducing the visibility to less than 5/8 of a mile. A dust storm usually arrives suddenly in the form of an advancing dust wall which may be miles long and several thousand feet high. Ahead of the dust wall the air is very hot and the wind usually light.

c) Dust devil: a small vigorous whirlwind, usually of short duration, made visible by dust and debris picked up from the surface. Dust devils usually occur on hot, calm afternoons with clear skies. They are seldom intense enough to cause appreciable damage.

7.6.4 BLOWING SAND

This is sand that is picked up fruit the surface of the earth by the wind and blown about in clouds or sheets, reducing the visibility to 6 miles or less. It is called a sandstorm when the wind is very strong and the visibility is reduced to 5/8 of a mile or less.

IMPORTANT road hazards created by dust storms and sand storms should be reported immediately to the Weather Service Office.

7.7 ELECTROMETEORS

An electrometeor is a visible or audible display of atmospheric electricity.

7.7.1 AURORA

The aurora, sometimes known as the "northern lights" in the northern hemisphere, is a luminous phenomenon of arcs, bands, or curtains of light in the high (and occasionally middle) latitudes and at very high altitudes. These are usually white, but they may have other colors. The lower edges of the arcs or curtains are usually well defined, while the upper edges are not. The aurora is caused by electrically charged particles ejected by the sun, acting on the rarified gases of the higher atmosphere. The particles are channeled by the earth's magnetic field, so the bases of the curtains are pointed toward the earth's magnetic poles.

7.7.2 THUNDER

This is a sharp or rumbling sound which accompanies and follows lightning discharges. It is caused by rapidly expanding gases along the channel of a lightning discharge.

7.7.3 LIGHTNING

Lightning is the flash of light from a sudden visible electrical discharge produced by thunderstorms. It takes the following forms:

a) Cloud to ground - bolts occurring between cloud and ground.

b) In-Cloud - lightning within the cloud only. The streaks are not visible from the ground.

c) Cloud to Cloud - streaks of lightning from one cloud to another, or from one part of a cloud through cloudless air to another. The streaks are visible from the ground.

d) Air discharges - lightning from a cloud into the air, but not striking the ground.

7.8 LUMINOUS METEORS

A luminous meteor is an atmospheric phenomenon appearing as a luminous pattern in the sky. It is produced by the reflection, refraction, diffraction, or interference of light from the sun or moon. The following types are observed.

7.8.1 HALO PHENOMENA

This is a group of phenomena in the form of rings, arcs, pillars, or bright spots produced by the reflection or refraction of sunlight or moonlight by ice crystals suspended in the atmosphere. Cirrus and cirrostratus clouds often produce halos. The rings are about 220 away from the sun or moon.

7.8.2 CORONA

One or more sequences of small colored rings centered on the sun or moon. A corona is usually smaller than a halo, and all colors may not be visible. Colors may be repeated irregularly, causing iridescence. They are produced by sunlight or moonlight shining through thin clouds consisting of water vapor.

7.8.3 RAINBOW

A group of concentric arcs produced on a “screen" of falling precipitation by the light from the sun or moon. In some cases a double rainbow may be seen, with the weaker bow being outside the stronger and having the sequence of colors reversed.

7.8.4 FOG BOW

A primary rainbow consisting of a white band which appears on a screen of fog. It is usually fringed with red on the outside and blue on the inside.

7.9 REPORTING AND RECORDING ATMOSPHERIC PHENOMENA

While all of the above phenomena should be recorded on the forms used by the observer to record other parameters, only a few of the phenomena need to be reported in real-time.

7.9.1 REAL-TIME REPORTING

Phenomena posing threats to lives and property should be reported to the NWS Forecast Office and, in many cases, to the police or other emergency preparedness office, as soon as possible. This will greatly assist the Office in the issuance of accurate warnings for areas in the path of the storm. The NWS representative or other NWS official will inform you where to report.

7.9.1.1 REPORTING TORNADOES AND FUNNEL CLOUDS

Whenever a tornado is observed in progress, call the designated NWS office immediately by telephone collect or other designated means, giving the following information:

a) Distance and direction from your station.
b) Direction toward which it is traveling.
c) Time it was observed.

Report funnel clouds also, when it appears they are intensifying, as tornadoes develop from funnel clouds. As noted above, what may appear as a funnel cloud may actually be a tornado, if the lower part has no cloud associated with it.

7.9.1.2 REPORTING OTHER PHENOMENA

Record information in the "Remarks" column of WS Form B-91 or other designated form, or on a separate sheet of paper. See subsection 2.7 for real-time reporting of other phenomena.

ATMOSPHERIC PHENOMENA

7.9.2 RECORDING ATMOSPHERIC PHENOMENA

7.9.2.1 TORNADOES, WATERSPOUTS, AND FUNNEL CLOUDS

Record as many of the following as you can: time of occurrence, direction and length of path, width of the path, destruction from wind and hail, injuries, deaths, and any other relevant circumstances.

7.9.2.2 THUNDERSTORMS

Record the time of occurrence, the direction and distance from the station, and the direction toward which the storm moved.

7.9.2.3 OTHER PHENOMENA

Record other phenomena in the "Remarks" column. Include information on damage, deaths, or injuries, if any.

SECTION 8: FLASH FLOODS

8.1 INTRODUCTION

Flash floods are caused mostly by sudden heavy rains filling natural and manmade drainage systems beyond their capacities. At other times, flash floods can result from dam breaks, the buildup of water behind ice jams, and by the breakup of ice jams. Water cannot be carried away fast enough. This results in the overflowing of the drainage systems, with raging water and its deadly cargo of uprooted trees, smashed structures of boulders, mud, and other debris. Rain-caused excessive runoff begins when the soil and vegetation cannot absorb rain or the combination of rain and melting snow.

8.2 AREAS MOST SUBJECT TO FLASH FLOODING

Flash flooding can occur quickly in urban areas where land development has made the earth's surface impervious to water, sweeping away vehicles and damaging residential and industrial property. It can occur in and near mountainous areas where steep slopes can accelerate runoff rates, quickly changing dry or trickling brooks into dangerous raging torrents. Flash flooding can also occur within a few hours of heavy or excessive rainfall which caused a dam failure. Sudden flash flooding is possible in areas having no rain, due to thunderstorms many miles away, out of sight and hearing range.

Even moderate rain, falling on impervious frozen, snow- or ice-covered ground, can produce flash flooding, especially if temperatures are high enough to add melted snow to the runoff.

Flash flooding is especially likely near the headwaters of river basins, where water levels may rise quickly in heavy storms. It can begin well before the rain stops falling. While water levels in major rivers usually change gradually, there is relatively little time between the onset of heavy rain and flood conditions in smaller basins.

Flash flooding occurring on streams and rivers behind ice jam and following the breakup of jam can cause severe devastation from chunk ice scouring and literally destroying anything along the banks of rivers.

8.3 FLASH FLOOD WARNINGS

The NWS assigns flash flood warning responsibilities to Weather Service Forecast Offices and Weather Service Offices. These offices rely on satellite, radar, observations from weather stations operating 24 hours per day, and particularly on reports from private individuals, the police, and local preparedness agencies.

Because flash floods, and particularly the thunderstorms that may cause them, can occur very suddenly and in very limited areas, the density of weather observations from 24-hour stations is inadequate to detect conditions leading to flooding. This, in turn, makes it very difficult for NWS offices to issue warnings with enough lead time to protect lives and property adequately.

FLASH FLOODING

You do not have to wait for a team to arrive. You can call unofficial observers to get their rainfall amounts during or prcnptly after the storm, lest they forget their readings later. Then, call the weather office (voice telephone) to report this information. This may be the only way the weather office learns of these extreme rainfall amounts or flood levels.

Therefore, individuals in these areas must be aware of the potential flood hazards and develop local preparedness plans to protect themselves from loss.

8.3.1 ROLE OF COOPERATIVE OBSERVERS

Cooperative observers can play a vital role in protecting lives and property by being alert to report excessive rains and rapidly rising or flooding streams to the Weather Service Office and to the police or other preparedness agencies in their communities. They should thus be encouraged to become involved in any preparedness plans developed by their community. Observers should be certain any special telephone numbers they have been given for reporting these events, are current.

8.4 SUPPLEMENTAL SURVEYS

Frequently in the aftermath of flash floods or other exceptionally heavy rainfall events, NWS or other authorities may decide to conduct supplemental precipitation surveys - popularly known as "bucket surveys." Within two or three days of the event, officials will go to the area of flooding or heavy rainfall to obtain data from citizens who do not routinely report rainfall amounts. They will contact people who had trash cans, jars, other containers, or any type of personal raingage that can be used as unofficial gages. They will also look for high water marks on buildings, trees, etc., to determine the maximum stream levels attained during flooding. Surveys must be done before subsequent rains wash away these water marks and before memories dim and records are lost.

The time rain began and ended (i.e., the duration of heavy rainfall) is also very important.

8.4.1 PURPOSE OF SURVEYS

Data obtained from bucket surveys are used to correlate heavy rainfall amounts with flood and flash flood crests. This information is vital in developing models that relate heavy rainfall to peak water levels. These relationships are used to increase the accuracy of future flash flood forecasts. They are also needed to justify the building of dams, the widening of drainage channels, the control of upstream urbanization (which can greatly increase future flooding risks), and to decide legal questions.

8.4.2 HOW THE COOPERATIVE OBSERVER CAN HELP

Since many cooperative observers routinely compare rainfall amounts with others, they can be of great help to the bucket survey teams by providing the locations and rainfall amounts recorded by others, or by informing the team how best to contact the other observers for further information. They can often help the team identify the area(s) having received the most precipitation.

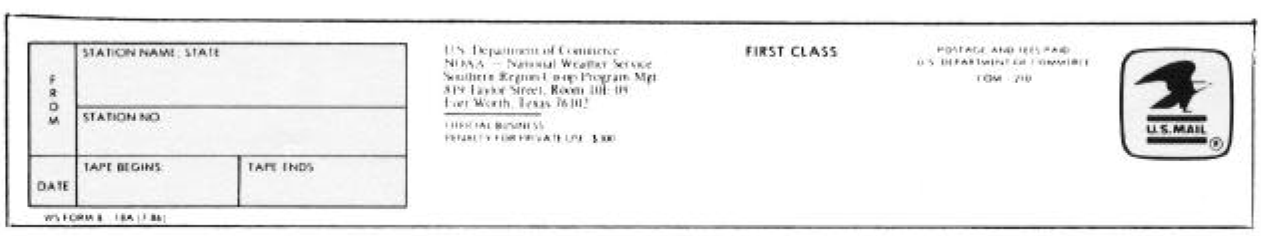
SECTION 9: MISCELLANEOUS FORMS

9.1 INTRODUCTION

This section describes and displays forms used in the cooperative Program to record or mail weather information, to request information or supplies, and to record information on cooperative stations in a master data base.

9.2 WS FORM B-18A: PUNCHED TAPE MAILING LABEL

This is the gummed label shown in exhibit 9.1. It is used for mailing Belfort (Fischer & Porter) precipitation tapes to NCDC or to other offices.



FROM

STATION NAME, STATE

STATION NO.

DATE

TAPE BEGINS:

TAPE ENDS

WS FORM B-18A (7-86)

U.S. Department of Commerce
NOAA — National Weather Service
Southern Region Co-op Program Mgr.
819 Taylor Street, Room 10E09
Fort Worth, Texas 76102

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

FIRST CLASS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-210

U.S. MAIL

Exhibit 9.1: WS Form B-18A - Punched Tape Mailing Label

9.3 WS FORM B-44: COOPERATIVE STATION REPORT

This form (not shown) contains a complete file on the location, instrumentation, observer name, etc., of each station. It is not used by cooperative observers. After the NWS representative visits an observer, he will mark any changes in the observing site on the form (change of equipment, instrument exposure, time of observation, new observer, etc.) and send it to his regional headquarters. There, the changes will be keyed into a regional and national computer data base.

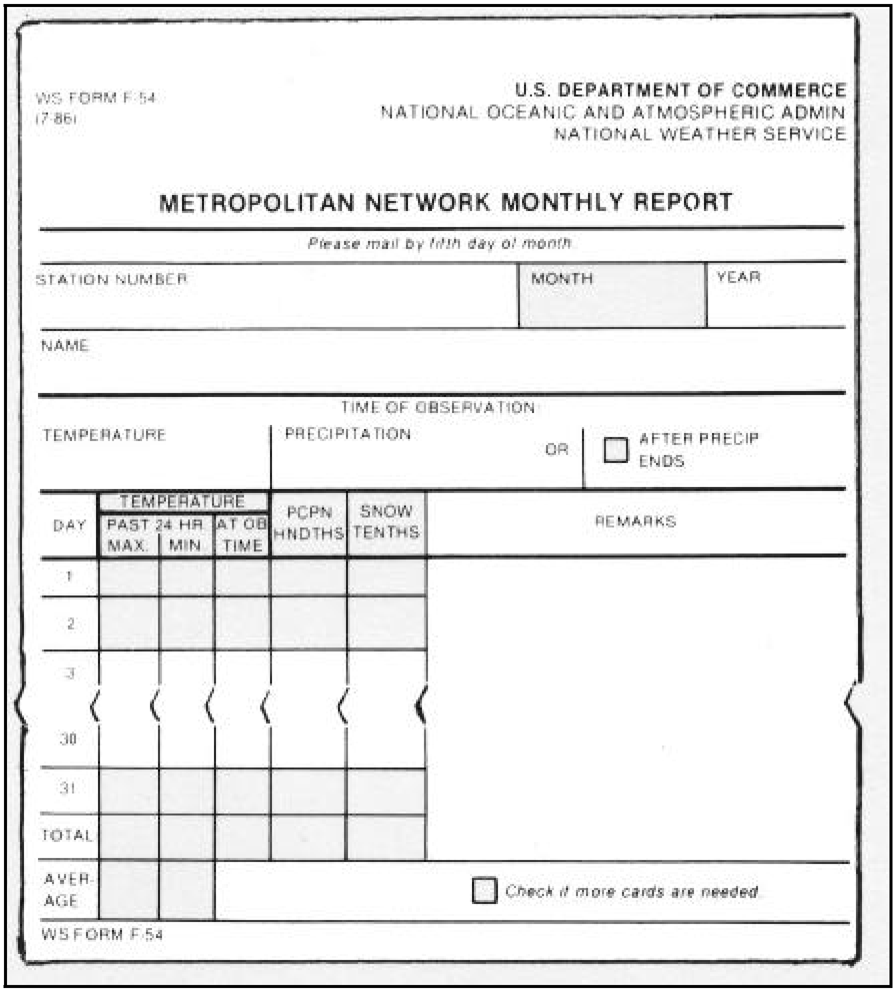
9.4 WS FORM F-54: METROPOLITAN NETWORK MONTHLY REPORT

Form F-54 is used mainly in volunteer temperature and precipitation-observing networks in metropolitan areas. The forms are mailed to local NWS offices, some of which use them in studies of the effects of urbanization and terrain on local weather patterns and to promote public interest in weather. Data from these networks are also used by lawyers, insurance companies, etc., much as the E-15's are used.

The metropolitan networks usually have many more observing sites per unit area than the cooperative network. The accuracy of data, however, can vary greatly from one network to another, as there may be no station inspection program.

MISCELLANEOUS FORMS

These data are classified as unofficial, and are not generally archived or published by NCDC.



WS FORM F-54
(7-86)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMIN
NATIONAL WEATHER SERVICE

METROPOLITAN NETWORK MONTHLY REPORT

Please mail by fifth day of month

STATION NUMBER	MONTH	YEAR
NAME		

TIME OF OBSERVATION

TEMPERATURE	PRECIPITATION	OR	AFTER PRECIP ENDS

DAY	TEMPERATURE PAST 24 HR. MAX.		TEMPERATURE AT OB TIME	PCPN HNDTHS	SNOW TENTHS	REMARKS
	MAX.	MIN.				
1						
2						
3						
30						
31						
TOTAL						
AVER-AGE						

Check if more cards are needed.

WS FORM F-54

Climate Monitoring Protocol for the Park Units of the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 6

Snow Measurement Guidelines

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for measuring snow attributes at National Weather Service (NWS) Cooperative Station Observation climate stations. This SOP was extracted from the NOAA web page (http://www.nws.noaa.gov/om/coop/Publications/snowguid.htm) without alteration, and is provided here to ensure accessibility. It is current as of November 16, 2004.

Snow Measurement Guidelines

10-23-96, replaces form WS TA B-0-26; 9-79

The following procedures were developed from previous National Weather Service procedures and input from a broad array of expertise from climatologists, snow specialists, weather observers, and data users. Some of the materials have been extracted from "The Snow Booklet" by Nolan J. Doesken and Arthur Judson, CSU, 1996.

It is essential for all observers to understand the importance of taking standard measurements in the prescribed consistent manner. Inconsistent observing and reporting methods result in incompatible data which can result in profoundly incorrect differences between stations and observers.

Each season before the first snows come: Review these instructions for measuring snow. It is easy to forget what needs to be measured, especially in those parts of the country where snow falls infrequently.

- At the beginning of each snowfall/freezing season, remove the funnel and inner measuring tube of the eight-inch manual rain gauge to expose the 8-inch diameter overflow can so that it can more accurately catch frozen precipitation.
- Put your snowboard(s) out and mark their location with a flag or some other indicator so they can be found after a new snowfall. They should be located in the vicinity of your station in an open location (not under trees, obstructions, or on the north side of structures in the shadows).
- Check your gauge to make sure there are no leaks. If there are leaks, take appropriate action.
- Once your equipment has been readied for winter you are prepared for taking snowfall measurements.

Observers should determine three values when reporting solid precipitation. They are:

1. Measure and record the snowfall (snow, ice pellets) since the previous snowfall observation,
2. Determine the depth of snow on the ground at the normal observation time,
3. Measure and record the water equivalent of snowfall since the previous day's observation.

Measure and record the greatest amount of snowfall that has accumulated on your snowboard (wooden deck or ground if board is not available) since the previous snowfall observation. This measurement should be taken minimally once-a-day (but can be taken up to four times a day, see note below) and should reflect the greatest accumulation of new snow observed (in inches and tenths, for example, 3.9 inches) since the last snowfall observation. If you are not available to watch snow accumulation at all times of the day and night, use your best estimate, based on a measurement of snowfall at the scheduled time of observation along with knowledge of what took place during the past 24 hours. If you are not present to witness the greatest snow accumulation, input may be obtained from other people who were near the station during the snow event. If your observation is not based on a measurement, record in your remarks that the "snow amount based on estimate".

Remember, you want to report the greatest accumulation since the last observation. If snowfall occurred several times during the period, and each snow fall melted either completely or in part before the next snowfall, record the total of the greatest snow depths of each event and enter in your remarks "snowfall melted during the OBS period". For example, three separate snow squalls affect your station during your 24-hour reporting day, say 3.0, 2.2, and 1.5 inches. The snow from each event melts off before the next accumulation and no snow is on the ground at your scheduled time of observation. The total snowfall for that reporting 24-hour day is the sum of the three separate snow squalls, 6.7 inches, even though the snow depth on your board at observation time was zero. Snow often melts as it lands. If snow continually melts as it lands, and the accumulation never reaches 0.1 inches on your measuring surface, snowfall should be recorded as a trace (T) and record in your remarks that the "snow melted as it landed".

It is essential to measure snowfall (and snow depth) in locations where the effects of blowing and drifting are minimized. Finding a good location where snow accumulates uniformly simplifies all other aspects of the observation and reduces the numerous opportunities for error. In open areas where windblown snow cannot be avoided, several measurements may often be necessary to obtain an average depth and they should not include the largest drifts. In heavily forested locations, try and find an exposed clearing in the trees. Measurements beneath trees are inaccurate since large amounts of snow can accumulate on trees and never reach the ground.

If your daily schedule permits, you may wish to make a snowfall observation every 6-hours, beginning with your regularly scheduled time of observation. This is the procedure followed by National Weather Service Forecast Offices. Follow the same rules for a once-a-day observation, but the snow accumulation reported will be the greatest for the previous six hours instead of 24 hours. If you take your observations at this frequency, make sure that you clear your snowboard (or other measuring surface) no more than once every 6 hours. Record the frequency of observations during the day in the comments section of your report. Never sum more than four, six-hourly observations to determine your 24-hour snowfall total. If you use more than four observations, it would falsely increase snowfall totals.

Freezing rain (glaze ice) should never be reported as snowfall. This precipitation type is liquid precipitation and should be reported as such.

1. Determine the total depth of snow, ice pellets, or ice on the ground. This observation is taken once-a-day at the scheduled time of observation with a measuring stick. It is taken by measuring the total depth of snow on exposed ground at a permanently-mounted snow stake or by taking the average of several depth readings at or near the normal point of observation with a measuring stick. When using a measuring stick, make sure the stick is pushed vertically into the snow until the bottom of the stick rests on the ground. Do not mistake an ice layer or crusted snow as "ground". The measurement should reflect the average depth of snow, ice pellets, and glaze ice on the ground at your usual measurement site (not disturbed by human activities). Measurements from rooftops, paved areas, and the like should not be made. Note: Even though the depth of hail (usually associated with spring, summer, or fall thunderstorms) at observation time is also reported in the same manner as snow depth, make sure you record in your remarks that the "accumulation on ground is from hail".

   Report snow depth to the nearest whole inch, rounding up when one-half inch increments are reached (example 0.4 inches gets reported as a trace (T), 3.5 inches gets reported as 4 inches). Frequently, in hilly or mountainous terrain, you will be faced with the situation where no snow is observed on south-facing slopes while snow, possibly deep, remains in shaded or north-facing areas. Under these circumstances, you should use good judgement to visually average and then measure snow depths in exposed areas within several hundred yards surrounding the weather station. For example, if half the exposed ground is bare and half is covered with six inches of snow, the snow depth should be entered as the average of the two readings, or three inches. When in your judgement, less than 50 percent of the exposed ground is covered by snow, even though the covered areas have a significant depth, the snow depth should be recorded as a trace (T). When no snow or ice is on the ground in exposed areas (snow may be present in surrounding forested or otherwise protected areas), record a "0".

   When strong winds have blown the snow, take several measurements where the snow was least affected by drifting and average them. If most exposed areas are either blown free of snow while others have drifts, again try to combine visual averaging with measurements to make your estimate.

2. Measuring the water equivalent of snowfall since the previous day's observation. This measurement is taken once-a-day at your specified time of observation. Melt the contents of your gauge (by bringing it inside your home or adding a measured amount of warm water) and then pour the liquid into the funnel and smaller inner measuring tube and measure the amount to the nearest .01 inch (use NWS provided measuring stick) just as you use for measuring rainfall. Do not measure the melted precipitation directly in the large 8-inch outer cylinder. Make sure the inner measuring tube can't fall over when pouring the liquid back into it. If the melted water equivalent (including any added warm water) exceeds two inches and cannot fit into the measuring tube all at one time, then empty the full measuring tube and pour the remaining liquid from the large 8-inch

outer cylinder into the emptied measuring tube. Then, add and record the water equivalent of the multiple measurements.

If you added warm water to the gauge to melt the snow, make sure you accurately measure the amount of warm water added before pouring it into the gauge. Then, when you take your liquid measurement, subtract the amount of warm water added from the total liquid measurement to get your final liquid water equivalent of the snowfall.

As winds increase, gauges collect less and less of the precipitation that actually falls. Generally speaking, the stronger the wind and the drier the snow, the less is captured in the gauge. If you notice that less snow is in the gauge than accumulated on the ground, you should first empty any existing snow from inside the 8-inch cylinder, then use it to take a snow sample, sometimes referred to as "take a core" or "cut a biscuit" from your snow board with the 8-inch overflow can. Melt the biscuit of snow, pour the liquid into the small measuring tube to measure the water equivalent.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #7

Instructions for National Weather Service WS Form B-91

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for recording climate data for National Weather Service (NWS) Cooperative Observation stations that lack an evaporation pan. This SOP was extracted from the NOAA web page (http://www.nws.noaa.gov/om/coop/forms/b91-notes.htm) without alteration, and is provided here to ensure accessibility. It is current as of November 16, 2004.

The B-91 Form is the monthly summary form used by NWS Coop Observers to record their observations.

Instructions for WS Form B-91

Taking and Recording Observations

1. FILLING IN THE TOP AND BOTTOM OF WS FORM B-91. Begin a new form on the first of every month by filling in the heading and bottom of the form completely. Most entries are self-evident. Enter in the space marked "TYPE OF RIVER GAGE" the word "wire-weight," "staff," "slope," "float tape," "recorder chart," "distance indicator" or other type in use. In the space marked "STANDARD TIME IN USE," enter one of the following: E (Eastern), C (Central), M (Mountain), P (Pacific), AH (Alaska-Hawaii) or the appropriate longitude time zone number (e.g., 150th). If using daylight saving time, precede the time zone letter with "D" (e.g., DE -Daylight Eastern).

The temperature at the time of observation for the last day of the preceding month should be entered in the space beneath the words "AT OBSN,." which is just above the space for entering the temperature at the time of observation for the first day of the month (95 is entered there in the example on the other side of this cover page). Similarly, in the next column to the right, precipitation beginnings and endings for the last day of the preceding month should be entered in the same manner (a wavy line is entered 8-11 p.m. in the example). CHECK BAR READINGS for the LAST DAY of the PRECEDING MONTH should be entered in the proper space at the bottom of the form if a wire-weight gage is used (22.10 is entered in the example). Enter your name, station index number, and supervising office on the bottom of the form.

2. MAKING YOUR DAILY ENTRIES. This sample form shows how entries should be made at stations taking river, precipitation, and temperature observations. Entries for each day should be on the corresponding date line of the date of observation except as indicated under "Special Observations" and "Remarks." AN ADDITIONAL FORM B-91 WILL BE USED IF MORE SPACE IS NEEDED as it is undesirable to have entries on the reverse side.

3. WHEN TO TAKE OBSERVATIONS.[1] Take your observations at the same hour each day, if at all possible. Prior approval is needed to change the scheduled time of observation. Routine River and/or Rainfall observations should ALWAYS be taken in the MORNING, preferably at 7 a.m. Temperature observations should be taken as late in the day as is convenient after 5 p.m. At climatological stations, however, precipitation should be measured at the same time the temperature reading are made (preferably after 5 p.m.). The times of observation should be entered in the third line of the heading and at the top of the river stage column. When an entry should be made in the first column to the right of the 'WEATHER" columns (marked "time of observation if different from above"), it should be encircled.

4. SUBSTITUTE OBSERVERS. Continuity of your records is very important. A member of your family, or some other competent person, should be taught to take and record observations in the event of your absence or illness.

5. USE OF WS FORMS B-82 AND E-14. You may use WS Form B-82, "Official Weather Observer's Record," to record the observations as you take them. Enter river stages under "Remarks and Notes" if you use WS Form B-82. If using this form, copy the data promptly onto Form B-91. You may retain Form B-82.

6. OTHER INSTRUCTIONS.[2] Additional instructions are found in Observing Handbook No. 2, "Cooperative Station Observations" and other publications. Please refer to these frequently, especially at the beginning of the snow season. Also feel free to ask your cooperative program manager for information at any time.

7. TEMPERATURE (-F). The maximum (MAX.) and minimum (MIN.) temperatures are the highest and lowest temperatures to have occurred during the past 24 hours. The AT OBSN temperature is the temperature at the time you take your observation. Enter to the nearest whole degree.

The minimum must be at least as low as the lowest of yesterday's and today's AT OBSN temperatures, and the MAX must be at least as high as the highest of today's and yesterday's AT OBSN temperatures. For example, if yesterday's AT OBSN temperature was 95, today's maximum must be at least as high as 95, even if the maximum this calendar day was only 86. You may record the 860 maximum in the REMARKS (far right) column as "PM MAX 86," as shown on the sample page [inside front cover] on the first day of the month. This is optional. See the REMARKS column on the sample page for the 23d of the month for recording last night's minimum (23), when it was warmer than yesterday's AT OB temperature (11).

7(a). MAXIMUM AND MINIMUM TEMPERATURE OBSERVATIONS - MAXIMUM-MINIMUM TEMPERATURE SYSTEM (MMTS). If you have liquid-in-glass thermometers, please see paragraph 7(b). If you have the MMTS, obtain the maximum and minimum temperatures by pressing the buttons marked "MAX" and "MIN", respectively. Record these readings, as well as the current temperature, to the nearest whole degree. The current temperature is the reading shown when no buttons are depressed. If the reading to the right of the decimal is 5 or greater, round off to the higher figure; i.e., 39.5 should be recorded as 40. After recording these values on your form, press the "RESET" and "MAX" buttons simultaneously, then do the same with the "RESET" and "MIN" buttons. You can check to be certain the readings reset properly by pressing the "MAX," then the "MIN" buttons. They should read the same as the current temperature.

WHAT TO DO WHEN THE MMTS DISPLAYS "HELP." If the display reads "HELP," there has been an interruption in the power supply. To restore the MMTS current temperature reading, press the reset button only. You may still obtain maximum and minimum temperatures by pressing the appropriate buttons. However, if the power was off during an extended period, including the time the highest or lowest temperature occurred, the readings shown may not be the highest and lowest. If you believe this is so, you may write "Power failure during time of max (or min) temperature" 'in the "REMARKS AND NOTES" area of your observation form.

7(b). LIQUID-IN-GLASS MAXIMUM AND MINIMUM TEMPERATURES.

MINIMUM TEMPERATURE. The MINIMUM thermometer should be read FIRST so that the index in the minimum thermometer will not be jarred or disturbed in any manner before the reading is made. It should be read while in its nearly horizontal or "set" position by reading the temperature scale at the end of the small index farthest from the bulb (the right hand side as you look at it). Do not reset the MINIMUM thermometer until the maximum thermometer has been read and reset. Reset the minimum thermometer by raising the bulb end sufficiently to allow the small index to slide to the end of the alcohol column, and then lowering the thermometer to its nearly horizontal position.

MAXIMUM TEMPERATURE. Lower the maximum thermometer slowly to a vertical position, with the bulb end down. Then, read the maximum temperature from the top of the mercury column. To reset it whirl it clockwise several times until the reading is approximately the same as shown on the minimum thermometer. Next, return it to its nearly horizontal position with the bulb end slightly elevated. NOTIFY THE SUPERVISING OFFICE if the maximum and minimum temperatures disagree by more than one degree after setting.

TEMPERATURE AT TIME OF OBSERVATION. This should be obtained by reading the maximum thermometer after it has been whirled and while it is still in a vertical position. The current temperature may be determined at other times of day by reading the end of the alcohol column of the minimum thermometer without disturbing it.

8. PRECIPITATION. Please enter the hours which precipitation fell even though you may not always know them exactly. Type a "Y" in the blocks for the hours of occurrence. If the time is uncertain to you, type a "P" through the hours when precipitation probably occurred. Precipitation times are shown for the calendar days on which it actually occurred.

8(a). RECORDING PRECIPITATION AMOUNTS. Under "24-hr. Amounts," enter the total precipitation in inches and hundredths (rain or melted hail, ice pellets or snow) which has accumulated during the 24 hours preceding the time of observation. ENTER THE AMOUNT ON THE DATE OF MEASUREMENT, even if some or all of it actually fell on the preceding calendar day. If the amount falling was too small to measure, enter "T" for a trace.

Every entry of .01" or more must be recorded to two decimal places, taking care to enter the decimal point in its proper place. For example, record nine-hundredths as .09, exactly two inches as 2.00, and a half inch as .50. If no precipitation occurred during the 24-hour observation period, a "0" (zero) should be entered so there will be no doubt as to whether any precipitation fell.

The raingage should be emptied immediately after the measurement has been made at the normal time of observation. DO NOT EMPTY THE GAGE AT TIMES OF SPECIAL OBSERVATIONS. However, for rainfall observers who report to a hydrologic service area, it may be necessary to empty the gage at times other than official observation times when water has overflowed the measuring tube.

8(b). MEASURING AND RECORDING FROZEN PRECIPITATION. In freezing weather, when snow or ice pellets are likely to occur, remove the funnel and inner tube of the raingage and leave only the large outer can exposed. Melt the catch of snow or ice pellets by adding a CAREFULLY measured amount of warm water from the tube. After the catch is melted in the can, pour the water into the tube (being careful not to spill any), and measure it.

Then subtract the amount of warm water previously added. The resulting figures are the water equivalents of the snow or ice pellets and should be entered as the amount of precipitation in the "Rain, melted snow, etc." column. If snow, ice pellets or hail fall when the funnel and inner tube have not been removed and it is apparent that the gage has caught only a portion of the precipitation, a section of the newly fallen snow, ice pellets or hail on the ground should be cut, using the outer can as a biscuit cutter, and this section melted and measured as indicated above. In the "Snow, ice pellets, (Ins. & tenths)" column, enter in inches and TENTHS, the amounts of these types of precipitation having fallen during the past 24 hours. Enter a "T" for depths too small to measure. Do not enter hail in this column.

In the next column ["At ob. - Snow, ice pellets, hail, ice on ground (Ins.)"], enter to the nearest INCH the average depth of all snow, ice pellets, and ice (including old and new) and hail remaining on the ground at the time of observation in the vicinity of the station. Enter a "T" for less than .5 inch. If drifting has occurred, make measurements at several points where drifting is the least evident, and enter the average amount. An entry should be made each day in this space as long as snow, ice pellets or ice remains on the ground. As soon as the covering has completely melted, enter "0" for the depth. Once this has been entered, leave the column blank until the next observation time at which there is frozen precipitation on the ground.

9. WEATHER (CALENDAR DAY). The columns marked 'FC&- ICE PELLETS," "GLAZE," "THUNDER," "HAIL," AND "DAMAGING WINDS" are designed for easy recording of these elements. Please enter an "X" for the dates on which any of these events occur. This information is very helpful in studying the climate of your area.

10. RIVER STAGES. In the "Condition" column enter (it applicable) one of the capital letters A to H, as described in the "CONDITION OF RIVER AT GAGE" table at the bottom left of the form.

10(a). Enter river stage readings taken at your regular observation time in the "Gage Reading" column [See paragraph 3 for observations taken at other times of day (special observations)]. Enter in feet and hundredths, unless you have been instructed otherwise. When the reading is below the zero of the gage enter a minus sign (-) before the recorded figure except where readings are made from a wire-weight gage. Wire-weight readings should be entered as read from the gage and the minus sign omitted unless instructed otherwise. No entries should be made in the "Adjusted gage readings, etc.," column. This space is reserved for use by the National Weather Service Office in entering adjusted stages, etc.

10(b). Occasionally extremely low stages occur, and the river gage will not extend into the water, possibly due to a sandbar covering the lower end of the gage, shifting of the channel away from the gage at low stages, a dry river, no flow, or the gage being in puddle. Any time any of these conditions exist, please enter an asterisk (*) in the "Gage reading" column and note the conditions in the "Remarks" space.

10(c). Enter either "F," "R," "S," or "U" in the "tendency" column to denote a Falling, Rising, Steady, or Unknown river stage tendency at the observation time, respectively.

11. REMARKS. Enter calendar day or p.m. maximum temperatures when lower than 24-hour maxima, and overnight or a.m. minima when higher than 24-hour minima (optional). Write brief reports of unusual weather or flood conditions, giving times and dates. Enter heights and times (if known) of crest stages, if higher than reported in the RIVER STAGE column. Brief reports of storm damage, and durations and amounts of heavy rain are useful. These additional remarks are often the only source of this information in your area, and can be very important.

12. SUMS. It would help the National Climatic Data Center or other processing center if you could enter the sums of 24-hour precipitation amounts in both the "Rain, melted snow, etc.," and the "Snow, ice pellets, hail" columns. This is optional.

13. MAILING IN YOUR FORMS. After the last observation of the month, please recheck your forms for completeness, accuracy and legibility of all entries. Mail the forms promptly (if possible, by the 3rd day of the next month) to the designated office, using the pre-stamped or business reply envelopes provided.

[1] Observation times of NCPN NWS-Coop stations vary from these standards based on the overall needs of NWS regional offices (see Obs. time in Appendix A of the Climate Monitoring Protocol Narrative).

[2] The National Weather Service Observing Handbook No. 2 (Cooperative Station Observations) is located at (http://www.nws.noaa.gov/om/coop/training.htm) (also see SOP #5).

WS FORM B-91
(12-93)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION *(Climatological)(River Station, if different*		MONTH **DEC**	**2000**
STATE	COUNTY	RIVER	
TIME (local) OF OBSERVATION RIVER	TEMP. **AM** * PRECIPITATION **AM**	STANDARD TIME IN USE	
TYPE OF RIVER GAGE	ELEVATION OF RIVER GAGE ZERO *Ft*	FLOOD STAGE *Ft.*	NORMAL POOL STAGE *Ft.*

DATE	TEMPERATURE F. 24 HRS ENDING AT OBSERVATION MAX	MIN	(52) AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc., (Ins. and hundredths)	Snow, ice pellets (Ins. And tenths)	At ob. Snow, ice pellets hail, ice on ground (Ins.)	*Type the letter Y through hours precipitation was observed, and a letter P through hours precipitation probably occurred unobserved.)* A.M. NOON P.M. 1 2 3 4 5 6 7 8 9 10 11 1 2 3 4 5 6 7 8 9 10 11	WEATHER Fog	Ice pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	RIVER STAGE CONDITION	GAGE READING AT __A.M.	TENDENCY	REMARKS (Special observations, etc.,)
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12							1 2 3 4 5 6 7 8 9 10 11 1 2 3 4 5 6 7 8 9 10 11											
13																		
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19																		
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22							1 2 3 4 5 6 7 8 9 10 11 1 2 3 4 5 6 7 8 9 10 11											
23																		
24																		
25																		
26																		
27																		
28																		
29																		
30																		
31																		
sum							CHECK BAR (For wire-weight) NORMAL CK. BAR	Fog	Ice pel	Glaze	Thund.	Hail	Dam. Winds					
CONDITION OF RIVER AT GAGE							READING DATE											

A. Obstructed by rough ice. B. Frozen, but open at gage C. Upper surface of smooth ice. D. Ice gorge above gage	E. Ice gorge below gage F. Shore ice. G. Floating Ice H. Pool stage.	OBSERVER SUPERVISING OFFICE **WFO**	STATION INDEX NO.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network Units

Standard Operating Procedure (SOP) #8

Instructions for National Weather Service WS Form B-92

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for recording climate data for National Weather Service (NWS) Cooperative Observing climate stations with an evaporation pan. This SOP was extracted from the NOAA instruction sheet located on the front cover of the B-92 data-sheet booklet without alteration, and is provided here to ensure accessibility.

WS FORM B-92, RECORD OF EVAPORATION AND CLIMATOLOGICAL OBSERVATIONS

INSTRUCTIONS

1. Begin new form on the first day of every month. Fill in the heading and bottom of the form completely. Enter E, C, M, wPmttw "standard line in use" box for Eastern, Central, Mountain, or Pacific. It using Daylight Saving Time, enter D after the E. C, M, or P, as follows: ED, CD, MD, or PD. Enter the following items from the last day of the preceding month in the spaces just above the line for the first of the month: dry-bulb temperature at complete observation, beginnings and endings of precipitation, anemometer dial reading, gage reading at observation, and gage reading when lank filled. Note: the dry-bulb is the thermometer reading (the temperature) at the time the maximum and minimum thermometers are read and reset.
Put entries for each day on the "date" line (left column) of the date of observation except as indicated under "Additional Data Remarks." Use an additional Form B-92 it more space is needed (do not make remarks on the reverse side). The sample form shows how entries should be made at evaporation stations with (bottom half of form) and without (top half) dry- and wet-bulb thermometers and water temperature instruments.

2. Take observations at the same hour each day. The preferred lime for the complete observation is in the morning, when the rate of evaporation is usually low. Read all instruments and record the values on the enclosed form during the complete observation. See National Weather Service Observing Handbook No. 2, Chapter 5, "Evaporation Station Observations," for more detailed instructions on taking observations. You may use WS Form B-82, "Official Weather Observers Record," (formerly Form F-7) to record the observations as they are taken, entering wet- and dry-bulb temperatures, wind, and evaporation readings under "Remarks and Notes." Be sure to copy the data promptly onto Form B-92. You may retain Form B-82.

Morning observers equipped with a psychrometer and making a complete observation should make a supplementary observation of the dry- and wet-bulb thermometers at some regular hour in the evening and record the temperature readings in the second set of dry- and wet-bulb columns provided. If you make the complete observation in the evening, make the supplemental readings in the heading of the supplemental columns. If you cannot make an observation at the regular time, show the lime it was taken in the remarks column on the same line.

3. Train a member of your family or some other competent person to take and record observations when you are unable to. Continuity of record is very important.
Instructions that follow cover the entry of data In the specific columns of the form.

4. AIR TEMPERATURE (°F). Read and record the 24-hour maximum and minimum temperatures (in the "Max." and "Min." columns) and temperature at the observation time (in the "Dry-bulb" column) to the nearest whole degree. Place a minus sign before the readings of sub-zero temperatures. The maximum and minimum thermometers should agree within one degree after setting. If the difference is greater, report this under "Additional Data Remarks" and notify your supervising office.

4a. Minimum Temperature, Liquid-in-glass thermometer. Read the minimum thermometer while it is in its nearly horizontal or "set" position by reading the temperature scale at the end of the small index farthest from the bulb. Read this first, so the Index in the minimum thermometer will not be jarred or disturbed in any manner before the reading is made. Set the minimum thermometer after the maximum thermometer has been read and set (see paragraph 4b), by raising the bulb end sufficiently to allow the small index to slide to the end of the alcohol column, then lowering the thermometer to its nearly horizontal position.

4b. Maximum Temperature, Liquid-in-glass. Read the top of the mercury column after the maximum thermometer has been lowered slowly to a vertical position with the bulb end down. Be careful not to touch the thermometer bulb before making the reading. After reading the thermometer, reset it by whirling it several times in a clockwise direction until the reading is within one degree of the alcohol column in the minimum thermometer. It should then be returned to its nearly horizontal position with the bulb end slightly elevated.
4c. Maximum-Minimum Temperature System (MMTS). Press the MAX and MIN buttons to obtain the highest and lowest temperatures, respectively. Release both buttons to read the present temperature. Record these to the nearest whole degree; that is, if the tenths digit is 5 through 9, round off the temperature to the next higher degree (for example, 47.5 is rounded to 48, -3.6 to -4, and 78.2 to 78). Reset the maximum and minimum temperatures by pressing the RESET and MAX buttons simultaneously, then the RESET and MIN buttons.

If the MMTS reads HELP, there has been an interruption in the power supply. Press the RESET button to restore readings. The maximum and minimum temperatures will not be accurate if the power was off very long. If you believe this is so, write "Power failure during time of max (or min) temperature" in the remarks column.

4d. Dry- and Wet-Bulb Temperature. Il you have psychrometers, read the dry- and wet-bulb temperatures to the nearest estimated tenth of a degree and enter readings in the Dry-and Wet-Bulb columns (do NOT round these oil). Instructions for reading wet-bulb temperatures are contained in Chapter 5 of the NWS Handbook H 2, "Cooperative Station Observations."

4a. Temperature at Observation. Stations not equipped with psychrometers will obtain the current temperature by reading the end of the alcohol column in the minimum thermometer while in its "set" position without disturbing the instrument. Another method is to read the maximum thermometer after it has been whirled and while it is still in a vertical position. The MMTS displays the current temperature any time none of the buttons is pushed.

41. Dew Point. Leave this column blank.
5. WATER TEMPERATURE (°F). If readings are made visually, record them to the nearest whole degree. If equipped with an autographic water temperature instrument, mail the recorder charter from this instrument to the National Climatic Data Center along with Form B-92, as Instructed.

6. PRECIPITATION. Enter times of beginning and ending on the calendar dates on which they occur, but enter amounts on the dates of measurement, For example, if .50" fell between 7 and 9 p.m. on the 5th, enter 7P and 9P in the "Time of beginning" and "Time of ending" columns on the 5th, and .50" in the "Time of beginning" and "Time of ending" columns on the 5th, and .50" in the "Rain, Melted Snow, etc." column on the 6th. When precipitation occurs during the night and the exact time is not known, use the expression "DM" to denote beginning and/or ending (use "DNA" or "DNP" to denote "during night a.m. or p.m.," respectively). Empty the rain gage immediately after making and recording the regular measurement. Do not empty the gage at times of supplementary observations, unless instructed otherwise.

6a. Under "24-Hr. Amounts," enter the total precipitation in inches and hundredths (rain, melted hail, and ice pellets) which has accumulated during the 24 hours preceding the time of observation. Enter the amount on the date of the measurement. If the amount was too small to measure, enter "T" for trace. Record every entry (except "T") to two decimal places; i.e., .05 for five-hundredths, or 1.50 for 1-1/2 inches. Always enter the decimal point in its proper place. If no precipitation occurred during the 24-hour observation period, enter a "0" (zero) so there will be no doubt as to whether any precipitation fell during the period.

6b. When freezing or frozen precipitation is observed, three entries are needed on the observation form: the 24-hour melted precipitation, the 24-hour snowfall, and the total of all frozen precipitation on the ground at the time of observation. See paragraphs 6c and 6d.

When snow or ice pellets are likely to occur, remove the funnel and Inner tube of the rain gage and leave only the large outer can exposed. Melt the catch of snow or Ice pellets by adding a carefully measured amount of warm water from the tube. After the catch is melted in the can, pour the water into the tube (being careful not to spill any) and measure it. Then subtract the amount of warm water previously added. The resulting figures are the water equivalent of the snow or ice pellets and are entered as the amount of precipitation. If snow, ice pellets, or hail falls when the funnel and inner tube have not been removed and it is apparent that the gage has caught only a portion of the precipitation, cut a section of the newly fallen snow, ice pellets, or hail on the ground by using the outer can as a biscuit cutter. Reduce this section to water and measure it as indicated above.

6c. Under the "Snow. Ice Pellets, Hail" column, enter in inches and tenths the depth of new snow, ice pellets, or hail that has fallen during the past 24 hours. Enter "T" for a depth too small to measure (less than .05 inch).

6d. Under the "Snow, Ice Pellets, Hail, Ice on Ground" column, enter to the nearest whole Inch the average depth of all (old and new) snow, ice pellets, ice, and hail remaining on the ground at the time of observation in the vicinity of the station. Enter "T" for less than 0.5 inch. If drifting has occurred, make measurements at several points where there is less evidence of drifting, and record the average of these. Make an entry each day in this space as long as snow, ice pellets, or ice remains on the ground. As soon as the covering has melted, it is not necessary to enter "0" each day after it has once been entered.

7. WIND. Record the anemometer dial reading to the nearest whole mile. You do not need to compute the miles of movement since the preceding observation.

8. EVAPORATION. See "National Weather Service Observing Handbook No. 2" for complete instructions on how to make evaporation readings. No entries need to be made in the "Amount of Evaporation" column.

8a. Hook Gage Readings. Read the gage to the nearest hundredth of an inch and enter the reading in the appropriate column. Fill the pan to a level two inches below the rim and refill to that level at the time of a regular observation whenever the water has receded one inch, to a level three Inches below the rim. When rains threaten to overflow the pan, remove enough water, regardless of the time of day, to lower its level to two or three inches below the rim. Read the gage immediately before and after making any change in the water level and record the readings in the "Remarks" column.

8b. Point Gage Measurements. Add water to or remove it from the pan so that the tip of the point gaga coincides with the water surface. When the water surface is beneath the point, measure with the measuring tube the amount of water needed to restore the water level in the pan. Enter this value preceded by a plus (±) in the column "Gage Reading, or Amount Added +/-." When the water surface is above the point, dip water from the pan into the measuring tube until the top of the point coincides with the water surface. Measure the water in the graduated tube and enter this reading preceded by a minus (-)f in the column "Reading When Tank Filled, or Amount Removed -."

9. ADDITIONAL DATA. Enter special data such as lake temperatures, additional evaporation readings, etc., in the extra vertical columns on the right of the form, giving the time of such readings and labeling each column accordingly (see the examples on the cover sheet). Any unusual conditions such as the pan overflowing or water being lost through means other than evaporation should be recorded in these columns. Enter remarks either horizontally along the date line of observation or vertically in the columns (indicating dates of occurrence), depending on how much space is needed. When the pan is cleaned, or at least once a month, remove the Six's thermometer from the pan and place it in the instrument shelter. Allow enough time for the thermometer to dry and reach the air temperature. Read the current air temperature from the minimum thermometer without resetting and the temperature from the Six's thermometer. Enter these comparative readings in the "Remarks" column. II the readings differ by 2° or more, notify your National Weather Service representative. The purpose of this check is to evaluate the reliability of the water temperature observations.

10. You do not have to enter the sums, averages, or greatest and adjusted totals (bottom two lines of the form), although it would be helpful if you totaled both of the 24-hour precipitation columns.

11. Enter your name, station index number, month, and year on the bottom of the form. Recheck your form (or completeness, accuracy, and legibility after the last observation of the month. It

should be mailed promptly to the National Climatic Data Center, Federal Building, Asheville, North Carolina 28801. Send one original and one carbon copy, unless instructed otherwise.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #9

Operating the Remote Observation System Automation (ROSA)

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This is the National Weather Service (NWS) Standard Operating Procedure (SOP) for using the ROSA system to report daily weather observations of National Weather Service (NWS) Cooperative Observing climate stations. ROSA is a phone-based system, and is used by two Northern Colorado Plateau Network (NCPN) park units for daily reporting (see Appendix B of the NCPN Climate Monitoring Protocol Narrative).

I. ROSA

The ROSA system uses a special telephone (the ROSA phone) to enter and transmit daily observations of precipitation, temperature, snow, and general observations of weather conditions. The following procedures describe how to use the ROSA system. Weather codes used in the ROSA system are presented in section **II**; special instructions for reporting snow data are detailed in section **III**.

Procedures:
The primary phone number is 1-800-705-5417. The white ROSA phone is pre-programmed with this number. If for some reason this number fails, an alternate number is 1-800-737-4783. If all else fails, call the weather into your regional NWS office.

STEP 1 – To expedite processing and to ensure accurate reporting, use copies of STEP 3 below to record the date and weather conditions before connecting to ROSA.

STEP 2 – Using the ROSA phone, ERASE the old data by doing the following:

1) Press PROGRAM key, then DATE key
2) Press PROGRAM key, then DATA 1 key
3) Press PROGRAM key, then DATA 2 key
4) Press PROGRAM key, then DATA 3 key
5) Press PROGRAM key, then DATA 4 key
6) Press PROGRAM key, then DATA 5 key
7) Press PROGRAM key, then DATA 6 key
8) Press PROGRAM key, then DATA 7 key

STEP 3 – Enter the date and weather information into the ROSA phone as follows:

Press PROGRAM, Press _ _ _ _ _ _ _ _ # , Press DATE
(month, day, hour, minutes) M M D D H H M M

Press PROGRAM, Press 2 1 _ _ # 2 2 _ _ # , Press DATA 1
(Current and maximum temperature, whole degrees F)

Press PROGRAM, Press 2 3 _ _ _ _ # , Press DATA 2
(Minimum temperature, whole degrees F. Use two stars for negative temperatures; e.g., enter **15 for -15)

Press PROGRAM, Press 1 0 _ _ _ _ _ # , Press DATA 3
(Precipitation, hundredths of inches. Use one star for decimals; e.g., enter 0*05 for 0.05 inches)

Press PROGRAM, Press 8 4 _ _ # 8 5 _ _ # # , Press DATA 4
(Current and past weather conditions – see **II.** R**osa Weather Codes**)

USE THESE LAST TWO LINES ONLY IN WINTER (See **II. Reporting Snow Data**)

Press PROGRAM, Press 6 8 _ _ _ _ _ # , Press DATA 5
(Snow fall in inches – see **III. Reporting Snow Data** for measurement resolution)

Press PROGRAM, Press 6 9 _ _ _ _ _ # # , Press DATA 6
(Snow depth, whole inches)

Make sure only your last entry ends with # #.

STEP 4 – Send the information to the ROSA system as follows:

1) Pick up handset, or press SPEAKER key
2) Press 9 to get an outside line
3) Press PRIMARY key (dials the ROSA #)
4) After connecting, press STATION key
5) Press DATE key
6) Press DATA 1 key
7) Press DATA 2 key
8) Press DATA 3 key
9) Press DATA 4 key
10) Press DATA 5 key
11) Press DATA 6 key

If successful, the ROSA voice will say “The computer accepted your data, Thank you”. Hang up after successfully sending the information.

II. Rosa Weather Codes

ROSA Weather Codes

II.A. Current weather conditions

Code	Weather condition	Code	Weather condition
01	clear sky (few or no clouds)	65	rain, steady, heavy
02	partly cloudy	66	rain, freezing
03	mostly cloudy or overcast	68	rain and snow mixed
04	smoke	71	snow, continuous, light
05	haze	73	snow, continuous, moderate
07	dust or sand raised by wind	75	snow, continuous, heavy
10	fog (visibility 0.5-mile or more)	79	sleet
13	lightning (no thunder)	80	showers, rain, light
14	precipitation not reaching ground	81	showers, rain, moderate
15	precipitation in sight but not at station	82	showers, rain, violent
17	thunderstorm but no precipitation	83	showers, rain and snow mixed
45	fog visibility less than 0.5 mile	85	showers, snow light
51	drizzle, light	86	showers, snow, moderate or heavy
53	drizzle, moderate	89	hail, showers, no thunder
55	drizzle, heavy	95	thunderstorm, light rain or snow
61	rain, steady, light	96	thunderstorm with small hail
63	rain, steady, moderate	97	thunderstorm, heavy rain or snow
-	-	99	thunderstorm, hail larger than a dime

II.B. Past weather conditions

Code	Weather condition
0	clouds covering 0.5 or less of the sky during the period less of the sky during part of the period
1	clouds covering more than 0.5 of the sky during part the period and covering 0.5 or less of the sky during part of the period
2	clouds covering more than 0.5 of the sky during part of the period
3	sandstorm, dust storm, or blowing snow
4	fog or thick haze
5	drizzle
6	rain
7	snow
8	showers

9	thunderstorm

II. Reporting Snow Data Instructions

Reporting Snow Data
III.A. Total Depth of All Snow on Ground
The total depth of all snow on the ground is reported to the nearest whole inch. Precede the measurement of the total depth of all snow on the round with the code number **68**. Follow the measurement of the total depth of all snow on the ground with the pound sign (**#**). If there is less than 0.5 inches of snow on the ground, enter a trace value (.001). Use the star character (*) on your phone for the decimal point. If the total depth of snow on the ground is missing, enter **68#**. Examples If the total depth of all snow on the ground is 7 inches, enter **687#**. If the total depth of all snow on the ground is less than 0.5 inches, enter **68*001#**. If the total depth of all snow on the ground is 110 inches, enter **68110#**.
III.B. New Snow
New snow on the ground is measured and reported to the nearest tenth (0.1) of an inch. The star character (*) on your telephone is used as the decimal point. Precede the current 24 hour amount of new fallen snow with the code number **69**. Follow the 24 hour amount of new fallen snow with the pound sign (**#**). If the 24 hour amount of new fallen snow is missing, enter **69#**. A trace of new fallen snow is entered as .001. If there has been no snow or other frozen precipitation in the past 24 hours, do not send the new snow group. Examples If the depth of new fallen snow on the ground is 4.3 inches, enter **694*3#**. If the depth of new fallen snow on the ground is 0.7 inches, enter **690*7#**. If there is a trace of new fallen snow on the ground, enter **69*001#**.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 10

Data Management

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) documents the procedures for processing and managing data from the five climate monitoring programs in the Northern Colorado Plateau Network (NCPN). Data are downloaded from various sources. Procedures for data management follow guidelines and standards that are detailed in the NCPN Data Management Plan: (http://science.nature.nps.gov/im/units/ncpn/library/beer_2004_573089.pdf).

Microsoft Access XP is the primary software environment for managing climate data. All data files reside on a secure server with regular backup routines that include offsite storage rotation.

I. Data Model

The procedures in this SOP have been developed so that climate data from multiple sources can be efficiently downloaded, merged into a standardized system, and made available for queries and analyses. Downloaded data are archived in their native format before processing (see below). Procedures for downloading data are documented in SOPs #11-15.

The Climate data model consists of six separate databases, one for each of the five climate monitoring programs and a single back-end Climate Station database that contains location information on all stations and details on station equipment. Figure 10-1 shows the relationships among the primary tables in the Climate Station database.

<u>Climate Databases</u>
Data are stored for stations belonging to five climate-monitoring programs:

- NWS-Coop (National Weather Service Cooperative Observing Program)
- SNOWNET (misc. automated stations)
- SNOTEL (SNowpackTELemetry – National Resources Conservation Service)
- SnowCourse (National Resources Conservation Service)
- RAWS (Remote Automated Weather Stations – National Interagency Wildland Fire Program)

The model for a climate database consists of a work table for importing ASCII climate data, and a finalized table of climate data. Each database includes a form that manages the import/append process and is described in the next section.

Current, working versions of the Climate and Station database are stored on the NCPN server:

X:\Vital_Signs\Climate\Data\Current_Data\.

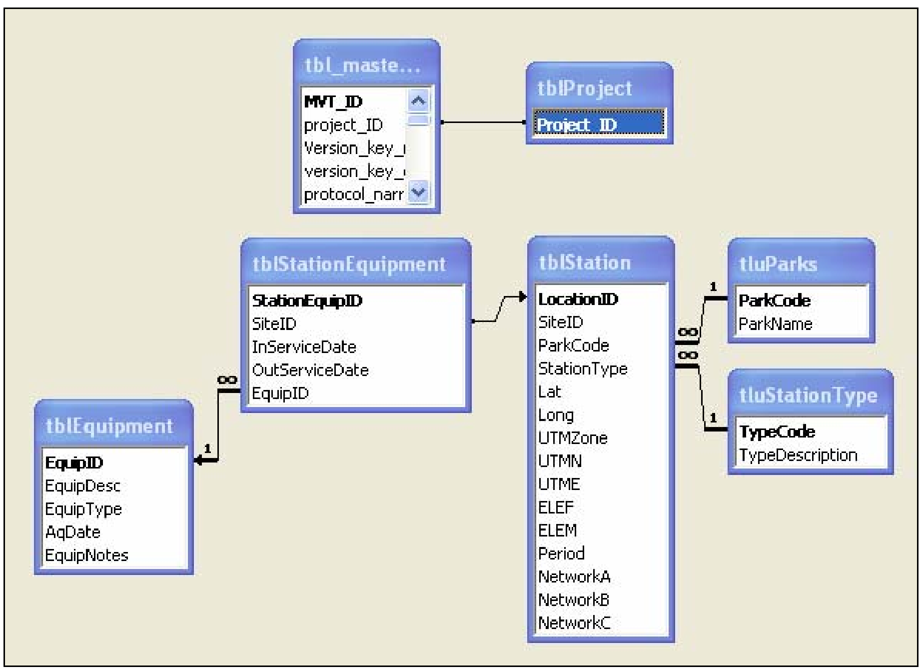


Figure 10-1. Data model for the Climate Station database, ClimateLocation.mdb. The primary table for the back-end database is tblStation, which contains one record for each climate station in the reporting network. Related to tblStation is tblStationEquipment which contains one record for each item of equipment in each station. Related to tblStationEquipment is tblEquipment which describes each item of equipment. Also shown are tblEquipType and tblStationType which describe the type of measurement (e.g., precipitation, snowfall, etc.) and type of station (i.e., RAWS, SNOTEL, etc.), respectively. Details on all protocol versions in effect at a given time are contained in tbl_master_version_table, which is a linked table that is external to ClimateLocation.mdb. The Project_ID field in tblProject links ClimateLocation.mdb to this external table.

II. Documentation of Database Tables

A. ClimateLocation.mdb – Climate Station Information Database

Table: **tblStation**
Description: Primary table that stores climate station information such as ID, station name, location, type of station. One record for each climate station.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
LocationID	Unique Record Identifier	dbLong	4
SiteID	Station ID	dbText	20
ParkCode	Park Code	dbText	4
StationType	Type of climate station	dbByte	1
Lat	Station latitude	dbText	10
Long	Station longitude	dbText	10
UTMN	Station coordinate UTM North	dbText	10
UTME	Station coordinate UTM East	dbText	10
UTMZone	UTM zone for UTM coordinates	dbInteger	2
ELEF	Elevation in feet	dbInteger	2
ELEM	Elevation in meters	dbInteger	2
Period	Period of record	dbText	20
NetworkA	Member of Climate Network A – Data are used to describe the climate of the United States (pertains to NWS-Coop data only)	dbBoolean	1
NetworkB	Member of Climate Network B – Data are used to describe the climate of the United States (pertains to NWS-Coop data only)	dbBoolean	1
NetworkC	Member of Climate Network C – Data are used to describe the climate of the United States (pertains to NWS-Coop data only)	dbBoolean	1

Table: **tblEquipment**
Description: Table for storing detailed information about climate measuring equipment. One record for each model of equipment.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
EquipID	Unique record identifier - primary key	dbLong	4
EquipDesc	Description of equipment	dbText	255
EquipNotes	Equipment notes - detailed equipment descriptions	dbMemo	Variable

Table: **tbl_master_version_table**
Description: Details on protocol and SOP versions in effect at a given date. Linked table from master_version_table.mdb.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
MVT_ID	Unique record identifier	dbLong	4
project_ID	Unique identifier for project	dbLong	4
Version_ key_number	Version key number; increments each time one or more SOPs or protocol narrative version number for a project changes	dbLong	4
version_key_date	Date version key number created; corresponds to date one or more SOPs or protocol narrative version number for a project changes	dbDate	8
protocol_narrative	Protocol narrative version	dbDecimal	16
SOP_1	SOP #1 version number	dbDecimal	16
SOP_2	SOP #2 version number	dbDecimal	16
SOP_3	SOP #3 version number	dbDecimal	16
SOP_4	SOP #4 version number	dbDecimal	16
SOP_5	SOP #5 version number	dbDecimal	16
SOP_6	SOP #6 version number	dbDecimal	16
SOP_7	SOP #7 version number	dbDecimal	16
SOP_8	SOP #8 version number	dbDecimal	16
SOP_9	SOP #9 version	dbDecimal.	16
SOP_10	SOP #10 version number	dbDecimal	16
SOP_11	SOP #11 version number	dbDecimal	16
SOP_12	SOP #12 version number	dbDecimal	16
SOP_13	SOP #13 version number	dbDecimal	16
SOP_14	SOP #14 version number	dbDecimal	16
SOP_15	SOP #15 version number	dbDecimal	16
SOP_16	SOP #16 version number	dbDecimal	16
SOP_17	SOP #17 version number	dbDecimal	16

Table: **tbl_project**
Description: Contains project ID that enables link to external tbl_master_version_table.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
project_ID	Unique project identifier; provides link to tbl_master_version_table	dbLong	4

Table: **tblStationEquipment**
Description: Table storing an inventory of equipment for each climate station. Table contains one record for each item of equipment at each station. Multiple equipment records can be associated with one station so that equipment changes can be tracked over time.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
StationEquipID	Unique Record Id	dbLong	4
SiteID	Climate Station ID foreign key to tblStation	dbLong	4
InServiceDate	Date equipment use began	dbDate	8
OutServiceDate	Date equipment use ended	dbDate	8
EquipID	Equipment ID foreign key to tblEquipment	dbLong	4

Table: **tluStationType**
Description: Lookup table for type of climate station RAWS, COOP, SNOTEL, and SNOWNET.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
StationTypeID	Station type code - unique record identifier	dbByte	1
TypeDescription	Station description	dbText	100

Table: **tluParks**
Description: Lookup table containing the 4-character park code, and park name.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
ParkCode	Four-letter park abbreviation	dbText	4
ParkName	Full Name of park	dbText	50

B. NOAA Cooperative Stations Database – CoopClimate.mdb

Table: **tblCOOPClimate**
Description: Primary table for storing NWS-Coop weather table data. Table will contain one record per station for each day of the year.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
ClimateID	Unique record key	dbLong	4
State	State Code	dbByte	1
StationID	Coop climate station ID – concatenated with State to form link field to tblStation SiteID	dbInteger	2
ObservationDate	Date climate data collected	dbDate	8
ObservationTime	Time climate data collected	dbDate	8
Precipitation	24 hour Precipitation (hundredths of an inch)	dbInteger	2
PCPNMeas	Precipitation measurement flag	dbText	1
PCPNQual	Precipitation quality control flag	dbText	1
SnowFall	24 hour Snowfall (tenths of an inch)	dbInteger	2
SNFLMeas	Snowfall measurement flag	dbText	1
SNFLQual	Snowfall quality control flag	dbText	1
SnowDepth	Snow depth (inches)	dbInteger	2
SNDPMeas	Snow depth measurement flag	dbText	1
SNDPQual	Snow depth quality control flag	dbText	1
TMAX	24 hour Maximum air temperature (F)	dbInteger	2
TMAXMeas	TMAX measurement flag	dbText	1
TMAXQual	TMAX quality control flag	dbText	1
TMIN	24 hour minimum air temperature (F)	dbInteger	2
TMINMeas	TMIN measurement flag	dbText	1
TMINQual	TMIN quality control flag	dbText	1
LinkStationID	Link to SiteID in tblStation	dbText	20

Table: **tblImportWork**
Description: Table into which NWS-Coop ASCII file is imported. The field names match those in tblCOOPClimate so that after editing, this table can be appended to tblCOOPClimate.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
State	Coop Network State Code	dbInteger	2
Station	Coop Network Station ID	dbInteger	2
OYear	Observation Year	dbInteger	2
OMonth	Observation Month	dbInteger	2
ODay	Observation Day	dbInteger	2
OHour	Observation Time	dbInteger	2
PCPN	Appends to tblCOOPClimate	dbText	6
PcpnMeas	Appends to tblCOOPClimate	dbText	1
PcpnQual	Appends to tblCOOPClimate	dbText	1
SNFL	Appends to tblCOOPClimate	dbText	6
SNFLMeas	Appends to tblCOOPClimate	dbText	1

tblImportWork. Cont.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
SNFLQual	Appends to tblCOOPClimate	dbText	1
SNDP	Appends to tblCOOPClimate	dbText	6
SNDPMeas	Appends to tblCOOPClimate	dbText	1
SNDPQual	Appends to tblCOOPClimate	dbText	1
TMAX	Appends to tblCOOPClimate	dbText	6
TMAXMeas	Appends to tblCOOPClimate	dbText	1
TMAXQual	Appends to tblCOOPClimate	dbText	1
TMIN	Appends to tblCOOPClimate	dbText	6
TMINMeas	Appends to tblCOOPClimate	dbText	1
TMINQual	Appends to tblCOOPClimate	dbText	1
LinkStationID	Foreign Key to tblStation	dbText	20
ObDate	Formatted date – mm/dd/yy	dbDate	8
ObTime	Formatted time – hh:mm	dbDate	8

Table: **tluMeasurementFlag**
Description: Lookup table for the codes and explanations used to describe the measurement flag associated with each observation.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
MeasCode	Measurement code from ASCII File	dbText	1
MeasDesc	Measurement description	dbText	60

Table: **tluQualityFlag**
Description: Lookup table for the codes and explanations used to describe the data quality flag associated with each observation.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
QualFlag	Quality Flag from ASCII file	dbText	1
QualDesc	Description of value	dbText	60

Table: **tluStateCode**
Description: Lookup table to cross-reference the numeric Coop state code with the standard character state code.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
StateCode	Numeric State Code	dbByte	1
StateAlpha	Alpha State Code	dbText	2

C. Remote Automated Weather Stations Database – RAWSClimate.mdb

Table: **tblRAWSClimate**
Description: Primary table for storing RAWS weather data. Table will contain one record per station for each day of the year.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
ID	Unique record identifier	dbLong	4
StationCode	Four character station identifier taken from ASCII file name because RAWS detail records include no station identifier	dbText	4
ODate	Date of observation	dbDate	8
TPrecip	Total precipitation (inches)	dbDouble	8
VTPrecip	Percentage of valid precipitation records	dbDouble	8
MinTemp	Minimum air temperature (F)	dbDouble	8
MaxTemp	Maximum air temperature (F)	dbDouble	8
MeanTemp	Mean air temperature (F)	dbDouble	8
VTemp	Percentage of valid temperature records	dbDouble	8
MinFuelTemp	Minimum fuel temperature (F)	dbDouble	8
MaxFuelTemp	Maximum fuel temperature (F)	dbDouble	8
MeanFuelTemp	Mean fuel temperature (F)	dbDouble	8
VFuelTemp	Percentage of valid fuel temperatures	dbDouble	8
MinHumid	Minimum relative humidity (%)	dbDouble	8
MaxHumid	Maximum relative humidity (%)	dbDouble	8
MeanHumid	Mean relative humidity (%)	dbDouble	8
VHumidity	Percentage of valid humidity records	dbDouble	8
MinFMoist	Minimum fuel moisture (%)	dbDouble	8
MaxFMoist	Maximum fuel moisture (%)	dbDouble	8
MeanFMoist	Mean fuel moisture (%)	dbDouble	8
VFuelMoist	Percentage of valid fuel moisture records	dbDouble	8
TSol	Total solar radiation (Langleys)	dbDouble	8
VTSol	Percentage of valid solar radiation records	dbDouble	8
MinWind	Minimum wind speed (mph)	dbDouble	8
MaxWind	Maximum wind speed (mph)	dbDouble	8
MeanWind	Mean wind speed (mph)	dbDouble	8
VWind	Percentage of valid wind speed records	dbDouble	8
AWindDir	Average wind direction (degrees)	dbDouble	8
VAWindDir	Percentage of valid wind direction records	dbDouble	8
MaxGust	Maximum wind gust (mph)	dbDouble	8
GustDir	Direction of maximum wind gust (degrees)	dbDouble	8
VGust	Percentage of valid wind gust records	dbDouble	8
LinkStationID	Foreign key to SiteID in tblStation in ClimateLocation.mdb	dbText	20

Table: **tblImportWork**
Description: Table into which the RAWS ASCII file is imported. The field names match those in tblRAWSClimate so that after editing, this table can be appended to tblRAWSClimate.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
ID	Unique record identifier	dbLong	4
OYear	Observation Year	dbInteger	2
OMonth	Observation Month	dbInteger	2
ODay	Observation Day	dbInteger	2
TPrecip	Appends to tblRAWSClimate	dbDouble	8
VTPrecip	Appends to tblRAWSClimate	dbDouble	8
MinTemp	Appends to tblRAWSClimate	dbDouble	8
MaxTemp	Appends to tblRAWSClimate	dbDouble	8
MeanTemp	Appends to tblRAWSClimate	dbDouble	8
VTemp	Appends to tblRAWSClimate	dbDouble	8
MinFuelTemp	Appends to tblRAWSClimate	dbDouble	8
MaxFuelTemp	Appends to tblRAWSClimate	dbDouble	8
MeanFuelTemp	Appends to tblRAWSClimate	dbDouble	8
VFuelTemp	Appends to tblRAWSClimate	dbDouble	8
MinHumid	Appends to tblRAWSClimate	dbDouble	8
MaxHumid	Appends to tblRAWSClimate	dbDouble	8
MeanHumid	Appends to tblRAWSClimate	dbDouble	8
VHumidity	Appends to tblRAWSClimate	dbDouble	8
MinFMoist	Appends to tblRAWSClimate	dbDouble	8
MaxFMoist	Appends to tblRAWSClimate	dbDouble	8
MeanFMoist	Appends to tblRAWSClimate	dbDouble	8
VFuelMoist	Appends to tblRAWSClimate	dbDouble	8
TSol	Appends to tblRAWSClimate	dbDouble	8
VTSol	Appends to tblRAWSClimate	dbDouble	8
MinWind	Appends to tblRAWSClimate	dbDouble	8
MaxWind	Appends to tblRAWSClimate	dbDouble	8
MeanWind	Appends to tblRAWSClimate	dbDouble	8
VWind	Appends to tblRAWSClimate	dbDouble	8
AWindDir	Appends to tblRAWSClimate	dbDouble	8
VAWindDir	Appends to tblRAWSClimate	dbDouble	8
MaxGust	Appends to tblRAWSClimate	dbDouble	8
GustDir	Appends to tblRAWSClimate	dbDouble	8
VGust	Appends to tblRAWSClimate	dbDouble	8
ODate	Formatted Date mm/dd/yy	dbDate	8
StationCode	First four digits of ASCII file name	dbText	4

Table: **tluStationName**
Description: Lookup table to cross-reference the file code from the ASCII file name with the ID to link to tblStation.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
StationCode	Station Code – taken from ASCII file name	dbText	4
LinkStationID	Link ID to tblStation in ClimateLocation.mdb	dbText	20

D. SNOWNET Weather Stations Database – SNOWNETClimate.mdb

Table: **tblSnowNetClimate**
Description: Primary table for storing SNOWNET weather data. Table will contain one record per station for each day of the year.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
SnowNetID	Unique record identifier	dbLong	4
ODate	Observation date	dbDate	8
SiteID	Foreign key to tblStation	dbText	3
MinTemp	Minimum air temperature (F)	dbDouble	8
MaxTemp	Maximum air temperature (F)	dbDouble	8
AvgTemp	Average air temperature (F)	dbDouble	8
VTemp	Percentage of valid temperature records	dbDouble	8
MinHumid	Minimum humidity (%)	dbDouble	8
MaxHumid	Maximum humidity (%)	dbDouble	8
AvgHumid	Average humidity (%)	dbDouble	8
VHumid	Percentage of valid humidity records	dbDouble	8
MinDew	Minimum dew point (F)	dbDouble	8
MaxDew	Maximum dew point (F)	dbDouble	8
AvgDew	Average dew point (F)	dbDouble	8
VDew	Percentage of valid dew point records	dbDouble	8
MinWind	Minimum wind speed (mph)	dbDouble	8
MaxWind	Maximum wind speed (mph)	dbDouble	8
AvgWind	Average wind speed (mph)	dbDouble	8
VWind	Percentage of valid wind records	dbDouble	8
WindDir	Average wind direction (degrees)	dbDouble	8
VWindDir	Percentage of valid wind direction records	dbDouble	8
MaxGust	Maximum wind gust (mph)	dbDouble	8
VMaxGust	Percentage of valid wind gust records	dbDouble	8
Precip	Total precipitation (inches)	dbDouble	8
VPrecip	Percentage of valid precipitation records	dbDouble	8
DataFlag	Data quality flag; 0=ok 1=suspect	dbLong	4

Table: **tblImportWork**
Description: Table into which the SNOWNET ASCII file is imported. The field names match those in tblSnowNetClimate so that after editing, this table can be appended to tblSnowNetClimate.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
ID	Unique record identifier	dbLong	4
OYear	Observation Year	dbLong	4
OMonth	Observation Month	dbLong	4
ODay	Observation Day	dbLong	4
MinTemp	Appends to tblSnownetClimate	dbDouble	8
MaxTemp	Appends to tblSnownetClimate	dbDouble	8
AvgTemp	Appends to tblSnownetClimate	dbDouble	8
VTemp	Appends to tblSnownetClimate	dbDouble	8
MinHumid	Appends to tblSnownetClimate	dbDouble	8
MaxHumid	Appends to tblSnownetClimate	dbDouble	8
AvgHumid	Appends to tblSnownetClimate	dbDouble	8
VHumid	Appends to tblSnownetClimate	dbDouble	8
MinDew	Appends to tblSnownetClimate	dbDouble	8
MaxDew	Appends to tblSnownetClimate	dbDouble	8
AvgDew	Appends to tblSnownetClimate	dbDouble	8
VDew	Appends to tblSnownetClimate	dbDouble	8
MinWind	Appends to tblSnownetClimate	dbDouble	8
MaxWind	Appends to tblSnownetClimate	dbDouble	8
AvgWind	Appends to tblSnownetClimate	dbDouble	8
VWind	Appends to tblSnownetClimate	dbDouble	8
WindDir	Appends to tblSnownetClimate	dbDouble	8
VWindDir	Appends to tblSnownetClimate	dbDouble	8
MaxGust	Appends to tblSnownetClimate	dbDouble	8
VMaxGust	Appends to tblSnownetClimate	dbDouble	8
Precip	Appends to tblSnownetClimate	dbDouble	8
VPrecip	Appends to tblSnownetClimate	dbDouble	8
DataFlag	Appends to tblSnownetClimate	dbLong	4
ODate	Formatted Date mm/dd/yy	dbDate	8
SiteID	Appends to tblSnownetClimate	dbText	3

E. Snow Course Weather Stations Database – SnowCourseClimate.mdb

Table: **tblSnowCourseClimate**
Description: Primary table for storing Snow Course weather data. Table will contain one record per station for each observation date.

FIELD NAME	FIELD_DESCRIPTION	FIELD TYPE	FIELD WIDTH
SnowCourseID	Unique record identifier	dbLong	4
SiteID	Foreign key to tblStation	dbText	20
ObservationDate	Date of Observation	dbDate	8
SnowDepth	Snow depth (inches)	dbDouble	8
SnowWaterEq	Snow-water equivalent (inches)	dbDouble	8

Table: **tblImportWork**
Description: Table into which the Snownet table is parsed. The field names match those in tblSnowCourseClimate so that after editing, this table can be appended to tblSnowCourseClimate.

FIELD NAME	FIELD_DESCRIPTION	FIELD TYPE	FIELD WIDTH
SnowCourseID	Unique record identifier	dbLong	4
SiteID	Foreign key to tblStation	dbText	20
ObservationDate	Date of Observation	dbDate	8
SnowDepth	Snow depth (inches)	dbDouble	8
SnowWaterEq	Snow-water equivalent (inches)	dbDouble	8

Table: **Snowcourse**
Description: Table into which raw Snow Course data is imported. Table rows consist of multiple Date/Snow Depth/Snow Water Equivalent fields (up to six, total), any of which may be null, which must be parsed into tblImportWork.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
ID	Unique record identifier	dbLong	4
OBYear	Year of observations	dbInteger	2
Date1	Date	dbText	5
Dep1	Snow Depth (inches)	dbText	5
SWE1	Snow Water Equivalent (inches)	dbText	5
Date2	Date	dbText	5
Dep2	Snow Depth (inches)	dbText	5
SWE2	Snow Water Equivalent (inches)	dbText	5
Date3	Date	dbText	5
Dep3	Snow Depth (inches)	dbText	5
SWE3	Snow Water Equivalent (inches)	dbText	5
Date4	Date	dbText	5
Dep4	Snow Depth (inches)	dbText	5
SWE4	Snow Water Equivalent (inches)	dbText	5
Date5	Date	dbText	5
Dep5	Snow Depth (inches)	dbText	5
SWE5	Snow Water Equivalent (inches)	dbText	5
Date6	Date	dbText	5
Dep6	Snow Depth (inches)	dbText	5
SWE6	Snow Water Equivalent (inches)	dbText	5

F. SNOTEL Weather Stations Database – SnotelClimate.mdb

Table: **tblSnotelClimate**
Description: Primary table for storing SNOTEL weather data. Table will contain one record per station for each day of the year.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
ID	Unique record ID	dbLong	4
SiteID	Station ID - external key to tluStationName	dbText	6
ODate	Observation date		
YPrecip	Accumulated precipitation (hundredths of inches) for water year (Oct 1 - Sept 30)	dbDouble	8
YPrecipM	Accumulated precipitation measurement flag	dbText	1
YPrecipQ	Accumulated precipitation quality flag	dbText	1
SDEP	Snow Depth (inches)	dbDouble	8
SDEPM	Snow depth measurement flag	dbText	1
SDEPQ	Snow depth quality flag	dbText	1
SnowWaterEq	Accumulated snow-water equivalent (tenths of inches) for water year (Oct 1 - Sept 30)	dbDate	8
SWEM	SWE measurement flag	dbDouble	8
SWEQ	SWE quality Flag	dbText	1
MaxTemp	Temperature air maximum (F)	dbText	1
MaxTempM	Temperature maximum measurement flag	dbText	1
MaxTempQ	Temperature maximum quality flag	dbText	1
MinTemp	Temperature air minimum (F)	dbDouble	8
MinTempM	Temperature minimum measurement flag	dbText	1
MinTempQ	Temperature minimum quality flag	dbText	1
AvgTemp	Average air temperature (F)	dbDouble	8
AvgTempM	Average temperature measurement flag	dbText	1
AvgTempQ	Average temperature quality flag	dbText	1
TOBS	Temperature at observation time (F)	dbDouble	8
TOBSM	Observation temperature measurement flag	dbText	1
TOBQ	Observation temperature quality flag	dbText	1

Table: **tblImportWork**
Description: Table into which the SNOTEL ASCII file is imported. The field names match those in tblSnotelClimate so that after editing, this table can be appended to tblSnotelClimate.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
SnotelID	Unique record identifier	dbLong	4
SnotelDate	Observation date mmddyy	dbLong	4
YPrecip	Appends to tblSnotelClimate	dbDouble	8
YPrecipM	Appends to tblSnotelClimate	dbText	1
YPrecipQ	Appends to tblSnotelClimate	dbText	1
SDEP	Appends to tblSnotelClimate	dbDouble	8
SDEPM	Appends to tblSnotelClimate	dbText	1
SDEPQ	Appends to tblSnotelClimate	dbText	1
SnowWaterEq	Appends to tblSnotelClimate	dbDouble	8
SWEM	Appends to tblSnotelClimate	dbText	1
SWEQ	Appends to tblSnotelClimate	dbText	1
MaxTemp	Appends to tblSnotelClimate	dbText	255
MaxTempM	Appends to tblSnotelClimate	dbText	1
MaxTempQ	Appends to tblSnotelClimate	dbText	1
MinTemp	Appends to tblSnotelClimate	dbText	255
MinTempM	Appends to tblSnotelClimate	dbText	1
MinTempQ	Appends to tblSnotelClimate	dbText	1
AvgTemp	Appends to tblSnotelClimate	dbText	255
AvgTempM	Appends to tblSnotelClimate	dbText	1
AvgTempQ	Appends to tblSnotelClimate	dbText	1
TOBS	Appends to tblSnotelClimate	dbDouble	8
TOBSM	Appends to tblSnotelClimate	dbText	1
TOBSQ	Appends to tblSnotelClimate	dbText	1
ODate	Formatted date mm/dd/yy	dbDate	8
SiteID	SNOTEL Station Code	dbText	6

III. Populating Climate Databases

Importing climate data from ASCII files involves the same basic procedures for each climate monitoring program, hereafter referred to as type of climate station. This procedure is illustrated in Fig. 10-2. After archiving all raw downloaded data, RAWS and SNOWNET data are run through customized Fortran programs (see SOPs #13 and #15) to derive 24-hour values. After this step, all Access climate databases open with the form frmImport, which displays a button for importing the ASCII files to a work table. The user then has the opportunity to correct any import errors manually. Once import errors are resolved, the user clicks a button to format and append the work table to the definitive climate data table.

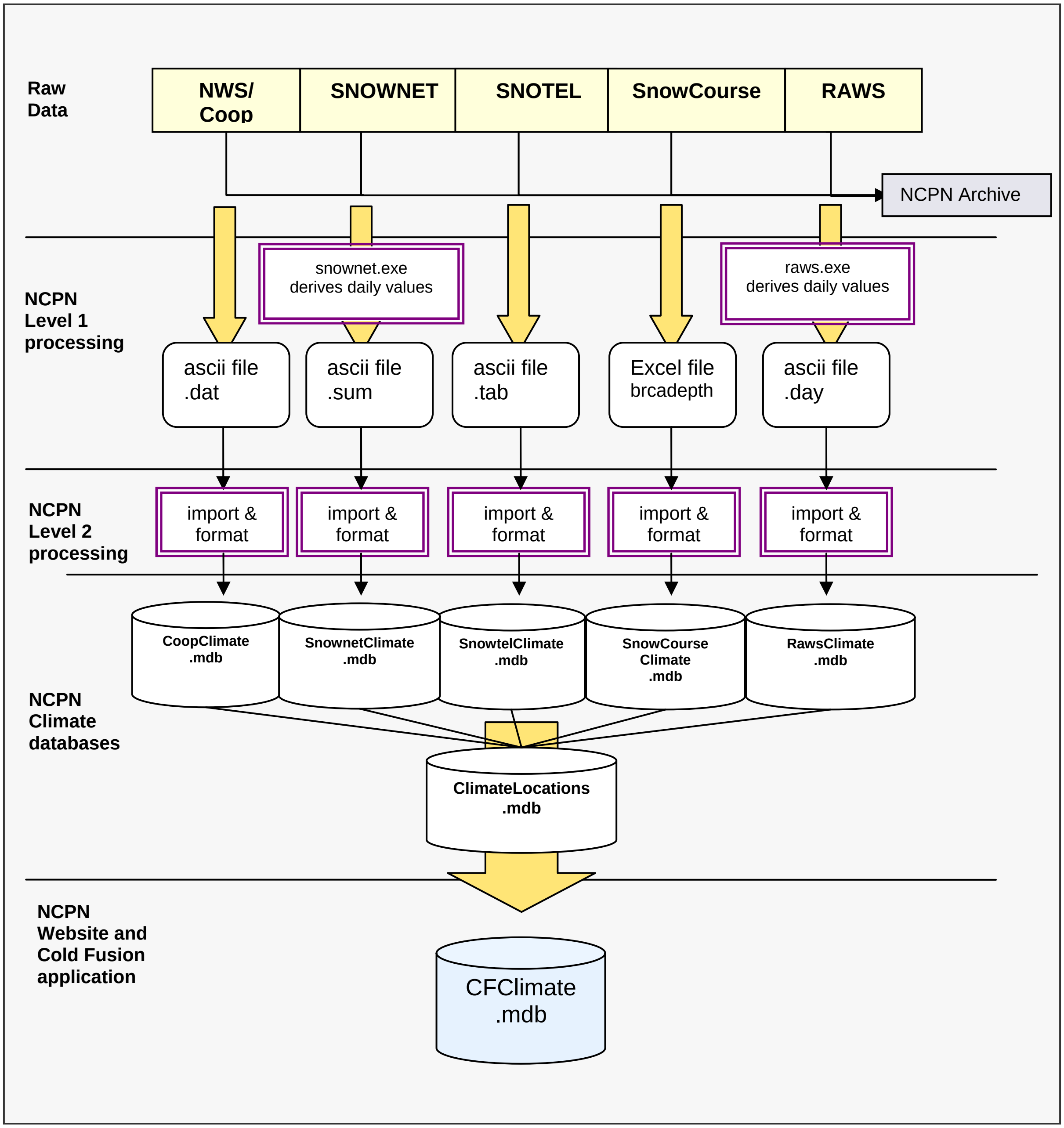


Figure 10-2. Data flow from climate station downloads to final NCPN database format.

ClimateLocation.mdb must be maintained manually by NCPN. As new climate stations are established, new entries into tblStation must be made, along with appropriate new entries into tblStationEquipment. As equipment is changed at climate stations, changes must be made to tblStationEquipment and related InServiceDate and OutServiceDate fields updated. When a new type of equipment is acquired, it must be added to tblEquipment, and if new station types are established, they must be added to tluStationType.

Importing NWS/Coop Climate Data

Import Steps

1. Each Coop ASCII file has 71 lines of metadata preceding the actual observation data. Open the .dat file in a text processor and delete all lines with a : in column 1.
2. Save the edited file. The file can be saved with any desired file extension, the import program will rename it .asc.
3. Open database CoopClimate.mdb.
4. Click on button Import ASCII Data. This button performs these functions:
   - A file directory tree will open from which the file from step 2 can be selected.
   - Coop data is named with a .dat file extension which Access does not recognize, so the file is renamed as .asc.
   - The file is imported using the Access import specification named CoopSpec into a work table named tblImportWork.
   - If there were import errors, a message box will be displayed to notify the user. A listing of the errors can be found in a table named filename_ImportErrors.
5. If there were import errors, they must be corrected before continuing with the table load. The error table will contain the row number, field name, and error, which is usually Type conversion. A time or date value out of range such as a day of 32 can cause this error, as will a non-numeric value. Remember to delete the error table when you are finished with it.
6. After correcting the import errors, or if no errors occurred, click the button Load Climate Table. This button performs these functions:
   - The values for time, day, month, and year for each record are converted into a valid Access date and time format and loaded into the record.
   - The Coop state code and station number are concatenated into a StationID field which loads the LinkStationID foreign key for linking with tblStation.
   - The query qryappClimateData is run which appends the records from tblImportWork into tblCoopClimate.
   - The query qrydelImportWork is run which clears tblImportWork.

Import Details

Clicking on the Import ASCII File button on frmImportCOOPData runs macImportCoop which initiates these steps:

- A browse window is opened to select a Coop .dat ASCII file to import.
- If the file extension on the selected file is not .asc, it is changed to .asc so the import command will recognize it.
- The file is imported into tblImportWork using the import specification COOPSpec.
- Table definitions are checked for an import errors table; if one is found, the message "Import errors - check error table" is displayed.

If the error message is displayed the user must open the Import_Errors table which will display the key of the bad record and an error description. Typical errors include date or time values out of range, required values null, and non-numeric values in numeric fields.

Once all import errors have been corrected, the Load Climate Data button may be clicked, which performs these steps:

- The ohour field in tblImportWork is converted to a standard Access date/time value and stored in OBTime.

- The omonth, oday, and oyear fields in tblImportWork are combined into a standard Access date/time format and stored in OBDate.
- The Coop state code field State and station ID Station are concatenated and saved in LinkStationID which will be the link to SiteID in the linked table tblStation.
- The query qryappClimate is run which is a simple append query to append tblImportWork to tblCOOPClimate.

The query qrydelImportWork is run which deletes all records from tblImportWork.

Importing SNOWNET Climate Data

Import Steps

1. Open database SNOWNETClimate.mdb. This database opens with the data import form.
2. Click on button Import ASCII Data. This button performs these functions:
   - A file directory tree will open with which the desired SNOWNET ASCII file can be selected.
   - SNOWNET data is named with a .sum file extension which Access does not recognize, so the file is renamed as .asc.
   - The file is imported using the Access import specification named SnowImportSpecification into a work table named tblImportWork.
   - The three-character station code is taken from the ASCII file name and loaded on the records in tblImportWork.
   - If there were import errors, a message box will be displayed to notify the user. A listing of the errors can be found in a table named filename_ImportErrors.
3. If there were import errors, they must be corrected before continuing with the table load. The error table will contain the row number, field name, and error, which is usually Type conversion. This can be caused by a null or non-numeric value. A blank record will also cause this error. Remember to delete the error table when you are finished with it.
4. After correcting the import errors, or if no errors occurred, click the button Load Climate Table. This button performs these functions:
   - The values for day month and year for each record are converted into a valid Access date format and loaded into the record.
   - The query qryappSnowData is run which appends the records from tblImportWork into tblSnowNetClimate.
   - The query qrydelImportWork is run which clears tblImportWork.

Import Details

Clicking on the Import ASCII File button on frmImport runs macImportSnowNet which initiates these steps:

- A browse window is opened to select a SnowNet .sum ASCII file to import.
- If the file extension on the selected file is not .asc, it is changed to .asc so the import command will recognize it.
- The file is imported into tblImportWork using the import specification SnowNetImportSpecification.
- The first three characters of the ASCII file name are saved in the StationCode field in tblImportWork to be cross-referenced to a link ID for tblStation.
- Table definitions are checked for an import errors table; if one is found, the message “Import errors - check error table” is displayed.

If the error message is displayed the user must open the Import_Errors table which will display the key of the bad record and an error description. Typical errors include date or time values out of range, required values null, and non-numeric values in numeric fields.

Once all import errors have been corrected, the Load Climate Data button may be clicked, which performs these steps:

- The fields oday, omonth, and oyear in tblImportWork are combined into standard Access date/time format and saved in ODate.
- The query qryappSnowData is run which is a simple append query to append tblImportWork to tblSnowNetClimate.
- The query qrydelImportWork is run which deletes all records from tblImportWork.

Importing SNOTEL Climate Data

<u>Import Steps</u>

1. Open database SnotelClimate.mdb. This database opens with the data import form.
2. Click on button Import ASCII Data. This button performs these functions:
    - A file directory tree will open with which the desired Snotel .tab ASCII file can be selected.
    - The file is imported using the Access import specification named SnotelImportSpecification into a work table named tblImportWork.
    - If there were import errors, a message box will be displayed to notify the user. A listing of the errors can be found in a table named filename_ImportErrors.
3. If there were import errors, they must be corrected before continuing with the table load. The error table will contain the row number, field name, and error. Remember to delete the error table when you are finished with it.
4. After correcting the import errors, or if no errors occurred, click the button Load Climate Table. This button performs these functions:
    - The values for day month and year for each record are converted into a valid Access date format and loaded into the record.
    - At this time, there is only one SNOTEL station downloading data, so the SiteID foreign key is set to 12m26S.
    - The query qryappSnotelData is run which appends the records from tblImportWork into tblSnotelClimate.
    - The query qrydelImportWork is run which clears tblImportWork.

<u>Import Details</u>

Clicking on the Import ASCII File button on frmImport runs macImportSnotel which initiates these steps:

- A browse window is opened to select a Snotel .tab ASCII file to import.
- If the file extension on the selected file is not .tab, it is changed to .tab so the import command will recognize it.
- The file is imported into tblImportWork using the import specification SnotelImportSpecification.
- Table definitions are checked for an import errors table; if one is found, the message “Import errors - check error table” is displayed.

If the error message is displayed the user must open the Import_Errors table which will display the key of the bad record and an error description. Typical errors include date or time values out of range, required values null, and non-numeric values in numeric fields.

Once all import errors have been corrected, the Load Climate Data button may be clicked, which performs these steps:

- The field SnotelDate in tblImportWork is converted into standard Access date/time format and saved in ODate
- The field SiteID is set to 12m26S.
- The query qryappSnowData is run which is a simple append query to append tblImportWork to tblSnotelClimate.
- The query qrydelImportWork is run which deletes all records from tblImportWork.

Importing SnowCourse Data

Import Steps

Importing SnowCourse data is largely a manual process. The spreadsheet file brcadepth.xls is exported to a text file – snowcourse.txt. Snowcourse.txt is edited manually to remove plain text and blank lines leaving only lines with measurement data. Snowcourse.txt is then imported into the table snowcourse in SnowCourseClimate.mdb. The table snowcourse is edited manually for dates with a value of "E/ST" which are replaced with estimated dates.

At this point, the table snowcourse consists of records each containing the observations for one year. Each year contains from one to six combinations of date(m/dd), snow depth, and snow water equivalent observations. Months of October, November, and December are represented by the letters "O", "J", and "K" respectively. The macro "macParseData" will parse out the date/snow depth/snow water equivalent fields into individual data records in tblImportWork.

The query "qryappSnowCourse" is then run which will append tblImportWork to tblSnowCourseClimate.

Importing RAWS Data

Import Steps

1. Open database RAWSClimate.mdb. This database opens with the data import form.
2. Click on button Import ASCII Data. This button performs these functions:
    - A file directory tree will open with which the desired RAWS ASCII file can be selected.
    - RAWS data is named with a .day file extension which Access does not recognize, so the file is renamed as .asc.
    - The file is imported using the Access import specification named RAWSImport into the work table named tblImportWork.
    - The four-character station code is taken from the ASCII file name and loaded on the records in tblImportWork.

- If there were import errors, a message box will be displayed to notify the user. A listing of the errors can be found in a table named filename_ImportErrors.

3. If there were import errors, they must be corrected before continuing with the table load. The error table will contain the row number, field name, and error, which is usually Type conversion. This can be caused by a null value which can be replaced by -9999, which is the RAWS missing value indicator. A date value out of range such as a day of 32 will also cause this error, as will a non-numeric value. Remember to delete the error table when you are finished with it.
4. After correcting the import errors, or if no errors occurred, click the button Load Climate Table. This button performs these functions:
   - The values for day month and year for each record are converted into a valid Access date format and loaded into the record.
   - The query qryappRAWSData is run which appends the records from tblImportWork into tblRAWSClimate.
   - The query qrydelImportWork is run which clears tblImportWork.
   - The query qryupdLinkStationID is run which looks up the station code in tluStationID and updates the foreign key field LinkStationID for reference to tblStation.

<u>Import details</u>

Clicking on the Import ASCII File button on frmImport runs macImportRAWS which initiates these steps:

- A browse window is opened to select a RAWS .day ASCII file to import.
- If the file extension on the selected file is not .asc, it is changed to .asc so the import command will recognize it.
- The file is imported into tblImportWork using the import specification RawsImport.
- The first four characters of the ASCII file name are saved in the StationCode field in tblImportWork to be cross-referenced to a link ID for tblStation.
- Table definitions are checked for an import errors table; if one is found, the message “Import errors - check error table” is displayed.

If the error message is displayed the user must open the Import_Errors table which will display the key of the bad record and an error description. Typical errors include date or time values out of range, required values null, and non-numeric values in numeric fields.

Once all import errors have been corrected, the Load Climate Data button may be clicked, which performs these steps:

- The fields ODay, OMonth, and OYear in tblImportWork are combined into standard Access date/time format and saved in ODate.
- The query qryappClimate is run which is a simple append query to append tblImportWork to tblRAWSClimate.
- The query qrydelImportWork is run which deletes all records from tblImportWork.

The query qryupdLinkStationID is run which updates the LinkStationID field in tblImportWork with LinkStationID from tluStationName using StationCode as the Inner Join field.

IV. Data Verification and Validation

Domain checks and data validation routines are performed in the RAWS and SNOWNET programs run by NCPN that produce daily summaries. SNOTEL data are summarized from the web. By the time data from these three types of stations reach the Access data import step, they have been validated for out-of-range values. The most common problem is missing data, which is indicated by a value of -9999.

Inherent in the process of converting text data to Access a check for valid date and time values, which will cause a type conversion error in Access, and non-numeric data in fields required to be numeric, which will also cause type conversion errors. These errors are corrected by the operator by supplying date and time values within valid ranges and entering a value of -9999 where a non-numeric character is found. Occasionally, a “t” for trace is indicated as a precipitation measurement flag; in these instances, precipitation is set to 0.

Each measurement in NWS-Coop weather station data is accompanied by a Measurement Flag and a Data-quality Flag. These flags are documented in Tables 10-1,2. Similarly, each measurement in the SNOTEL data is accompanied by a Measurement and a Data Quality flag. These are documented in Tables 10-3,4. Both sets of measurement and data-quality flags are imported to the Access databases.

Table 10-1. NWS-Coop data measurement flags.

Flag	Description
A	Accumulated amount
B	Accumulated amount includes estimated values
E	Estimated (see data quality flag for method of estimation)
J	Value has been manually validated
M	Data is missing
S	Included in a subsequent value
T	Trace (data = 00000 in this case)
(	Expert system edited value, not validated
)	Expert system approved edited value
>	OSC flag; original data value too high to store
<	OSC flag; original NCDC data value too low to store

Table 10-2. NWS-Coop data-quality flags.

Flag	Description
0	Valid data element (for original data only)
1	Valid data element (for “unknown” source)
2	Invalid data element, replaced by subsequent value
3	Invalid data element, not replaced
4	Validity unknown (not checked)
5	Original non-numeric replaced by deciphered numeric

Table 10-2. cont.

Flag	Description
A	Substituted TOBS(temperature at time of observation) for TMAX or TMIN
B	Time shifted value
C	Estimated by 10:1 ratio, precipitation from snowfall
D	Transposed digits
F	Adjusted TMAX or TMIN by +- a multiple of 10 degrees
G	Changed sign
H	Moved decimal point
I	Other rescaling than F, G, H
J	Educated guess (subjectively derived value)
K	Extracted from an accumulated value
L	Switched TMAX and TMIN
M	Switched TOBS for TMAX or TMIN
N	Substitution of “3 nearest station mean”
O	Switched snow and precipitation amount
P	Added snowfall to snowdepth
Q	Switched snowfall and snow on ground
R	Precipitation not reported – zero estimated
S	Manually edited value
T	Failed internal consistency check
U	Failed areal consistency check (beginning Oct 1992)
)	Expert system approved edited value

Table 10-3. SNOTEL data measurement flags.

Flag	Description
A	Accumulated value since last measurement
E	Estimated (see data quality flag for method of estimation)
M	Missing
S	Included in a subsequent value
T	Trace

Table 10-4. SNOTEL data-quality flags.

Flag	Description
0	Original data element
1	Validated original data element, inspected by QC process
2	Invalid data element, replaced by subsequent value
3	Invalid data element, not replaced
4	Validity not known
5	Edited to missing value, replacement for invalid non-missing value
F	Field edits from Data Collection Officers
R	Provisional realtime data through NWS Gateway (LDM ingestion)
P	Provisional realtime data direct from NRCS
V	Provisional data, NRCS evaluation – bad data
A	Made extreme max/min compatible with previous day
B	Absolute bounds exceeded
F	Flat-liner, constant for 6 days or longer
L	Switched TMAX and TMIN
N	Revised based on nearest neighbors, aeral comparisons
Q	Provisional data, quality is suspect according to NRCS real-time QC
S	General manual edit for whatever reason
T	Other automated edit
U	Unknown NRCS flag
W	WRCC edit not covered by other flags
X	Original missing replaced by areal estimate

V. Version Control

Version control is the process of managing copies of changing files over the course of a project. Change includes any alteration to the structure or content of the files, which should not be made without the ability to fully recover a data set as it existed before changes were made. Before making any major changes to a file, a copy of the file is saved with a unique version number. Naming conventions and directory structures related to version control are detailed in the Data Archiving section, below.

VI. Data Archiving

Raw Data

All data sets that are downloaded from web-based sources will be archived in their native format before any data manipulation. These data sets will be stored on the NCPN server:
X:\ Archive\Monitoring_Archive\Climate\Raw_Data\NWSCoop
\ Snownet
\ Snowtel
\ SnowCourse
\ RAWS
File names will consist of the data source name, the station acronym, and the download date. Example:
NWSCoopARCH_10Feb2004.ext
SnownetTICA_25Nov2005.ext
where .ext is the extension of the native format.

Working Backup Files

Access databases containing processed data are backed up before new data sets are appended. These backups are maintained until the next append cycle, at which time they are replaced by new backups. Working backup files are stored on the NCPN server:
X:\Vital_Signs\Climate\Data\Working_Backup

File names of working backup files will consist of the database name and date. Example:
SnotelClimate_10Oct2004.mdb
ClimateLocations_27Feb2005.mdb

Archives

Long-term archive files are created before any database version upgrade occurs. These data sets will be stored on the NCPN server in their native Access format:
X:\Archive\Monitoring_Archive\Climate\Version_Archive

A subdirectory will be created for each database and version number. File names of archive files will contain the database name, the database version number (available from login screen), and the word Archive. Example:
SnotelClimate\Version_1-00\SnotelClimate_1-00_archive.mdb
CoopClimate\Version_1-20\CoopClimate_1-20_archive.mdb

In addition to the copy of the database in Access format, all tables will be archived in a comma-delimited ASCII format by using the Access_to_ascii.mdb utility developed by NCPN. These ASCII files will reside in the same version archive subdirectory as their associated Access database. File names consist of the table name and a .txt extension. Example:
SnotelClimate\Version_1-00\YPrecipQ.txt
SnotelClimate\Version_1-00\SDEP.txt

VII. Metadata

Each table and field in all Access databases will be defined and documented. NCPN will complete and keep up-to-date a Dataset Catalog record for each database. Any GIS data resulting from the project that are distributed or used for analysis will have an associated FGDC-compliant metadata record completed.

The complete protocol for this project (Protocol Narrative and SOP #s 1-17) is an integral component of the project metadata. All narrative and SOP version changes are noted in a Master Version Table (MVT), which is maintained in SOP #17. Any time the narrative or an SOP version change occurs, a new Version Key number (VK#) must be created and recorded in the MVT, along with the date of the change and the versions of the narrative and SOPs in effect. The Version Key number is essential for project information to be properly interpreted and analyzed. *The protocol narrative, SOPs, and data should not be distributed independently of this table.*

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #11

Downloading NWS-Coop Climate Data

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for acquiring National Weather Service (NWS) Cooperative Observing Program (Coop) climate station data from the Western Regional Climate Center (WRCC). Data are inserted into the Northern Colorado Plateau Network (NCPN) climate database using procedures described in SOP #10.

I. Downloading NWS-Coop Data

There are 17 NWS-Coop stations in the NCPN (see Appendix A of the NCPN Climate Monitoring Protocol Narrative). Data from these stations and from the other climate networks will be used to generate annual climate summaries, to identify climatic extremes, and to aid in the analysis and interpretation of trends in other monitored vital signs. Historical data from these stations are maintained on the NCPN server to facilitate their access and use in a wide range of management and research activities in the NCPN. Data for the current year need to be added to the NCPN databases at least annually. However, updates can occur as often as necessary to meet specific needs. The WRCC is the official repository for NWS-Coop data, and has provided the NCPN access to daily measures for Coop stations on National Park Service lands.

Procedures:

1. Send an email to wrcc@dri.edu with a list of the NWS-Coop stations and the desired dates. Station names and IDs are listed in Appendix A of the NCPN Climate Monitoring Protocol Narrative. WRCC will generate ASCII files for the requested stations and time periods, store the files on an anonymous ftp site, and contact you with the location of the files. Use standard ftp protocols to download the ASCII data.

2. Downloaded data are stored in *X:\Archive\Monitoring_Archive\Climate\Raw_Data\NWSCoop.* File names will consist of the data source name, the station acronym, and the download date; e.g., NWSCOOP*BRCAFeb2004.txt.* Data are added to the NCPN climate database using procedures described in SOP #10.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #12

Downloading SNOTEL Climate Data

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for downloading SNOTEL climate data from the Western Regional Climate Center (WRCC) web page. Data are inserted into the Northern Colorado Plateau Network (NCPN) climate database using procedures described in SOP #10.

I. Downloading SNOTEL Data

The single SNOTEL climate station in the NCPN is located in Bryce Canyon National Park (see Appendix D of the NCPN Climate Monitoring Protocol Narrative). Data from this station and from the other climate networks will be used to generate annual climate summaries, to identify climatic extremes, and to aid in the analysis and interpretation of trends in other monitored vital signs. Historical data from this station are maintained on the NCPN server to facilitate their access and use in a wide-range of management and research activities in the NCPN. Data for the current year need to be added to the NCPN databases at least annually. However, updates can occur as often as necessary to meet specific needs. Data are easily extracted from the WRCC web page.

Procedures:

1. Access the following WRCC web page:
   http://www.wrcc.dri.edu/snotel/snoutah.html

2. A map of SNOTEL stations in UT will appear. Place the cursor over the Agua Canyon Snotel site and left-click.

3. The following will be displayed on the screen. Select the desired start and end dates, and select all other options as shown in this display.

Snotel Graph

Available data: Period of Record.
Hourly Data Type only available when selecting less than a 30 day interval.
No Hourly Data Type available before Oct. 1 1996.
Select the station:

UTAH, AGUA CANYON

Start Date (YYYYMMDD): 1994100 End Date (YYYYMMDD): 20040923

Data Type: (•) Daily ( ) Hourly

Image Size: (•) Small (510x290) ( ) Medium (650x370) ( ) Large (850x480) ( ) ExtraLarge (1100x625) ( ) Giant (1400x800)

Select Elements to Plot: [✓] Precipitation [✓] Snow Water Content [✓] Temperature

POR Averages to Plot: [✓] Precipitation [✓] Snow Water Content [✓] Max. Temperature [✓] Min. Temperature

Create Graph

Scaling

[✓] Automatically Set Scales

Precipitation Min.: 0 Max.: 50

Snow Water Content offset: 0 This amount will be added to the Snow Water Content, then plotted on the Precipitation scale.

Temperature Min.: -20 Max.: 80

Data

[✓] Display Data Table

4. A graph and data table will be displayed. Scroll down below the graph to where the daily measures are displayed. Daily measures begin below the column-header line (e.g., the line beginning with 4200011996100124 in the display immediate below is the first row of data).

```
:wrccNo YrMoDyHr  PrecFF SDepFF  SWEff TmaxFF TminFF TaveFF TobsFF
:----====-==-- =====-======-======--=====--=====-======-======--
4200011996100124     0 0    0M     0 0   67 1   43 1   54 1    0M
4200011996100224    50 0    0M     0 0   49 1   34 1   40 1    0M
4200011996100324    50 0    0M     0 0   52 1   37 1   42 1    0M
```

5. To copy the data from the screen, depress the left mouse button and highlight the desired data. Then while holding down the CTRL button on your key board, depress the “C” key. This will copy the highlighted data to the clip board. On your local computer, open a new Excel file and copy the data into the sheet by depressing CTRL key and the “V” key at the same time. Save the data as a Text (MS-DOS)(*.txt) file in *X:\Archive\Monitoring_Archive\Climate\Raw_Data\SNOTEL*. File names will consist of the data source name, the station acronym, and the download date; e.g., SNOTELAGUA*Feb2004.txt.* Data are inserted into the NCPN climate database using procedures described in SOP #10.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #13

Downloading and Processing RAWS Climate Data

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for: 1) downloading RAWS (Remote Automated Weather Station) climate station data from the Western Regional Climate Center (WRCC) web page; and 2) summarizing hourly data to daily values. Summarized data are inserted into the Northern Colorado Plateau Network (NCPN) climate database using procedures described in SOP #10.

I. Downloading RAWS Data

There are six RAWS stations in the NCPN (Appendix C of the NCPN Climate Monitoring Protocol Narrative). 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. Historical data from these stations are maintained on the NCPN server to facilitate access and use in a wide range of management and research activities. Data for the current year need to be added to the NCPN databases at least annually. However, updates can occur as often as necessary to meet specific needs. The WRCC is the official repository for RAWS data, and has provided the NCPN with access to hourly RAWS data. Data are downloaded with the following procedures.

Procedures:

1. Access the following WRCC Web page:

   http://www.wrcc.dri.edu/wraws/

2. A map of the US will appear on the screen**.** Left-click inside the state of UT (to access the RAWS data for stations in BRCA, ZION) or CO (to access the RAWS data for

stations in DINO, BLCA). A map of RAWS stations within the selected state will appear along with an alphabetic list of RAWS sites which is displayed on the left-hand side (LHS) of the screen (Fig. 13-1).

RAWS sites
Aqua Canyon - Bryce Canyon NP.
Aragonite
Assay - Hatch 10SW
Badger Spring - Ivins 14W
Barney Reservoir - Escalante 15SE
Bear River Utah
....

Figure 13-1. Alphabetical list of RAWS sites displayed on the WRCC Web page.

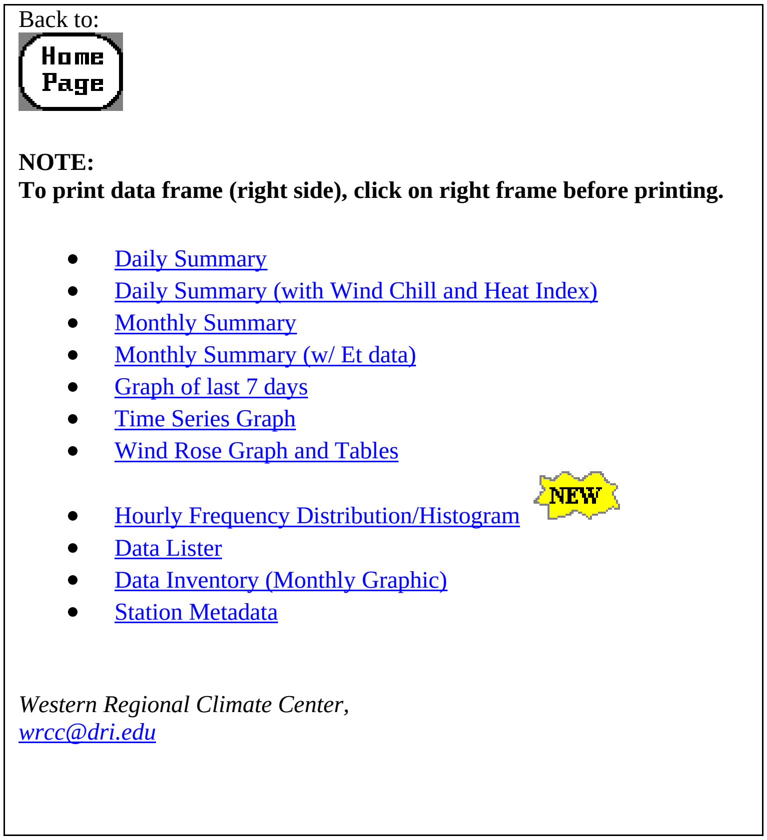
3. Click on the desired station in the alphabetized list. This will result in displaying the Data Availability list (Fig. 13-2) on the right-hand side (RHS), and the Station Retrieval Options on the LHS (Fig. 13-3) of the screen.

Aqua Canyon - Bryce Canyon NP.

BOLD, Red indicates some data available for month and year.

2004	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	Oct	Nov	Dec
2003	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2002	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2001	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2000	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1999	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1998	Jan	Feb	Mar	Apr	May	Jun	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1997	Jan	Feb	Mar	Apr	May	Jun	**Jul**	Aug	Sep	Oct	Nov	Dec
1996	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1995	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1994	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1993	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1992	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	Sep	**Oct**	**Nov**	**Dec**
1991	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1990	Jan	Feb	Mar	Apr	May	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**

Figure 13-2. Data Availability list.


Back to:

Home Page

NOTE:
To print data frame (right side), click on right frame before printing.

- Daily Summary
- Daily Summary (with Wind Chill and Heat Index)
- Monthly Summary
- Monthly Summary (w/ Et data)
- Graph of last 7 days
- Time Series Graph
- Wind Rose Graph and Tables
- Hourly Frequency Distribution/Histogram NEW
- Data Lister
- Data Inventory (Monthly Graphic)
- Station Metadata

Western Regional Climate Center,
wrcc@dri.edu

Figure 13-3. Station Retrieval Options.

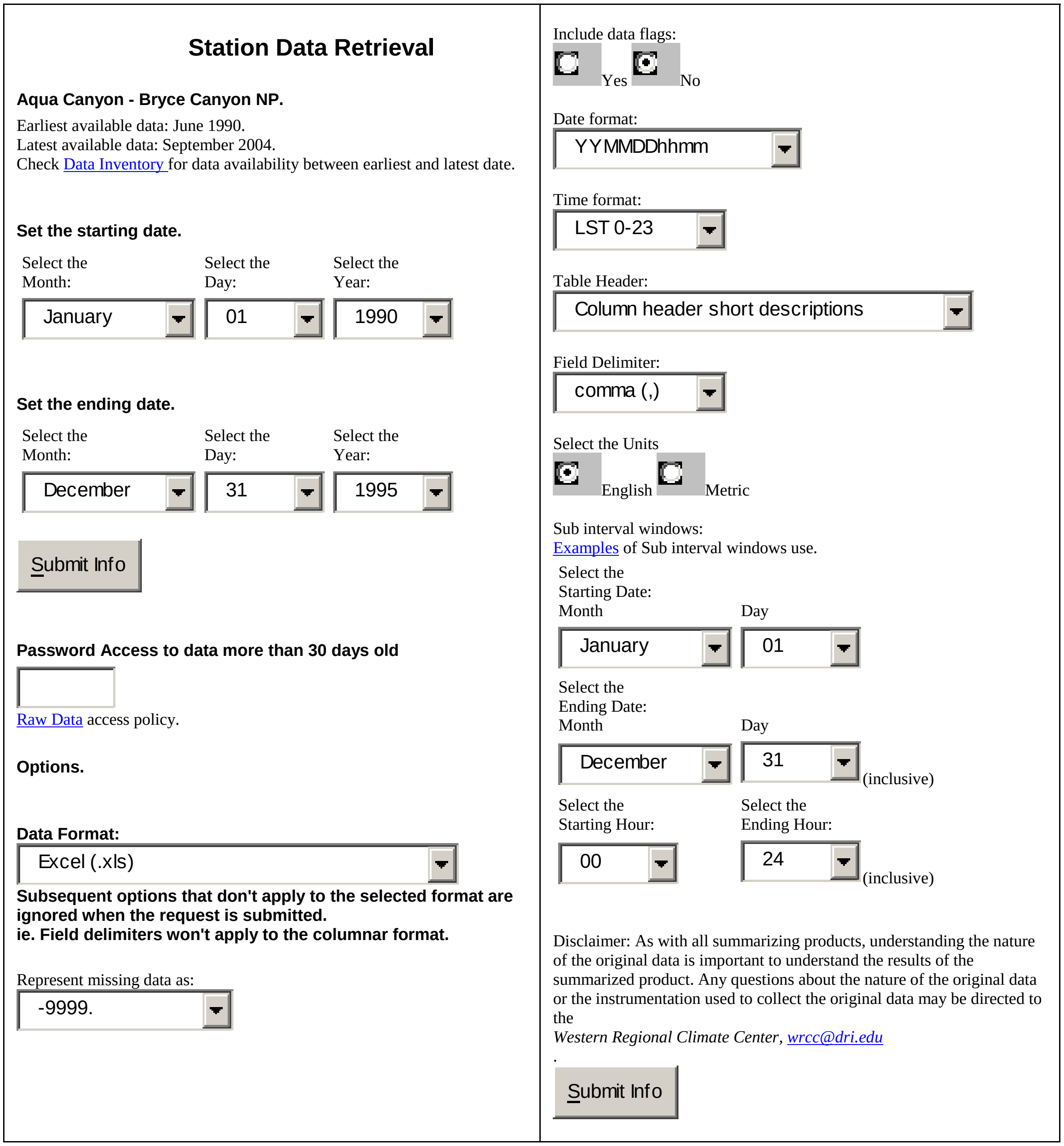
4. Click on “Data Lister” in the Station Retrieval Options list. The Station Data Retrieval window (Fig. 13-4) will appear.

5. In the Station Data Retrieval display, set the desired starting and ending date. Under Options, set all options to those displayed in Fig. 13-4. This will result in downloading an Excel format of the hourly data that is commensurate with an existing, customized analysis package (explained below).

6. Under the *“Password Access to data more than 30 days old”*, you must enter the password provided to the NCPN by WRCC. This password is stored on a secure computer drive at NCPN headquarters in Moab, UT. Contact the NCPN Ecologist, Data Manager, or Administrative Assistant for the password.

7. After completing all required fields, click on Submit Info above the Password Access box. Processing time will vary with the amount of requested data, but eventually you will be queued to Open or to Save the Excel file. Always elect to Save the file. After selecting Save, a standard Windows *Save As* dialogue box will appear. Enter a valid local directory and a file name to save the Excel file. These data are stored, however, as ASCII files. In Excel, save each downloaded file in Text (MS-DOS)(*.txt) format and

store the ASCII files in *X:\Archive\Monitoring_Archive\Climate\Raw_Data\RAWS.* File names will consist of the data source name, the station acronym, and the download date; e.g., R*AWSBLCAFeb2004.txt.* A readme file resides in this directory that describes the native format of these data. Data must be processed before being added to the climate database (see II. below).



Station Data Retrieval

Aqua Canyon - Bryce Canyon NP.

Earliest available data: June 1990.
Latest available data: September 2004.
Check Data Inventory for data availability between earliest and latest date.

Set the starting date.

Select the Month: January | Select the Day: 01 | Select the Year: 1990

Set the ending date.

Select the Month: December | Select the Day: 31 | Select the Year: 1995

Submit Info

Password Access to data more than 30 days old

Raw Data access policy.

Options.

Data Format:
Excel (.xls)

Subsequent options that don't apply to the selected format are ignored when the request is submitted.
ie. Field delimiters won't apply to the columnar format.

Represent missing data as:
-9999.

Include data flags:
Yes No

Date format:
YYMMDDhhmm

Time format:
LST 0-23

Table Header:
Column header short descriptions

Field Delimiter:
comma (,)

Select the Units
English Metric

Sub interval windows:
Examples of Sub interval windows use.

Select the Starting Date:
Month: January Day: 01

Select the Ending Date:
Month: December Day: 31 (inclusive)

Select the Starting Hour: 00
Select the Ending Hour: 24 (inclusive)

Disclaimer: As with all summarizing products, understanding the nature of the original data is important to understand the results of the summarized product. Any questions about the nature of the original data or the instrumentation used to collect the original data may be directed to the
Western Regional Climate Center, *wrcc@dri.edu*
.

Submit Info

Figure 13-4. The Station Data Retrieval display.

Summarizing RAWS Data

The raw data in the downloaded Excel file will contain 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 among years. Although the hourly data are of value, daily values of climate elements are easier to work with, and are generally more useful when assessing the interplay between climate and trends in ecosystem patterns and processes. Also, given the potential for multiple headers within a data file, there is a need to process the WRCC data files into a form that can be more easily stored and managed. A customized program is used to automatically convert the WRCC format to a standardized list of climate elements, and to summarize hourly data to daily values. The data downloaded from the WRCC web page must be processed by this program before being added to the historical archive.

RAWS data from WRCC are processed using the program RAWS.exe . The source code and executable are stored on the NCPN I&M server at *X:\Archive\Monitoring_Archive\Climate\Raw_Data\RAWS*. A copy of the source code is included here as Attachment A. The first 16 elements listed in Table 13-1 typically are included in a WRCC RAWS data set. However, the numbers and types of elements can vary within and among stations over time, depending on instrumentation failure. Also, one of the NCPN RAWS stations (BLCA) currently does not report fuel moisture. Data for snow depth and additional rain gauges (noted as #2 rain gauge in Table 13-1) tend to be very limited, in both amount and quality. These attributes currently are not included in the daily summary. Battery voltage also is not carried over into the daily summaries.

Table 13-1. Climate elements (units) in the WRCC RAWS data set.

1. Year (YY)	10. Fuel Temperature (F)
2. Month (MM)	11. Relative humidity (F)
3. Day (DD)	12. Battery Voltage (volts)
4. Hour (HH) LST	13. Average fuel moisture (%)
5. Minute (mm) LST	14. Maximum wind gust – direction (degrees)
6. Accumulated precipitation (in)	15. Maximum wind gust – speed (mph)
7. Wind speed (mph)	16. Solar radiation (^{o}ly)
8. Wind direction (degrees)	17. Accumulated snow depth (in)
9. Average air temperature (F)	18. Accumulated precipitation from #2 rain gauge (in)

Domain checks employed in the program are derived from standards published by MesoWest (www.met.utah.edu/cgi-bin/database/variable_select.cgi - 9/16/04), with modification to accommodate higher, valid wind-gust speeds (Table 13-2). Only processed elements are subject to domain checks. Additionally, a value of -9999 is interpreted as missing. Values failing a domain check are considered invalid, and eliminated from the daily summary.

Table 13-2. Valid ranges for RAWS climate measures.

Climate element (units)	Valid Range (lower, upper values are inclusive)
Year (YY)	User specified
Month (MM)	1-12
Day (DD)	1-31
Hour (HH) LST	0-24
Minute (mm) LST	0-59
Accumulated precipitation (in)	0-2/hr [>6/day is flagged as suspect]
Wind speed (mph)	0 -180
Wind direction (degrees)	0-360
Average air temperature (F)	-75 - +140
Fuel Temperature (F)	0 – 150
Relative humidity (F)	0 – 100
Average fuel moisture (%)	0 – 100
Maximum wind gust – direction (degrees)	0 – 360
Maximum wind gust – speed (mph)	0 – 180
Solar radiation (^{o}ly)	0 – 100

Climate elements and measures output by RAWS.EXE are shown in Table 13-3. Most daily measures are presented as a minimum, maximum, and average. Additionally, the percentage of valid records for a day is reported for each element. Elements with missing or no valid observations are always included in the output, but measures are assigned a value of -9999.

Table 13-3. Attributes output by RAWS.EXE.

Climate element (units)	Daily (24-hr) Measures
Year (YY)	-
Month (MM)	-
Day (DD)	-
Precipitation (in)	min, max, average, % of valid records
Air temperature (F)	min, max, average, % of valid records
Rel. humidity (%)	min, max, average, % of valid records
Fuel temperature (F)	min, max, average, % of valid records
Fuel moisture (%)	min, max, average, % of valid records
Wind speed (mph)	min, max, average, % of valid records
Wind direction (degrees)	average [vector average], % of valid records
Solar radiation (ly)	total, % of valid records
Max. wind gust	Speed (mph) and direction (deg) of the highest maximum wind gust, % of records with valid measures for both max. wind gust speed & direction

Procedures:

1. Open the Excel file created in Step I above for the data set to be processed. Save the file as a Text (MS-DOS) (*.txt) file.

2. Use the program called RAWS.EXE to convert hourly data to standardized, daily summaries. This program resides in the *X:\Archive\Monitoring_Archive\Climate\Raw_Data\RAWS* directory on the NCPN I&M server. To execute the program, right-click on the Start button in the tool bar of your computer, then left-click on the Open menu item. Navigate to the *X:\Archive\Monitoring_Archive\Climate\Raw_Data\RAWS* directory and double left-click on RAWS.EXE. The program queues for the name of the .csv file you created in #1 and the name of the file to store the output. The program automatically interprets parameter headers in a file. The program converts hourly measures to daily values, and outputs daily measures for nine elements in a standard format (Table 13-3). In addition, the percentage of valid, hourly records for each climate parameter is reported as a means to assess the underlying sample size, and thus, the credibility of the daily summaries. The output from the RAWS.EXE program is added to the NCPN climate database using procedures described in SOP #10.

Attachment A - RAWS.f source code

```
      program raws

c ****************************************************************************************
c  Summarizes hourly RAWS data to daily values
c  Developed for:  NPS Northern Colorado Plateau Inventory and Monitoring Program (NCPN I&M)
c  Source and executable reside on NCPN I&M server: x:\Archive\Monitoring_Archive\Climate\Raw_Data\RAWS

c  Version 1.0 -   12/15/04
c
c  Modifications:
c
c
c
c ****************************************************************************************


c ********************************************************************************
c  Global Variables:
c
c   store(x,y); x - climatic parameter
c               1 - precipitation
c               2 - wind speed
c               3 - wind direction
c               4 - air temperature
c               5 - fuel temperature
c               6 - relative humidity
c               8 - fuel moisture
c               9 - max. gust direction
c               10 - max. gust speed
c               11 - solar radiation
c               20 - running tally of vector-related attributes for
c                    wind direction for direction >90 to <270 degrees
c
c             y - 1 - No. of values for a 24-hr period
c               2 - Minimum value
c               3 - Maximum value
c               4 - Sum of values

c   col(x) - names of climatic parameters
c             x - 1   Cumulative precip (in)
c               2   Wind speed (mph)
c               3   Wind direction (degrees)
c               4   Average air temp (F)
c               5   Fuel temp (F)
c               6   Rel. humidity (%)
c               7   Battery voltage (volts)
c               8   Average fuel moisture (%)
c               9   Max gust direction (degrees)
c               10  Max gust speed (mph)
c               11  Solar radiation (ly)



c  SubRoutines:
c    Init - Initializes local storage
c    Initc - Initializes array col(), climatic parameter names
c    Interogate - Determines the climatic parameters in the input file
c    Output - Outputs daily summaries
c    Triangle - Derives the rise and run of a right triangle
```

```
c   Winddir - Derives vector average for wind direction

c  Functions:
c   Valid - Validates domain of climatic parameters

c  Input File Format:
c   variable no. of climatic parameters

c  Output File Format:
c   year
c   month
c   day
c   24-hr precip (in),%valid precip records;
c   24-hr min, max, average air temp (F) & % valid records;
c   24-hr min, max, average fuel temp (F) & % valid records;
c   24-hr min, max, average rel. humidity (%) & % valid records;
c   24-hr min, max, average fuel moisture (%) & % valid records;
c   24-hr total solar radiation (ly) & % valid records;
c   24-hr min, max, average wind speed (mph) & % of valid records;
c   24-hr average wind direction (degrees) & % of valid windspeed and direction records
c    used to derive this average;
c   24-hr speed (mph) and direction (degrees) of the maximum wind-gust speed



c  Processing steps:

c  1) Determine if a parameter-header statement exists.  If so, determine relationships
c  between column order and climatic parameter, and store parameter order.

c  2) Store parameters for each 24-hr period, recording the number of valid records
c  in the period

c  3) When data for the next day or a new parameter-header statement is read, derive min,
c  max, mean values for parameters, determine the % of valid records in the 24-hr period,
c  derive vector average of wind direction, output daily summary, initialize
c  local arrays, continue processing.

c  The domain of all parameter values are validated according to MESOWEST
c  guidelines.  These are listed in subroutine Valid.
c ********************************************************************************

      common/dat/store(20,20)
      common/datac/col(20)
      dimension array(100)
      integer order(20)
      integer year,month,day,hour
      integer oyr,omo,oday
      character fi*60,fo*60,col*30,alpha*100


      print*,'Version# 1.0 - 11/03/04'
      print*,'This program summarizes hourly RAWS data to daily values'
      print*,' '

      print*,'Enter name of RAWS data file'
      print*,' '
      read*,fi

      print*,'Enter name of output file'
      print*,' '
      read*,fo
```

```
      open(10,file=fi)
      open(11,file=fo)


c  init col()
      call Initc


c ************************************************************
c  Subroutine Interogate determines input parameter list.

502    call Interogate(icol,order)

      print*,'Parameters on input file:'
      do 1 i=1,icol
        print*,col(order(i))
1     continue
      print*,' '

c ************************************************************


c ************************************************************
c  flag1 = 0 if reading the first record; used to set precip variable
      flag1=0

c ohr initialized to -1.  Records first value, and used
c     to determine reporting interval.  The reporting interval
c     is divided into 24 hrs to determine the max. number
c     of valid records per day.  This value, in turn, is
c     used to determine the proportion of valid records
c     used to derive a daily value.

      ohr=-1

c  init variables that store previous year time stamp
      oyr=-1
      omo=0
      oday=0

c  init precip base value
      basep =0

c  init storage
      call Init
c ************************************************************


c ************************************************************
c   read past header
10    read(10,*)alpha
      if(alpha(1:1).eq.'Y' .or. alpha(2:2).eq.'Y')goto 11
      goto 10
11    continue
c ************************************************************



c ************************************************************
```

```
c ************************************************************
20    read(10,*,end=999)alpha

c  The following looks for headers within a file.
c  If ":" is detected, then there is a new data format, and
c  the following occurs: 1) output currently stored data,
c  2) re-init array order(), 3) then return to above call to Interogate().

      if(alpha(1:1).eq.":") then
102      format(a100)
        call output(oyr,omo,oday,time)
        do 21 i=1,20
           order(i)=0
21       continue
        print*,'There is another data format in this file'
        goto 502
      endif
      backspace(10)
c ************************************************************



c ************************************************************
      read(10,101,end=999)year,month,day,hour
101   format(i2,i2,i2,i4)
      backspace(10)
      read(10,*,end=999)alpha,(array(k),k=1,icol)


      if(ohr.eq.-1) then
         ohr=hour
      else if(ohr.ge.0) then
         if(hour.eq.0)hour=2400
         time = abs(hour-ohr)
         if(time.gt.60)time=60*(time/100)
         time=(24.0*60.)/time
         print*,'Number of reporting intervals/24hr = ',time
         ohr=-2
         pause
      endif
      if(oyr.eq.-1) then
         oyr=year
         omo=month
         oday=day
      endif

c  if new day, month, or year, then output stored info, re-init, continue processing
      if(oyr.ne.year .or. omo.ne.month.or.oday.ne.day) then
         call Output(oyr,omo,oday,time)


         oyr=year
         omo=month
         oday=day
         call Init
      endif

c  Init speed and direction - both are required for vector averaging.
c  At the end of the do 30 loop, speed and direction are validated,
c  then the rise and run are derived and stored.

      speed=-1
```

```
      direction=-1

      gspeed=-1
      gdire=-1
c ***********************************************************



c ***********************************************************
c  process each climate element

      do 30 i=1,icol


c *************** if battery voltage, JP to next element
        if(order(i).eq.7) goto 30


c  validate value - skip over precip; validation performed below
c                 on the precip amount.  Precip value here
c                 is accumulated precip amount.
        if(order(i).ne.1)then
          if(Valid(order(i),array(i)).eq.0) goto 30
        endif


c **************** precip
        if(order(i).eq.1) then

         if(array(i).eq.-9999) goto 30

         store(1,1)=store(1,1)+1
         if(flag1.eq.0)then
           basep=array(i)
         else
          if(array(i).lt.basep) then
            basep=array(i)
          else
            store(1,2)=store(1,2)+(array(i)-basep)
            basep=array(i)
          endif
         endif

c ********************** wind speed
        else if(order(i).eq.2) then

          speed=array(i)

          store(2,1)=store(2,1)+1
          if(array(i).lt.store(2,2))store(2,2)=array(i)
          if(array(i).gt.store(2,3))store(2,3)=array(i)
          store(2,4)=store(2,4)+array(i)

c *********************** wind direction
        else if(order(i).eq.3) then

          direction=array(i)

c *********************** air temp
        else if(order(i).eq.4) then
          store(4,1)=store(4,1)+1
          if(array(i).lt.store(4,2))store(4,2)=array(i)
```

```
          if(array(i).gt.store(4,3))store(4,3)=array(i)
          store(4,4)=store(4,4)+array(i)


c ************************ fuel temp
        else if(order(i).eq.5) then
          store(5,1)=store(5,1)+1
          if(array(i).lt.store(5,2))store(5,2)=array(i)
          if(array(i).gt.store(5,3))store(5,3)=array(i)
          store(5,4)=store(5,4)+array(i)

c *********************** rel. humidity
        else if(order(i).eq.6) then

          store(6,1)=store(6,1)+1
          if(array(i).lt.store(6,2))store(6,2)=array(i)
          if(array(i).gt.store(6,3))store(6,3)=array(i)
          store(6,4)=store(6,4)+array(i)

c *********************** fuel moisture
        else if(order(i).eq.8) then

          store(8,1)=store(8,1)+1
          if(array(i).lt.store(8,2))store(8,2)=array(i)
          if(array(i).gt.store(8,3))store(8,3)=array(i)
          store(8,4)=store(8,4)+array(i)

c **************** max. gust direction
        else if(order(i).eq.9) then
          gdire=array(i)


c **************** max. gust speed
        else if(order(i).eq.10) then
          gspeed=array(i)



c **************** solar radiation
        else if(order(i).eq.11) then

          store(11,1)=store(11,1)+1
          store(11,2)=store(11,2)+array(i)

        endif
30      continue
c ****************************************************************

c  validate max speed and direction, then determine if gspeed is greater
c   than the currently stored value
      if(gspeed.ge.0 .and. gdire.ge.0) then
        store(10,1)=store(10,1)+1
        if(gspeed.gt.store(10,2)) then
          store(10,2)=gspeed
          store(9,2)=gdire
        endif
      endif

c  validate wind speed & direction, then derive and store the rise and run values
      if(speed.ge.0 .and. direction.ge.0) then
        call Triangle(speed,direction,a,b)
```

```
c  if the lower-two quads, save running tally of rise and run in store(20,x)
         if(direction.gt.90 .and. direction .lt.270) then
           store(20,1)=store(20,1)+1
           store(20,2)=store(20,2)+a

           store(20,3)=store(20,3)+b
           store(20,4)=store(20,4)+speed
         else
c if upper-two quads, save running tally of rise and run in store(3,x)
           store(3,1)=store(3,1)+1
           store(3,2)=store(3,2)+a
           store(3,3)=store(3,3)+b
           store(3,4)=store(3,4)+speed
         endif
      endif


      if(flag1.eq.0)flag1=1
      goto 20
c ************************************************************
c ************************************************************

999   call Output(oyr,omo,oday,time)
      stop
      end




c *****************************************************************
c     subroutine Init
c     initialized local storage
c *****************************************************************
       subroutine Init
       common/dat/store(20,20)

         do 10 i=1,20
         do 10 j=1,20
           store(i,j)=0
           if(i.eq.2 .and. j.eq.2)store(i,j)=99999
           if(i.eq.4 .and. j.eq.2)store(i,j)=99999
           if(i.eq.5 .and. j.eq.2)store(i,j)=99999
           if(i.eq.6 .and. j.eq.2)store(i,j)=99999
           if(i.eq.8 .and. j.eq.2)store(i,j)=99999
10         continue
      return
      end




c ****************************************
c     subroutine Initc
c     Initializes array col()
c ****************************************
      subroutine Initc
      common/datac/col(20)

      character col*30
      col(1)=' Cumulative precip (in)'
      col(2)=' Wind speed (mph)'
      col(3)=' Wind direction (degrees)'
```

```
      col(4)=' Average air temp (F)'
      col(5)=' Fuel temp (F)'
      col(6)=' Rel. humidity (%)'
      col(7)=' Battery voltage (volts)'
      col(8)=' Average fuel moisture (%)'
      col(9)=' Max gust direction (degrees)'
      col(10)=' Max gust speed (mph)'
      col(11)=' Solar radiation (ly)'
      return
      end


c ******************************************************************
c     subroutine Interogate(icol,order)
c     Determines the climatic parameters included in the input file
c       icol - number of columns in the input file
c       order() - records the order of climatic parameters on the
c                input file
c ******************************************************************
      subroutine Interogate(icol,order)
      integer order(20)
      character alpha1*132,alpha2*132



c  delete, then temporary file
      call system('del temp')
      call system('del temppy')

      open(20,file='temp')

2     read(10,100,end=111)alpha1
100   format(a11)
      if(alpha1(1:11).ne.': Date/Time') goto 2
      backspace(10)

      read(10,200)alpha1
200   format(t12,a120)
      read(10,200)alpha2
      backspace(10)

c  Interogate for a standard set of variables.  All other variables are ignored.


c  Precip
      i=INDEX(alpha1,'Precip')
      if(i.ne.0) then
        id=1
        write(20,300)i,id
300     format(2(i10,1x))
      endif


c Wind speed
      i=INDEX(alpha2,'Speed')
      if(i.ne.0) then
        id=2
        write(20,300)i,id
      endif
```

```
c Wind direction

      i=INDEX(alpha2,'Direc')
      if(i.ne.0) then
        id=3
        write(20,300)i,id
      endif


c Av Air

      i=INDEX(alpha1,'Av Air')
      if(i.ne.0) then
        id=4
        write(20,300)i,id
      endif

c Fuel Temp

      i=INDEX(alpha1,'Fuel')
      if(i.ne.0) then
        id=5
        write(20,300)i,id
      endif

c Rel Humidity


      i=INDEX(alpha1,'Rel')
      if(i.ne.0) then
        id=6
        write(20,300)i,id
      endif

c Battery Voltage

      i=INDEX(alpha1,'Battery')
      if(i.ne.0) then
        id=7
        write(20,300)i,id
      endif

c Av Fuel moisture

      i=INDEX(alpha1,'Av Fuel')
      if(i.ne.0) then
        id=8
        write(20,300)i,id
      endif

c Max Gust Direct

      i=INDEX(alpha2,'MxGust')
      if(i.ne.0) then
        id=9
        write(20,300)i,id
      endif

c Max Gust speed

      i=INDEX(alpha1,'Mx Gust')
      if(i.ne.0) then
```

```
        id=10
        write(20,300)i,id
      endif

c Solar

      i=INDEX(alpha1,'Solar')
      if(i.ne.0) then
        id=11
        write(20,300)i,id
      endif

      icol=0

111   close(20)
      call system('sort <temp >temppy')
      open(20,file='temppy')

      icol=0
20     read(20,*,end=222)i,id
       icol=icol+1
       order(icol)=id
       goto 20
222   close(20)
      return
      end



c ***************************************************************
c    subroutine Output(oyr,omo,oday,time)
c    Outputs daily summaries.
c     oyr - previous year
c     omo - previous month
c     oday - previous day
c     time - Max. no. of reporting intervals 24 hrs
c ***************************************************************
      subroutine Output(oyr,omo,oday,time)
      common/dat/store(20,20)
      integer oyr,omo,oday




c  derive averages where required


c precip
      if(store(1,1).le.0) store(1,2)=-9999

c  wind speed
      if(store(2,1).gt.0) then
        store(2,4)=store(2,4)/store(2,1)
        store(2,1)=(store(2,1)/time)*100.0
      else
        store(2,4)=-9999
        store(2,2)=-9999
        store(2,3)=-9999
      endif
```

```
c  air temp
      if(store(4,1).gt.0) then
         store(4,4)=store(4,4)/store(4,1)
         store(4,1)=(store(4,1)/time)*100.0
      else
         store(4,4)=-9999
         store(4,2)=-9999
         store(4,3)=-9999
      endif

c  fuel temp
      if(store(5,1).gt.0) then
         store(5,4)=store(5,4)/store(5,1)
         store(5,1)=(store(5,1)/time)*100.0
      else
         store(5,4)=-9999
         store(5,2)=-9999
         store(5,3)=-9999
      endif

c  rel. humidity
      if(store(6,1).gt.0) then
         store(6,4)=store(6,4)/store(6,1)
         store(6,1)=(store(6,1)/time)*100.0
      else
         store(6,4)=-9999
         store(6,2)=-9999

         store(6,3)=-9999
      endif


c fuel moisture
      if(store(8,1).gt.0) then
         store(8,4)=store(8,4)/store(8,1)
         store(8,1)=(store(8,1)/time)*100.0
      else
         store(8,4)=-9999
         store(8,2)=-9999
         store(8,3)=-9999
      endif


c  solar radiation
      if(store(11,1).gt.0) then
        store(11,1)=(store(11,1)/time)*100.0
      else
        store(11,2)=-9999
      endif



c  max wind-gust speed & direction
      if(store(10,1).gt.0) then
        store(10,1)=(store(10,1)/time)*100.0
      else
        store(10,2)=-9999
        store(9,2)=-9999
      endif
```

```
c  special processing for vector averaging of wind direction
      call Winddir(time)


c  output year; month; day;
c  total precip (in),%valid precip records;
c  min, max, average air temp (F) & % valid records;
c  min, max, average fuel temp (F) & % valid records;
c  min, max, average rel. humidity (%) & % valid records;
c  min, max, average fuel moisture (%) & % valid records;
c  total solar radiation (ly) & % valid records;
c  min, max, average wind speed (mph) & % of valid records;
c  average wind direction (degrees) & % of valid windspeed and direction records
c   used to derive this average;
c  speed (mph) and direction (degrees) of the maximum wind-gust speed;


      write(11,100)oyr,omo,oday,store(1,2),
     &(store(1,1)/time)*100.0,store(4,2),store(4,3),store(4,4),
     &store(4,1),store(5,2),store(5,3),store(5,4),store(5,1),
     &store(6,2),store(6,3),store(6,4),store(6,1),
     &store(8,2),store(8,3),store(8,4),store(8,1),
     &store(11,2),store(11,1),
     &store(2,2),store(2,3),store(2,4),store(2,1),
     &store(3,2),store(3,1),
     &store(10,2),store(9,2),store(10,1)
100       format(i2,1x,i2,1x,i2,1x,31(f10.4,1x))
      return
      end



c ****************************************************************
c     subroutine Triangle(hypo,angle,a,b)
c     Derives the rise (a) and run (b) of a right triangle given

c     the angle and a value for the hypotenuse (hypo)
c ****************************************************************
      subroutine Triangle(hypo,angle,a,b)

      dtorad = 3.14159/180.0

      a = sin(angle*dtorad)*hypo
      b = cos(angle*dtorad)*hypo
      return
      end



c ****************************************************************
c     subroutine Winddir(time)
c     Dervies vector average for wind direction
c      time - Max. no. of reporting intervals per 24 hrs

c ****************************************************************
      subroutine Winddir(time)
      common/dat/store(20,20)
c  special processing for average wind direction
c  average the run, average the rise, then derive the ATAN of ( mean_rise/mean_run)

      if(store(3,1).gt.0) then
```

```
         store(3,2)=store(3,2)/store(3,1)
         store(3,3)=store(3,3)/store(3,1)
         store(3,2)=atan(store(3,2)/store(3,3))*(180.0/3.14159)
         if(store(3,2).lt.0)store(3,2)=360+store(3,2)

      else
         store(3,2)=-9999
      endif

      if(store(20,1).gt.0) then
         store(20,2)=store(20,2)/store(20,1)
         store(20,3)=store(20,3)/store(20,1)
         store(20,2)=atan(store(20,2)/store(20,3))*(180.0/3.14159)
         if(store(20,2).lt.0)store(20,2)=360+store(20,2)
         store(20,2)=store(20,2)+180
         if(store(20,2).gt.360)store(20,2)=store(20,2)-360
      else
         store(20,2)=-9999
      endif

      if(store(3,2).eq.-9999 .and. store(20,2).eq.-9999) goto 10

        if(store(3,4).gt.0 .and.store(20,4).gt.0) then
           store(20,4)=store(20,4)/(store(3,4)+store(20,4))
           store(3,4)=1-store(20,4)
        else
           store(20,4)=1
        endif
c        if(store(20,2).eq.-9999) then store(3,2) contains the average wind direction
         if(store(3,2).eq.-9999) then
           store(3,2)=store(20,2)
         else if(store(20,2) .ne.-9999) then
           store(3,2)=(store(20,4)*store(20,2))+(store(3,4)*store(3,2))
         endif

c as a last check, if average windspeed ==0, then set average wind direction to 0
         if(store(2,4).eq.0)store(3,2)=0

c  save the sum of all wind direction values in store(3,2)
      store(3,1)=store(3,1)+store(20,1)

      store(3,1)=(store(3,1)/time)*100.0
10     return
      end




c ***********************************************************************
c      real function Valid(i,value)

c      Validates domain of values, by climatic variable
c      i= 1 precipitation (in) [i.e., rainfall in an hour]
c      i= 2 wind speed (mph)
c      i= 3 wind direction (degrees)
c      i= 4 air temp (F)
c      i= 5 fuel temp (F)
c      i= 6 rel. humidity (%)
c      i= 7 not used - battery voltage
c      i= 8 fuel moisture (%)
c      i= 9 max gust direction (degrees)
c      i=10 max gust speed (mph)
```

```
c     i=11 solar radiation (ly)
c ***********************************************************************
      real function Valid(i,value)
      Valid=1

c  -9999 = no value for all elements
      if(value.eq.-9999) then
        Valid=0
        return
      endif

      if(i.eq.7) then
         print*,'ERROR, battery voltage is not evaluated'
         stop
      endif
      if(i.eq.1) then
         if(value.lt.0 .or. value .gt. 2.0)Valid=0
      else if(i.eq.2) then
         if(value.lt.0 .or. value .gt. 180)Valid=0
      else if(i.eq.3) then
         if(value.lt. 0 .or. value .gt. 360)Valid=0
      else if(i.eq.4) then
         if(value.lt. -75.or. value .gt.140)Valid=0
      else if(i.eq.5) then
         if(value.lt. 0 .or. value .gt. 150)Valid=0
      else if(i.eq.6) then
         if(value.lt.0 .or. value .gt.100)Valid=0
      else if(i.eq.8) then
         if(value.lt.0 .or. value .gt. 100.0)Valid=0
      else if(i.eq.9) then
         if(value.lt.0 .or. value .gt. 360)Valid=0
      else if(i.eq.10) then
         if(value.lt.0 .or. value .gt. 180)Valid=0
      else if(i.eq.11) then
         if(value.lt.0 .or. value .gt. 100)Valid=0
      endif
      return
      end
```

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #14

Downloading Snow Course Climate Data

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for downloading Snow Course data from the Natural Resources Conservation Service (NRCS) web page. Data are inserted into the Northern Colorado Plateau Network (NCPN) climate database using procedures described in SOP #10.

I. Downloading Snow Course Data

The single Snow Course site in Bryce Canyon provides measures of snow depth and snow-water equivalence once to twice a month during winter. Although these data are limited in scope, this site has been in operation since the 1930's, and thus offers insight to the temporal variation in snow pack. Historical data from this station are maintained on the NCPN server to facilitate their access and use in a wide-range of management and research activities in the NCPN. Data for the current year need to be added to the NCPN databases at least annually. However, updates can occur as often as necessary to meet specific needs. Data are downloaded from the NRCS web page using the following procedures.

Procedures:

1. Access the following NRCS web page:
   ftp://ftp.wcc.nrcs.usda.gov/data/snow/snow_course/utsnow.txt

2. Data for all stations in UT will be displayed in the format shown in Fig. 14-1. Scroll through the display until the following station appears:

   Station : 12M08, BRYCE CANYON

3. When updating the archived database annually, the handful of new values can be read directly from the screen and entered directly into a *.txt file. If there is a need to record numerous values, the display on the screen can be cut and pasted to an Excel sheet. To copy the contents from the screen, depress the left mouse button and highlight the desired data. Then while holding down the CTRL button on your key board, depress the "C" key. This will copy the highlighted data to the clip board. On your local computer, open an Excel sheet and copy the data into the sheet by depressing CTRL key and the "V" key at the same time. Save the data as a Text (MS-DOS)(*.txt) file in *X:\Archive\Monitoring_Archive\Climate\Raw_Data\SNOWCOURSE.* File names will consist of the data source name, the station acronym, and the download date; e.g., SNOWCOURSEBRCA*Feb2004.txt.* Data are inserted into the NCPN climate database using procedures described in SOP #10.

```
Station : 12M08, BRYCE CANYON SNOWCOURSE
-------
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
     ---- --- ----- ---- --- ----- ---- --- ----- ---- --- ----- ---- --- ----- ---- ---
-----

95-1 1/01       4.7 2/01      10.5 3/01      12.5 4/01      15.5 5/01       5.8 6/01
0.0
96-1 1/01       0.9 2/01       2.8 3/01       5.2 4/01       2.4 5/01       0.0 6/01
0.0
97-1 1/01       3.4 2/01       7.3 3/01       8.5 4/01       2.0 5/01       0.0 6/01
0.0
98-1 1/01       2.4 2/01       4.2 3/01       8.3 4/01       9.5 5/01       4.0 6/01
0.0
99-1 1/01       3.4 2/01       4.4 3/01       5.2 4/01       0.0 5/01       0.0 6/01
0.0
..........
```

Figure 14-1. Snow Course data display.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #15

Downloading and Processing SNOWNET Climate Data

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures for: 1) acquiring SNOWNET climate station data from MesoWest (a National Weather Service-funded program at the Univ. of Utah); and 2) summarizing the raw data to daily values. Summarized data are inserted into the Northern Colorado Plateau Network (NCPN) climate database using procedures described in SOP #10.

I. Downloading SNOWNET Data

Three automated climate stations in the NCPN are assigned to the SNOWNET network by MesoWest, the primary source of archived data for these stations (see Appendix E of the NCPN Climate Monitoring Protocol Narrative). However, these stations also are included in the USDA Forest Service Avalanche and National Weather Service Cooperating Observer program (NWS-Coop). Data from these stations and from the other climate networks in the NCPN will be used to generate annual climate summaries, to identify climatic extremes, and to aid in the analysis and interpretation of trends in other monitored vital signs. Historical data from these stations are maintained on the NCPN server to facilitate their access and use in a wide-range of management and research activities in the NCPN. Data for the current year need to be added to the NCPN databases at least annually. However, updates can occur as often as necessary to meet specific needs. MesoWest is a reliable repository for the NCPN SNOWNET stations, and provides the raw observations from these stations upon request.

Procedures:

1. Access the following MESOWEST web page:

   www.met.utah.edu/cgi-bin/devel/meso_station.cgi?area=&sort=6

2. Figure 15-1 illustrates the information that will appear on the computer screen upon successful access the to the MesoWest web page. Scroll to one of the NCPN SNOWNET stations - CRN (Capitol Reef NP), TPC (Timpanogos Cave), ZNP (ZION east gate) – then click on the STN name. The Site Information window will appear on the left-hand side (Fig. 15-2).

MesoWest Station Listing

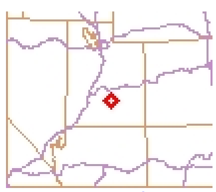
Order by: STN NAME LATITUDE LONGITUDE ELEVATION MNET STATE

STN	NAME	ST LAT	LON	ELV	MNET
MMAA	ACAPULCO/G. ALVAREZ	16.77	-99.75	16 ft	MEXICO
MMAS	AGUASCALIENTES	21.88	-102.3	6184 ft	MEXICO
MMBT	BAHIAS DE HUATULCO	15.78	-96.27	469 ft	MEXICO
MMCP	CAMPECHE/IGNACIO	19.85	-90.55	16 ft	MEXICO
MMUN	CANCUN INTL AIRPORT	21.03	-86.87	16 ft	MEXICO
MMCM	CHETUMAL	18.5	-88.3	39 ft	MEXICO
MMCT	CHICHEN_ITZA	20.64	-88.45	92 ft	MEXICO

Figure 15-1. Example of the MesoWest Station Listing window.

SITE INFORMATION

ID: CRN
NAME: CAPITOL REEF NP
LATITUDE: 38.2898
LONGITUDE: -111.2619
ELEVATION: 5905 ft
MNET: SNOWNET



(Click above or here for topo map)

SITE LINKS

Help

MesoWest

Metric Units

Greenwich Mean Time

2 Week Summary

Past Data

Data Quality

Station Information

Station Status

Restrictions

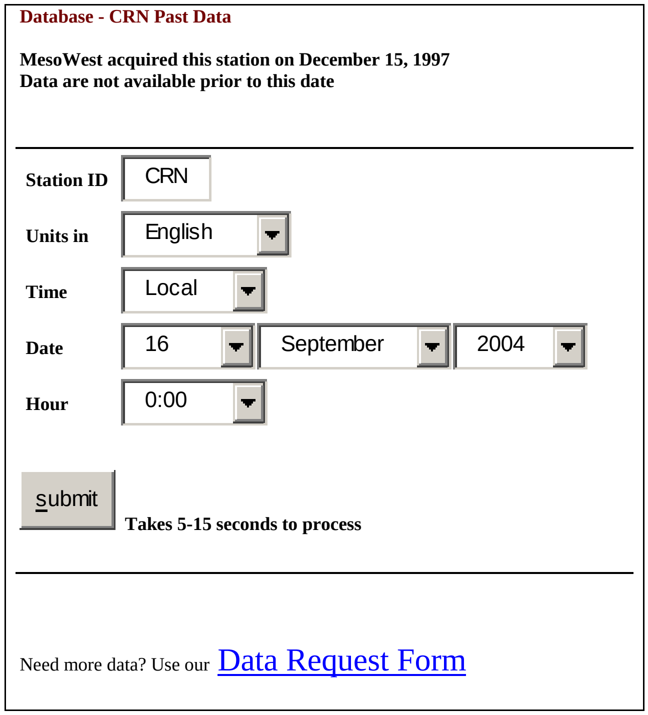
Data in Spreadsheet Format

DATA COURTESY OF
SLC WSFO/NWS Western Region

Figure 15-2. Site Information window.

3. Select *Past Data* in the Site Information window. This will result in displaying the Data Selection window (Fig. 15-3).

4. Select *Data Request Form* located at the bottom of the Data Selection window to submit a data request. The MesoWest Data Request Form will appear (Fig. 15-4).



Database - CRN Past Data

MesoWest acquired this station on December 15, 1997
Data are not available prior to this date

Station ID	CRN
Units in	English
Time	Local
Date	16 September 2004
Hour	0:00

submit Takes 5-15 seconds to process

Need more data? Use our Data Request Form

Figure 15-3. Data Selection window.

5. Fill-out the Data Request Form as illustrated, except enter the dates of interest (data for the dates shown have already been downloaded), and your name, phone number, and email address. When completed, click on *submit* to send your data request. When MesoWest has loaded the requested data onto their ftp site, an email will be sent to you indicating the file names of the requested data and their location. Standard ftp procedures are used to download the data. Downloaded data are in a comma-delimited, ASCII format.

6. Store the raw data files in the *X:\Archive\Monitoring_Archive\Climate\Raw_Data\SNOWNET* directory. File names will consist of the data source name, the station acronym, and the download date; e.g., SNOWNETTICA*Feb2004.txt.* A readme file resides in this directory that describes the native format of these data. Data must be processed before being added to the NCPN Climate database (see II. below).

Data Fields	
List the geographic area of interest (or the specific MesoWest station IDs, if known):	CRN, TPC, ZNP
Enter the specific period of time for which the data request will be:	CRN – 12/15/97-present; TPC – 12/28/97-present; ZNP – 11/2/97-present
List the meteorological parameters you are requesting:	Air temp; dew pt, rel. humidity, wind speed, wind gust, wind direction, precip, snow (depth,fall)
Contact Information	
Enter your Name:	*Your name*
Enter your Company or Institution Name (if applicable):	Northern Colorado Plateau (NCPN) Inventory & Monitoring (I&M) Program, National Park Service
Enter your mailing address:	2282 SW Resource Blvd, Moab, UT 84532
Enter your phone number:	*Your phone number*
Enter your email address:	*Your email address*
Data Usage	
What is the intended use of the MesoWest data?	Monitoring of climate in the Northern Colorado Plateau
Will the use of the data involve litigation?	No
Will the use of the data involve scientific research?	Data will be used in general climate reports to park managers, to aid in the interpretation of ecosystem pattern and processes monitored as part of the NCPN I&M program, and will be made available to scientific research on an as need basis.
Who will benefit as a result of your use of the MesoWest data?	Data will be used in general climate reports to park managers, to aid in the interpretation of ecosystem pattern and processes monitored as part of the NCPN I&M program, and will be made available to scientific research on an as need basis.
Will you be charging for use of data or derived products from the MesoWest data?	No

Click submit to submit your application form. Click reset to clear your application form or to start over.

Figure 15-4. MesoWest Data Request Form.

II. Summarizing SNOWNET Data

Data downloaded from MesoWest will contain raw measures of a suite of climate elements. Air temperature, dew point, relative humidity, wind speed and direction, and wind-gust speed generally will be reported in a consistent format. The number and quality of precipitation and snow measures tend to be variable among stations and among years. A parameter statement is included in the raw data file at the beginning of each year-block indicating reported parameters. Additionally, the reporting interval varies among stations, ranging from every 15 min to every hour. Given the complexity of the data format and the mixture of reporting intervals, a customized program is used to convert the raw data to daily measures for a set number of climate elements. The raw, downloaded data must be processed by this program before being added to the historical archive.

SNOWNET data from MesoWest are processed using the program SNOWNET.exe. The source code and executable are stored in the NCPN I&M server at *X:\Archive\Monitoring_Archive\Climate\Raw_Data\SNOWNET*. A copy of the source code is included here as Attachment A. Based on the recommended data request (Fig. 15-4), the first 11 elements listed in Table 15-1 typically are included in a MesoWest SNOWNET data set. (Note: other possible variables are listed at www.met.utah.edu/cgi-bin/database/variable_select.cgi). However, the numbers and types of elements can vary within and among stations over time, depending on instrumentation availability and failure. Previous examination of the historical data for the three NCPN SNOWNET stations indicated that data for accumulated snow depth and accumulated precipitation have been very limited, in both amount and quality. For this reason, these attributes currently are not included in the daily summary. Also, only the precipitation element that corresponds to the reporting frequency of the climate station should be used to derive daily measures (e.g., 15-min for the stations at CARE and ZION; 1-hr for the station at TICA).

Table 15-1. Climate elements (units) in the MesoWest SNOWNET data sets.

1. Stn Acronym (e.g., CRP, TPC, ZNP)	10. Wind gust speed (knots)
2. Year (YY)	11. Wind direction (degrees)
3. Month (MM)	12. 5-min precipitation (in)
4. Day (DD)	13. 15-min precipitation (in)
5. Hour/minute (HHmm) GMT	14. 1-hr precipitation (in)
6. Air temperature (F)	15. 3-hr precipitation (in)
7. Rel. humidity (%)	16. Accumulated precipitation (in)
8. Dew Point (F)	17. Accumulated snow depth (in)
9. Wind speed (knots)	

Domain checks employed in the program are based on standards published by MesoWest (www.met.utah.edu/cgi-bin/database/variable_select.cgi) (Table 15-2). Only processed elements are subject to domain checks. Additionally, a value of -9999 is interpreted as missing. Values failing a domain check are considered invalid, and eliminated from the daily summary.

Table 15-2. Valid ranges for SNOWNET climate measures.

Climate element (units)	Valid Range (lower, upper values are inclusive)
Year (YY)	User specified
Month (MM)	1-12
Day (DD)	1-31
Hour/minute (HH) GMT	0-2345
Air temperature (F)	-75 - +135
Rel. humidity (%)	0 - 100
Dew Point (F)	-75 - +135
Wind speed (knots)	0 - 125
Wind gust speed (knots)	0 - 150
Wind direction (degrees)	0 - 360
15-min precipitation (in)	0 -0.5
1-hr precipitation (in)	0 – 2

Climate elements and measures output by SNOWNET.exe are shown in Table 15-3. For proper derivation of daily measures, the program first translates observations from Greenwich Mean Time (GMT) to Local Standard Time (LST). Most daily measures are presented as a minimum, maximum, and average. Wind speed values are converted from knots to mph for consistency with data from other climate-station sources. Additionally, the percentage of valid records for a day is reported for each element. Elements with missing or no valid observations are always included in the output, but measures are assigned a value of -9999.

The initial summary of the historical data revealed the potential for the 15-min and 1-hr precipitation elements to be confounded with what appeared to be accumulated precipitation. An indication of this problem is an unusually high monthly total. To warn data users of this problem, a data-quality flag was included with the precipitation measure, and is set for all daily measures in a month if the sum of monthly precipitation is $\geq$ 6.0 in.

Table 15-3. Attributes output by SNOWNET.EXE.

Climate element (units)	Daily (24-hr) Measures
Year (YY)	-
Month (MM)	-
Day (DD)	-
Air temperature (F)	min, max, average, % of valid records
Rel. humidity (%)	min, max, average, % of valid records
Dew point (F)	min, max, average, % of valid records
Wind speed (mph)	min, max, average, % of valid records
Wind direction (mph)	Average (vector average), % of valid records
Wind gust (mph)	Maximum wind-gust speed, % of valid records
Precipitation (in)	total, % of valid records, data-quality flag (1 for suspect, else 0)

Procedures:

1. Use the program called SNOWNET.EXE to convert the raw data to standardized, daily summaries. This program resides in the *X:\Archive\Monitoring_Archive\Climate\Raw_Data\SNOWNET* on the NCPN I&M server. To execute the program, right-click on the Start button in the tool bar of your computer, then left-click on the Open menu item. Navigate to the *X:\Archive\Monitoring_Archive\Climate\Raw_Data\SNOWNET* and double left-click on SNOWNET.EXE. The program queues for the name of a raw data file downloaded from MesoWest and the name of the file to store the output. The program automatically checks for parameter statements in the input file. When a parameter statement is detected, the precipitation and snow elements (#12-17 in Table 15-1) included in the list are displayed to the screen. The user selects the proper element to process. The program converts observations to daily values, and outputs the daily measures for seven elements (Table 15-3). In addition, the percentage of valid records in a 24-hr period for each climate parameter is reported as a means to assess the underlying sample size, and thus, the credibility of the daily summaries. The output from the SNOWNET.EXE program is added to the NCPN climate database using procedures described in SOP #10.

Attachment A – SNOWNET.f source code

```
      program snownet

c ******************************************************************************************
c  Summarizes 15-min & hourly data from SNOWNET automated stations to daily values
c  Developed for: NPS Northern Colorado Plateau Inventory and Monitoring Program (NCPN I&M)
c  Source and executable reside on NCPN I&M server:
x:\Archive\Monitoring_Archive\Climate\Raw_Data\SNOWNET

c  Version 1.0 - 12/15/04
c
c  Modifications:
c
c
c
c ******************************************************************************************


c ******************************************************************************************
c  Global Variables:

c  store(x,y):  x -  individual climatic parameters
c               1 temperature
c               2 relative humidity
c               3 dew point
c               4 wind speed
c               5 wind gust
c               6 wind direction
c               7 precipitation
c
c             y -  1 sum of climatic parameter
c                  2 number of observations in a day
c                  3 minimum value
c                  4 maximum value
c                  5 stores wind speed; used in vector averaging


c  dst(x,y):    Beginning and end dates of daylight saving time
c             x - year (coded & can handle up to 100 yrs)

c             y - 1 month when DST begins
c                 2 day when DST begins
c                 3 hour when DST begins
c                 4 month when DST ends
c                 5 day when DST ends
c                 6 hour when DST ends

c  dstindex:    Used to translate dst() year value to a coded value



c  flag(x,y):   Set to 1 to indicate suspect precipitation data
c             x - year (coded from 1 to n)
c             y - month (coded from 1 to 12)

c  month(x):    An index for month
c             x - month (coded from 1 to 12)

c  year(x):     An index for year
c             x - year (coded from 1 to n)

c  yrid, moid:  Maximum no. of coded years and months stored in
```

```
c            arrays year() and month(), respectively

c  days(x):     No. of days in a month
c            x - month (1-12)


c  SubRoutines:
c    Average - Derives averages & writes output
c    GMTLST  - Converts from GMT to LST
c    Initdst - Initializes dst() by reading file=SnowNetDst.dat
c    Precip - Evaluates monthly sum of precipitation,
c           sets quality flag if data are suspect, outputs
c           the final data summary
c    Summary - Derives daily summaries of climatic parameters
c    Triangle - Derives the rise and run of a right triangle given
c            the angle and a value for the hypotenuse


c  Functions:
c    FiltRec1 - Determines if record is valid based on temperature,
c            rel. humidity, and dew pt. values
c    FiltVar1 - Determines if climatic parameter value is -9999 (missing)
c    FiltVar2 - Validates acceptible difference between wind gust
c            and wind speed
c    findm - Stores month value in array month() and returns an index
c    FindParm - Determines internal code for selected precipitation parameter
c    findy - Stores year value in array year() and returns an index
c    Valid - Validates domai of climatic parameters

c  Input File Format:
c   Variable no. of climatic parameters (see Processing Step 3)

c  Output File Format:
c  year
c  month
c  day
c  24-hr min, max, average air temperature (F) & % of valid records
c  24-hr min, max, average rel. humidity (%) & % of valid records
c  24-hr min, max, average dew pt. (F) & % of valid records
c  24-hr min, max, average wind speed (mph) & % of valid records
c  24-hr average [vector average] wind direction (degrees) & % of valid records
c  24-hr max wind gust (mph) and % of valid records
c  24-hr precipitation (in) and % of valid records.
c  data-quality flag [1 - when monthly precip. >6 in, else 0]


c  General Processing Steps:
c  1) Convert from GMT to LST.
c  2) Look for a PARM statement.  This determines the climate parameters
c    that follow.
c     Assumption: The word PARM starts in column 2.

c  3) Using the PARM line, evaluate the climatic parameters that follow.
c     Assumptions: The parameter acronyms begin at column 10.
c              Parameter acronyms are 4 characters
c              The first 6 parameters are similar among data sets:
c                            temp, rel.humdity, dew pt., wind speed, wind gust,
c                 wind direction.
c              Parameters 7-n are precipitation and snow parameters
c
c  NOTE: Inspection of historical snow and accumulated precip data
c    indicates these parameters are inconsistent.  These should not be processed.
```

```
c
c  4) Precipitation recorded in a reporting interval (5min, 15 min, 1hr, 3hr)
c     can be selected by the user for processing.  Only one of these variables can be
c     processed at a time.  The user is queued to determine the most appropriate
c     precipitation parameter to process.  Precipitation is summarized to derive
c     total daily precipitation.
c
c  5) Store parameters for each 24-hr period, recording the number of valid records
c     in the period
c
c  6) When data for the next day or a new Parm statement is read, derive the min
c     max, mean values for parameters, determine the % of valid records in the 24-hr period,
c     derive vector average of wind direction, output daily summary to a temp. file,
c     initialize local arrays, continue processing.
c
c  7) After processing all data, start at the beginning of the daily summaries
c     and tally total monthly precipitation.  If total monthly values are >6 in., then
c     set the data-quality flag for all days in the month.
c
c  8) Output daily summaries and the data-quality flag to the requested output file.

c  The domain of all parameter values are validated according to MESOWEST guidelines
c ******************************************************************************************

      common/dat/store(50,5)
      common/dat2/flag(100,100)
      common/dat3/year(100),month(100),yrid,moid
      common/dat4/dst(100,6),dstindex,days(12)

      dimension nam(50)
      dimension parms(50)
      integer begin,parmid
      integer year,month,flag,yrid,moid

      character fi*60,fo*60
      character str*100,nam*4,parms*11




      call system('cls')
c ****************************************************************************
c  initialize days()
      do 1 i=1,12
        days(i)=31
1      continue
      days(2)=28
      days(4)=30
      days(6)=30
      days(9)=30
      days(11)=30




c ****************************************************************************
c  initialize DST.  Begin and end dates and times are stored in an ASCII
c                file called SnowNetDst.dat. This file can be
c                modified using a text editor, if necessary.

      call Initdst
```

```
c ******************************************************************************
      print*,'This is Version 1.0 - 10/13/04'
      print*,'This program produces daily summaries for automated',
     &' climate stations.  Data are acquired from MESOWEST.'
      print*,' '
      print*,'Specify the raw-data file '
      print*,' '
      read*,fi

      print*,'Enter file name for the output '
      print*,' '
      read*,fo

      open(10,file=fi)
      open(11,file='temp2')

c ******************************************************************************

c ******************************************************************************
      print*,'Pre-processing MESOWEST data'
10    read(10,100,end=999)str
100   format(a100)

c  if PARM statement, then determine number and types of climatic variables
      if(str(2:5).eq.'PARM') then
c  initialize icnt; icnt will indicate the number of parameters
        icnt=0
        do 20 i=10,100,5
          if(str(i:i+3).gt." ") then
            icnt=icnt+1
            nam(icnt)=str(i:i+3)
          endif
20        continue

        write(11,300)icnt,(nam(k),k=1,icnt)
300     format('PARM ',i3,1x,50(a4,1x:))
        goto 10
      endif

c ******************************************************************************

c ******************************************************************************
c  If not PARM statement, then process climatic parameters
      if(str.gt."  ") then
        begin=1
        parmid=0
        do 30 i=1,100
          if(str(i:i).gt." ") then
           if(str(i:i).eq.',') then
              parmid=parmid+1
               parms(parmid)=str(begin:i-1)
               begin=i+1
           else if(str(i:i).eq.'/') then
              parmid=parmid+1
              if(parmid.eq.2) then
                 parms(parmid)=str(begin:begin+1)
                 parmid=parmid+1
                 parms(parmid)=str(begin+2:begin+3)
                 parmid=parmid+1
```

```
                parms(parmid)=str(begin+4:begin+5)
              else
               parms(parmid)=str(begin:i-1)
              endif

              begin=i+1
            endif
          else
            parmid=parmid+1
            parms(parmid)=str(begin:i-1)
            goto 40
          endif
30      continue
40      continue
        write(11,200)(parms(k),k=1,parmid)
200     format(50(a11,1x:))
      endif
      goto 10
999   close(10)
      close(11)


c     Convert from GMT to LST
      call GMTLST


c  Subroutine Summary reads FN=10, Average writes to FN=11
      open(10,file='temp1')
      open(11,file='temp2')

c  output interim summary of parameters
      call Summary

c  delete interim, temp file
      call Precip(fo)
      call system('del temp1')
      call system('del temp2')
      stop
      end

c ******************************************************************************
c ******************************************************************************



c ************************************************************************
c     subroutine Average(yr,month,day)
c     Derive averages & writes output
c       yr, month, day are year, month, day of currently summarized data
c ************************************************************************
      subroutine Average(oyr,omo,oday,time)
      common/dat/store(50,5)
      integer oyr,omo,oday


c ******************************************************************************
      do 10 i=1,4

        if(store(i,2).gt.0) then
          store(i,1)=store(i,1)/store(i,2)
        else
```

```
            store(i,1)=-9999
            store(i,3)=-9999
            store(i,4)=-9999
          endif
10    continue
c ******************************************************************************


c ******************************************************************************
c  special processing for wind gust
      if(store(5,2).lt.0) then
        store(5,4)=-9999
      endif

c  special processing for average wind direction
c  average the run, average the rise, then derive the ATAN of ( mean_rise/mean_run)

      if(store(6,2).gt.0) then
        store(6,1)=store(6,1)/store(6,2)
        store(6,4)=store(6,4)/store(6,2)
        store(6,1)=atan(store(6,1)/store(6,4))*(180.0/3.14159)
        if(store(6,1).lt.0)store(6,1)=360+store(6,1)
      else
        store(6,1)=-9999
      endif

      if(store(50,2).gt.0) then
        store(50,1)=store(50,1)/store(50,2)
        store(50,4)=store(50,4)/store(50,2)
        store(50,1)=atan(store(50,1)/store(50,4))*(180.0/3.14159)
        if(store(50,1).lt.0)store(50,1)=360+store(50,1)
        store(50,1)=store(50,1)+180
        if(store(50,1).gt.360)store(50,1)=store(50,1)-360
      else
        store(50,1)=-9999
      endif

      if(store(6,1).eq.-9999 .and. store(50,1).eq.-9999) goto 15

        if(store(6,5).gt.0 .and.store(50,5).gt.0) then
          store(50,5)=store(50,5)/(store(6,5)+store(50,5))
          store(6,5)=1-store(50,5)
        else
          store(50,5)=1
        endif
c         if(store(50,1).eq.-9999) then store(6,1) contains the average wind direction
         if(store(6,1).eq.-9999) then
           store(6,1)=store(50,1)
         else if(store(50,1) .ne.-9999) then
           store(6,1)=(store(50,5)*store(50,1))+(store(6,5)*store(6,1))
         endif

c as a last check, if average windspeed ==0, then set average wind direction to 0
         if(store(4,1).eq.0)store(6,1)=0

c  save the sum of all wind direction values in store(6,1)
      store(6,2)=store(6,2)+store(50,2)

c  special processing for preciptation
15    if(store(7,2).eq.0)store(7,1)=-9999

      do 20 i=1,7
```

```
       if(time.gt.0) then
         store(i,2)=(store(i,2)/time)*100.0
       endif
20     continue
c *****************************************************************************

c *****************************************************************************
c  output year; month; day; min, max, average, % of valid records for
c  temp (F), rel. humidity (%), dew pt. (F), & wind speed (mph);
c  mean wind direction (degrees) and % of valid records;
c  max wind gust (mph) and % of valid records,
c  total daily precipitation (inches) and % of valid records.

      write(11,100)oyr,omo,oday,(store(i,3),store(i,4),store(i,1),
     &store(i,2),i=1,4),store(6,1),store(6,2),store(5,4),store(5,2),
     &store(7,1),store(7,2)
100   format(i2,1x,i2,1x,i2,1x,22(f10.4,1x))
      return
      end



c ***********************************************************************
c     subroutine GMTLST
c     Converts records from GMT to LST
c ***********************************************************************
      subroutine GMTLST
      common/dat4/dst(100,6),dstindex,days(12)
      dimension array(50)
      dimension name(50)
      integer yr,mo,dd,hr,hour
      character nam*4,name*4


c  temp2 is created in main(), and is simply the raw data
c  separated into distinct columns.  This routine reads temp2,
c  converts from GMT to LST, and outputs data (in same format
c  as temp2) to temp1 which is further processed in Summary().
c  The file 'temp2' is is overwritten in Average().
c  NOTE: both temp1 and temp2 are deleted before program termination.

      open(10,file='temp2')
      open(11,file='temp1')
10    read(10,*,end=999)nam,iv
      if(nam.eq.'PARM') then
        backspace(10)
        read(10,*)nam,iv,(name(k),k=1,iv)
        write(11,100)nam,iv,(name(k),k=1,iv)
100     format(a4,1x,i2,1x,50(a4,1x:))
        ivars=iv
        goto 10
      else
        backspace(10)
        read(10,*)nam,yr,mo,dd,hr,(array(k),k=1,ivars)
        index=(yr-dstindex)+1
        hour=0

c  first: set local variable - hour - to MST
c  then:  check for DST using following logic:
c   If observation falls on or within DST months, then
c   if observation falls on or within DST days, then
```

```
c   set hour to hr-600, then if first or last day of DST,
c   check to see if the observation falls within the
c   begin & end hour of DST (typically 2AM on the first
c   and last days).

c   If hour is negative, then add 2400 and adjust day and month
c   accordingly.

         hour=hr-700
         if(mo.ge.dst(index,1).and. mo.le.dst(index,4)) then
           if(dd.ge. dst(index,2).and. dd.le.dst(index,5)) then
             hour=hr-600
             if(dd.eq.dst(index,2)) then
               if(hr-600.gt.dst(index,3)) then
                 hour=hr-600
               else
                 hour=hr-700
               endif
             else if(dd.eq.dst(index,5)) then
               if(hr-600.lt.dst(index,6)) then
                 hour=hr-600
               else
                 hour=hr-700
               endif
             endif
           endif
         endif

c   If hour is negative, then add 2400 and adjust day and month
c   accordingly.  If adjusted month = Feb, check for a leap year.
         if(hour.lt.0) then
           hour=hour+2400
           dd=dd-1
           if(dd.le.0) then
             mo=mo-1
             dd=days(mo)
             if(mo.eq.2) then
               if((yr/4) * 4 .eq.yr) dd=dd+1
             endif
           endif
         endif

         write(11,200)nam,yr,mo,dd,hour,(array(k),k=1,ivars)
200      format(a4,1x,3(i4,1x),i5,1x,50(f20.4,1x:))
      endif
      goto 10
999   close(10)
      close(11)
      return
      end



c *************************************************************************
c     subroutine Initdst
c     Reads SnowNetDst.dat and initializes dst() yr; mm,dd,hh when
c     daylight saving time begins and ends
c *************************************************************************
      subroutine Initdst
      common/dat4/dst(100,6),dstindex,days(12)
      integer year,monthb,dayb,hourb
```

```
      integer monthe,daye,houre
      character header*1

c  SnowNetDst.dat - yr; mm,dd,hour when DST begins, mm,dd,hour when it ends.
c  The first record is used to set dstindex, and must correspond
c  to the earliest year that needs to be considered -i.e., for the
c  three NCPN SnowNet stations this is 1997.

      open(10,file='SnowNetDst.dat')
      read(10,*,end=1000)header

      read(10,*)year,monthb,dayb,hourb,
     &monthe,daye,houre
      dstindex=year
      dst(1,1)=monthb
      dst(1,2)=dayb
      dst(1,3)=hourb
      dst(1,4)=monthe
      dst(1,5)=daye
      dst(1,6)=houre

10    read(10,*,end=999)year,monthb,dayb,hourb,
     &monthe,daye,houre
      index=(year-dstindex)+1
      if(index.gt.100) then
       print*,'ERROR, dst index >100 '
       stop
      endif
      dst(index,1)=monthb
      dst(index,2)=dayb
      dst(index,3)=hourb
      dst(index,4)=monthe
      dst(index,5)=daye
      dst(index,6)=houre
      goto 10
999   close(10)

      return
1000  print*,"ERROR, File SnowNetDst.dat doesn't exist."
      print*,'Contact NCPN Data Manager!'
      stop
      end



c ***************************************************************************
c     subroutine Precip(fo)
c     Evaluates monthly sum of precipitation, sets data quality flag
c     if necessary, then outputs the final data summary
c
c       fo - name of final output file
c ***************************************************************************
      subroutine Precip(fo)
      common/dat2/flag(100,100)
      common/dat3/year(100),month(100),yrid,moid
      dimension array(100)
      integer oyr,omo
      integer year,month,flag,yrid,moid
      character fo*60

      open(10,file='temp2')
```

```
      open(11,file=fo)

      oyr=-1
10    read(10,*,end=999)iyr,im,iday,(array(k),k=1,21)
       if(oyr.eq.-1) then
         oyr=iyr
         omo=im
         index1=findy(oyr)
         index2=findm(omo)
       endif
       if(oyr.ne.iyr .or. omo.ne.im) then
         if(total.gt.6) then
           flag(index1,index2)=1
         endif
         total=0
         oyr=iyr
         omo=im
         index1=findy(oyr)
         index2=findm(omo)
       endif
       if(array(21).lt.0)goto 10

       total=total+array(21)
       goto 10
999      if(total.gt.6) then
         flag(index1,index2)=1
       endif

c  now output final summary with precip flag
       rewind(10)
20     read(10,*,end=1010)iyr,im,iday,(array(k),k=1,22)
       index1=findy(iyr)
       index2=findm(im)

c  output year; month; day; min, max, average, % of valid records for
c  temp (F), rel. humidity (%), dew pt. (F), & wind speed (mph);
c  mean wind direction (degrees) and % of valid records;
c  max wind gust (mph) and % of valid records,
c  total daily precipitation (inches) and % of valid records,
c  precip data-quality flag (if monthly sum >6", then flag=1 for all
c  daily records, else flag=0)


       write(11,100)iyr,im,iday,(array(k),k=1,22),flag(index1,index2)
100    format(i2,1x,i2,1x,i2,1x,22(f10.4,1x),i1)
       goto 20
1010     close(10)
       close(11)
       return
       end




c ****************************************************************************************
c     Subroutine Summary

c     Derives daily summaries of climatic parameters
c     format of FN=10:
c       PARM statement indicates climatic variables
c       Data rows contain station code, yr, mo, d, hr, parameters 1 thru n
c ****************************************************************************************
```

```
      subroutine Summary
      common/dat/store(50,5)


      dimension array(50)
      dimension name(50)
      integer yr,mo,day,hr
      integer oyr,omo,oday,ohr
      real ktom
      character nam*4,name*4

c ***************************************************************************
c     conversion from knots to MPH
      ktom = 1.15077945

      print*,'Processing summaries '
c initialize store()
      do 1 i=1,50
        store(i,1)=0
        store(i,2)=0
        store(i,3)=999999
        store(i,4)=0
        store(i,5)=0
1      continue

c initialize 'previous' values for yr, mo, and day
      oyr=-1
      omo=0
      oday=0
      jvar=0
c ***************************************************************************


c ***************************************************************************
c  read data processed in main()
10    read(10,*,end=999)nam,iv

c  If PARM statement, then read number of climatic variables and their acronyms.
c  If >6 vars, then queue user to determine which additional parameter to process.

      if(nam.eq.'PARM') then
        backspace(10)
        read(10,*)nam,iv,(name(k),k=1,iv)
        ivars=iv
        ohr=-1
        jvar=0

        if(ivars.gt.6) then
          print*,' '
          print*,'More than the standard 6 parameters are available.'
          print*,'Additional parameters include:'
          do 11 i=7,ivars
           print*,i,name(i)
11          continue
          print*,' '
          print*,'Select one variable by entering corresponding number.'
          print*,'Enter 0 for no selection.'
          print*,' '
          read*,jvar
        endif
        goto 10
      else
```

```
c  else, read climatic parameters
        backspace(10)
        read(10,*)nam,yr,mo,day,hr,(array(k),k=1,ivars)
      endif
c ****************************************************************************

c ****************************************************************************
c  set 'previous' variables if at beginning of data (i.e., oyr==-1)
      if(oyr.eq.-1) then
        oyr=yr
        omo=mo
        oday=day
      endif

c  ohr is init to -1.  ohr stores the first time stamp after a PARM statement.
c  The second time stamp is then differenced (second from the first) to determine
c  the reporting time interval.  This difference is then divided into 24 hrs
c  to determine the maximum number of reporting intervals in a day (stored in variable time).
c  The variable 'time' is then used to determine the proportion of valid records in
c  a day, which is reported for each climatic variable.
      if(ohr.ge.0) then
        time=hr-ohr
        if(time.gt.60) time=60*(time/100)
        time=(24.0*60.)/time
        print*,'Number of reporting intervals/24hrs = ',time
        ohr=-2
      endif
      if(ohr.ge.-1)ohr=hr
c ****************************************************************************


c ****************************************************************************
c  if previous and current yr, mo, day are not the same, then
c   output daily summaries
      if(oyr.ne.yr.or.omo.ne.mo.or.oday.ne.day) then
c         print*,'Outputing summaries for yr,mo,day ',oyr,omo,oday

        call Average(oyr,omo,oday,time)

c  update yr, mo, and day
        oyr=yr
        omo=mo
        oday=day

c  re-initialize store()
      do 12 i=1,50
        store(i,1)=0
        store(i,2)=0
        store(i,3)=999999
        store(i,4)=0
        store(i,5)=0
12      continue

      endif
c ****************************************************************************

c ****************************************************************************
c   The following filter was derived from reviewing the data.  Generally,
c   If temp AND rel. humdity are <0, then the record is incomplete or
c   missing, and the record should be discarded.  Also, if temp, rel. humdity,
c   and dewpt are <=0, then the record is incomplete or missing and should
c   be discarded.  These checks are a bit redundant, but ensure inclusive
```

```
c   filtering of incomplete or invalid records.

     if(FiltRec1(array(1),array(2),array(3)).eq.0) goto 10
c ****************************************************************************


c ****************************************************************************
c  store climatic variables
     do 20 i=1,4

c       FiltVar1 filters for missing value (-9999 = MESOWEST standard for missing value)
       if(FiltVar1(array(i)).eq.0) goto 20
       if(Valid(i,array(i)).eq.0) goto 20

c  FiltVar2 evaluates the difference between windgust and windspeed
        if(i.eq.4) then
          if(FiltVar2(array(5),array(4)).eq.0) goto 20
        endif

        convert=1.0
        if(i.eq.4)convert=ktom
        store(i,1)=store(i,1)+(array(i)*convert)
        store(i,2)=store(i,2)+1
        if(array(i)*convert.lt.store(i,3))store(i,3)=array(i)*convert
        if(array(i)*convert.gt.store(i,4))store(i,4)=array(i)*convert
20    continue
c ****************************************************************************

c ****************************************************************************
c   store max. wind-gust speed
       if(FiltVar1(array(5)).eq.0) goto 30
       if(Valid(5,array(5)).eq.0) goto 30
       if(FiltVar2(array(5),array(4)).eq.0) goto 10
       store(5,2)=store(5,2)+1
       if(array(5)*ktom.gt.store(5,4)) then
          store(5,4)=array(5)*ktom
       endif

c  store wind direction record
30      continue
       if(Valid(4,array(4)).eq.0) goto 40
       if(Valid(6,array(6)).eq.0) goto 40

c  store(6,1) = the rise, store(6,4)= the run of a right triangle for quads 1,2
c  store(60,1) = the rise, store(50,4)= the run of a right triangle for quads 3,4

       call Triangle(array(4),array(6),a,b)
       if(array(6).gt.90 .and. array(6).lt.270) then
        store(50,1)=store(50,1)+a
        store(50,4)=store(50,4)+b
        store(50,2)=store(50,2)+1

c  store wind speed for weighted averaging
        store(50,5)=store(50,5)+array(4)
       else
        store(6,1)=store(6,1)+a
        store(6,4)=store(6,4)+b
        store(6,2)=store(6,2)+1

c  store wind speed for weighted averaging
        store(6,5)=store(6,5)+array(4)
       endif
```

```
c ****************************************************************************

c ****************************************************************************
c  if a precipitation variable was selected, then summarize daily observations
40      if(jvar.gt.0) then
        id=FindParm(name(jvar))
        if(Valid(id,array(jvar)).eq.0) goto 10
        if(FiltVar1(array(jvar)).eq.0) goto 10
        store(7,1)=store(7,1)+array(jvar)
        store(7,2)=store(7,2)+1
       endif
c ****************************************************************************

      goto 10

999   continue
c     print*,'Outputing summaries for yr,mo,day ',oyr,omo,oday
      call Average(oyr,omo,oday,time)
      close(10)
      close(11)
      return
      end



c *****************************************************************
c      subroutine Triangle(hypo,angle,a,b)
c      Derives the rise (a) and run (b) of a right triangle given
c      the angle and a value for the hypotenuse.
c        hypo - hyptenuse (wind speed)
c        angle - wind direction
c        a - derived rise
c        b - derived run
c *****************************************************************
       subroutine Triangle(hypo,angle,a,b)
       dtorad = 3.14159/180.0

       a=sin(angle*dtorad)*hypo
       b=cos(angle*dtorad)*hypo
       return
       end



c *******************************************************************************************
c     real function FiltRec1(temp, rel,dew)
c   This filter was derived from reviewing the data.  Generally,
c   If temp AND rel. humdity are <0, then the record is incomplete or
c   missing, and the record should be discarded.  Also, if temp, rel. humdity,
c   and dewpt are <=0, then the record is incomplete or missing and should
c   be discarded.  These checks are a bit redundant, but are used to

c   ensure inclusive filtering of incomplete or invalid records.
c      temp - temperature
c      rel - rel. humidity
c      dew - dew pt.
c *******************************************************************************************

      real function FiltRec1(temp,rel,dew)

      FiltRec1=1
      if(temp.lt.0 .and. rel.lt.0) FiltRec1=0
```

```
      if(temp.le.0 .and. rel.le.0 .and. dew.le.0) FiltRec1=0
      return
      end


c ****************************************************************************************
c     real function FiltVar1(value)
c     Filters missing values (= -9999)
c       value - value of a climatic parameter
c ****************************************************************************************

      real function FiltVar1(value)
      FiltVar1=1
      if(value.eq.-9999)FiltVar1=0
      return
      end


c ****************************************************************************************
c     real function FiltVar2(gust,speed)
c     Compares difference between wind gust and wind speed.  If >75 knots
c     then both values are ignored.
c       gust - wind gust speed
c       speed - wind speed
c ****************************************************************************************

      real function FiltVar2(gust,speed)
      FiltVar2=1
      if(gust-speed .gt.75)FiltVar2=0
      return
      end


c ******************************************************************
c     real fucntion findm(jkl)
c     sets month() with coded month, returns index
c       jkl - month value
c ******************************************************************
      real function findm(jkl)
      common/dat3/year(100),month(100),yrid,moid
      integer year,month,yrid,moid

      if(moid.eq.0) then
        moid=1
        month(1)=jkl
        findm=1
        return
      endif
      do 10 i=1,moid
         if(month(i).eq.jkl) then
           findm=i
           return
         endif
10    continue
      moid=moid+1
      month(moid)=jkl
      findm=moid
      return
      end
```

```
c ***************************************************************************
c     real function FindParm(var)
c     Returns id code for precipitation parameters
c      var - Mesowest precipitation acronym
c ***************************************************************************
      real function FindParm(var)
      character var*4
      FindParm=0

      if(var.eq.'P01I') then
        FindParm=7
      else if(var.eq.'P03I') then
        FindParm=8
      else if(var.eq.'P05I') then
        FindParm=9
      else if(var.eq.'P15I') then
        FindParm=10
      endif
      if(FindParm.eq.0) then
        print*,'ERROR, precip parameter not found ',var
        stop
      endif
      return
      end



c *******************************************************
c     real function findy(jkl)
c     sets year value into year(), returns index
c *******************************************************
      real function findy(jkl)
      common/dat3/year(100),month(100),yrid,moid
      integer year,month,yrid,moid

      if(yrid.eq.0) then
       yrid=1
       year(1)=jkl
       findy=1
       return
      endif
      do 10 i=1,yrid
        if(year(i).eq.jkl) then
          findy=i
          return
        endif
10     continue
      yrid=yrid+1
      year(yrid)=jkl
      findy=yrid
      return
      end



c *************************************************************************
c      real function Valid(i,value)

c      Validates domain of value for climatic variable = i
c      i= 1 temperature (F)
c      i= 2 relative humidity (%)
c      i= 3 dew point (F)
```

```
c      i= 4 wind speed (knots)
c      i= 5 wind gust (knots)
c      i= 6 wind direction (degrees)
c      i= 7 1-hr precipitation (inches)
c      i= 8 3-hr precipitaton (inches)
c      i= 9 5-min precipitation (inches)
c      i=10 15-min precipitation (inches)
c
c      value - value of climatic parameter
c ***********************************************************************
      real function Valid(i,value)
      Valid=1
      if(i.eq.1) then
        if(value.lt.-75 .or. value .gt.135)Valid=0
      else if(i.eq.2) then
        if(value.lt.0 .or. value .gt.100)Valid=0
      else if(i.eq.3) then
        if(value.lt. -75 .or. value .gt.135)Valid=0
      else if(i.eq.4) then
        if(value.lt.0 .or. value .gt.125)Valid=0
      else if(i.eq.5) then
        if(value.lt.0 .or. value .gt.150)Valid=0
      else if(i.eq.6) then
        if(value.lt.0 .or. value .gt.360)Valid=0
      else if(i.eq.7) then
        if(value.lt.0 .or. value .gt.2.0)Valid=0
      else if(i.eq.8) then
        if(value.lt.0 .or. value .gt. 6.0)Valid=0
      else if(i.eq.9) then
        if(value.lt.0 .or. value .gt. .5)Valid=0
      else if(i.eq.10) then
        if(value.lt.0 .or. value .gt. .5)Valid=0
      endif
      return
      end
```

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #16

Data Analysis and Reporting

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures to generate the annual climate report for Northern Colorado Plateau Network (NCPN) park units. There are four components to the climate report: 1) a monthly summary of reported climatic parameters, 2) an annual summary; 3) assessments of annual, monthly, and daily measures in the context of historical trends (i.e., climatic extreme assessments); and 4) a comparison of climatic conditions among the NCPN park units. Components 1-3 are produced for each climate station in a park unit; assessments of climatic extremes (3) involve comparisons of recent-year conditions with the historical data of a climate station. All climate stations in the NCPN are employed in component 4. The annual climate report will report on conditions and trends for the most recent year, and is scheduled to be distributed by February of the following year. Procedures for monthly and annual summaries are well developed. General procedures for assessing and reporting on climatic extremes are developed, but will undergo further enhancement as methods and needs evolve. Additionally, rudimentary methods are developed for network-wide comparisons, and likewise, will be expanded with experience. In accordance with SOP revision procedures (see SOP #17), enhancements will be reflected in this SOP and tracked as version updates.

Analyses and reporting occurs for five of the seven climate monitoring programs in the NCPN; NWS-Coop, RAWS, SNOTEL, Snow Course and SNOWNET. Monitoring program and station details are provided in the Climate Protocol Narrative. Data from the five programs are stored in separate databases. The database structures are documented in SOP #10 (Data Management). The procedures for generating reports will require knowing the station ID of each station in each of the five databases. This information is contained in appendices of the NCPN Climate Protocol Narrative. These appendices are referenced in the instructions below.

I. Monthly and Annual Summaries

Summaries are generated using observations in the climate databases. An example of a monthly summary for a NWS-Coop station is shown in Attachment A; the accompanying annual summary is shown in Attachment B. The general structure of the summaries is consistent among climate stations of the different monitoring networks. However, the numbers and types of parameters in a summary differ due to differences in sensor configurations among the climate programs. Data in the five climate databases must first be translated to ASCII files using Access utilities. Custom programs use these ASCII files to generate the summary information. There is a separate program for each climate program. The programs have very similar structure, but I/O differs to accommodate the different database formats. An example of the NWS-Coop summary program is provided in Attachment C.

Procedures:

1. To translate the observations in the climate databases to ASCII, navigate to the *X:\Vital_Signs\Climate\Data\Current_Data* directory in MS-Windows Explorer and click on each of the following utilities (listed below as xx_to_ascii.mdb):

For NWS-Coop data;
Coop_to_ASCII.mdb [translates tblCOOPClimate to coopascii.txt]

For RAWS data;
RAWS_to_ASCII.mdb [translates tblRAWSClimate to rawsascii.txt]

For SNOWNET data;
SNOWNET_to_ASCII.mdb [translates tblSnowNetClimate to snownetascii.txt]

For Snow Course data;
SnowCourse_to_ASCII.mdb [translates tblSnowCourseClimate to snowcascii.txt]

For SNOTel data;
SNOTEL_to_ASCII.mdb [translates tblSnotelClimate to snotelascii.txt]

The ASCII file for each table noted above will reside in:
X:\Vital_Signs\Climate\Data\Current_Data

2. In MS-Windows Explorer, navigate to the directory:
X:\Vital_Signs\Climate\Data\Tools

The custom summary programs (executable and source) reside in this directory. There is a separate program for each climate program:

- CoopSummary.exe – summarizes NWS-Coop data
- RawsSummary.exe – summarizes RAWS data
- SnotelSummary.exe – summarizes SNOTEL data
- SnowcSummary.exe – summarizes Snow Course data
- SnownetSummary.exe – summarizes SNOWNET data

Click on a program name to begin program execution. Programs generally have the same five queues, which are listed below:

a) Enter name of file containing daily xxx data
b) Enter StationID
c) Enter Year
d) Enter the prefix for naming monthly output files
e) Enter name of file for the annual summary

The queues are explained below in sequential order:

a) Enter the name of the ASCII file created in Step1. ‘xxx’ is the name of the climate-monitoring program. For instance, CoopSummary.exe will display “NWS-Coop”; RAWSsummary.exe will display the term “RAWS “. The input data set must match the type required by the program (e.g., a RAWS ASCII file can only be processed by RAWSsummary.exe).
b) Enter the station ID or number for the station of interest. NWS-Coop station numbers are documented in Appendix A; RAWS station IDs are listed in Appendix C; SNOTEL and Snow course IDs are listed in Appendix D; SNOWNET station IDs are listed in Appendix E.
c) Enter the year of interest. This is the calendar year for all but the summary of Snow Course data. Snow Course data are organized by water year (beginning Oct. 1); enter the water year when summarizing these data.
d) Enter a prefix for the monthly summary files. A file is generated for each month. The user-specified prefix is appended with a 3-letter month code to identify the 12 files. The prefix can be up to 57 characters long. The prefix should identify the park, the climate monitoring program, and the year; e.g., zioncoop2004. Given the preceding prefix, the summary information for the month of December would be output to a file called zioncoop2004dec. An exception is that SnowcSummary.exe does not output monthly summaries; the user is not queried for this prefix in this program.
e) Enter the name of the file for storing the annual summary information. This name can be up to 60 characters long.

These programs process data for a single user-specified station. The programs must be executed multiple times to generate reports for all stations.

3. Once the summaries are produced, the data can be inserted into MS-Word Table templates designed for each type of climate station. Templates are located in *X:\Vital_Signs\Climate\Data\Tools* , and labeled by station name, climate-monitoring

program, and report type; e.g., archcoopmonth.doc is the monthly summary table for the NWS-Coop station in Arches National Park (ARCH). To create a table, open the appropriate template and the data-summary file in MS-Word. Cut and paste from the summary file to the template. Once completed, the template should be renamed and stored in a local directory.

An alternative to using the templates is to use the Convert Text to Table feature in MS-Word. First, open the ASCII summary file in Word. Highlight the unformatted ASCII text. Under the Tables menu select Convert, Convert Text to Table. MS-Word will convert the data to a table format. Nominal editing will be required to convert the table to the formats shown in Attachments A and B.

Output files of the summary programs include nominal annotation and vary among the programs. Nominal annotation is to facilitate importing into MS-Word templates. Formats of output files for each program are documented below for reference.

CoopSummary.exe. The monthly summary format for CoopSummary.exe is documented in Table 16-1. Only the underlined text is actually displayed in the output files. All other annotation is used here to document the format. The station ID, month, and year are listed in the first row of the output. The second row starts with a 1 for the first day of the month followed by six columns of numbers with each separated by a space. The six columns correspond to the climatic parameters listed in Table 16-1, from left to right. This format continues for each day of the month. Immediately after the last day of the month, three rows of six numbers are listed that correspond to the monthly minimum, maximum, and average for the six climatic parameters. Following this is a row with two numbers that correspond to the monthly sum for rainfall and snowfall. The next row indicates the percentage of valid daily records for the six parameters. The last four rows include the annotation that is underlined in Table 16-1. However, instead of the terms "$<5^{th}$" and "$>95^{th}$", the actual values for the 5^{th} percentile for minimum temperature and for the 95^{th} percentile for maximum temperature are displayed. Two numbers follow each of the first two annotated lines indicating the number of days <32 F and $<5^{th}$ for minimum temperature, and the number of days <32 F and $>95^{th}$ for maximum temperature. Percentile values are based on all months combined for the historical period of record (years other than the one being summarized). Three values follow each of the last two annotated lines, indicating the number of days in the month with rainfall and with snowfall $\geq$ 0.01, 0.1, and 1.0 inches. Invalid or missing observations are noted in the output as "***". Monthly values also have this designation when there are no valid daily observations. The general structure of the monthly summary illustrated in Table 16-1 is created by all summary programs.

Table 16-1. Format of the monthly summary information output by CoopSummary.exe.

StationID;		Month;	Year;			
Day	Min. Air Temp (F)	Max. Air Temp (F)	Ave. Air Temp (F)	Rainfall (in)	Snowfall (in)	Snow depth (in)
1	26	50	38	0	0	0
2	26	52	39	0	0	0
.	.	.	.	.	.	.
Last day of month	23	44	34	0	0	1
Min	12	38	25	0	0	1
Max	35	56	45	0.38	2	2
Average	24	46	35	0.03	0.1	0.1
Total	-	-	-	0.80	2.0	-
% valid records	100	100	100	96.8	93.3	96.8
No. days with Min Temp <32, $<5^{th}$				29	4	
No. days with Max Temp <32, $>95^{th}$				0	0	
No. days with Precip >= 0.01, 0.1, 1.0				6	3	0
No. days with Snowfall >= 0.01, 0.1, 1.0				1	1	1

The annual summary format for CoopSummary.exe is documented in Table 16-2. The stationId, year, the minimum temperature corresponding to the 5^{th} percentile, and the maximum temperature corresponding to the 95^{th} percentile are listed in the first row of the file. Starting with the second row, 13 columns of numbers are listed. The columns correspond, from left to right, to the 12 months of the year starting with January. The right-most column is the yearly average or sum. Successive rows following the first line correspond to the attributes listed in Table 16-2. For example, rows 2-7 correspond to the six attributes listed for Min. Air Temp in Table 16-2. Each set of values for a climatic parameter are separated by a space. Invalid or missing observations are noted in the output as "***". Year values also have this designation when there are no valid monthly observations. The general structure of the annual summary output illustrated in Table 16-2 is created by all summary programs.

Table 16-2. Format of the annual summary output in CoopSummary.exe.

	Definition of values	
Content of successive rows	***Monthly values***	***Annual value***
StationID; Year; 5^{th} & 95^{th} Temp. Percentiles;		
Min Air Temp (F) *Min*	monthly min	average
Max	monthly max	Average
Aver	monthly average	Average
No. days <32F	sum	Sum
No. days <5th	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	Average

Table 16-2. cont.

space		
Max Air Temp (F) *Min*	monthly min	average
Max	monthly max	Average
Aver	monthly average	Average
No. days <32F	sum	sum
No. days >95th	sum	Sum
% valid records	100*(no. valid obs./no. of days in month)	Average
space		
Av. Air Temp (F) *Min*	monthly min	average
Max	monthly max	Average
Aver	monthly average	Average
% valid records	100*(no. valid obs./no. of days in month)	Average
space		
Precip. (in) *Min*	monthly min	average
Max	monthly max	Average
Aver	monthly average	Average
Total	sum	sum
No. days >=0.01 in	sum	sum
No. days >=0.1 in	sum	sum
No. days >=1.0 in	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Snow fall (in) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
Total	sum	sum
No. days >=0.01 in	sum	sum
No. days >=0.1 in	sum	sum
No. days >=1.0 in	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Snow depth (in) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
% valid records	100*(no. valid obs./no. of days in month)	average

RawsSummary.exe. The monthly summary format for RawsSummary.exe is shown in Table 16-3. This format is similar to that created by CoopSummary, except the order of climatic parameters is different and there are 20 instead of six climatic parameters. Additionally, a monthly total is derived only for precipitation.

The annual summary format for RawsSummary.exe is shown in Table 16-4. The general structure is the same produced by CoopSummary.exe. But again, the order of climatic parameters differs and there are more rows in the output due to the larger number of parameters. The format shown in Table 16-4 for Av. Air Temp is repeated for the remaining climatic parameters which are ordered as shown in Table 16-3 (i.e., Min fuel temp, Max fuel temp…. Max wind gust direction). It should be noted that not all summary values will be of interest. For example, monthly and annual average wind direction are meaningless. For code-efficiency reasons, all summary programs provide monthly minimum, maximum, and average values regardless of the climatic parameter. In generating the hard-copy reports, values of limited significance or meaning are eliminated. In RAWS reports, wind direction values only are included in the monthly summary report.

Table 16-3. Format of the monthly summary information output by CoopSummary.exe.

StationID; Month; Year;

Day	Precip (in)	Min Air Temp (F)	Max Air Temp	Aver Air Temp	Min Fuel Temp (F)	Max Fuel Temp	Aver Fuel Temp	Min Rel. Humidity (%)	Max Rel. Humidity	Aver Rel. Humidity	Min fuel moisture (%)	Max fuel moisture	Aver fuel moisture	Total solar Radiation (ly)	Min wind speed (mph)	Max wind speed	Aver wind speed	Min wind direction (degrees)	Max wind gust (mph)	Max wind gust direction (degrees)
1																				
2																				
.																				
Last day of month																				
Min																				
Max																				
Aver																				
Total		na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
% valid records																				

No. of days with Min Temp <32, <5th	x	x	
No. of days with Max Temp <32, >95th	x	x	
No. of days with Precip >= 0.01, 0.1, 1.0 inches	x	x	x

Table 16-4. Format of the annual summary output in RawsSummary.exe.

	Definition of values	
Content of successive rows	***Monthly values***	***Annual value***
StationID; Year; 5th & 95th Temp. Percentiles;		
Precip. (in) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
Total	sum	sum
No. days >=0.01 in	sum	sum
No. days >=0.1 in	sum	sum
No. days >=1.0 in	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Min Air Temp (F) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
No. days <32F	sum	sum
No. days <5th	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Max Air Temp (F) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
No. days <32F	sum	sum
No. days >95th	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Av. Air Temp (F) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Etc…..		

SnotelSummary.exe. The monthly summary format for SnotelSummary.exe is shown in Table 16-5; the annual summary format is shown in Table 16-6. Format standards and interpretations are similar to those for CoopSummary.exe (see description above).

Table 16-5. Format of the monthly summary information output in SnowtelSummary.exe.

StationID; Month; Year;						
Day	Min. Air Temp (F)	Max. Air Temp (F)	Ave. Air Temp (F)	Rainfall (in)	Snow depth (in)	Snow-water equivalent (in)
1	26	50	38	0	0	0
2	26	52	39	0	0	0
.	.	.	.	.	.	.
Last day of month	23	44	34	0	0	1
Min	12	38	25	0	0	1
Max	35	56	45	0.38	2	2
Average	24	46	35	0.03	0.1	0.1
Total	-	-	-	0.80	2.0	-
% valid records	100	100	100	96.8	93.3	96.8
No. days with Min Temp <32, <5th				29	4	
No. days with Max Temp <32, >95th				0	0	
No. days with Precip >= 0.01, 0.1, 1.0				6	3	0
No. days with Snowfall >= 0.01, 0.1, 1.0				1	1	1

Table 16-6. Format of the annual summary output in SnotelSummary.exe.

	Definition of values	
Content of successive rows	***Monthly values***	***Annual value***
StationID; Year; 5th & 95th Temp. Percentiles;		
Min Air Temp (F)		
Min	monthly min	average
Max	monthly max	average
Aver	monthly average	average
No. days <32F	sum	sum
No. days <5th	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Max Air Temp (F)		
Min	monthly min	average
Max	monthly max	average
Aver	monthly average	average
No. days <32F	sum	sum
No. days >95th	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average

Table 16-6. cont.

space		
Av. Air Temp (F) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Precip. (in) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
Total	sum	sum
No. days >=0.01 in	sum	sum
No. days >=0.1 in	sum	sum
No. days >=1.0 in	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average

SnowcSummary.exe. Due to the limited number of parameters and observation frequency, only one type of report is generated (Table 16-7). The first row of the summary output consists of the station ID and the water year (starts October 1). This is followed by rows containing a day value and two values for each month from November through June. Generally, observations are obtained on the first and/or the 15th of a month. The first of the two values for each month corresponds to snow depth (inches - D), the second corresponds to snow-water equivalent (inches - WE). For a water year, there generally will only be 2-4 rows of data. Given the limited temporal record within a month, monthly averages currently are not derived.

Table 16-7. Summary output from SnowcSummary.exe.

StationID; Water Year;																
	Nov.		Dec.		Jan.		Feb.		March		April		May		June	
Day	D	WE	D	WE	D	SW	D	SW	D	SW	D	SW	D	SW	D	SW
.																
.																
.																

SnownetSummary.exe. The monthly summary format for SnownetSummary.exe is shown in Table 16-8; the annual summary format is shown in Table 16-9. Format standards and interpretations are similar to those for CoopSummary.exe (see description above). The format shown in Table 16-9 for Av. Air Temp is repeated for the remaining climatic parameters which are ordered as shown in Table 16-8 (i.e., Min Rel. humidity temp, Max Rel. humidity…. Max wind gust).

Table 16-8. Format of the monthly summary information output by SnownetSummary.exe.

StationID ; Month; Year;															
Day	Precip (in)	Min air temp (F)	Max air temp	Aver air temp	Min Rel. humidity (%)	Max Rel. humidity	Aver Rel. humidity	Min dew point	Max dew point	Aver dew point	Min wind speed (mph)	Max wind speed	Aver wind speed	Min wind direction (degrees)	Max wind gust (mph)
1															
2															
.															
Last day of month															
Min															
Max															
Aver															
Total		Na	na	na	na	na	na	na	na	na	na	na	na	na	na
% valid records															
No. days with Min Temp <32, <5th					x	x									
No. days with MaxTemp <32, >95th					x	x									
No. days with Precip >= 0.01, 0.1, 1.0 in					x	x	x								

Table 16-9. Format of the annual summary output in SnownetSummary.exe.

	Definition of values	
Content of successive rows	***Monthly values***	***Annual value***
StationID; Year; 5th & 95th Temp. Percentiles;		
Precip. (in) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
Total	sum	sum
No. days >=0.01 in	sum	sum
No. days >=0.1 in	sum	sum
No. days >=1.0 in	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Min Air Temp (F) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
No. days <32F	sum	sum
No. days <5th	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Max Air Temp (F) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
No. days <32F	sum	sum
No. days >95th	sum	sum
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Av. Air Temp (F) *Min*	monthly min	average
Max	monthly max	average
Aver	monthly average	average
% valid records	100*(no. valid obs./no. of days in month)	average
space		
Etc…..		

II. Climatic Extremes

Initial assessments of climatic extremes will focus on comparing current-year conditions to historical trends. Analyses are designed to illustrate temporal trends, and to determine the percentage of observations that are near or exceed historical limits. At a minimum, assessments must include the key climatic vital signs – minimum and maximum air temperature, and precipitation. Examples of analyses for annual, monthly, and daily measures are illustrated in Figs. 16-1 to 16-3. Custom programs are used to derive the information shown in these figures. Also, available templates of the illustrated graph structures will provide consistent, rapid visualization of results.

A web-based tool is being developed that will allow a user to implement customized analyses of climatic extremes. This tool will provide access to all climatic parameters stored in the NCPN climate database (see SOP #10). The user will be able to select specific climatic parameters for analysis, specify observational periods for comparisons, and specify types of analytical summaries (e.g., no. of days exceeding historical extremes or exceeding 5th and 95th percentiles). The functionality of this tool will evolve with experience and needs. This tool will be used by NCPN staff for assessments included in annual climate reports. Also, this tool will enable all NCPN park staff to perform customized analyses on an as-needed basis. The underlying structure and interface of this web application has been developed (Attachment D). The near-term goal is to add the functionality shown in Figs. 16-1 to 16-3. Once completed, the web-based application will obviate the need to use the custom programs and graph templates described in the following Procedures section.

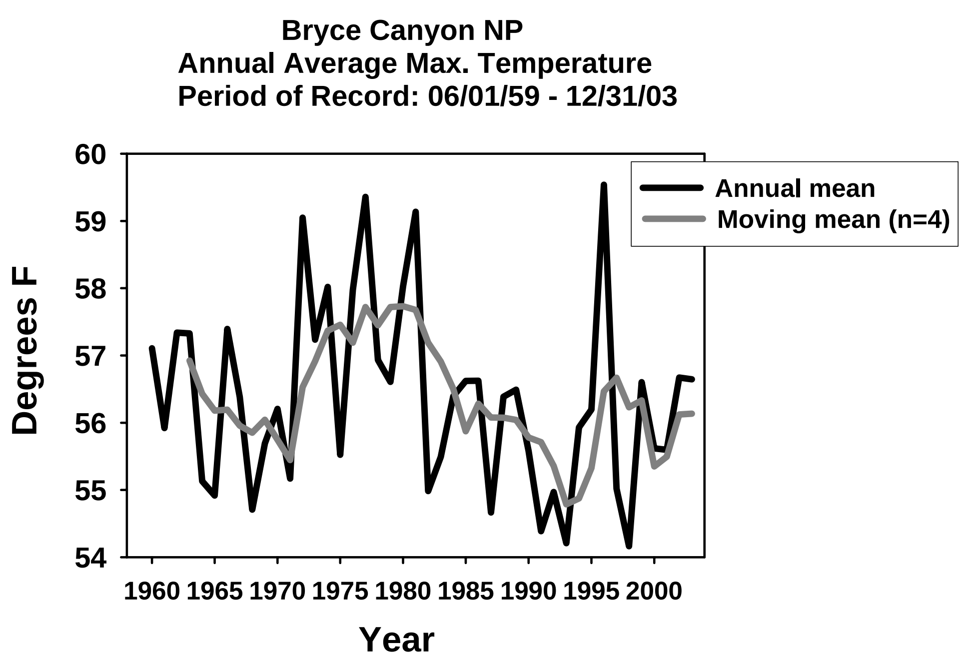


Figure 16-1. Example of a moving mean analysis of annual average maximum temperature. In this example, the moving mean shown for each year is derived from the average of the three preceding values plus the value for the year. In the web-tool version (see text), the user will be able to select the climate station, the climatic parameter, the period of record, and the moving-mean size parameter.

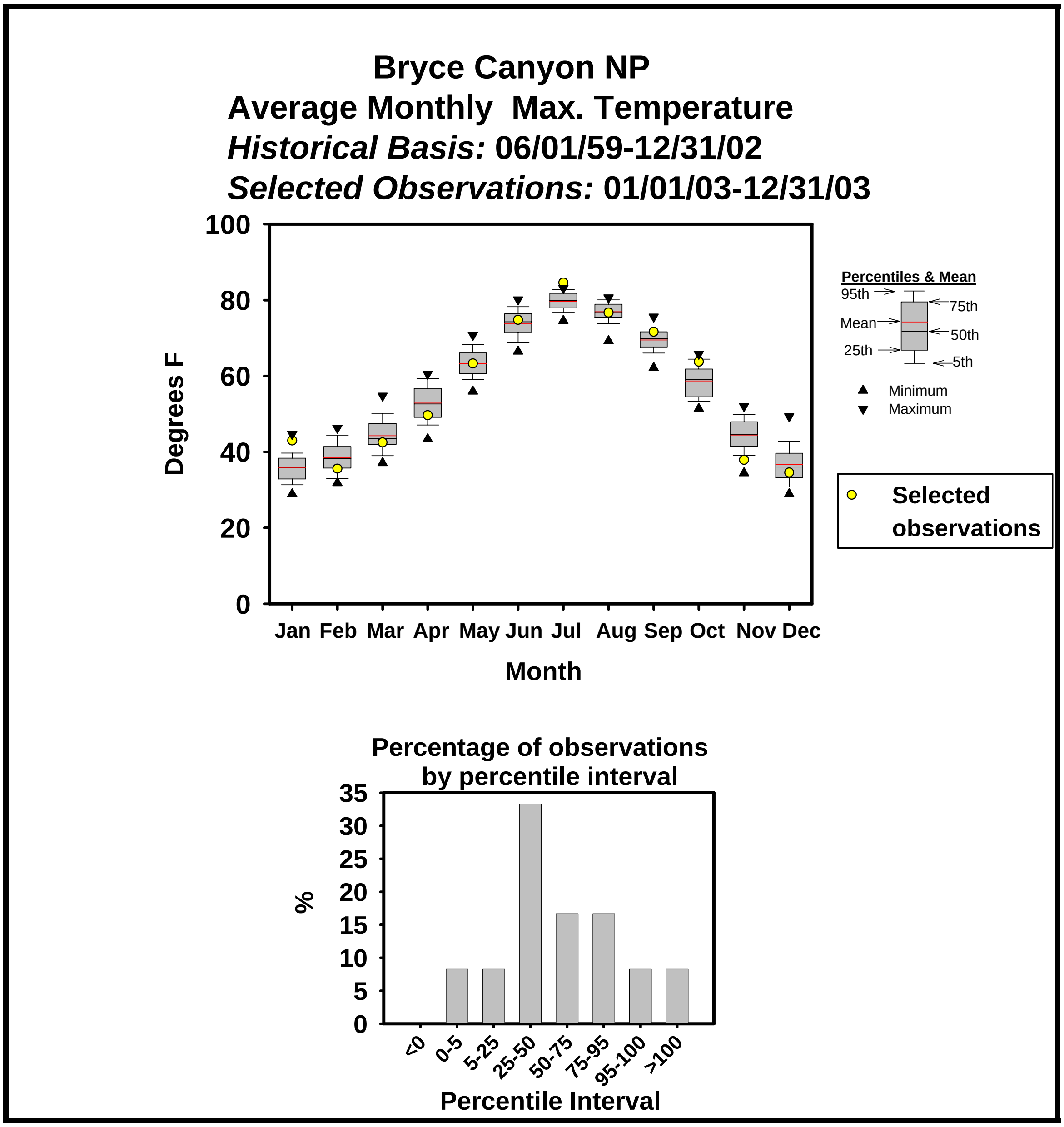


Figure 16-2. Example of an assessment of extremes in average monthly maximum temperature. In the top graph, historical data are graphed as Box-Whisker plots; observations from 2003 are plotted as filled circles. The bottom graph is a summary of the percentage of observations from 2003 that occurred within specified percentile intervals of the historical period of record. In the web-tool version (see text), the user will be able to select the climate station, the climatic parameter, the temporal bounds of the historical basis and of the selected observations, and the percentile intervals shown in the top graph and used in the descriptive summary shown in the bottom graph

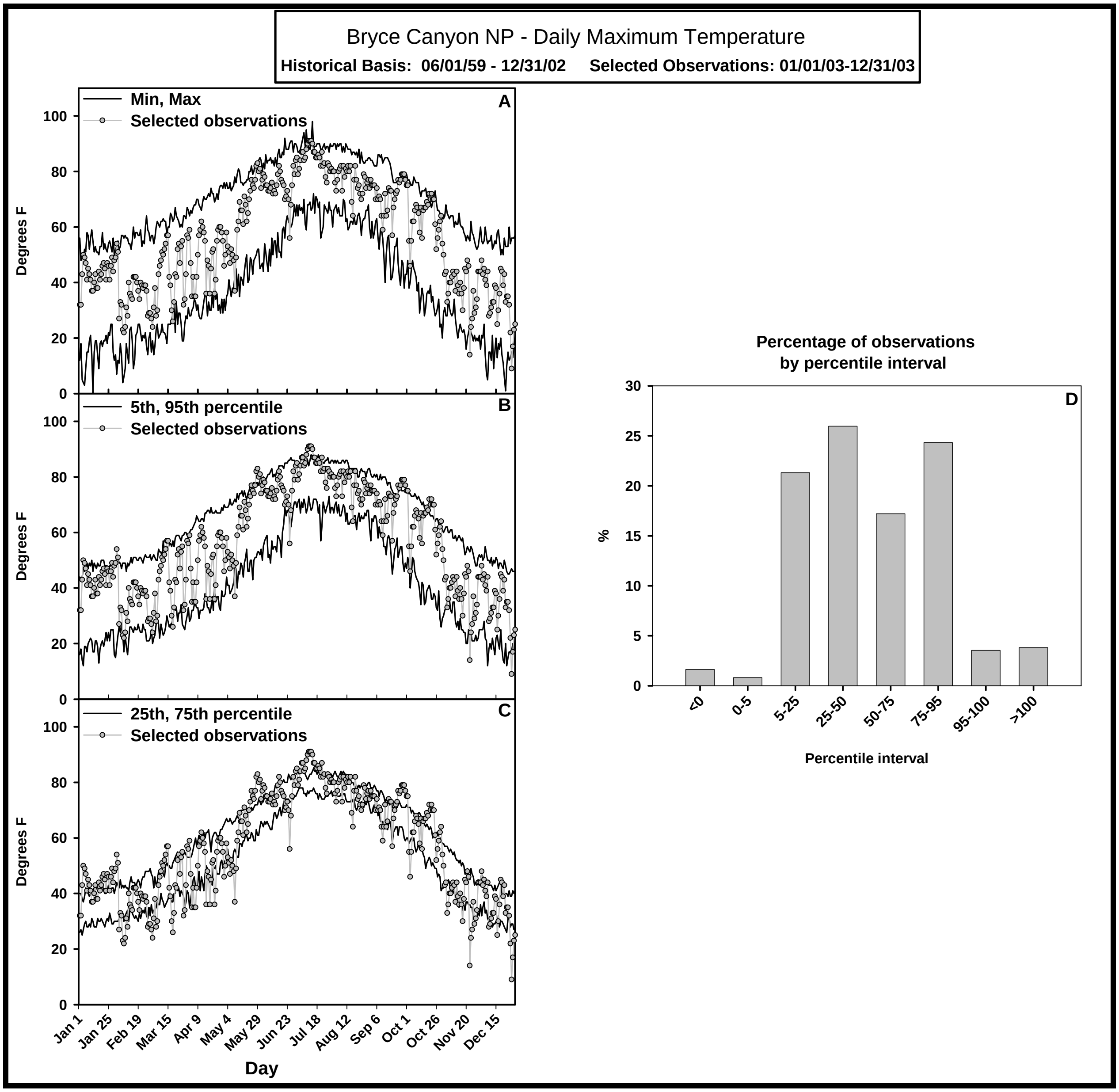


Figure 16-3. Example of an assessment of extremes in daily maximum temperature. Historical trends are shown as minimum and maximum (A), 5th and 95th percentiles (B), and 25th and 75th percentiles (C). Observations from 2003 are plotted as filled circles. Graph D is a summary of the percentage of observations from 2003 that occurred within specified percentile intervals of the historical period of record. In the web-tool version (see text), the user will be able to select the climate station, the climatic parameter, the temporal bounds of the historical basis and of the selected observations, and the percentile intervals shown in graphs A-C and used in the descriptive summary shown in graph D.

Procedures:

1. Summaries are generated using observations in the climate databases. Data in the five climate databases must first be translated to ASCII files using Access utilities. Use the ASCII conversion procedures described above in I.1.

2. Custom programs (source and executable) for illustrating trend and extremes information are stored in: X:\Vital_Signs\Climate\Data\Tools\Extremes\ . There are three programs, one for deriving annual trends (annualtrend.exe), one for illustrating monthly trends and extremes (monthlytrend.exe), and one for daily trends and extremes (dailytrend.exe). Each program can process data from all five databases. Navigate to this directory and click on the desired program. Programs have a standard set of queues followed by unique prompts reflecting the particulars of the specific analyses. The standard queues include:

1) Enter the name of the input ASCII data file
2) Enter the type of climate data [enter the number]
3) Enter the StationID
4) Select the climatic parameter [enter the number]
5) Enter the name of the output file

The input ASCII data file is the file generated in step #1 above. In queue #2, a numbered list of the climate data sets is displayed (1- NWS-Coop, 2- RAWS, 3- SNOTEL, 4- SNOWNET, 5- Snow Course). Station IDs are documented in appendices of the Climate Monitoring Protocol narrative: Appendix A – NWS-Coop stations; Appendix C - RAWS stations; Appendix D - SNOTEL and Snow Course; Appendix E -SNOWNET stations. A numbered list of possible parameters corresponding to the type of climate data is displayed in queue #4.

Additionally, the annualtrend.exe program queries for the temporal interval of interest (i.e., beginning and ending dates). The monthly and daily programs require specifying the temporal interval for the historical basis (i.e., beginning and ending dates) and for the period of record (i.e., beginning and ending dates) to compare with the historical basis.

The programs operate on one station and one parameter at a time. Thus, programs must be executed multiple times to derive information for all stations and climatic variables. Future enhancements are proposed for more automated and rapid processing.

3. Output from programs is graphed using the SigmaPlot package. The NCPN Data Manager will have a list of the computers on which SigmaPlot is installed. You must perform these procedures on one of these computers. Templates for the three graph types shown in Figs. 16-1 to 16-3 are available in: X:\Vital_Signs\Climate\Data\Tools\Extremes\. Annualtrend.jnb contains the annual trend graph, Monthlytrend.jnb contains the monthly trend graph, and dailytrend.jnb contains the daily trend graph. In SigmaPlot, open the desired notebook (i.e., a .jnb file) and import the corresponding data generated in step #2 above. Output from the programs

is formatted for the corresponding graph template. In the template, insert the data starting in row and column #1. This is accomplished by first highlighting the cell, then selecting the import function under the File menu. Plots will automatically update upon importing the data. Information in the graph title must be manually modified to reflect the station being examined, the climatic variable being graphed, and the period of record and temporal interval of the selected observations. Procedures for editing text in SigmaPlot are similar to those in MS wordprocessing packages; click on the text to be modified, then enter the edits. Once a graph has been created, it should be named and stored locally. The templates should be preserved for future use.

III. Network-wide Comparisons

Comparisons will consist, at a minimum, of arraying key climatic attributes along environmental gradients of NCPN park units, and a qualitative comparison of climatic extremes. Key climatic variables include mean annual minimum and maximum air temperature, and total annual precipitation. Climatic variables are arrayed along the basic environmental gradients, which include latitude, longitude, and elevation. The qualitative comparison of extremes evaluates trends in the percentage of observations that exceed a specific historical level.

Procedures:

1. Arraying climatic variables along environmental gradients will use the graphic features of SigmaPlot. The NCPN Data Manager will have a list of the computers on which SigmaPlot is installed. You must perform these procedures on one of these computers. Execute SigmaPlot and open the template called climategrad.jnb located in *X:\Vital_Signs\Climate\Data\Tool.* This notebook contains the names of the climate stations and their physical attributes, and data columns labeled by climate variable. Insert values from the annual summaries generated above into the corresponding columns. The standard graphs for each attribute will automatically update (e.g., Figs. 16-4, 16-5). Previous assessments with the historical period of record have determined correlations between physical attributes and each climatic parameter. Standardized graphs use the most highly correlated variable for the abscissa axis. For consistency among annual reports, the standard graphs should be produced. However, relationships between climatic and physical attributes of stations always can be re-examined; procedures for this are described below.

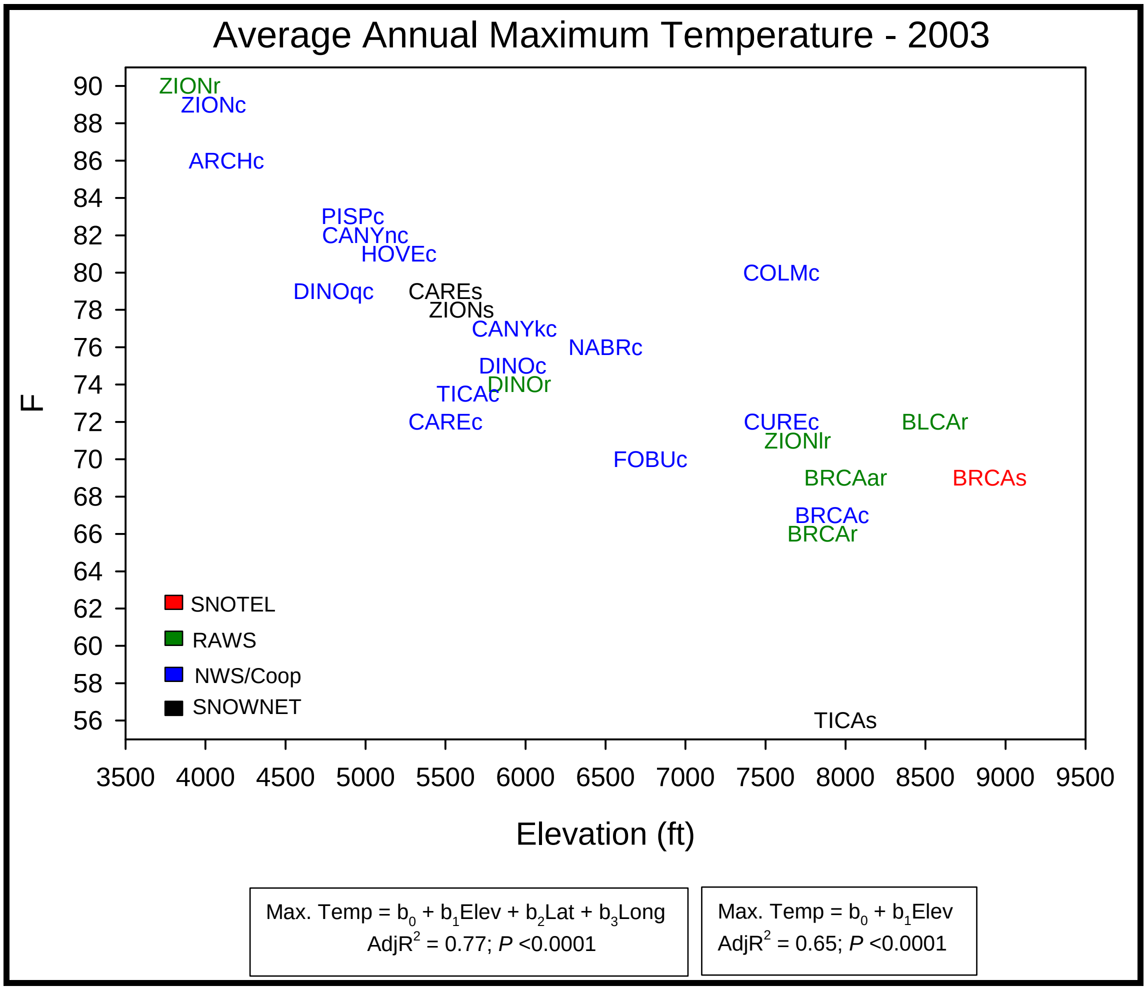


Figure 16-4. Comparison of average annual maximum temperature in 2003 among climate stations included in the NCPN climate databases. See Table 16-10 for legend.

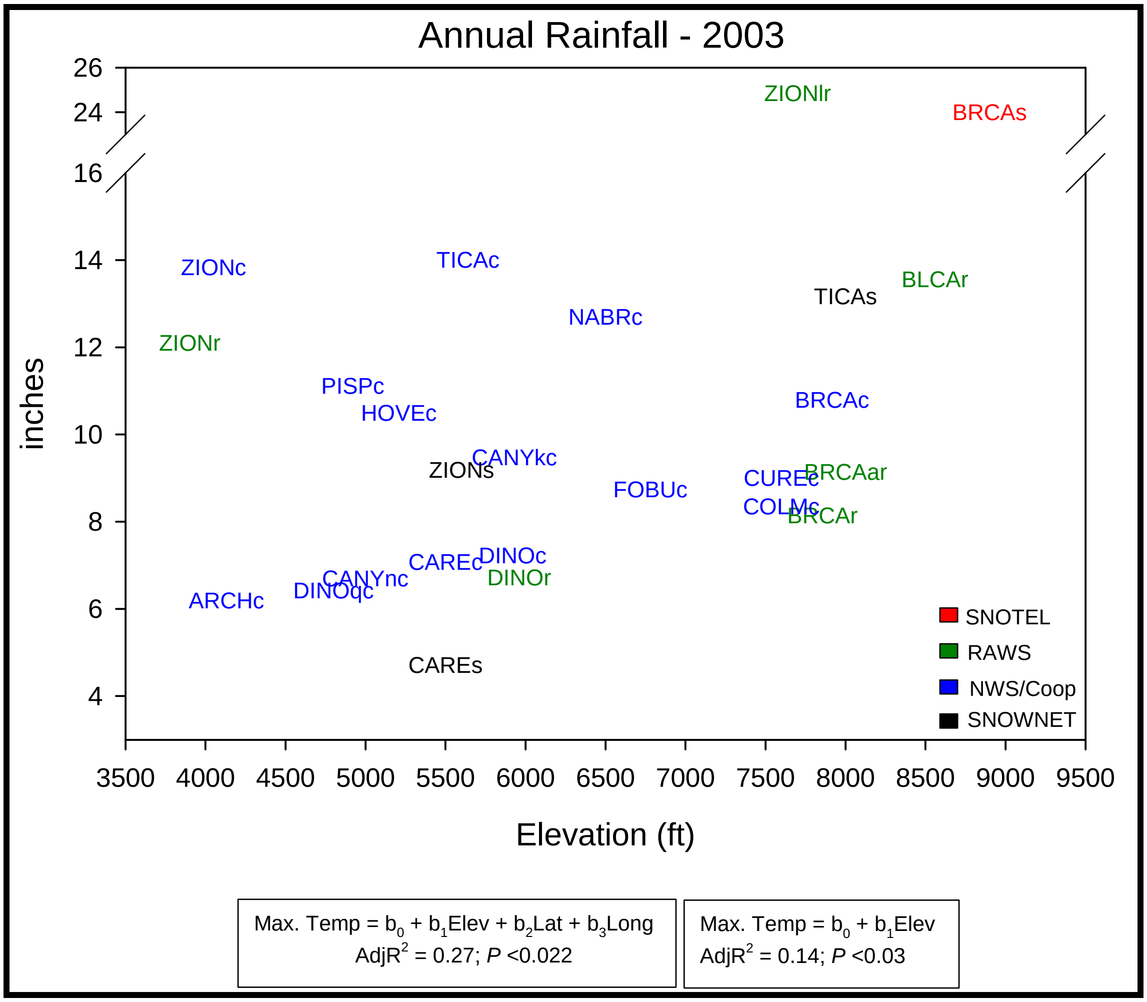


Figure 16-5. Comparison of annual rainfall in 2003 among climate stations included in the NCPN climate databases. See Table 16-10 for legend.

Table 16-10. Legend for Figures 16-4 and 16-5.

Climate Monitoring Program	Figure Code	Park/Station name	Climate Monitoring Program	Figure Code	Park/Station name
SNOTEL	BRCAs	BRCA – Agua Canyon	NWS/Coop	COLMc	COLM
RAWS	BLCAr	BLCA		CUREc	CURE
	BRCAar	BRCA – Agua Canyon		DINOqc	DINO/Quarry
	BRCAr	BRCA – Bryce Canyon		DINOc	DINO/National Monument
	DINOr	DINO		FOBUc	FOBU
	ZIONlr	ZION/Lava Pt.		HOVEc	HOVE
	ZIONr	ZION Headquarters		NABRc	NABR
NWS/Coop	ARCHc	ARCH		PISPc	PISP
	BLCAc	BLCA		TICAc	TICA
	BRCAc	BRCA		ZIONc	ZION
	CANYkc	CANY/ The Neck	SNOWNET	CAREs	CARE
	CANYnc	CANY/ The Needles		TICAs	TICA
	CAREc	CARE		ZIONs	ZION/East Gate

2. The statistical assessments shown in Figs. 16-4 and 16-5 illustrate the strength of linear relationships between the climatic parameter and the physical attributes of climate stations. The statistics are not generated automatically, but must be generated using other features in SigmaPlot**.** In SigmaPlot, select the Statistics menu, then Regression Wizard. Under Equation Category, select User Defined. Six equation names will appear. Equations were developed to assess linear relationships between all three physical attributes, and between a specific attribute and each of the three key climatic variables. Equations are named accordingly; e.g., <u>maxtempfull</u> for the regression of average maximum temperature on all three physical attributes (i.e., the full set of variables), <u>maxtempelev</u> for the regression of maximum temperature on elevation. Select the model of interest, then select the Run button. Results of the regression are displayed. These results must be manually transcribed to the statistical-results section of the graph. This simply requires editing the text of this section. Procedures for editing text in SigmaPlot are similar to those in MS wordprocessing packages; click on the text to be modified, then enter the edits.

There may be instances where customized regressions are desired. These can be performed in SigmaPlot. In SigmaPlot, select the Statistics menu, then Regression Wizard. Under Equation Category select User Defined. Highlight one of the provided equation names and select the Edit Code button on the right-hand side of the dialogue box. The equation can be modified as required and saved as a new, custom equation. Procedures for editing an equation are beyond the scope of this SOP. If assistance is required, contact the NCPN Data Manager or Ecologist for further instructions.

3. The qualitative comparison of climatic extremes will initially focus on describing trends in the percentage of observations of a climatic variable that exceed a specific historical level (e.g., trends in the percentage of months with precipitation <5^{th} percentile). The qualitative comparison of climatic extremes will require using the histograms produced in II above. For the key climatic variables, tally the percentage of monthly and daily observations below and above the 5^{th} and 95 percentiles, respectively. These tallies can be arrayed in a table and simply described. Alternatively, percentages can be arrayed along environmental gradients using the graph type shown in Fig. 16-4. Procedures described above in III.1 can be used to enter and graph percentages. Consistency in trends among park units, or along environmental gradients is a key feature to highlight in the accompanying narrative. Procedures for more comprehensive and standardized comparisons will be developed in the future.

IV. The Annual Climate Report

The annual climate report must be distributed by February of the following year to all park units with climate stations. The climate report will contain information specific to a park. Thus, a separate report must be generated for each park. Park-specific information will include the following for each climate station in a park unit:

- brief description of the climate station(s), including the associated climate-monitoring program, location information, a general overview of the station sensors, the period of record, and any equipment or data problems and issues that occurred during the year

- monthly summaries and the annual summary (e.g., Attachments A, B) for the full suite of climatic parameters reported by a climate station
- assessments of climatic extremes (annual, monthly, and daily trends for min. and max. temperature, total precipitation) (e.g., Figs. 16-1 to 16-3). This will include a brief narrative summarizing and interpreting the degree and magnitude of extremes

Additionally, each report will include the same network-wide comparisons of the key climatic parameters. The network section of the report will include:

- a table showing the types of stations in the network, and elevation and location information
- results of the graph-based comparisons (e.g., Figs. 16-4, 5), and a brief narrative that summarizes and interprets network-wide patterns for each climatic variable
- graphical comparisons, tables, and a narrative that summarizes and interprets network-wide patterns in climatic extremes for the key climatic variables

Reports must be written in NPS scientific format. Guidelines for this format can be found at:
http://www1.nrintra.nps.gov/pub-page/handbook/All2-04.htm#P1227_80620.

Attachment A. Monthly climate summary for Arches National Park – December 2003 (NWS-Coop Stn. ID – ANPU1).

December 2003	Temperature (°F)			Precipitation (in)		
Day	Minimum	Maximum	Average	Rainfall	Snowfall	Snowdepth
1	26	50	38	0	0	0
2	26	52	39	0	0	0
3	25	56	41	0	0	0
4	22	48	35	0	0	0
5	22	52	37	0	0	0
6	30	50	40	0	0	0
7	31	51	41	0	0	0
8	35	55	45	0.38	0	0
9	28	43	36	0.13	0	0
10	22	45	34	0	0	0
11	24	43	34	0	0	0
12	21	45	33	0	0	0
13	23	44	34	0	0	0
14	28	45	36	0	0	0
15	29	52	40	0.03	0	0
16	16	44	30	0	0	0
17	16	40	28	0	0	0
18	17	40	28	0	0	0
19	18	42	30	0	0	0
20	21	45	33	0	0	0
21	25	44	34	0	0	0
22	34	52	43	0	0	0
23	24	52	38	0	0	0
24	24	44	34	0	0	0
25	28	46	37	-	-	-
26	28	51	40	0.04	-	0
27	30	49	40	0	0	0
28	15	38	26	0	0	0
29	12	38	25	0	0	0
30	22	38	30	0.15	2	2
31	23	44	34	0.0	0	1
Minimum	12	38	25	-	-	1
Maximum	35	56	45	-	-	2
Average	24	46	35	-	-	-
Total	-	-	-	0.79	2	-
% Valid records	100	100	100	96.8	93.3	96.8

Climate Attribute	Number of days
Minimum Air Temp < 32° F	29
Minimum Air Temp < 17° F (5th percentile)	5
Maximum Air Temp < 32° F	0
Maximum Air Temp > 102° F (95th percentile)	0
Rainfall ≥ 0.01 in	6
Rainfall ≥ 0.1 in	3
Rainfall ≥ 1.0 in	0
Snowfall ≥ 0.01 in	1
Snowfall ≥ 0.1 in	1
Snowfall ≥ 1.0 in	1

Attachment B. Annual climate summary for Arches National Park, 2003 (NWS-Coop Stn. ID – ANPU1).

2003	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Minimum Air Temperature (°F)													
Min	20	16	21	28	32	52	62	60	40	28	12	12	32
Max	34	40	47	58	68	70	79	78	68	59	45	35	57
Average	25	29	35	41	48	61	70	67	53	45	31	24	44
No. of days													
≤ 17°F	0	2	0	0	0	0	0	0	0	0	3	5	10
≤ 32°F	30	19	7	7	1	0	0	0	0	1	16	29	110
% of days with valid records	100	100	100	100	100	100	100	100	100	100	100	100	100
Maximum Air Temperature (°F)													
Min	39	37	44	56	64	85	102	90	73	66	34	38	61
Max	59	61	78	83	104	102	116	107	100	95	71	56	86
Average	51	52	62	73	84	94	107	100	88	81	54	46	74
No. of days													
≥102°F	0	0	0	0	3	3	31	12	0	0	0	0	49
≤ 32°F	0	0	0	0	0	0	0	0	0	0	0	0	0
% of days with valid records	100	100	100	100	100	100	100	100	100	100	100	100	100
Precipitation Rainfall (in)													
Total	0.1	1.18	1.02	0.0	1.09	0.28	0.15	0.35	0.51	0.36	0.27	0.79	6.1
No. of days													
≥0.01”	2	7	6	1	4	4	2	6	3	4	5	6	50
≥ 0.1”	0	4	2	0	1	1	0	2	2	1	0	3	16
≥ 1.0”	0	0	0	0	0	0	0	0	0	0	0	0	0
% of days with valid records	100	100	100	96.7	100	100	100	100	100	100	96.7	96.8	99.2

Attachment B. cont.

2003	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Snowfall (in)													
Total	0	0	0	0	0	0	0	0	0	0	0	2	2.0
No. of days													
≥0.01”	0	0	0	0	0	0	0	0	0	0	0	1	1
≥ 0.1”	0	0	0	0	0	0	0	0	0	0	0	1	1
≥ 1.0”	0	0	0	0	0	0	0	0	0	0	0	1	1
% of days with valid records	100	100	100	100	100	100	100	100	100	100	93.3	93.3	98.9
Snow Depth (in)													
Average	0	0	0	0	0	0	0	0	0	0	0	0.10	-
% of days with valid records	100	100	100	100	100	100	100	100	100	100	90	96.8	98.9

Attachment C. CoopSummary.f source code.

```
c ****************************************************************************************************
        program coopsummary

c  Derives monthly and annual summaries for NWS/COOP climate stations.
c  Developed for:  NPS Northern Colorado Plateau Inventory and Monitoring Program (NCPN I&M).
c  Source and executable reside on NCPN I&M server: x:\Vital_Signs\Climate\Data\Tools\.

c       Version 1.0  12/15/04
c
c
c       Modifications (List Version number, date, reason for modification, and summarize
c               modifications):
c

c ****************************************************************************************************


c  Global Variables
c
c     store(x,y,z)    - daily climatic-parameter values
c                         x - climatic parameter
c                       1 - precipitation (in)
c                    2 - min. air temperature (F)
c                          3 - max . air temperature
c                          4 - average air temperature (derived)
c                          5 - snowfall (in)
c                          6 - snowdepth (in)
c                         y - month(1-12)
c                         x - day (1-31)

c       aver(x,y)   - monthly averages
c                         x - climatic parameter
c                         y - month (1-13, where 13 = annual average)


c       mmobs(x,y,z)      - minimum and maximum values
c                         x - climatic parameter
c                         y - month(1-13, where 13 = annual average)
c                         z - 1 - minimum
c                             2 - maximum

c       precip(x,y)- no. of days with rainfall >= 0.01, 0.1, 1.0 in.
c                         x - month (1-13, where 13 = annual average)
c                         y - 1 = no. of days >= 0.01
c                             2 = no. of days >0.1
c                             3 = no. of days >1.0

c       snowfall(x,y)     - no. of days with snowfall >= 0.01, 0.1, 1.0 in.
c                         x - month (1-13, where 13 = annual average)
c                         y - 1 = no. of days >= 0.01
c                             2 = no. of days >0.1
c                             3 = no. of days >1.0

c       total(x,y)   - monthly totals
c                         x - climatic parameter
c                         y - month (1-13, where 13 = annual sum)


c       tempn(x,y)- no. of days with daily min & max temperature <32F,
c                               and beyond specified percentiles
c                         x - month (1-13, where 13 = annual sum)
c                         y - 1 - no. of days min. temp <32 F
c                             2 - no. of days min. temp <5th percentile
c                             3 - no. of days max. temp <32 F
c                             4 - no. of days max. temp >95th percentile
```

```
c       vobs(x,y)  - percentage of valid observations per month
c                        x - climatic parameter
c                        y - month (1-13, where 13 = annual average)

c  Misc.
c       month(x)   - names of the 12 months
c                        x - month (1-12)

c       days(x)          - no. of days per month
c                        x - month (1-12)

c *********************
c  SubRoutines

c   AnnualSum - Derive annual summaries

c   Fileio - Opens file for recording monthly summaries

c   Initial - Initializes gobal variables

c   MinMax - Derive min & max of each climatic parameter, for each month

c   MonthSum - Derive monthly average and sums

c   OutputAnnual - Output annual summary

c   OutputMonth - Output monthly summary

c   Percentiles - Derive 5th, 95th percentiles for min., max. temperature, respectively,
c    from the historical record, then determine no. of days each month that
c    fall below/above percentiles in addition to no. of days
c    min. was below 32 F, and max. temp was below 32 F

c   PrecipDays - Derive no. of days with precip >= 0.01, .1, 1.0 inches

c   RecObs - Record number of valid observations each month, for each
c    climatic parametr

c   SetNull - Determines the summary variables that should be set to NULL due to
c          the lack of observations

c   SnowFallDays - Derive no. of days with snowfall >=0.01, 0.1, 1.0 inches

c   VDays - Derive percentage of days with valid observations


c ********************
c  Input Format - see Climate Monitoring Protocol SOP#10


c ********************
c  Output Format - see Climate Monitoring Protocol SOP#16

c       File name for monthly summaries:
c             [user-provided prefix][3-letter month code]
c       File name for annual summary:
c             [user-provided prefix]



c       Summary of processing steps:
c             1) User is queried for the name of the ascii file output by Coop_to_ascii.mdb utility
c             2) User is queried for StationID
c             3) User is queried for the year of the summary
c             4) User is queried for the prefix for output files
c             5) Measurement quality flag is checked for missing data.  If missing data
c             climatic-parameter variable is set to -9999
c             6) Data are stored by month, by day.  Routines are called to
c             summarize monthly and annual totals, averages, and no. of days
c             precipitation and snowfall were >=0.01, 0.1, 1.0 inches.
```

```
c                        7) The 5th percentile for min. temperature, and the 95th percentile for
c                         max. temperature are determined; and no. of days beyond percentiles
c                        and <32 F are derived.
c
c                        8) Output monthly and annual summaries
c
c
c
***************************************************************************************************
    common/dat1/store(6,12,31)
    common/dat2/vobs(6,13)
    common/dat3/mmobs(6,13,2)
    common/dat4/precip(13,3),snowfall(13,3)
    common/dat5/total(6,13),aver(6,13)
    common/dat6/tempn(13,4)
    common/dat7/prefix,fout,prefixcnt
    common/dat8/month(12),days(12)

    real    mmobs


    integer  stationid,year
    integer  prefixcnt
    integer  stnid,yr,mo,dd,hr
    integer  cid,stateid


    character filein*60,filean*60
    character month*15,prefix*60,fout*60

    character pcpnflag1*2,pcpnflag2*2,snflflag1*2,snflflag2*2
    character sndepthflag1*2,sndepthflg2*2,tmaxflag1*2,tmaxflag2*2
    character tminflag1*2,tminflag2*2


c ***************************************************************************************
c  initialize globals
    call Initial

c    Queue for input file name
    print*,"Enter name of file containing daily NWS-Coop data"
    print*,' '
    read*,filein
    open(10,file=filein)
    read(10,*,end=998)i
    rewind(10)


c    Queue for StationID
    print*,"Enter StationID"
    print*,' '
    read*,stationid


c    Queue for Year
    print*,"Enter Year [e.g., 1980]"
    print*,' '
    read*,year


c    Queue for file_name prefix
    print*,"Enter prefix for naming output files[57 letter max]"
    print*,' '
    read*,prefix

c    Set up file-name codes for output files
    call FnCode


c  If selected year is a leap year, then add one day to february
```

```
      if((year/4)*4 .eq.year) days(2)=days(2)+1


c     Queue for file name for storing annual summary
      print*,'Enter name of file for annual summary'
      print*,' '
      read*,filean


      open(12,file=filean)



c  open temp files for storing min. temperature & max. temperature
      open(13,file='temp1')
      open(14,file='temp2')
      open(15,file='temp3')


c ************************************************************************************
c  cid = climateID
c  stateid = state code
c  stnid - station ID
c  yr - year
c  mo - month
c  dd - day
c  hr - hour
c  pcpn (rainfall) in hundreths of inches
c  snfl (snowfall) in 10ths of inches

c  sndepth (snowdepth) in inches
c  tmax & tmin (air temp max & min) in degrees F
c  xxflag1 = measurement flag for climatic parameter xx
c  xxflag2 = data quality flag for climatic parameter xx


10    read(10,*,end=111)cid,stateid,stnid,yr,mo,dd,hr,pcpn,
     &pcpnflag1,pcpnflag2,snfl,snflflag1,snflflag2,sndepth,
     &sndepthflag1,sndepthflg2,tmax,tmaxflag1,tmaxflag2,tmin,
     &tminflag1,tminflag2

c  scale precip and snowfall to inches
      pcpn=pcpn*0.01
      snfl=snfl*0.1

c  check for missing obs
       if(pcpnflag1.eq.'M')pcpn=-9999
       if(snflflag1.eq.'M')snfl=-9999
       if(sndepthflag1.eq.'M')sndepth=-9999
       if(tmaxflag1.eq.'M')tmax=-9999
       if(tminflag1.eq.'M')tmin=-9999

       if(stationid.eq.stnid) then
         if(year.eq.yr) then
           store(1,mo,dd)=pcpn
           store(2,mo,dd)=tmin
           store(3,mo,dd)=tmax

c  derive 24-hr average
           if(tmin.ne.-9999 .or. tmax.ne.-9999) then
             ave=(tmin+tmax)/2.0
           else
             ave=-9999
           endif
           store(4,mo,dd)=ave
           store(5,mo,dd)=snfl
           store(6,mo,dd)=sndepth

           write(15,101)mo,tmin,tmax
101          format(i2,1x,2(f10.4,1x))
```

```
      else

c  If correct station and not summary year, then store min. & max. temperature
c    for later determination of percentiles.
         if(tmin.ne.-9999)then
           write(13,100)tmin
           tminn=tminn+1
100          format(f10.4)
         endif
         if(tmax.ne.-9999) then
           write(14,100)tmax
           tmaxn=tmaxn+1
         endif
      endif
     endif
    goto 10
c ****************************************************************************************

c  close all files; rewind FN=15 [min., max. temp for summary year]
111   close(10)
    close(13)
    close(14)
    rewind(15)


c  derive number of valid observations
    call RecObs

c  derive min/max of climatic parameter
    call MinMax

c  derive no. of days for precip limits
    call PrecipDays

c  derive no. of days for snowfall limits
    call SnowFallDays

c  derive monthly average and totals
    call MonthSum

c  derive percentage of days with valid observations
    call VDays

c  derive no. of days min. & max. temperature were outside percentiles
    call Percentiles(tminn,tmaxn,tminvalue,tmaxvalue)


c  derive annual summaries
    call AnnualSum

c  output monthly summaries, then annual summary
    call SetNull
    call OutputMonth(tminvalue,tmaxvalue,stationid,year)
    call OutputAnnual(tminvalue,tmaxvalue,stationid,year)

    goto 999

998   print*,'ERROR, FILE DOES NOT EXIST'


c  clean up temp files
999   call system('del temp1')
    call system('del temp2')
    call system('del temp3')
    call system('del temp')
    stop
    end
```

```
c ****************************************************************
c    subroutine AnnualSum
c    Derive annual summaries
c ****************************************************************
      subroutine AnnualSum
      common/dat2/vobs(6,13)
      common/dat3/mmobs(6,13,2)
      common/dat4/precip(13,3),snowfall(13,3)
      common/dat5/total(6,13),aver(6,13)
      common/dat6/tempn(13,4)
      common/dat8/month(12),days(12)

      real      mmobs
      character month*15


      do 10 i=1,6
        do 20 j=1,12
          if(mmobs(i,j,1).ne.-9999)then
            mmobs(i,13,1)=mmobs(i,13,1)+mmobs(i,j,1)
          endif
          if(mmobs(i,j,2).ne.-9999)then
            mmobs(i,13,2)=mmobs(i,13,2)+mmobs(i,j,2)
          endif
          if(aver(i,j).ne.-9999) then
            aver(i,13)=aver(i,13)+aver(i,j)
          endif
          if(total(i,j).ne.-9999) then
            total(i,13)=total(i,13)+total(i,j)
          endif
          if(vobs(i,j).ne.-9999) then
            vobs(i,13)=vobs(i,13)+vobs(i,j)
          endif
20      continue
        mmobs(i,13,1)=mmobs(i,13,1)/12.0
        mmobs(i,13,2)=mmobs(i,13,2)/12.0
        aver(i,13)=aver(i,13)/12.0
        vobs(i,13)=vobs(i,13)/12.0
10    continue


      do 30 i=1,12
        tempn(13,1)=tempn(13,1)+tempn(i,1)
        tempn(13,2)=tempn(13,2)+tempn(i,2)
        tempn(13,3)=tempn(13,3)+tempn(i,3)
        tempn(13,4)=tempn(13,4)+tempn(i,4)

        precip(13,1)=precip(13,1)+precip(i,1)
        precip(13,2)=precip(13,2)+precip(i,2)
        precip(13,3)=precip(13,3)+precip(i,3)
30    continue

      return
      end



c ****************************************************************
c    subroutine Fileio(month)
c    Opens file for recording monthly summaries
c ****************************************************************
      subroutine Fileio(i)
      common/dat7/prefix,fout,prefixcnt
      integer prefixcnt
      character fout*60,prefix*60


c  append month & year to fout
```

```
c  i = month
     if(i.eq.1) then
       fout(prefixcnt+1:prefixcnt+3)='jan'
       open(11,file=fout)
     else if(i.eq.2) then
       fout(prefixcnt+1:prefixcnt+3)='feb'
       open(11,file=fout)
     else if(i.eq.3) then
       fout(prefixcnt+1:prefixcnt+3)='mar'
       open(11,file=fout)
     else if(i.eq.4) then
       fout(prefixcnt+1:prefixcnt+3)='apr'
       open(11,file=fout)
     else if(i.eq.5) then
       fout(prefixcnt+1:prefixcnt+3)='may'
       open(11,file=fout)
     else if(i.eq.6) then
       fout(prefixcnt+1:prefixcnt+3)='jun'
       open(11,file=fout)
     else if(i.eq.7) then
       fout(prefixcnt+1:prefixcnt+3)='jul'
       open(11,file=fout)
     else if(i.eq.8) then
       fout(prefixcnt+1:prefixcnt+3)='aug'
       open(11,file=fout)
     else if(i.eq.9) then
       fout(prefixcnt+1:prefixcnt+3)='sep'
       open(11,file=fout)
     else if(i.eq.10) then
       fout(prefixcnt+1:prefixcnt+3)='oct'
       open(11,file=fout)
     else if(i.eq.11) then
       fout(prefixcnt+1:prefixcnt+3)='nov'
       open(11,file=fout)
     else if(i.eq.12) then
       fout(prefixcnt+1:prefixcnt+3)='dec'
       open(11,file=fout)
     else
      print*,'ERROR in file_name assignment ',i
      stop
     endif
     return
     end


c ***************************************************************
c     subroutine FnCode
c     Sets up file-name codes for output files
c ***************************************************************
     subroutine FnCode
     common/dat7/prefix,fout,prefixcnt
     integer year,prefixcnt
     character prefix*60,fout*60

c  set prefix into fout
     prefixcnt=0

     do 10 i=1,60
       if(prefix(i:i).ne. " ") then
          fout(i:i)=prefix(i:i)
       else
          if(prefixcnt.eq.0)prefixcnt=i-1
          goto 20
       endif
10     continue
20     continue
     return
     end
```

```
c ****************************************************************
c     subroutine Initial
c     Initializes gobal variables
c ****************************************************************
      subroutine Initial
      common/dat1/store(6,12,31)
      common/dat8/month(12),days(12)

      character month*15



c  initialize days()
      do 10 i=1,12
        days(i)=31
10    continue
      days(2)=28
      days(4)=30
      days(6)=30
      days(9)=30
      days(11)=30


c  initialize months()
      month(1)='January'
      month(2)='February'
      month(3)='March'
      month(4)='April'
      month(5)='May'
      month(6)='June'
      month(7)='July'
      month(8)='August'
      month(9)='September'
      month(10)='October'
      month(11)='November'
      month(12)='December'


      do 20 i=1,6
      do 20 j=1,12
      do 20 k=1,31
        store(i,j,k)=-9999
20    continue

      return
      end



c ****************************************************************
c     subroutine MinMax
c     Derive min & max of each climatic parameter, for each month
c ****************************************************************
      subroutine MinMax
      common/dat1/store(6,12,31)
      common/dat3/mmobs(6,13,2)
      real mmobs

c  Initialize mmobs
      do 10 i=1,6
        do 20 j=1,12
          mmobs(i,j,1)=-9999
          mmobs(i,j,2)=-9999
20      continue
10    continue
```

```
c  derive min, max values
      do 30 i=1,6
        do 40 j=1,12
           do 50 k=1,31
              if(store(i,j,k).ne.-9999) then

c  derive minimum
                if(mmobs(i,j,1).eq.-9999) then
                   mmobs(i,j,1)=store(i,j,k)
                else
                   if(store(i,j,k).lt.mmobs(i,j,1))
     &                         mmobs(i,j,1)=store(i,j,k)
                endif

c  derive maximum
                if(store(i,j,k).gt.mmobs(i,j,2))
     &              mmobs(i,j,2)=store(i,j,k)
              endif
50         continue
40      continue
30    continue

      return
      end



c ****************************************************************
c     subroutine MonthSum
c     Derive monthly average and sums
c ****************************************************************
      subroutine MonthSum
      common/dat1/store(6,12,31)
      common/dat2/vobs(6,13)
      common/dat5/total(6,13),aver(6,13)



      do 10 i=1,6
        do 20 j=1,12
          do 30 k=1,31
            if(store(i,j,k).ne.-9999) then
               total(i,j)=total(i,j)+store(i,j,k)
            endif
30          continue
          if(vobs(i,j).le.0) then
            aver(i,j)=-9999
          else
            aver(i,j)=total(i,j)/vobs(i,j)
          endif
20        continue
10      continue
      return
      end



c ****************************************************************
c     subroutine OutputAnnual(tminvalue,tmaxvalue,stationid,year)
c     Output annual summary
c ****************************************************************
      subroutine OutputAnnual(tminvalue,tmaxvalue,stationid,year)
      common/dat1/store(6,12,31)
      common/dat2/vobs(6,13)
      common/dat3/mmobs(6,13,2)
      common/dat4/precip(13,3),snowfall(13,3)
      common/dat5/total(6,13),aver(6,13)
      common/dat6/tempn(13,4)
```

```
      common/dat8/month(12),days(12)
      real mmobs
      integer stationid,year
      character month*15

      write(12,50)stationid,year,int(tminvalue),int(tmaxvalue)
50    format(i10,2x,i4,1x,'5th & 95th Temp. Percentiles= ',i10,1x,i10)

c  output min. temperature
      write(12,101)(int(mmobs(2,k,1)),k=1,13)
      write(12,101)(int(mmobs(2,k,2)),k=1,13)
      write(12,101)(int(aver(2,k)),k=1,13)
      write(12,101)(int(tempn(k,1)),k=1,13)
      write(12,101)(int(tempn(k,2)),k=1,13)
      write(12,102)(vobs(2,k),k=1,13)

      write(12,500)
500   format(' ')

c  output max temperature
      write(12,101)(int(mmobs(3,k,1)),k=1,13)
      write(12,101)(int(mmobs(3,k,2)),k=1,13)
      write(12,101)(int(aver(3,k)),k=1,13)
      write(12,101)(int(tempn(k,3)),k=1,13)
      write(12,101)(int(tempn(k,4)),k=1,13)
      write(12,102)(vobs(3,k),k=1,13)
      write(12,500)

c  output average temperature
      write(12,101)(int(mmobs(4,k,1)),k=1,13)
      write(12,101)(int(mmobs(4,k,2)),k=1,13)
      write(12,101)(int(aver(4,k)),k=1,13)
      write(12,102)(vobs(4,k),k=1,13)
      write(12,500)

c  output precipitation
      write(12,100)(mmobs(1,k,1),k=1,13)
      write(12,100)(mmobs(1,k,2),k=1,13)
      write(12,100)(aver(1,k),k=1,13)
      write(12,100)(total(1,k),k=1,13)
100   format(13(f5.2,1x))

      write(12,101)(int(precip(k,1)),k=1,13)
      write(12,101)(int(precip(k,2)),k=1,13)
      write(12,101)(int(precip(k,3)),k=1,13)

101   format(13(i3,1x))

      write(12,102)(vobs(1,k),k=1,13)
102   format(13(f5.1,1x))
      write(12,500)

c  output snowfall
      write(12,102)(mmobs(5,k,1),k=1,13)
      write(12,102)(mmobs(5,k,2),k=1,13)
      write(12,102)(aver(5,k),k=1,13)
      write(12,102)(total(5,k),k=1,13)
      write(12,101)(int(snowfall(5,1)),k=1,13)
      write(12,101)(int(snowfall(5,2)),k=1,13)
      write(12,101)(int(snowfall(5,3)),k=1,13)
      write(12,102)(vobs(5,k),k=1,13)
      write(12,500)

c  output snowdepth
      write(12,102)(mmobs(6,k,1),k=1,13)
      write(12,102)(mmobs(6,k,2),k=1,13)
      write(12,102)(aver(6,k),k=1,13)
      write(12,102)(vobs(6,k),k=1,13)

      return
```

```
      end


c ****************************************************************
c     subroutine OutputMonth(tminvalue,tmaxvalue,stationid,year)
c     Output monthly summary.  tmin and tmax value are the
c     5th and 95th percentiles for min, and max. temperature,
c     respectively
c ****************************************************************
      subroutine OutputMonth(tminvalue,tmaxvalue,stationid,year)
      common/dat1/store(6,12,31)
      common/dat2/vobs(6,13)
      common/dat3/mmobs(6,13,2)
      common/dat4/precip(13,3),snowfall(13,3)
      common/dat5/total(6,13),aver(6,13)
      common/dat6/tempn(13,4)
      common/dat8/month(12),days(12)
      real mmobs
      integer stationid,year
      character month*15

c  i = month
      do 10 i=1,12
       call fileio(i)

       write(11,50)stationid,month(i),year
50     format(i10,2x,a15,2x,i4)

       do 20 j=1,int(days(i))
        write(11,100)j,(int(store(k,i,j)),k=2,4),store(1,i,j),
     &(store(k,i,j),k=5,6)
100      format(i2,1x,3(i3,1x),3(f5.2,1x))
20     continue

       write(11,200)(int(mmobs(k,i,1)),k=2,4),
     &mmobs(1,i,1),(mmobs(k,i,1),k=5,6)

       write(11,200)(int(mmobs(k,i,2)),k=2,4),
     &mmobs(1,i,2),(mmobs(k,i,2),k=5,6)

       write(11,200)(int(aver(k,i)),k=2,4),aver(1,i),
     &(aver(k,i),k=5,6)
       write(11,201)total(1,i),total(5,i)
200    format(t4,3(i3,1x),3(f5.2,1x))
201    format(t16,2(f5.2,1x))


       write(11,300)(vobs(k,i),k=2,4),vobs(1,i),(vobs(l,i),l=5,6)
300    format(t4,6(f5.1,1x))


       write(11,400) int(tminvalue),(int(tempn(i,k)),k=1,2)
400    format('No. days with Min Temp <32,  <',i3,t47,2(i3,1x))
       write(11,401) int(tmaxvalue),(int(tempn(i,k)),k=3,4)
401    format('No. days with Max Temp <32,  >',i3,t47,2(i3,1x))

       write(11,500) (int(precip(i,k)),k=1,3)
500    format('No. days with Precip >= 0.01, 0.1, 1.0 ',t47,3(i3,1x))
       write(11,501) (int(snowfall(i,k)),k=1,3)
501    format('No. days with Snowfall >= 0.01, 0.1, 1.0 ',t47,3(i3,1x))

       close(11)

10    continue
      return
      end
```

```
c ****************************************************************************
c     subroutine Percentiles
c     Derive 5th, 95th percentiles for min., max. temperature, respectively,
c     from the historical record, then determine no. of days each month that
c     fall below/above percentiles in addition to no. of days
c     min. was below 32 F, and max. temp was below 32 F
c ****************************************************************************
      subroutine Percentiles(tminn,tmaxn,tminvalue,tmaxvalue)
c  tminn - no. of min. temp records - SET in main
c  tmaxn - number of max. temp records - SET in main
c  tminvalue - the 5th percentile for min. temperature - SET here
c  tmaxvalue - the 95th percentile for max. temperature - SET here

      common/dat6/tempn(13,4)

c  find 5th percentile for min. temperature
      call system('del temp')
      call system('sort <temp1 >temp')
      index = int(.05*tminn)
      open(10,file='temp')
      do 20 i=1,index
        read(10,*)value
20    continue
      close(10)
      tminvalue=value
c       print*,tminvalue,tminn,index



c  find 95th percentile for max. temperature
      call system('del temp')
      call system('sort <temp2 >temp')
      index = int(.95*tmaxn)
      open(10,file='temp')
      do 30 i=1,index
        read(10,*)value

30    continue
      close(10)
      tmaxvalue=value
c       print*,tmaxvalue,tmaxn,index




c  determine no. of days below 32F & 5th percentile for min. temp.
c  determine no. of days below 32F & >95th percentile for max. temp
35    read(15,*,end=222)mo,tmin,tmax
      if(tmin.ne.-9999) then
         if(tmin.lt.tminvalue)tempn(mo,2)=tempn(mo,2)+1
         if(tmin.lt.32)tempn(mo,1)=tempn(mo,1)+1
      endif
      if(tmax.ne.-9999)then
         if(tmax.gt.tmaxvalue) tempn(mo,4)=tempn(mo,4)+1
         if(tmax.lt.32)tempn(mo,3)=tempn(mo,3)+1
      endif
      goto 35
222   close(15)
      return
      end




c *******************************************************************
c     subroutine PrecipDays
c     Derive no. of days with precip >= 0.01, .1, 1.0 inches
c *******************************************************************
      subroutine PrecipDays
      common/dat1/store(6,12,31)
```

```
      common/dat4/precip(13,3),snowfall(13,3)

c  store(1,,) = total precipitation
      do 10 i=1,1
        do 20 j=1,12
          do 30 k=1,31
            if(store(i,j,k).ne.-9999) then
              if(store(i,j,k).ge. 0.01)precip(j,1)=precip(j,1)+1
              if(store(i,j,k).ge. 0.1)precip(j,2)=precip(j,2)+1
              if(store(i,j,k).ge. 1.0)precip(j,3)=precip(j,3)+1
            endif
30        continue
20      continue
10    continue

      return
      end



c ****************************************************************
c     subroutine RecObs
c     Record number of valid observations each month, for each
c     climatic parametr
c ****************************************************************
      subroutine RecObs
      common/dat1/store(6,12,31)
      common/dat2/vobs(6,13)
      do 10 i=1,6
        do 20 j=1,12
          do 30 k=1,31
             if(store(i,j,k).ne.-9999)vobs(i,j)=vobs(i,j)+1
30        continue
20      continue
10    continue
      return
      end



c ****************************************************************
c     subroutine SetNull
c     Sets values to null where appropriate.  This the last
c     step before outputing monthly and annual summaries.
c ****************************************************************
      subroutine SetNull
      common/dat1/store(6,12,31)
      common/dat2/vobs(6,13)
      common/dat3/mmobs(6,13,2)
      common/dat4/precip(13,3),snowfall(13,3)
      common/dat5/total(6,13),aver(6,13)
      common/dat6/tempn(13,4)

      real mmobs


c  check precipitation
      do 10 i=1,13
        if(vobs(1,i).le.0) then
           aver(1,i)=-9999
           total(1,i)=-9999
           precip(i,1)=-9999
           precip(i,2)=-9999
           precip(i,3)=-9999
           mmobs(1,i,1)=-9999
           mmobs(1,i,2)=-9999
        endif
10    continue
```

```
c  check snowfall
     do 20 i=1,13
       if(vobs(5,i).le.0) then
          aver(5,i)=-9999
          total(5,i)=-9999
          snowfall(i,1)=-9999
          snowfall(i,2)=-9999
          snowfall(i,3)=-9999
          mmobs(5,i,1)=-9999
          mmobs(5,i,2)=-9999
       endif
20     continue


c  check min. temperature
     do 30 i=1,13
       if(vobs(2,i).le.0) then
          aver(2,i)=-9999
          tempn(i,1)=-9999
          tempn(i,2)=-9999
          mmobs(2,i,1)=-9999
          mmobs(2,i,2)=-9999
       endif
30     continue

c  check max temperature
     do 40 i=1,13
       if(vobs(3,i).le.0) then
          aver(3,i)=-9999
          tempn(i,3)=-9999
          tempn(i,4)=-9999
          mmobs(3,i,1)=-9999
          mmobs(3,i,2)=-9999
       endif
40     continue


c  check all other climatic parameters
     do 60 i=4,6
      do 50 j=1,13
       if(vobs(i,j).le.0) then
         mmobs(i,j,1)=-9999
         mmobs(i,j,2)=-9999
         aver(i,j)=-9999
       endif
50      continue
60     continue
     return
     end



c ****************************************************************
c     subroutine SnowFallDays
c     Derive no. of days with snowfall >= 0.01, 0.1, 1.0 inches
c ****************************************************************
     subroutine SnowFallDays
     common/dat1/store(6,12,31)
     common/dat4/precip(13,3),snowfall(13,3)

c  store(5,,) = snowfall
     do 10 i=5,5
       do 20 j=1,12
         do 30 k=1,31
           if(store(i,j,k).ne.-9999) then
             if(store(i,j,k).ge. 0.01)snowfall(j,1)=snowfall(j,1)+1
             if(store(i,j,k).ge. 0.1)snowfall(j,2)=snowfall(j,2)+1
             if(store(i,j,k).ge. 1.0)snowfall(j,3)=snowfall(j,3)+1
           endif
```

```
30        continue
20      continue
10    continue

      return
      end




c ****************************************************************
c     subroutine VDays
c     Derive percentage of days with valid observations
c ****************************************************************
      subroutine VDays
      common/dat2/vobs(6,13)
      common/dat8/month(12),days(12)

      character month*15


      do 10 i=1,6
        do 20 j=1,12
          vobs(i,j)=(vobs(i,j)/days(j))*100.0
20      continue
10    continue
      return
      end
```

Attachment D – Web-based Application for Climate Reporting

Web-Based Climate Reporting

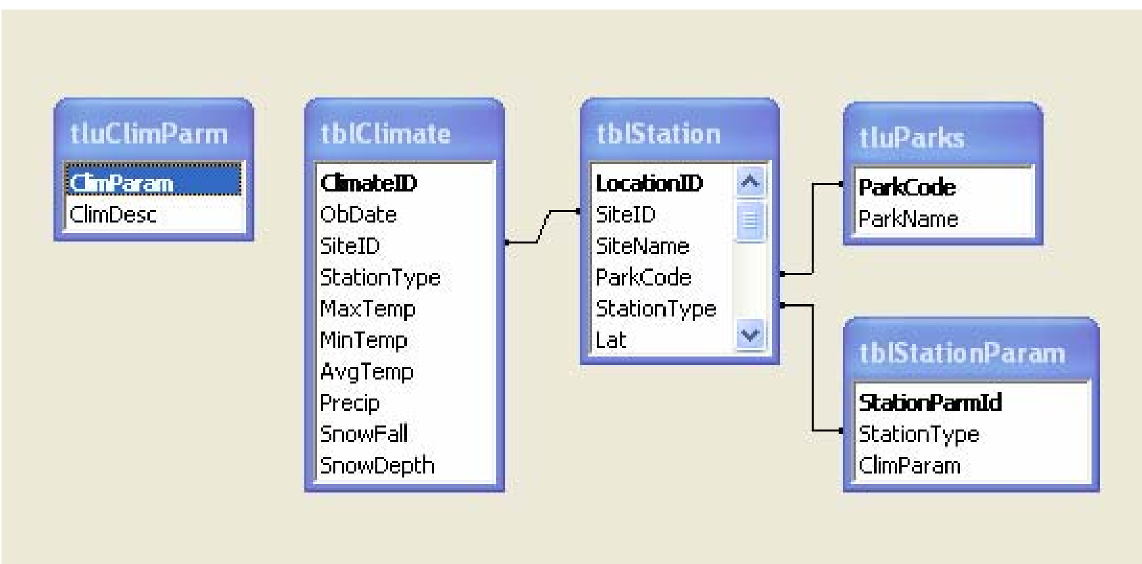
Web-based climate reporting has been developed to provide a quick and easy means to view comparative data from climate stations in or adjacent to NCPN park units. The initial version of this application provides simple graphs based on a selected climate station, climatic parameter, temporal parameter and date range. This application is based on the Cold Fusion application development tool which provides dynamic, data-driven web database connectivity.

The data and corresponding Cold Fusion programs for this web-based tool reside in an NCPN directory established on a secure web server maintained by the NPS in Ft. Collins, CO. Cold Fusion files include:

ClimSelect.cfm: station, climatic parameter, and temporal parameter selection
ClimDates.cfm: date range parameters selection
ClimChart.cfm: daily graph
ClimChartMonth.cfm: monthly graph
ClimChartAnnual.cfm: annual graph

Web Climate Database

Data for web climate reporting are stored in CfClimate.mdb which resides in the Database directory of the NCPN website. This database contains a subset of climate data maintained by NCPN and is optimized for Cold Fusion performance. As a result, the database does not always follow normalization guidelines.



Data model for the web-based climate reporting database, CfClimate.mdb. The primary table for the database is tblClimate, which contains one record for each observation date for all climate stations in the reporting network. Related to tblClimate is tblStation which contains one record for each climate station. Related to tblStation is tluParks which contains the park name for the selected station and tblStationParam which cross-references the selected station type with its available climatic parameters. Also shown is tluClimParm which provides a description of the climatic parameter for page headings and graph labels.

Documentation of database tables

Table: **tblClimate**
Description: Primary table that stores climate data. This table contains one record for each climate station for each observation date. Observation fields store -9999 for all values for which the station does not have a valid observation for that date.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
ClimateID	Unique record ID	dbLong	4
ObDate	Observation date mm/dd/yy	dbDate	8
SiteID	Station ID - foreign key to tblStation	dbText	20
StationType	Station type - foreign key to tblStationType	dbByte	1
MaxTemp	Maximum temperature - degrees Fahrenheit	dbSingle	4
MinTemp	Minimum temperature - degrees Fahrenheit	dbSingle	4
AvgTemp	Average temperature - degrees Fahrenheit	dbSingle	4
Precip	Precipitation in hundredths of inches	dbSingle	4
SnowFall	24 hour snowfall in tenths of inches	dbSingle	4
SnowDepth	Accumulated snow depth in inches	dbInteger	2

Table: **tblStation**
Description: Table for storing detailed information about climate station. There is one record for each climate station.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
LocationID	Unique Record Identifier	dbLong	4
SiteID	Station ID	dbText	20
SiteName	Station Name	dbText	25
ParkCode	Park Code	dbText	4
StationType	Type of climate station	dbByte	1
Lat	Station latitude	dbText	10
Long	Station longitude	dbText	10
UTMN	Station coordinate UTM North	dbText	10
UTME	Station coordinate UTM East	dbText	10
ELEF	Elevation in feet	dbInteger	2
ELEM	Elevation in meters	dbInteger	2
Period	Period of record	dbText	20
NetworkA	Member of Climate Network A - Data are used to describe the climate of the United States	dbBoolean	1
NetworkB	Member of Climate Network B - Data are used to support NWS hydrological programs	dbBoolean	1
NetworkC	Member of Climate Network C - Data are used to support meterological forecast and warning	and public service programs of the NWS.	dbBoolean
TypeDescription	Description of Station Type	dbText	50

Table: **tblStationParam**
Description: Table storing available climatic parameters for each climate station. When user selects a climate station, the corresponding parameters will appear in the select box.

FIELD NAME	FIELD_DESCRIPTION	FIELD TYPE	FIELD WIDTH
StationParamId	Unique record identifier	dbLong	4
StationType	Climate station type	dbByte	1
ClimParam	Climate parameter code - external key to tluClimParm	dbByte	1

Table: **tluParks**
Description: Lookup table containing the 4-character park code, and park name.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
ParkCode	Four-letter park abbreviation	dbText	4
ParkName	Full Name of park	dbText	50

Table: **tluClimParam**
Description: Lookup table that stores the climate parameter description.

FIELD NAME	FIELD DESCRIPTION	FIELD TYPE	FIELD WIDTH
ClimParam	Parameter number - unique record identifier	dbByte	1
ClimDesc	Parameter description	dbText	20

Populating the Climate Database

The CfClimate database is populated through frmImportClimate. This form contains one button to import each type of climate data from Access databases residing on the NCPN server: CoopClimate.mdb, SnowCourseClimate.mdb, SNOWNETClimate.mdb, SNOTELClimate.mdb, and RAWSClimate.mdb. The appropriate climate database table must be linked to CfClimate prior to clicking the button. When the import button is clicked, the program reads the external database, performs any necessary data manipulation such as conversion from Centigrade to Fahrenheit, and writes records to tblClimate. Fields for which the selected station type does not record data are filled with -9999.

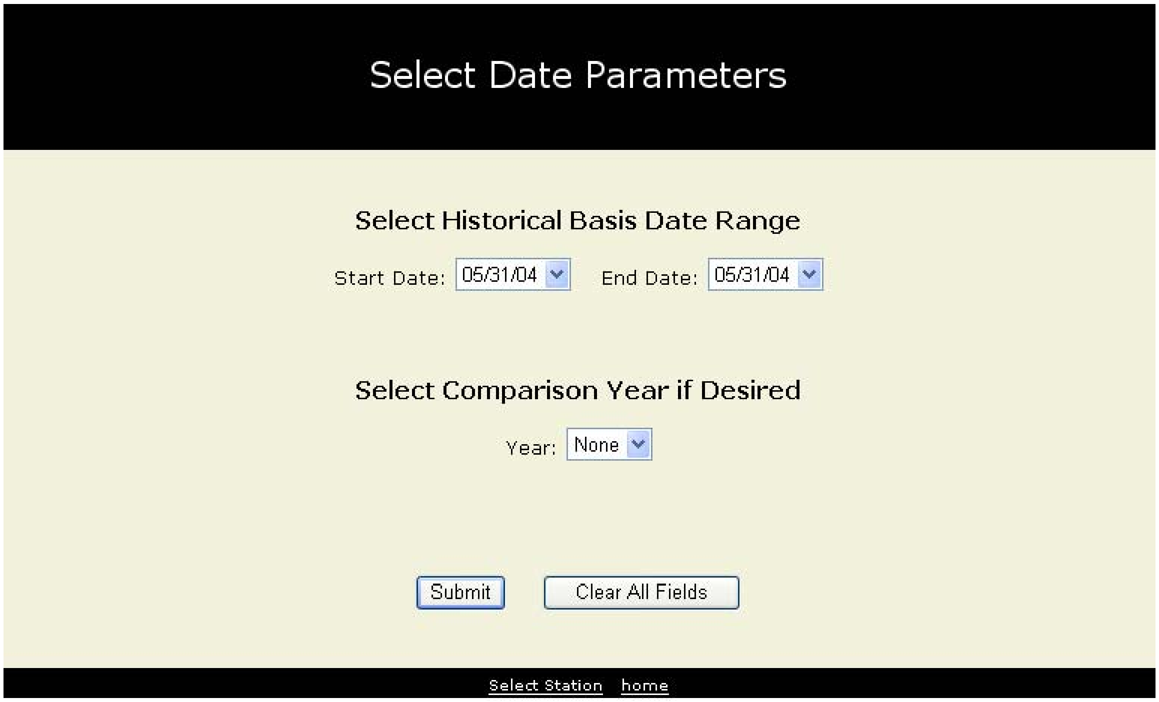
Population of tblStation, tblStationParam, tluParks, and tluClimParam is not automated; rather, the tables are built and maintained manually by the IT Specialist at NCPN.

Web-Based Climate Data Retrieval

From the NCPN Inventory & Monitoring home page, click the link to Data & Reports. From this page, click the link to Climate Charts to display this page:

Station and climate parameter selection page.

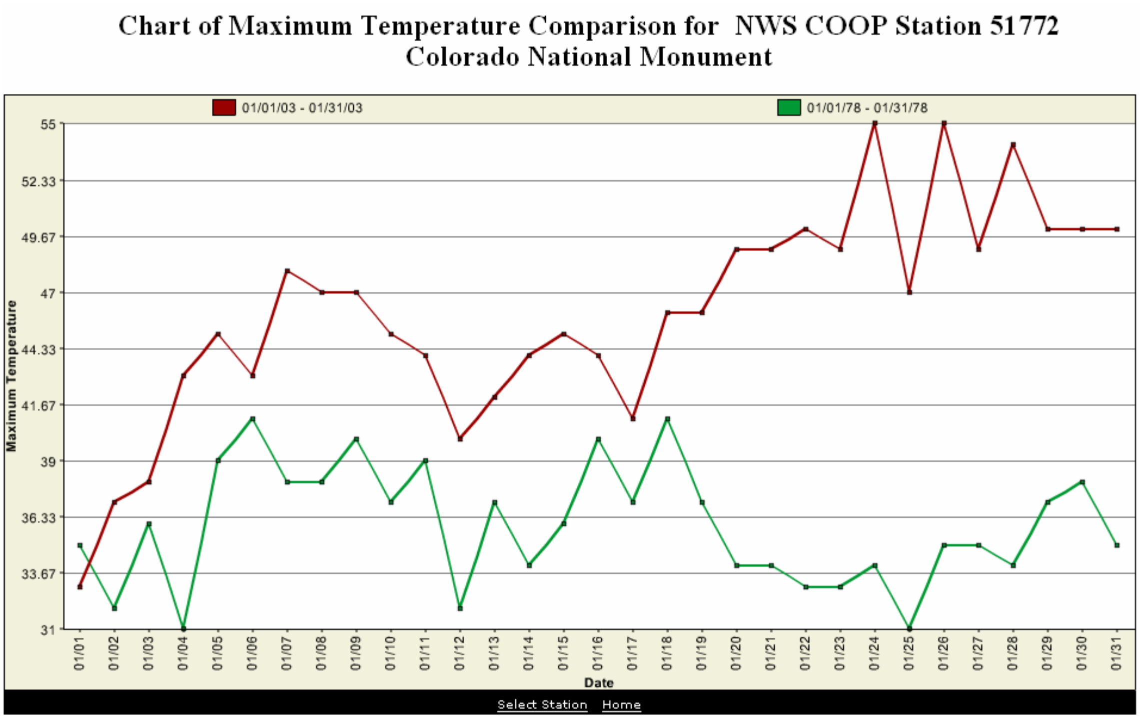
The user selects a station from the drop-down list. Once a station is selected, all the climate parameters available for selection will appear in the "select parameter" drop-down list. When a station and climate parameter have been selected, the user selects a temporal parameter; daily, monthly, annual–all months, or annual–single month. Clicking on the submit button will display different format date range selection pages depending on the temporal parameter that was selected.



Daily date parameter selection page.

Daily Date Selection

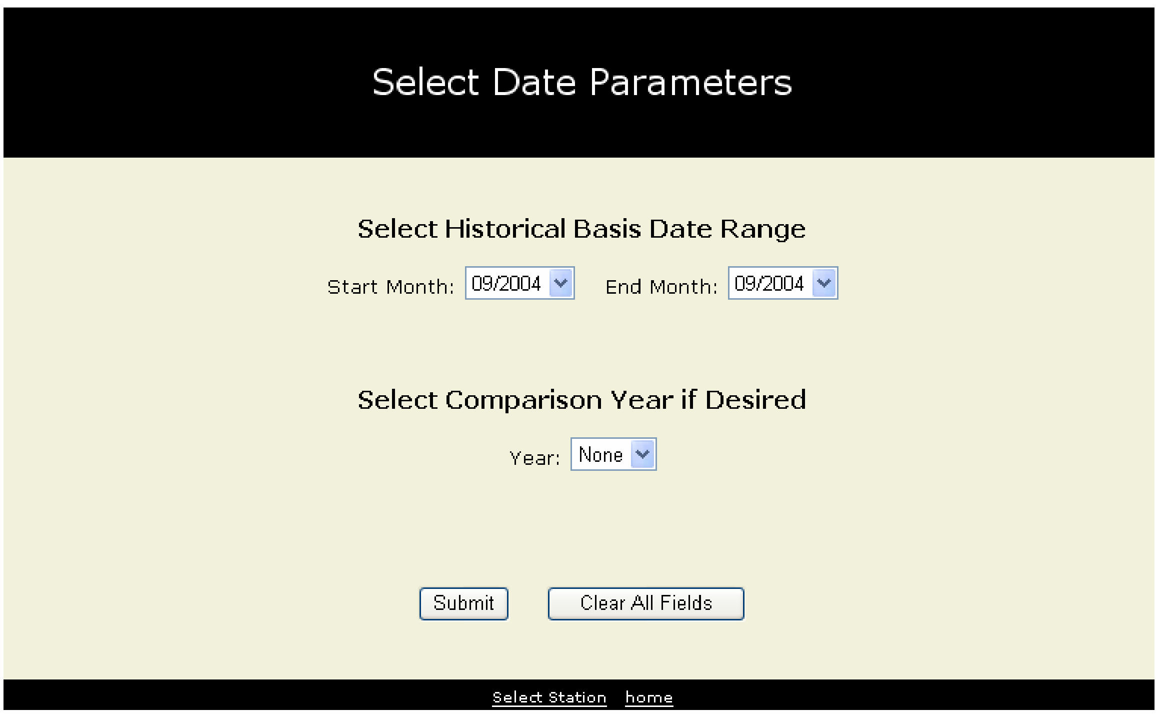
When the temporal parameter selected is “daily”, the page shown directly above will allow selection of day-by-day date ranges, and a comparison year to display along with the historical selection. Selection of “None” in the comparison year will produce a graph of just the historical date range. The selected Start Date must be an earlier date than the End Date. The date selection boxes will display date ranges for which any climate data is available for the selected station. This does not mean that there will necessarily be data for the climatic parameter the user has selected: no valid data may exist for selected days. Therefore, it is not unusual to observe gaps in the resulting graphs. Selection of valid parameters and clicking the submit button will produce the flowing type of graph.



Graph of daily maximum temperature over selected date range.

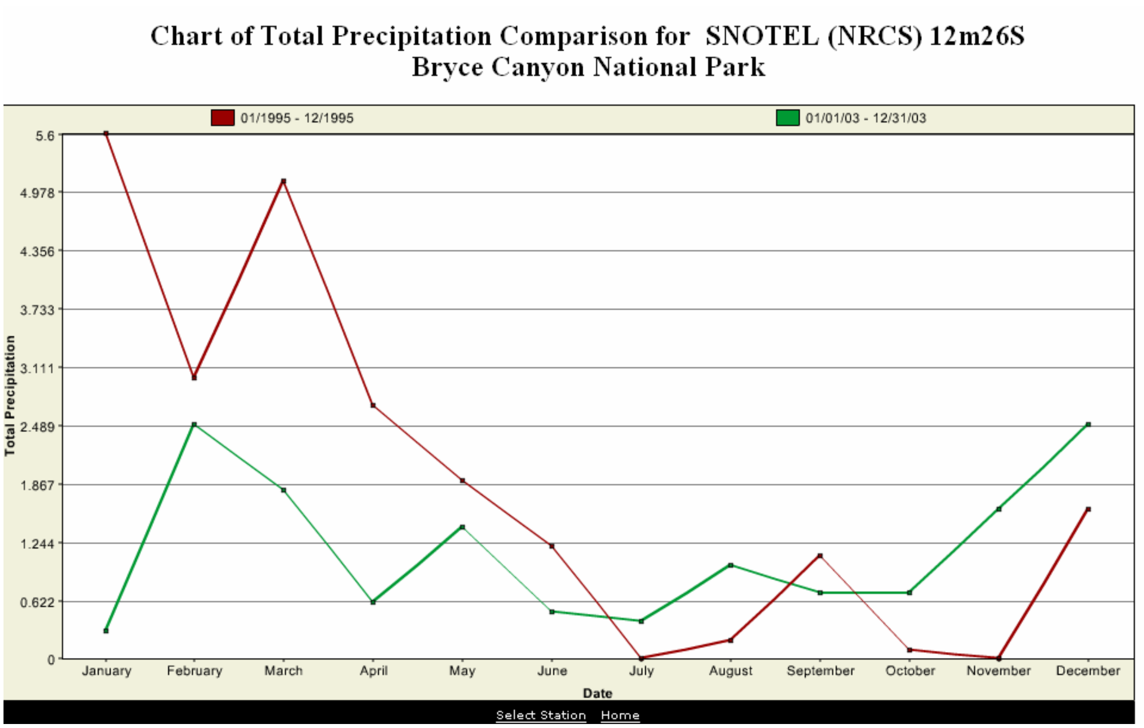
Monthly Date Selection

Selection of the “monthly” temporal parameter will return this date selection page:



Monthly date parameter selection page

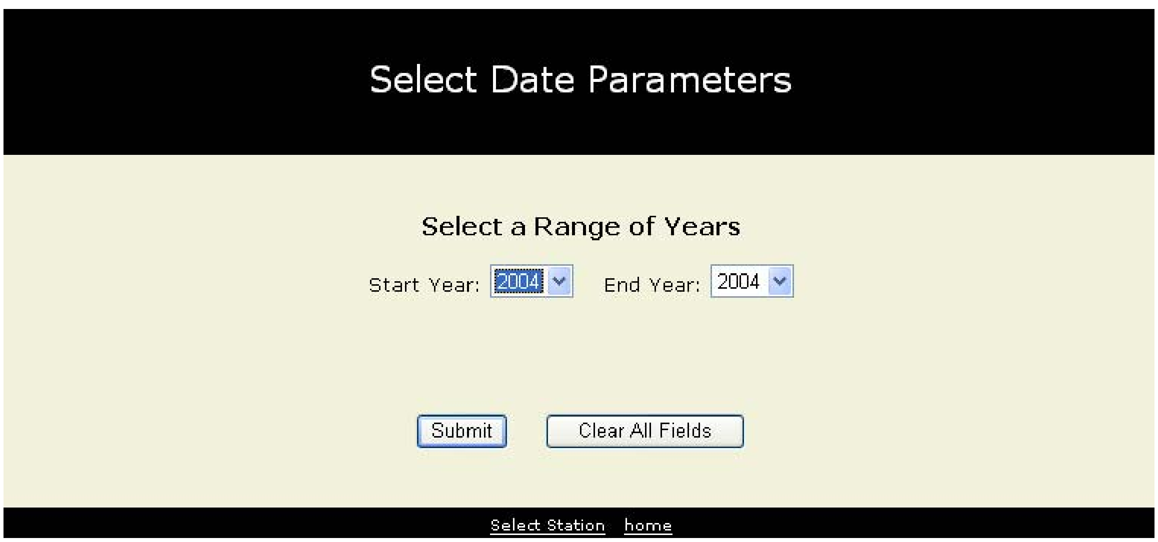
As with the daily selection page, Start Month must be earlier than End Month and Comparison Year is not required. In addition, Start Month and End Month must be within the same calendar year. When selecting months, it is advised that the first and last months on the drop down lists not be selected as these months usually contain incomplete data. Monthly selections will produce a graph similar to this:



Graph of monthly precipitation over selected date range.

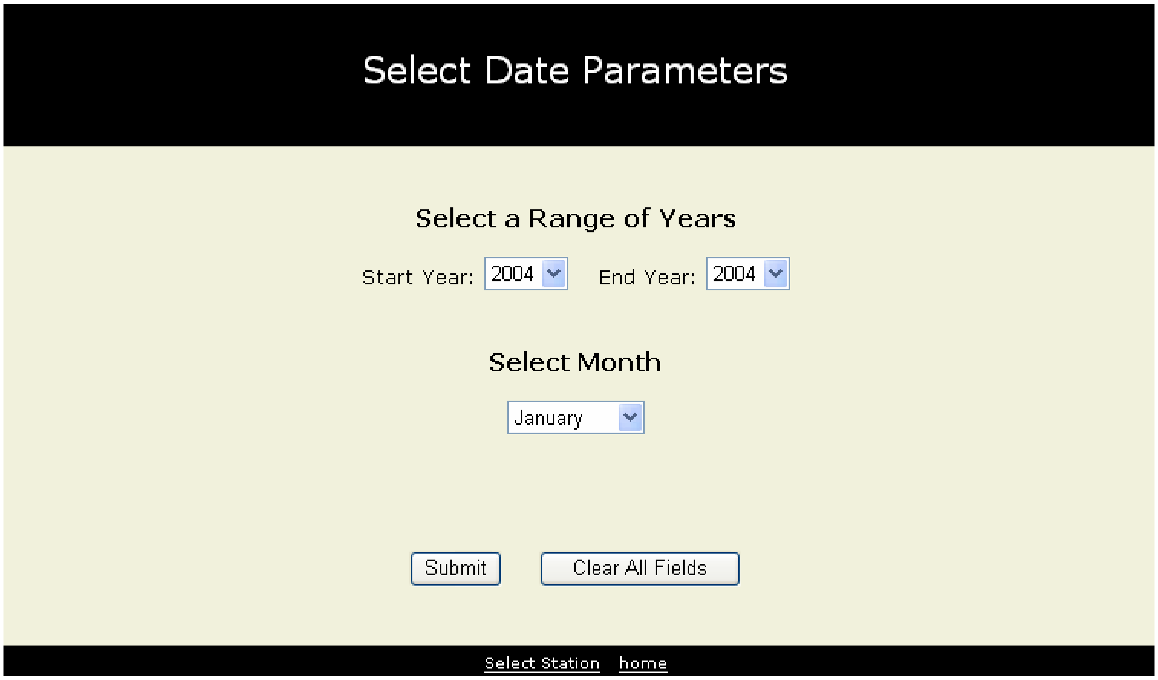
Annual Date Selection

Selection of "Annual – All Months" on the climate parameter selection page will return this data parameter selection page:



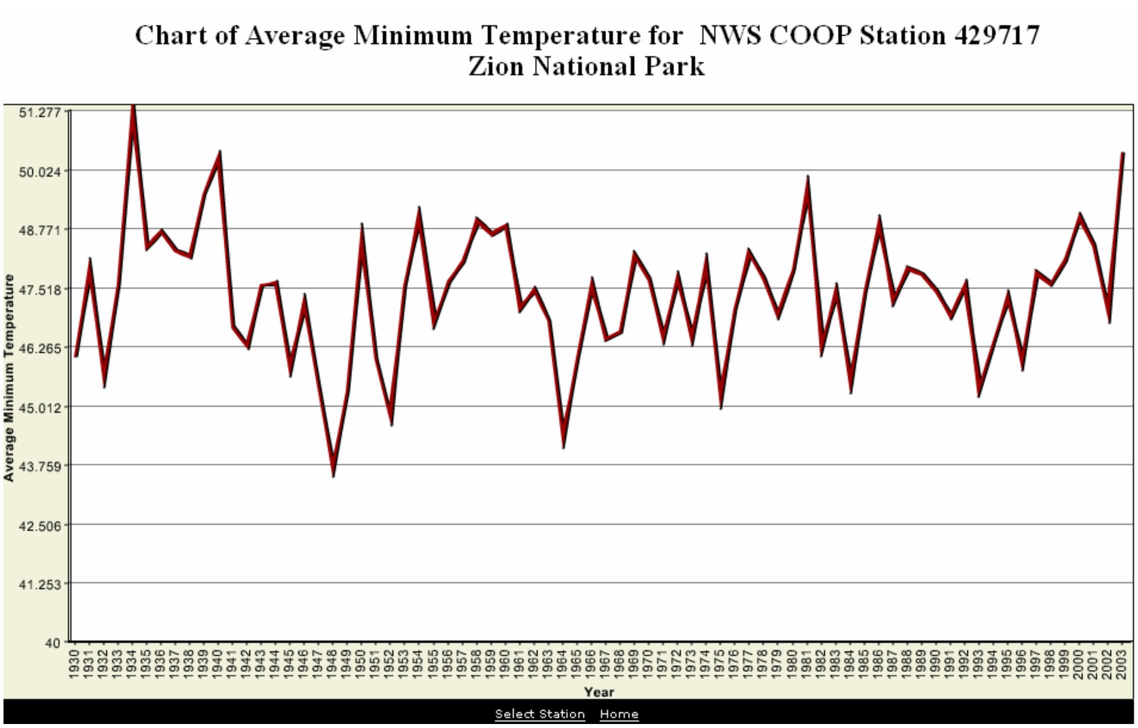
Annual – All Months date parameter selection page.

While selection of “Annual – Single Month” returns this date selection page:



Annual – Single Month date parameter selection page.

Selection of annual parameters is similar to the daily and monthly selection process. As with monthly date selection, avoid selecting either the first or last available year due to the likelihood of incomplete data. Annual graphs have no comparison dates:



Graph of average annual minimum temperature over selected range of years.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #17

Revising the Protocol Narrative and SOPs

Version 1.00 (December 15, 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains how to make and track changes to the Climate Monitoring Protocol Narrative and associated SOPs for the park units of the Northern Colorado Plateau Network (NCPN). The Climate Monitoring Protocol Narrative and SOPs were based on cost-effective and logical methods for acquiring climate data, and on current perceptions of the types of analyses and reports most useful to park managers and researchers. However, the protocol narrative and SOPs will require modifications as climate sensors, data retrieval capabilities, and information needs change. Changes first should be evaluated in terms of cost and benefit, then subjected to appropriate review, and if approved, implemented in a timely manner.

The following procedures must be followed when making changes to ensure that previous data collection and processing procedures are clearly understood when using and interpreting historical data sets. Similarly, clearly articulating new methods is key to credible interpretation of data acquired since the implementation of changes. Personnel making changes must be familiar with this SOP to ensure that proper reviews are conducted, and that documentation standards are followed.

Procedures:

1. The NCPN climate monitoring effort relies on existing climate stations that are sponsored by various national programs. Tracking changes in data collection methods and data availability will require the Data Management staff to frequently review climate-station metadata, and data availability. Metadata sources and contacts are listed in Table 17-1. Station metadata should be reviewed at least once a year. Evaluating data access is accomplished through the annual acquisition of climate data (as outlined in SOP#s 11-15), and documenting changes in data-access policies.

Table 17-1. Metadata sources for climate stations in the NCPN park units.

Climate station	Contact
NWS-Coop stations – ARCH, BLCA, CANY, COLM, CURE, DINO,HOVE, NABR	National Weather Service, 792 Eagle Drive, Grand Junction, CO 81506-8646
NWS/Coop stations – BRCA, CARE, TICA, ZION East Gate; SNOWNET - CARE	National Weather Service, 2242 West North Temple, Salt Lake City, UT 84116
NWS/Coop stations – PISP, ZION HQ	National Weather Service, 7851 Industrial Rd., Las Vegas, NV 89139-6628
NWS/Coop station – FOBU	National Weather Service, 12744 West U.S. Highway 26, Riverton, WY 82501
RAWS – BRCA, ZION	Kristen Meyer, Fire-fuels technician, Bryce Canyon National Park
RAWS – DINO, BLCA	Mark Rosenthal, Fire-management specialist, Dinosaur National Monument
Snow Course - BRCA	Steve Mazur, Park Ranger, Bryce Canyon National Park
SNOTEL - BRCA	National Resources Conservation Service, Salt Lake City, UT
Avalanche station - TICA	Jon Jasper,Resource Management Specialist, Timpanogos Cave National Monument

2. Modifications must be reviewed for clarity and technical soundness. Small changes or additions to existing methods will be reviewed in-house by NCPN Inventory and Monitoring staff. An outside review is required for substantive changes in methods. Regional and national staff of the National Park Service and experts outside of the Park Service with familiarity in climate monitoring and data analysis will be used to review major changes.

3. All changes must be documented, and updated protocol versions must be recorded in the Revision History Log that accompanies the Protocol Narrative and each SOP. Changes are recorded only in the Protocol Narrative or the SOP being modified. Version numbers will increase incrementally by hundredths (e.g., version 1.01, version 1.02, etc.) for minor changes. Major revisions will be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 …). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for the changes along with the new version number.

4. Narrative and SOP updates may occur independently. That is, a change in one SOP will not necessarily invoke changes in other SOPs; a narrative update may not require SOP modifications. All narrative and SOP version changes must be noted in the Master Version Table (MVT), which is maintained in this SOP. Any time a narrative or an SOP version change occurs, a new Version Key number (VK#) must be created and recorded in the MVT, along with the date of the change and the versions of the narrative and SOPs in effect. The VK number increments by whole integers (e.g., 1,2,3,4,5). Updates to the MVT also must be provided to the NCPN Data Manager for inclusion in the master version table database. The Version Key number is essential for project information to be properly interpreted and analyzed. *The protocol narrative, SOPs, and data should not be distributed independently of this table*.

5. New versions of the protocol narrative and SOPs must be posted on the NCPN web page. Previous versions of the Protocol Narrative and SOPs must be archived in the NCPN Climate Protocol Library (X:\Archive\Monitoring_Archive\Climate\Protocol_Library\).

6. Modifications to the source code of the two data-processing programs (RAWS.f [SOP #13] and SNOWNET.f [SOP #15]), the five monthly-annual summary programs (SOP #16, section I), and the three programs used to output trend information (SOP #16, section II) constitute SOP modifications. Changes must be recorded in the Revision History Log of the respective SOPs and included as a comment in the source code under “Modifications:”, which is located in the header of a program.

Climate Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network Master Version Table

Version Key #	Date of Change	Narrative	SOP #1	SOP #2	SOP #3	SOP #4	SOP #5	SOP #6	SOP #7	SOP #8	SOP #9	SOP #10	SOP #11	SOP #12	SOP #13	SOP #14	SOP #15	SOP #16	SOP #17
VK1	12-15-2004	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00