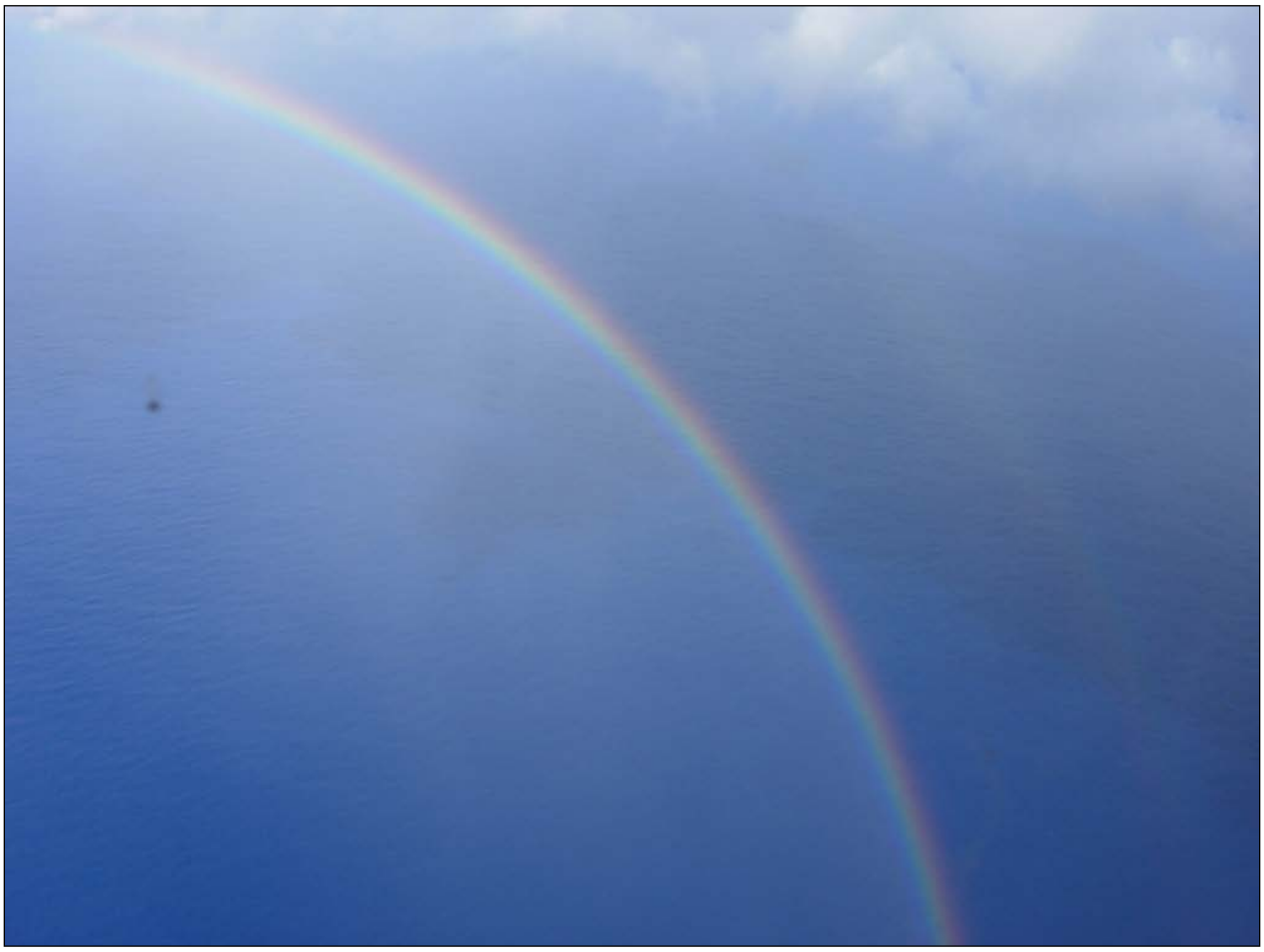
National Park Service
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Natural Resource Stewardship and Science

Weather/Climate Monitoring Protocol - Pacific Island Network

Version 1.0

Natural Resource Report NPS/PACN/NRR—2011/435



ON THE COVER
Rainbow at Afono Pass, American Samoa
Photograph by: Tahzay Jones, NPS

Weather/Climate Monitoring Protocol - Pacific Island Network

Version 1.0

Natural Resource Report NPS/PACN/NRR—2011/435

Karin Schlappa
Hawaii-Pacific Islands Cooperative Ecosystems Studies Unit (University of Hawaii at Manoa)
Inventory and Monitoring Program, Pacific Island Network
Hawaii Volcanoes National Park
P.O. Box 52
Hawai'i National Park, HI 96718-0052

Pao-Shin Chu
Department Of Meteorology
University of Hawaii at Manoa
2525 Correa Road, HIG 350
Honolulu, HI-96822

Ying Ruan
Department Of Meteorology
University of Hawaii at Manoa
2525 Correa Road, HIG 350
Honolulu, HI-96822

Kelly Kozar
National Park Service
Inventory and Monitoring Program, Pacific Island Network
Hawaii Volcanoes National Park
P.O. Box 52
Hawai'i National Park, HI 96718-0052

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National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Change History

Only changes in the protocol narrative will be logged here. Version numbers will be incremented by a whole number (e.g., version 1.3 to version 2.0) for major changes. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) for minor modifications.

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Abstract

This vital sign monitoring protocol explains the procedures for monitoring weather and climate at Pacific Island Network (PACN) national park units. The Weather/Climate Monitoring Protocol consists of this protocol narrative, which includes several appendices as well as a set of standard operating procedures. The narrative gives the background, objectives and basic approach for this project; the appendices provide in-depth information on specific issues; and the standard operating procedures detail the tasks for various personnel.

Climate is widely recognized as a major driver for terrestrial as well as marine ecosystems, affecting biotic as well as abiotic ecosystem attributes. Island ecosystems have been shown to be particularly vulnerable to the effects of climate variability and change. This weather/climate monitoring protocol enables the PACN Inventory and Monitoring Program to describe an important physical part of the ecosystems found in the national parks in Hawaii, Guam, Saipan and American Samoa. The weather/climate monitoring protocol will be implemented in all PACN parks. The basic approach is to use data from existing weather stations belonging to major weather monitoring programs as well as some stations belonging to the National Park Service (NPS) and the Haleakala Climate Network (Hale-net). The PACN is adding stations in 2010. This project is dependent on the efforts of various agencies and institutions for maintaining stations as well as downloading and posting data. The objectives of this protocol are two-fold. First, tracking of weather elements to determine short and long-term trends and second, tracking of extreme weather events to determine frequency and patterns of droughts and periods of prolonged wind reversals and other extremes. Annual reports will provide data in tabular and graphic forms, showing monthly and annual data and their variability. In five-year intervals trend reports will be published, showing trends and long-term variability for stations with a long historic record. The aim is to provide data on weather patterns and trends that will characterize ecosystems and aid the interpretation of other natural resource monitoring data.

Acknowledgments

We owe thanks to the many park staff who provided details about ongoing and historical weather monitoring in their parks. Thanks also go to three anonymous reviewers as well as to Fritz Klasner, Kenai Fjords NP, who conceived this project in its initial stages and provided comments on the draft document. Some of the information was gleaned from the weather and climate monitoring protocols of other I&M networks. Much information and help was also provided by the NPClime team. Thanks also go to Tonnie Casey for her assistance with the final edits to the protocol. This protocol was developed under Task Agreements (J8080070008, J8080040032, and J2132080313) between the National Park Service, Pacific Island Network and the University of Hawaii at Manoa, Pacific Cooperative Studies Unit.

Chapter 1: Background and Objectives

The Natural Resource Challenge (NRC), initiated in 1999 under the auspices of the Omnibus Act (1998), is an action plan for preserving natural resources throughout the National Park Service (NPS) system. The NPS established 32 Inventory and Monitoring (I&M) networks[1] across the nation, encompassing 270 national park system units. Each network is comprised of NPS units that share geographic and natural resource characteristics, allowing these parks to share financial resources and expertise. The Inventory and Monitoring program's first objective was to complete basic inventories of natural resources in all parks. This information formed the baseline for long-term monitoring efforts. Because program funding is limited and not all ecosystem components or characteristics can be monitored, monitoring programs were built around measuring critical parameters (vital signs) within each network. As defined by the NPS, vital signs are a subset of physical, chemical, and biological elements and processes of park ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values. This subset of monitored resources and processes is part of the total suite of natural resources that park managers are directed to preserve "unimpaired for future generations" (National Park Service Organic Act of 1916), including water, air, geological resources, plants and animals, and the various ecological, biological, and physical processes that act on those resources. Major challenges addressed in the NRC caused by changes and variability in climate includes native and endangered species, non-native species, and environmental stewardship. The Pacific Island Network (PACN) Vital Signs Monitoring Plan (HaySmith et al. 2006) and this protocol address these issues. The information gained by monitoring will be used to inform natural resource management decision-making.

Rationale for Monitoring Weather and Climate

Analyses of ecosystem development and processes are based on the ideas of Jenny (1941, 1980) who identified five 'state factors' that determine how systems evolve, differ from each other, and vary from one landscape to another. Climate is one of these state factors or major ecosystem drivers; the others are organisms, topography, parent material, and time (Figure 1.1).

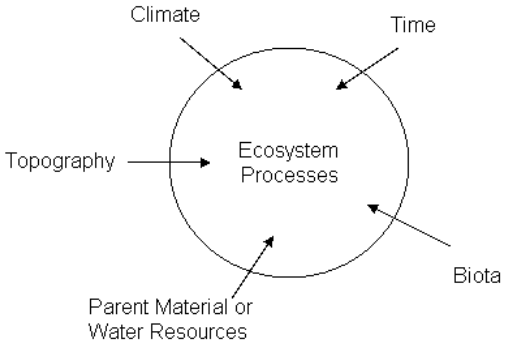


Figure 1.1. State factors affecting ecosystem processes, adapted from Jenny (1941).

Note: this figure was adapted to include water resources in addition to terrestrial substrate.

[1] http://science.nature.nps.gov/im/networks.cfm

Climate not only influences ecosystem processes, but also affects other control factors directly, such as water resources and biota. All of the 14 PACN vital signs are directly or indirectly affected by variability and changes in climatic conditions.

Further global warming and increasing sea levels have been predicted in countless studies. With the publication of the 4th assessment report by the Intergovernmental Panel on Climate Change (IPCC 2007), global warming and sea level rises are now the accepted and scientifically validated outlook for the future. A number of publications specifically focus on the effects of climate variability and change to resources of national parks and other protected areas (Daly et al. 2000, Burns et al. 2003, Saunders et al. 2006). Managers of protected areas have been looking at what measures should be taken to protect the lands under their stewardship (Noss 2001, Hannah 2003, Welch 2005). There are many recommendations dealing with selecting sites for future protected areas and adaptive management strategies. Pertinent for this weather/climate monitoring protocol are the following recommendations: (1) National parks (or other protected areas) should be promoted as long-term monitoring sites for climate as well as for ecosystem characteristics and processes that are sensitive to climate. (2) Data reporting must be 'user-friendly' and pertinent for protected area managers. (3) Climate data for protected areas should be available to support downscaled climate modeling even if that is not yet available for the area in question. This last point refers to the fact that most climate prediction models make forecasts for long time scales and large regions, often continents. However, as policy-makers require shorter-term predictions, new models for a two-decade time scale are being tested (Zwiers 2002). Moreover, while most climate models simulate large-scale circulation well, they cannot resolve sub-grid features. This problem is particularly true for Hawaii because the islands are small, the topography is complex, and rainfall diversity is very pronounced even within a small distance. Accordingly, spatial downscaling from model simulations is required. (4) Forming partnerships between a number of agencies and institutions is essential in monitoring climate and using climate change data to protect natural areas. The PACN climate monitoring protocol incorporates all of these recommendations.

Parks Where the Protocol Will Be Implemented

This vital sign monitoring protocol will be implemented at all PACN parks:

War in the Pacific National Historical Park (WAPA)
American Memorial Park (AMME)
National Park of American Samoa (NPSA)
World War II Valor in the Pacific National Monument (VALR)
Kalaupapa National Historical Park (KALA)
Haleakala National Park (HALE)
Ala Kahakai National Historic Trail (ALKA)
Puukohola Heiau National Historic Site (PUHE)
Kaloko-Honokohau National Historical Park (KAHO)
Puuhonua o Honaunau National Historical Park (PUHO)
Hawaii Volcanoes National Park (HAVO)

Setting

Though the actual landmass of the islands on which the Pacific Island Network parks are located is very small, the region the PACN encompasses is larger than the continental U.S. (Figure 1.2).

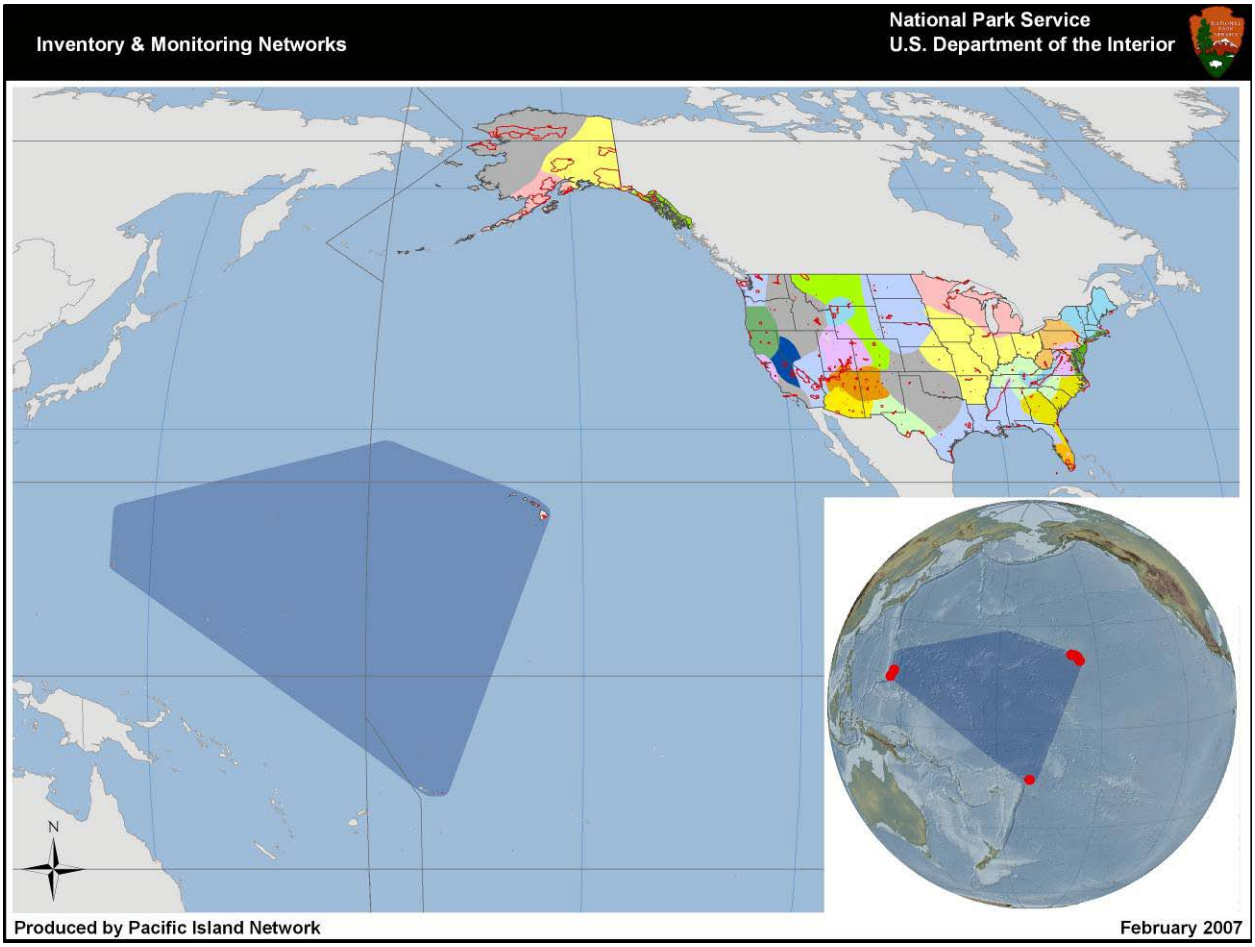


Figure 1.2. Map showing the extent of the Pacific Island Network.

Eight of the Pacific Island Network parks are in the Hawaiian Islands in the Central Pacific between 19° and 22°N. HAVO, KAHO, PUHE, PUHO, and ALKA are on the island of Hawaii, the youngest of the main Hawaiian Islands at the south-east end of the archipelago. HALE is on Maui, the second youngest Hawaiian Island and KALA is on Molokai Island. VALR is located on the main Hawaiian Island of Oahu. Two PACN parks are situated in the western Pacific Ocean between 13° and 15°N in Micronesia. WAPA is on the western side of the island of Guam and AMME is on the west coast of Saipan, which is part of the Commonwealth of the Northern Mariana Islands (CNMI). On the Polynesian islands of American Samoa at approximately 14°S, NPSA is spread out over three islands. One unit of NPSA is on the island of Tutuila, and two others are on Tau and Ofu of the Manua Island group 96 km (60 miles) east of Tutuila (Figure 1.3).

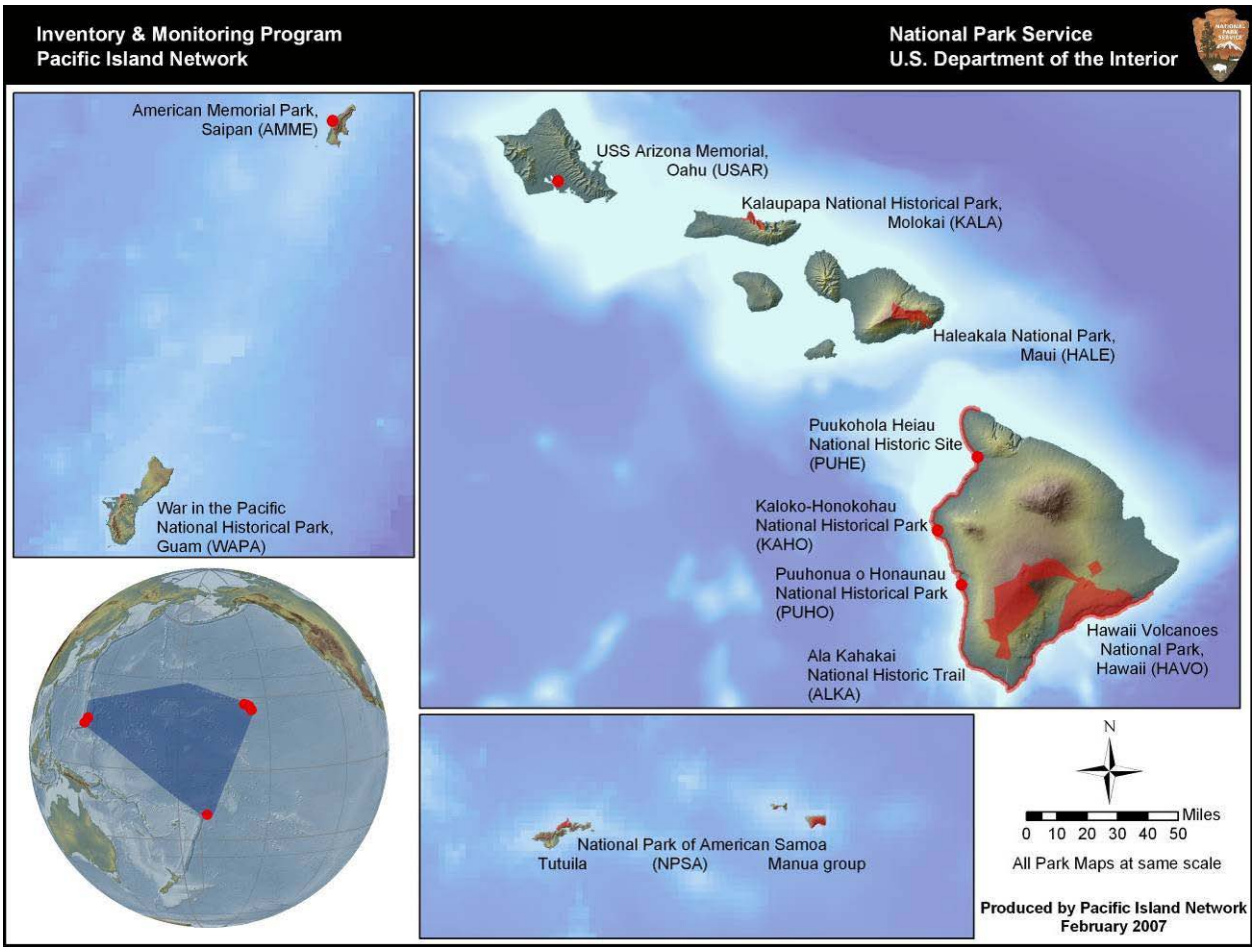


Figure 1.3. Map showing the locations of Pacific Island Network parks.

Climate in the Pacific Island Network Region

The climate in the PACN region is often described as mild, referring to relatively warm temperatures and minimal daily and seasonal temperature fluctuations. The dominant factor shaping the climate is the tropical marine setting. The vast Pacific Ocean dampens the temperature fluctuations and leads to constantly high relative humidity. Located between 15°S and 21°N the climate in the PACN is influenced by Hadley cell circulation (Figure 1.4), which describes the global circulation pattern in these latitudes. Warm, moist tropical air rises near the equator (the doldrums), moves poleward, and, as it cools, sinks back to the surface at around 30° north and south. At the surface the air moves from the subtropical high pressure center back toward the equatorial trough. As a result of the Coriolis force these air masses are deflected, such that the northern and southern hemispheres experience persistent northeast and southeast trade winds.

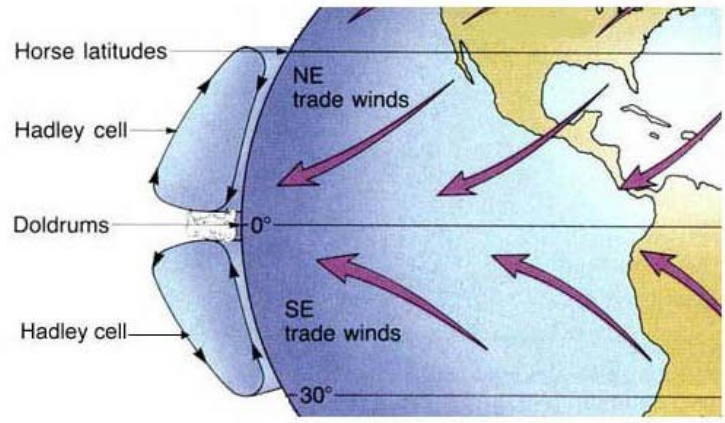


Figure 1.4. Hadley cell circulation and the trade winds.

A characteristic feature of the Hadley cell is the trade wind inversion. Subsiding air in the Hadley cell warms as a result of compression. At the same time, air rising from the surface cools. At the meeting point of the two air masses warm air overlays cool air forming an inversion. The presence of the trade wind inversion is an important factor influencing PACN ecology as it creates distinct zones along elevation gradients on the taller islands. The inversion acts like a 'lid' in the atmosphere such that moist air masses uplifted along the mountains are capped by the warmer, more stable, overlying air. This leads to the formation of a persistent cloud belt just below the inversion supporting cloud and rain forest habitat in contrast to much drier habitat above the inversion (Figure 1.5). Additionally, the interaction of the trade winds and the relief create wet windward and dry leeward climate zones. Thus, despite the tropical setting, the parks in the PACN encompass nearly all of the world's major climate types as defined by Koeppen (Giambelluca and Sanderson 1993), sometimes within a single park (HAVO, HALE).

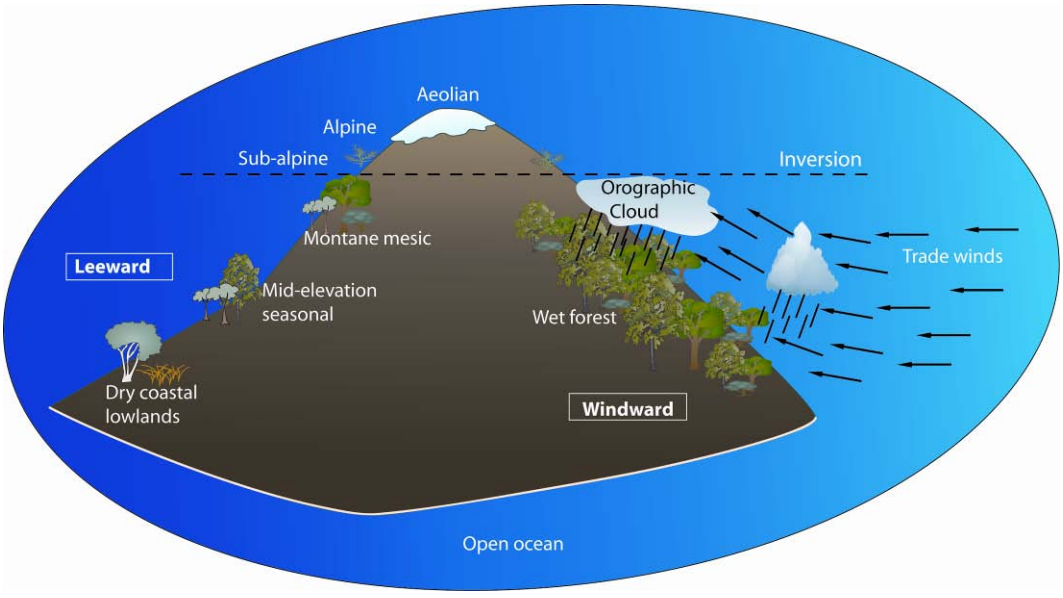


Figure 1.5. Interaction of climate and topography on tall islands in the Pacific Island Network.

Climate Variability

Moderately wet and dry seasons exist throughout the PACN region, yet these seasons are not synchronous. For example, in American Samoa the wet season lasts from October to May, in the Marianas from July to November, in most of Hawaii from October to April, while in some portions of leeward Hawaii Island (i.e., North Kona) it lasts from April to September.

Tropical cyclones, which include tropical depressions, tropical storms, and hurricanes, are not unexpected in the region, bringing extreme rainfall, winds, and storm swells to the islands. Hurricane season in Hawaii lasts from June to November and in American Samoa from November through April. In the western Pacific hurricanes are called typhoons. In this region, which includes Guam and Saipan, these storms are more frequent and often more intense than in the rest of the Pacific. While the majority of typhoons occur between June and September they may occur year-round.

Climate variability for the region is affected by the El Niño/Southern Oscillation (ENSO). These naturally occurring phenomena are defined by atmospheric and oceanic conditions in the Pacific Ocean but affect climatic and oceanic conditions around the globe. An El Niño phase is characterized by unusually warm waters over the eastern and central tropical Pacific. The opposite is true during La Niña; sea surface temperatures (SST) in the region are cooler than normal. El Niño and La Niña events often but not always follow each other and each typically lasts for a year to 18 months. El Niño events recur every 3-7 years. The Southern Oscillation refers to differences in atmospheric sea level pressure (SLP) between Darwin, Australia and Tahiti. The two phenomena are related such that during an El Niño event sea level pressure tends to rise in the western Pacific and drop in the eastern Pacific, causing a reduction of the trade winds. As a result some areas of the Pacific experience droughts while others suffer from extreme rainfall events.

It is important to note that not all El Niño/La Niña events are created equal; the strength of the events as judged by the observed SST or SLP anomalies affects the impacts on regional weather and climate. Thus, a mild event may only cause a slight decrease or increase in rainfall for a short time in a given area whereas severe events can lead to prolonged drought or heavy, prolonged rainfall. Additionally, spatial variability within the Pacific is also affected by the strength of the events. Keeping in mind that impacts vary with the strength of the events, the following effects have been documented in the Pacific Island Network region: In Hawaii, El Niño related drought starts at the end of an El Niño year and lasts throughout the spring of the following year while La Niña has just the opposite effect on rainfall variations in Hawaii (Chu 1995, Chu and Chen 2005). On Saipan and Guam very dry conditions prevail in the year following an El Niño (Ropelewski and Halpert 1987, Lander and Guard 2003, Lander 2004). In American Samoa rainfall increases during all seasons of an El Niño year; in the following year rainfall is also increased, but to a lesser extent in all seasons except during summer when it is slightly decreased (PEAC [Pacific ENSO Application Center], website accessed 21 Sept. 2010)[2]. Tropical cyclone activity in the Pacific Ocean is also affected by ENSO (Chu 2004). For example, more tropical cyclones in the vicinity of Hawaii were observed during El Niño years

[2] http:// http://www.prh.noaa.gov/peac/

and fewer storms were found in La Niña years (Chu and Wang 1997). Fire activity in Hawaii is also affected by ENSO. This is not surprising because the warmer and drier climate associated with ENSO naturally increases the potential for fire occurrence. Focusing on the Island of Oahu, Chu et al. (2002) noted a large increase in total acres burned by wildland fire in spring and summer of the year following the onset of ENSO. Usually, ENSO related drought in Hawaii occurs in winter of the ENSO onset year and spring of following year. Thus, fire climate follows the ENSO-rainfall cycle with a lag of one season. This relationship offers a potential for long-lead (one to two seasons ahead) prediction of wildfire activity in the Hawaiian Islands.

Unless otherwise noted the rainfall and temperature data presented in this section are based on datasets developed by the Oregon State University, PRISM (Parameter-elevation Regressions on Independent Slopes Model) Group. These datasets cover the time period from 1971 to 2000. Maps depicting these data can be found in Appendix A. Climate and other characteristics of Pacific Island Network Parks are summarized in Table 1.1.

Of all the Pacific Island Network parks, HAVO and HALE are the largest parks and also have the greatest elevation range. As a result these two parks include within their boundaries several climate zones with a range of temperature and rainfall regimes. Haleakala National Park is located on East Maui. It extends from the 3,055 m summit of Haleakala down the southeast flank of the mountain to the Kipahulu coast near Hana. This park also includes lands in the leeward rain shadow of Haleakala, down to 1,220 m elevation. Annual precipitation in the park varies from about 1,200 mm in the crater, the southern slope, and Kaupo Gap to about 8,000 mm on the upper northeastern slopes of Haleakala. Research at Waikamoi, just outside the NE corner of the park indicates that fog too makes a significant contribution to the water input at the upper elevations (Scholl et al. 2002). Every few years the summit of Haleakala is covered in snow after a winter storm. Annual mean maximum (minimum) temperatures vary between 12˚C (4˚C) at the summit to 27˚C (19˚C) at the coast.

The largest of the PACN parks, HAVO, is located on the southeastern part of Hawaii Island, where it extends from sea level to the summits of Kilauea Volcano at around 1,200 m and Mauna Loa Volcano at more than 4,000 m. Kahuku, the latest addition to HAVO is positioned on southern Mauna Loa and extends down both the eastern and western flanks of the volcano. The highest mean annual rainfall (6,600 mm) within the park is found within the Olaa Tract, a small discontiguous section of the park with a steep rainfall gradient. In general, the eastern windward portion of HAVO has high rainfall, which diminishes upslope, particularly above the trade wind inversion layer near 1,800 m elevation. The leeward, western portions of HAVO in the rain shadows of Mauna Loa and Kilauea summit are typically dry. Along the coast, the Kau Desert area has the lowest amount of rainfall at approximately 600 mm per year. In the interior, the summit of Mauna Loa has a mean annual rainfall of less than 300 mm. Fog, which is not included in the precipitation estimates, has been estimated to add 739 mm to 1,800 mm to the water input in the rainforest at the Kilauea summit (Heath 2001, Schlappa 2006). Typically several times during the winter storms blanket the summit of Mauna Loa (and Mauna Kea outside the park) in snow. Annual mean maximum (minimum) temperatures vary between 8˚C (-2˚C) at Mauna Loa summit to 27˚C (19˚C) at the coast.

The three small coastal parks on the west and leeward side of Hawaii Island, PUHE, KAHO, and PUHO, extend upslope to elevations of less than 60 m, with the exception of a tiny discontiguous unit of PUHO (the botanical garden), which is located at approximately 274 m elevation. Sheltered by the two tall volcanoes from the NE trade winds, the leeward side experiences a pronounced daily wind pattern of night time land and day time sea breezes. KAHO and PUHO have a mean annual rainfall of approximately 600 mm. PUHE is located within one of the rainfall minima of the island of Hawaii and receives less than 300 mm of rain annually. Annual mean maximum (minimum) temperatures are 28˚C (19˚C).

The ALKA runs through the coastal lowlands of western and south-eastern Hawaii Island; it includes almost 2/3 of the circumference of Hawaii Island. Because the ALKA covers such a long linear transect, the weather pattern is variable with the leeward side distinctly drier and slightly warmer than the windward side. Mean annual precipitation is less than 300 mm in the PUHE area. Then it increases to 300 to 900 mm for most of the trail until it reaches the midpoint of the HAVO coastline from where it increases quickly to about 2,400 mm at the end of the trail along the Puna coast. Annual mean maximum (minimum) temperatures are 28˚C (19˚C) for most of the trail, but a degree higher in the North Kona area and the Kau Desert.

KALA is situated on a windswept peninsula projecting from the north shore of the island of Molokai. The flat peninsula is backed by steep cliffs with the elevation ranging from sea level to 1,287 m. Mean annual precipitation in the park varies between 900 mm at the coast and 2,700 mm at the highest elevation. The high elevation rainforest is frequently immersed in fog, which likely contributes to the water input, but no studies have been conducted to quantify the input. Annual mean maximum (minimum) temperatures vary between 27˚C (20˚C) for most of the peninsula to 19˚C (11˚C) at the high elevation NE corner of the park.

The VALR is a tiny park located on southern Oahu within Pearl Harbor. Due to the presence of the Koolau range, which runs from north to south along the eastern coast this island has distinct windward and leeward climate regimes. Mean annual precipitation in the leeward area where VALR is located is 600 mm per year. Mean annual maximum temperature is 29˚C (20˚C).

In the western Pacific, AMME is a small park restricted to coastal lowlands (<10 m elevation) on the western shore of Saipan. The other park in the western Pacific, WAPA, consists of seven discontiguous units in coastal as well as inland sites. The inland sites are on the slopes of Mt. Alifan (265 m) and Mt. Tenjo (318 m). Both islands are relatively low with the highest elevation at 474 m on Saipan and 406 m on Guam, thus they don't experience a pronounced rain shadow effect. The rainfall pattern is strongly seasonal with a wet season from July to November and a pronounced dry season from December to June. Annual mean precipitation is 1,800 mm at AMME as well as for some other areas along the coast of Saipan. For most of the island it is between 1,800 mm and 2,100 mm. Mean annual maximum (minimum) temperature in the park is 30˚C (24˚C) with only little variation for the island as a whole at 27-30˚C (21-24˚C). At the WAPA units, precipitation ranges from 2,100 to 2,700 mm annually similar to the rest of the island. Highest precipitation on the island is approximately 3,000 mm. Mean annual maximum (minimum) temperature in the park varies from 28˚C (22˚C) in the higher elevation units to 30˚C (24˚C) in the coastal units. Across the entire island the maximum and minimum temperature ranges are very similar to the WAPA units.

In the southern hemisphere, NPSA is composed of three units. The Ofu unit is largely coastal, but the Tutuila and Tau units range from sea level to 491 m and 966 m elevation. The planned expansion of NPSA will include the summits of Ofu (499 m) as well as almost the entire island of Olosega with a summit at 639 m. Rainfall is seasonal with greater monthly means from October to May and a moderate dry season from June to September. On Tutuila annual mean rainfall is between 2,400 and 5,700 mm for the entire island and between 3,300 and 7,500 mm for the national park unit. Ofu and Olosega experience a range of 3,300 to 4,200 mm and on Tau the range is 3,300 to 7,500 mm. While the mountains in the islands lead to a precipitation gradient with elevation, they are not tall enough to create distinct windward and leeward rainfall regimes. The summits of Tau and Olosega are on most days immersed in clouds during the daytime. Thus, fog is presumably contributing to the water input, but this input has not been quantified. Mean annual maximum (minimum) temperatures in the Tutuila national park unit range from 27 to 30˚C (22 to 24˚C), with only a slightly larger range for the island as a whole. Ofu and Olosega have ranges of 26 to 30˚C (21 to 24˚C) and Tau has a range of 24-30˚C (19 to 24˚C).

Table 1.1. Summary of climate and other characteristics for Pacific Island Network parks.

National Park (year authorized)	Total Size (marine portion[a]) ha	Elevation Range m	Dry Season	Mean Rainfall mm/yr	Mean max. (min.) Temperatures ˚C
WAPA (1978)	801 (401)	-50 to 318	Dec.- June	2,100 to 2,700	29 (23)
AMME (1976)	58 (0)	0 to 3	Dec.- June	1,800	30 (24)
NPSA (1988)	5,915 (2129)	-50 to 966	June – Sep.	2,400 to 7,500	24 (19) to 30 (24)
VALR[b] (1978)	7 (2)	-12 to 23	May – Sept.	600	29 (20)
KALA (1980)	4,553 (834)	-61 to 1,287	May – Sept.	900 to 2,700	19 (11) to 27 (20)
HALE (1916)	12,215 (0)	0 to 3,055	May – Sept.	1,200 to 8,000	12 (4) to 27 (19)
ALKA[c] (2000)	TBD	0 to 122	Oct. - March (N Kona) May – Sept (other areas)	<300 to 2,400	28 (19)
PUHE (1972)	35 (3)	-15 to 52	Oct. - March	<300	28 (19)
KAHO (1978)	481 (217)	-46 to 24	No apparent seasonality	600	28 (19)
PUHO (1961)	231 (0)	0 to 274	No apparent seasonality	600	28 (19)
HAVO (1916)	135,091 (0)	0 to 4,169	May – Sept.	<300 to 6,600	8 (-2) to 27 (19)

Note: Data sources include NPS Lands Division authorized park boundary maps, USGS DLG political boundaries, TMK parcels (from GDSI), 2001 IKONOS imagery, VALR park webpage, and PRISM data for 1971-2000.
a. Identified as 0 where authorized park boundary ends at high tide line. Includes the shoreline and offshore waters of inholdings.
b. Authorized marine size is an estimate. Terrestrial size from park webpage.
c. Elevation range is an estimate.

How Will Global Climate Change Affect the Region?

While global circulation models don't always agree on the magnitude of change expected for precipitation and temperature over continental areas, they generally agree about the direction of change. This is not the case for large oceanic areas with very small landmasses, e.g., for Pacific Islands. In a presentation at the Forum for Climate Change in Hawaii in March of 2008, Oliver Timm from the University of Hawaii reported that in a test of 21 global models about half of them predicted precipitation to decrease and half of them predicted increased precipitation over the Hawaiian Islands with increasing atmospheric carbon dioxide concentrations. As a consequence efforts have been focused on downscaling these models. Based on results of runs with six downscaled models, Timm and Diaz (2009) now report that it is likely that winter time

(wet season) rainfall will be decreasing by 5-10% while summertime (dry season) rainfall will increase by 5% in Hawaii by the year 2100. However, the authors acknowledge that these estimates still come with a significant amount of uncertainty and further refinement of the models is needed. To refine these estimates, future improvements will require additional information in the form of multivariate predictor climate fields. The height and strength of the trade wind inversion, vertical motions on the 700-hPa level, transient eddy activity, and low-level moisture convergence are fundamental control factors (Lyons 1982; Chu et al. 1993; Schroeder 1993; Cao et al. 2007).

Analysis of long-term precipitation data has shown that rainfall declined throughout the state of Hawaii in the 20 years up to 2003 likely due to changes in Hadley cell circulation (Diaz et al. 2005). Chu and Chen (2005) also point out a period of low rainfall in Hawaii between the mid 1970s and 2001 as a result of a negative correlation between rainfall and the Pacific Decadal Oscillation (PDO). In their words, the HRI (Hawaii Rainfall Index) is negatively correlated with the PDO index, with the correlation coefficients being significant at the 95% confidence level.

Oki (2004) showed a decline in long-term (1913-2002) streamflow with a similar downward trend in rainfall for this time period. This study also found correlations of streamflow trends with the PDO and ENSO. If the observed decreasing trend in rainfall is in fact caused by and continues due to global climate change a number of significant effects on both abiotic and biotic ecosystem characteristics can be expected. A continued decrease in rainfall and thus stream base flow will reduce groundwater levels and recharge. This would mean decreased availability of groundwater for human consumption (of interest to park management), but also changes to water quality in sensitive ecosystems such as anchialine pools which are influenced by tides as well as freshwater. Decreased streamflow impacts stream water quality and may reduce available habitat for stream fauna. Clearly rainfall patterns also affect vegetation; short-term changes may affect the health of certain plant communities while long-term declining or increasing trends will affect species distribution.

As reported by Timm at the 2008 Forum for Climate Change, Global Climate Models (GCMs) are also ambiguous about the effect of global climate change on temperatures in the Hawaiian Islands, though a slight majority predicted a warming rather than cooling trend. Results for temperature predictions for downscaled models are not available but a new study has looked at temperature changes in Hawaii for recent decades. Giambelluca et al. (2008) report a rapid rise in surface temperatures in Hawaii since the mid 1970s which is especially pronounced at high elevations. The author's report that for much of the 20th century temperature changes in Hawaii have correlated with the PDO, but that despite recent cooling associated with the PDO a warming trend has persisted. As the author's point out their findings agree with results by Cao et al. (2007) who found that the presence of the trade wind inversion in Hawaii has been increasing in frequency, a trend that, if it continues, points to drier and warmer conditions in the future. A more frequent inversion would extend limits on vertical cloud development and rainfall in Hawai‘i. Consequently, Hawaiian mountainous tropical ecosystem and water resources would be affected. Our finding that the inversion is present more than 82% of the time illustrates the importance of the TWI (Trade Wind Inversion) at Hawai‘i, especially considering that it acts as a dominant control on local weather and climate (e.g., Schroeder 1993). It is known that the relatively shallow vertical cloud development below the TWI results in less precipitation than would occur in the absence of an inversion. Orographic rainfall on high mountain slopes

is strongly influenced by the presence of the inversion (Tran 1995). A trend towards increased ocean and island temperatures has also been shown for South Pacific Islands (Folland et al. 2003).

One of the ways that species respond to a change in climate is by moving their range, however, on small oceanic islands there is little room for range displacement (Whittaker 1998). Furthermore, studies have already shown that climate change can favor non-native species over native ones (Dukes and Mooney 1999) and, given that island communities are particularly sensitive to non-native species invasions, there is concern that a warmer and drier island climate could exacerbate the problem.

In Hawaii there is particular concern about the effect that a warmer environment could have on the spread of mosquitoes, vectors of avian malaria and pox (Atkinson and LaPointe 2009). Cool, high elevation forests currently provide refugia from the diseases for honeycreepers of which several species are listed as endangered. Additionally there is concern that increased high altitude temperatures could lead to increased densities of predators (rats, cats, mongoose) for endangered seabirds which nest at high elevations (NPS, D. Hu, Regional Ecologist, email, October 2009). A host of consequences of global climate change are also expected in the marine environment and will thus affect all national parks in the PACN. The effects include disturbances to coral reef ecosystems due to episodes of coral bleaching, facilitation of aquatic invasive species establishment and spread, loss of resilience of native habitats to these invasions, increased sea levels, increased salinity, and increased ocean acidity leading to a decreased ability of organisms to produce calcium carbonate (Kennedy et al. 2002, Osgood 2008, U.S. Environmental Protection Agency (EPA) 2008).

Weather Monitoring in the Pacific Island Network

Weather conditions have been monitored in the PACN parks by several different monitoring programs (Table 1.2). An inventory of weather stations[3] in and near PACN parks was compiled by the Western Regional Climate Center (Davey et al. 2006).

Table 1.2. Weather monitoring programs in Pacific Island Network units.

		Number of Stations in Individual Parks[a]								
Weather Monitoring Program	**Agency**	**NPSA**	**AMME**	**WAPA**	**KALA**	**HALE**	**PUHE**	**KAHO**	**PUHO**	**HAVO**
NWS-COOP (Cooperative Observer Program)	NOAA-NWS (National Oceanic and Atmospheric Administration - National Weather Service)	(1)		1	1(2)	1(2)	1	1	1	4(4)
RAWS (Remote Automated Weather Stations)	National Interagency Fire Center			[1]	1(2)	1		1		4(2)

[3] Report available online at http://www.wrcc.dri.edu/nps/reports.php

GPMN (Gaseous Pollutant Monitoring Network)	NPS (National Park Service)					(1)				2	
HaleNet (Haleakala Climate Network)	University of Hawaii at Manoa (Geography Department)					3[b]					
USGS- Rain Gauges (US Geological Survey)	USGS-WRD Water Resources Division					1					
ALERT (Automated Local Evaluation in Real Time	Various agencies in HALE initiated					6					

Table 1.2. Weather monitoring programs in Pacific Island Network Units (continued).

Weather Monitoring Program	Agency	Number of Stations in Individual Parks[a]								
		NPSA	AMME	WAPA	KALA	HALE	PUHE	KAHO	PUHO	HAVO
CASTNET (Clean Air Status and Trends Network)	EPA and NPS (Environmental Protection Agency and National Park Service)									(1)
PACN Weather Stations	Pacific Island Network Inventory and Monitoring Program	[2]	[1]		[2]		[1]		1	[2]
HAVO Rain gauges	NPS-HAVO									5

a. Numbers refer to currently active stations; numbers in () refer to additional stations that collected data in the past; numbers in [] refer to stations for which installation is planned in the near future.

The exact trail corridor of ALKA has not yet been established; thus, the number of stations in this park cannot be determined except that stations in PUHE, PUHO, KAHO and HAVO also are part of ALKA. There are no weather stations in AMME, NPSA or VALR.

Weather Stations within Pacific Island Network Parks

Weather stations in the PACN parks belong to a variety of different weather monitoring networks. All but HaleNet and Hawaii Volcanoes rain gauges are large networks with stations throughout the country. Maps showing the distribution of stations in the PACN parks can be found in Appendix A.

National Weather Service (NWS) Cooperative Observer Program (COOP): The NWS COOP[4] was created in 1890. Observations for COOP weather stations are taken by either volunteers or contractors to provide observational meteorological data required to define the climate of the United States and to help measure long-term climate changes. In addition the COOP aims to provide observational meteorological data in near real-time to support forecast, warning, and other public service programs of the NWS. Most COOP stations measure daily maximum and minimum temperatures and 24-hour precipitation totals.

Remote Automated Weather Stations (RAWS): The RAWS[5] stations provide weather data that assists land management agencies with a variety of projects such as monitoring air quality, rating fire danger, and providing information for research applications. Hourly averages of meteorological variables are downloaded via the Geostationary Operational Environmental

[4] http://www.nws.noaa.gov/om/coop/
[5] http://www.fs.fed.us/raws/

Satellite (GOES). Measured variables typically include temperature, precipitation, wind, humidity, solar radiation, barometric pressure, fuel temperature, and fuel moisture.

Haleakala Climate Network (HaleNet): The HaleNet[6] stations are operated and maintained by Tom Giambelluca (University of Hawaii at Manoa, Geography Department). This network has been in place since 1988 and provides high quality data for a long list of climate variables. The network is aligned along two transects, windward and leeward. Three of the 10 active stations are located within HALE, another three are located within .5 km of the park boundary. The remaining stations are within 1.5 to 11 km from the HALE boundary.

Hawaii Volcanoes National Park rain gauges (HAVO-RG): In addition to the manual COOP rain gauges HAVO maintains five rain gauges that use the same equipment, but are not part of the COOP. These rain gauges are here referred to as HAVO-RG to distinguish them from the COOP rain gauges; however this is not officially a separate monitoring network. HAVO staff maintains these gauges in the same way as the COOP gauges and report the data on the same datasheets though data are not logged by the NWS. The Hawaii State Climate Office, to which weekly datasheets are sent, has entered data from these stations since 1984 into a database. These rain gauges are situated along an elevation gradient from sealevel to Kilauea at just above 2,000 m (6,700 ft) on Mauna Loa, with the oldest station dating back to 1918.

Gaseous Pollutant Monitoring Network (GPMN): Weather data are collected by the GPMN[7] primarily to support interpretation of data on airborne pollutants. The HAVO stations are maintained by USGS Hawaiian Volcano Observatory staff. Measured variables include temperature, precipitation, wind, humidity, and barometric pressure.

U.S. Geological Survey (USGS) rain gauges: The USGS Water Resources Division maintains rain gauges around the country in support of their surface water and ground water monitoring programs[8]. A stream gauge and associated rain gauge is located at Kipahulu in HALE.

Automated Local Evaluation in Real Time (ALERT): Stations belonging to ALERT[9] consist of remote sensors in the field, which transmit environmental data to a central computer in real time. This system was developed in the 1970's by the National Weather Service and has been used by numerous federal, state, and local agencies, and international organizations. Six rain gauges and three associated stream gauges were installed and are maintained by HALE due to the danger caused by flash floods.

Pacific Island Network (PACN) Stations: The PACN has purchased nine Campbell Scientific weather stations. Currently it is anticipated that these stations will be installed in the following parks: AMME (1), HAVO (2), KALA (2), NPSA (2), and PUHE (1); a WeatherHawk station that has been installed at PUHO will be replaced by a Campbell Scientific station. The stations will be maintained by park and PACN staff. Measured variables include temperature, precipitation, wind speed and direction, relative humidity, and solar radiation.

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6 http://webdata.soc.hawaii.edu/climate/HaleNet/
7 http://www.fs.fed.us/raws/
8 http://water.usgs.gov/
9 http://www.alertsystems.org/

Weather Stations near Pacific Island Network Parks

There are a number of NWS-COOP and RAWS stations on most of the islands on which PACN parks are located. As mentioned above, several HaleNet stations are located outside park boundaries. In additions weather stations belonging to the following networks or programs provide long-term, high quality data.

National Oceanic and Atmospheric Administration, Earth Systems Research Laboratory, Observatory Operations (NOAA ESRL OBOP): For several decades NOAA ESRL (formerly CMDL) observatories have been collecting meteorological data[10] in support of air quality and climate research projects. Meteorological quantities, trace gases and particulates (visibility) are measured continuously at these stations. Two of these observatories are close to PACN parks: Mauna Loa Observatory is just 3 km outside of HAVO and the American Samoa Observatory on Tutuila is approximately 10 km outside NPSA.

The U.S. Climate Reference Network[11] (USCRN), which is being developed by NOAA, operates two experimental stations on the island of Hawaii. One station is located at the Mauna Loa Observatory about 3 km outside of HAVO; the other is located near Hilo at the University of Hawaii Waiakea Experiment Station. No operational CRN stations are located in the PACN.

National Weather Service Automated Surface Observing System (ASOS): The ASOS[12] provides meteorological measurements for airports. Airports in Hawaii, on Guam, and on Saipan have ASOS stations, and, in some cases, are located near the national parks. The NWS weather stations at airports in American Samoa belong to NWS COOP.

The U.S. Geological Survey (USGS): The USGS Pacific Islands Water Science Center[13] operates an extensive network of rain gauges throughout the PACN region. In some cases other meteorological measures are also taken.

Weather and Climate Data for the Region

Weather and climate are different because of time. Weather is considered a measurement of the conditions during a short period of time, where climate is a measurement of atmospheric conditions over a long period of time. So, those phenomena imminent to our daily lives are considered "weather" and the data for any region includes alerts, forecasts, and current conditions which are provided by the NWS Pacific Region Headquarters[14] For instance, measurements of barometric pressure, precipitation, temperature and wind conditions are of interest in the immediate weather forecast.

For long term trends, the Hawaii State Climate Office provides monthly and yearly summaries of several climate variables for Hawaii. Information about ENSO, including the impacts on different areas of the Pacific, analysis of current conditions, and forecasts, are provided by

[10] http://www.mlo.noaa.gov/programs/search_pages/search_meteorology.html
[11] http://www.ncdc.noaa.gov/crn/programoverview.html
[12] http://www.nws.noaa.gov/asos/index.html
[13] http://hi.water.usgs.gov/
[14] http://www.prh.noaa.gov/

PEAC[15]. The Western Regional Climate Center (WRCC) also provides current data and historic summaries for Hawaii stations online as well as a climate narrative for Hawaii.

Weather versus Climate Stations

It is important to note that none of the weather stations belonging to federal agencies in the PACN is considered a climate monitoring station. The Western Regional Climate Center explains the difference between weather and climate monitoring:

> "Weather versus Climate Definitions
>
> It is also important to distinguish whether the primary use of a given station is for weather purposes or for climate purposes. Weather station networks are intended for near-real-time usage, where the precise circumstances of a set of measurements are typically less important. In these cases, changes in exposure or other attributes over time are not as critical. Climate networks, however, are intended for long-term tracking of atmospheric conditions. Siting and exposure are critical factors for climate networks, and it is vitally important that the observational circumstances remain essentially unchanged over the duration of the station record." (Davey et al. 2006)

The only monitoring stations specifically set up by federal agencies for the purpose of climate monitoring are the NOAA climate reference network (CRN) stations. Currently there are two experimental CRN stations in the PACN, both located on the island of Hawaii. Data from these stations will not be included in the PACN weather monitoring efforts given that these stations are intended for designing experiments and testing equipment.

In addition to the CRN stations, NOAA has identified a subset of COOP stations that are suitable for climate monitoring though they were originally set up for weather monitoring purposes. This monitoring network, known as United States Historical Climatology Network[16] (USHCN), includes stations with a long history of high quality data. Data from these stations are now available online[17] after having undergone rigorous quality control and homogeneity testing and adjustment procedures to ensure that signals of climate variability and change are separated from confounding factors such as heat island effects. USHCN sites having been selected according to spatial coverage, record length, data completeness, and historical stability. The USHCN, therefore, consists primarily of long-term COOP stations whose temperature records have been adjusted for systematic, nonclimatic changes that bias temperature trends. Unfortunately, the USHCN dataset currently only includes stations in the contiguous 48 states. However, plans are underway at NOAA to process data from additional COOP stations including stations outside the continental U.S. (NOAA, Matt Menne, email, May 2009).

HaleNet stations were specifically set up to “provide indicators of global change effects on Hawaii’s climate and biota”.

[15] http://www.prh.noaa.gov/peac/
[16] http://cdiac.ornl.gov/epubs/ndp/ushcn/newushcn.html
[17] http://www.ncdc.noaa.gov/oa/climate/research/ushcn/

The overall goal for monitoring weather and climate in the Pacific Island Network is to provide researchers and park managers with easily accessible and easily understandable information about weather and climate conditions and trends. The data will provide information that can be used for short-term park management needs, to discern possible effects of climate on other ecosystem characteristics, and to assess measures that may be implemented to mitigate the effects of future climate change. As mentioned earlier, climate change is expected to have significant impacts on various aspects of Pacific Island Ecosystems. The PACN vital sign monitoring program includes freshwater habitat, marine benthic communities, anchialine pools, water quality in freshwater and nearshore marine habitat, groundwater dynamics, landbirds, Hawaiian petrels and vegetation. All of these long-term monitoring projects will look, among other things, at effects of climate and climate change, thus information about current rainfall and temperature conditions as well as trend data will be beneficial to many PACN and park research and monitoring projects. The PACN weather/climate monitoring staff is working closely with staff of the other monitoring projects to ensure that data analysis and reporting is presented to complement their needs.

The overarching objective of the weather/climate monitoring protocol will be to track the range of variation in weather patterns for PACN parks. Specific monitoring objectives and questions are listed below. We will carefully examine our data to see if they suggest that the PACN region is experiencing regional consequences of global climate change. However, it needs to be noted that the types of the weather stations we are using and limitations in resources for data processing will not allow us to determine with certainty that climate change is responsible for regional weather patterns. This may change in the future though. If more funding becomes available for PACN weather/climate monitoring it is the goal of the program to expand observations to new sites (see chapter 2 for discussions on selecting new sites). Preferably an expansion of the monitoring effort would occur through partnerships with other agencies, include the purchase of more robust equipment, and thus move the monitoring effort from primarily weather analysis to climate analysis.

Objective 1: Tracking weather elements
Determine variability and short and long-term weather trends for all PACN parks through monthly and annual summaries of descriptive statistics for core weather parameters.

Question 1a: What are the patterns and trends for core weather parameters (relative humidity, temperature, precipitation, wind speed, and direction) on park-wide, island-wide and network-wide spatial scales?

Question 1b: What are the long-term trends for other parameters (selected based on site-specific needs and data availability) such as soil moisture or solar radiation?

Objective 2: Tracking extreme weather events
Determine frequencies and patterns of extreme weather conditions for islands in the PACN.

Question 2: What are the frequency, spatial extent, and duration of extreme weather events such as droughts, intense precipitation, tropical cyclones, and changes in predominant wind patterns?

Chapter 2: Sampling Design

Rationale for Sampling Design and Site Selection

The goals and objectives of external weather and climate monitoring programs have dictated the numbers and locations of most weather stations in the PACN. In general, a rigid sampling design was not used to locate stations. The NWS-COOP stations, which are manually downloaded, were located based on ease of access and tend to be near park visitor centers. The locations of RAWS stations were generally determined by wildfire threat. Thus, RAWS stations, which are downloaded by satellite, are often located in the backcountry. The CASTNET and GPMN stations were co-located with air quality monitoring stations. Site selection of HaleNet stations was driven by the desire to represent windward and leeward elevation gradients on Haleakala. In the parks where weather stations are available, they are sparsely distributed and, because they belong to a variety of monitoring programs, they are sometimes located in close proximity to each other. These limitations result in a coarse sampling scheme.

Site selection for new stations established by the PACN will take into account the need for weather data in support of other vital sign monitoring as well as support for park specific needs. Once a general area for the site has been determined, site selection will follow the requirements for the associated weather or climate monitoring program. Site selection criteria for NWS COOP stations are described in the Cooperative Observer Handbook No.2 (SOP 3), RAWS requirements are outlined in the Fire Weather Station Standards (National Wildfire Coordinating Group 2008). If a station does not belong to a weather monitoring program, site selection will, to the extent possible, follow specifications outlined in the site selection guidance[18] for climate stations provided by the CRN. Following these guidelines strictly in PACN parks will not always be possible given that many of the parks are small, and site selection also needs to follow other, sometimes conflicting, regulations such as avoiding areas with sensitive cultural and natural resources, and maintaining viewsheds. Additionally, some stations may be set up to characterize weather patterns in a specific area of the park, but topography and vegetation may not be in line with CRN site standards. Requirements for permits and compliance necessary for establishing new weather stations are discussed in Chapter 6.

Figures 2.1 to 2.6 show the locations of stations included in PACN monitoring on an island-wide scale that also shows their distribution within watersheds and contour lines to provide information about topographical factors influencing weather variability. More detailed maps of station locations with station names are given in Appendix A. Considerations for locating new stations are outlined below. While general locations are described here, detailed locations including GIS coordinates and access descriptions for existing as well as planned stations in the parks are given in the Sampling Sites Supplementary Material document.

The PACN will install a weather station at AMME in one of three locations, 1) on the roof of the park's maintenance building 2) near the vegetation composting area, or 3) at the north end of the mangrove swamp. The latter two areas may need compliance documents and a fence constructed around the station for security from vandalism. Currently the park does not have a weather station; the nearest COOP station is at 200 m elevation where rainfall is higher (see PRISM maps

[18] http://www.ncdc.noaa.gov/crn/sitedescription.html

in Appendix A). The additional data will be useful in evaluating water input into the AMME wetland which provides habitat for the endangered Mariana Moorhen (Rauzon 2009). Freshwater input to the wetland is influenced by local rainfall as well as seaward-flowing groundwater from higher elevations (Perreault 2007). AMME is included in the PACN groundwater protocol. AMME is a very small park with no climatic variability, thus site selection is driven by the need to avoid visual and habitat disturbance and data bias due to environmental factors.

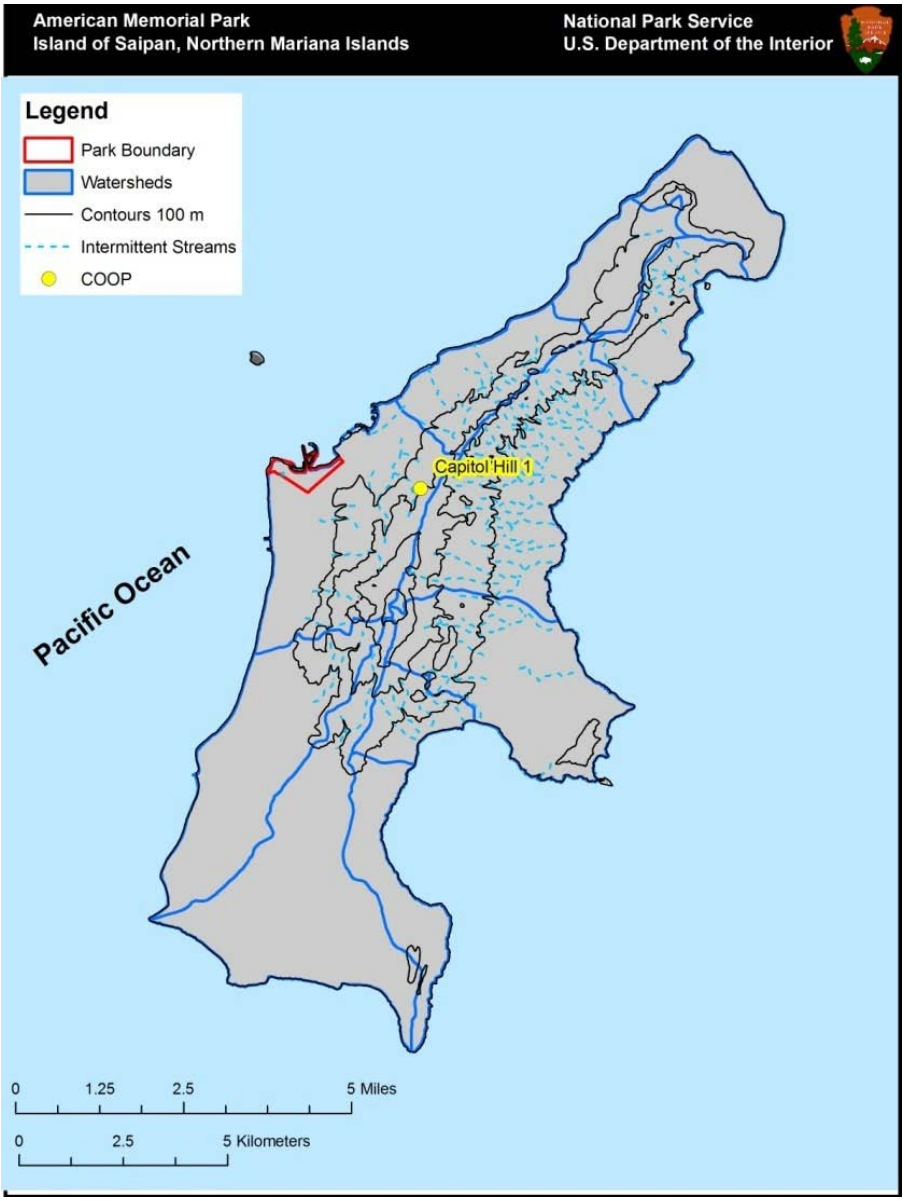


Figure 2.1. Map showing weather station location and watersheds on Saipan.

The location of WAPA and watersheds on the island of Guam are shown in Figure 2.2. The park purchased a RAWS several years ago but, due to personnel changes, it was never set up. The PACN is supporting the set up of this station. The location chosen by WAPA staff lies in the Asan Inland Unit approximately half way back in Asan Valley. This general location was selected because weather information at this site would complement ongoing vegetation and erosion monitoring that is conducted by the park. It may now also provide data for PACN water quality monitoring conducted in nearby Asan River. The specific site was selected because it fit the RAWS site requirements, it is reasonably easy to access, and the pole from the weather station would not be visible from the Asan lookout.

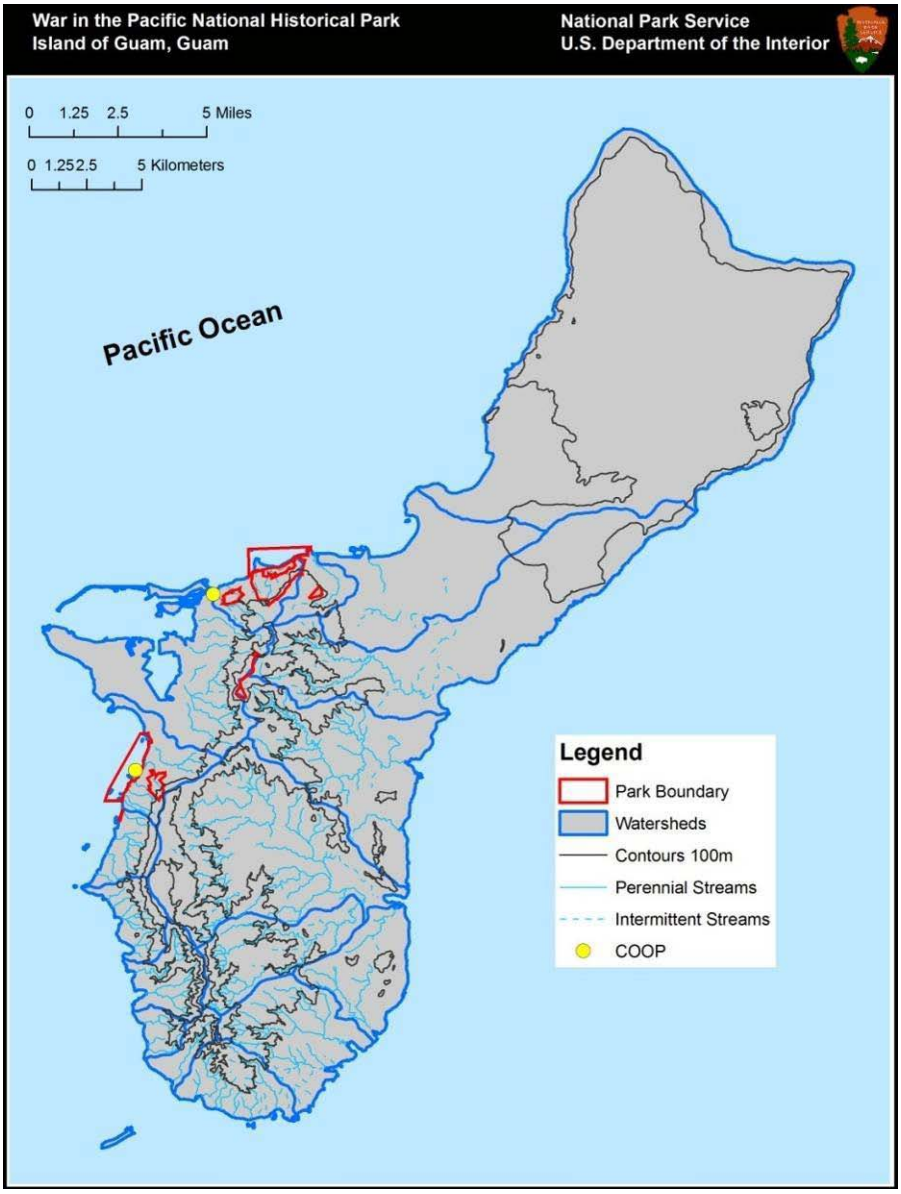


Figure 2.2. Map showing weather station location and watersheds on Guam.

The National Park of American Samoa currently has no weather stations within its boundaries. The closest COOP station with a long-term and reliable record is located at Pago Pago (Figure 2.3). However, the steep ridgeline that makes up the park's southern boundary influences rainfall and wind regimes, thus park staff is interested in acquiring weather data from within the park. Two weather stations will be installed by the PACN at NPSA. In mid September 2009, park and PACN staff determined two locations within the Tutuila unit. One site is at the eastern end of the park at approximately 100 m elevation; this site is used by the park to collect native plant seeds for propagation and it is near a PACN freshwater monitoring sampling site. The other location is near a ridgeline towards the western end of the park, where an opening in the forest provides a suitable site. Park staff was going to follow up by hiking to the locations and taking GIS coordinates, but during the Tsunami of September 29, 2009, the visitor center, offices, and much of the equipment at the park were destroyed. NPSA I&M staff are currently working to obtain these points, and when the stations are installed in 2011, all required data on each station will be acquired. Park and PACN staff have also expressed interest in weather data for the islands of Tau and Ofu-Olosega, for which there are currently no weather data available either within or outside park boundaries. Travel times to these islands are long, making routine trips by park staff for station maintenance impractical. Should more funding become available, a partnership with another agency that is also interested in data from these islands (e.g., the NWS which had a station at Ofu until it was destroyed by a hurricane) should be pursued. Given the remote locations, ideally data should be downloaded via satellite.

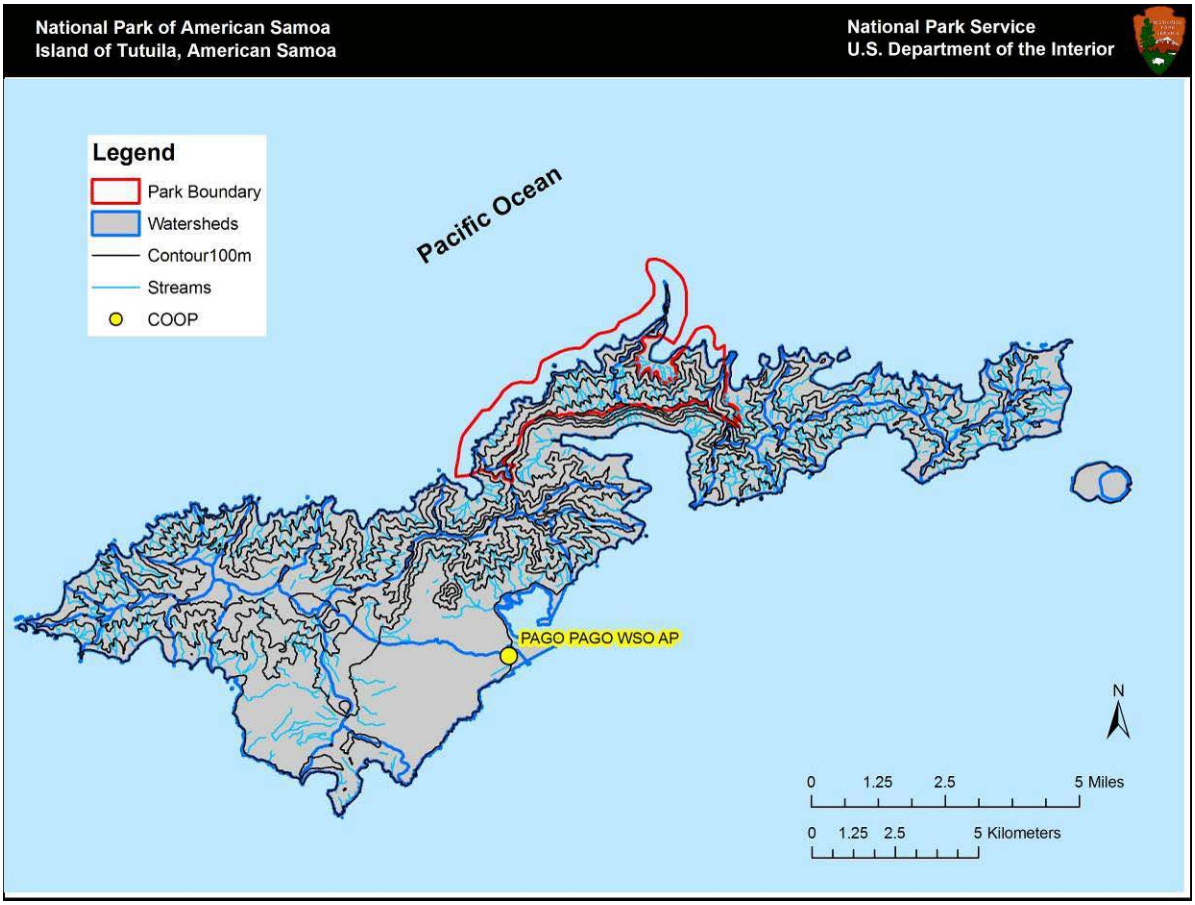


Figure 2.3. Map showing weather station location and watersheds on Tutuila.

No monitoring of natural resources is occurring at VALR on the island of Oahu and there are no plans to add a weather station to this park.

On Molokai, KALA currently has two COOP stations and one RAWS (Figure 2.4), though the COOP rain gauge on top of the cliff has a very poor observation record. Despite the short distance, weather conditions on the peninsula are not representative of the conditions along the steep cliffs. Park staff is particularly interested in measuring the precipitation gradient. The PACN is supplying two weather stations, which will be located along the top of the ridge, one at the top of the communications trail, and the other in the Puu Alii Natural Area Reserve cabin. Stations at these higher elevations in remote area will assist in further characterizing the precipitation gradient and weather conditions in the almost pristine native rainforest of the upper elevations.

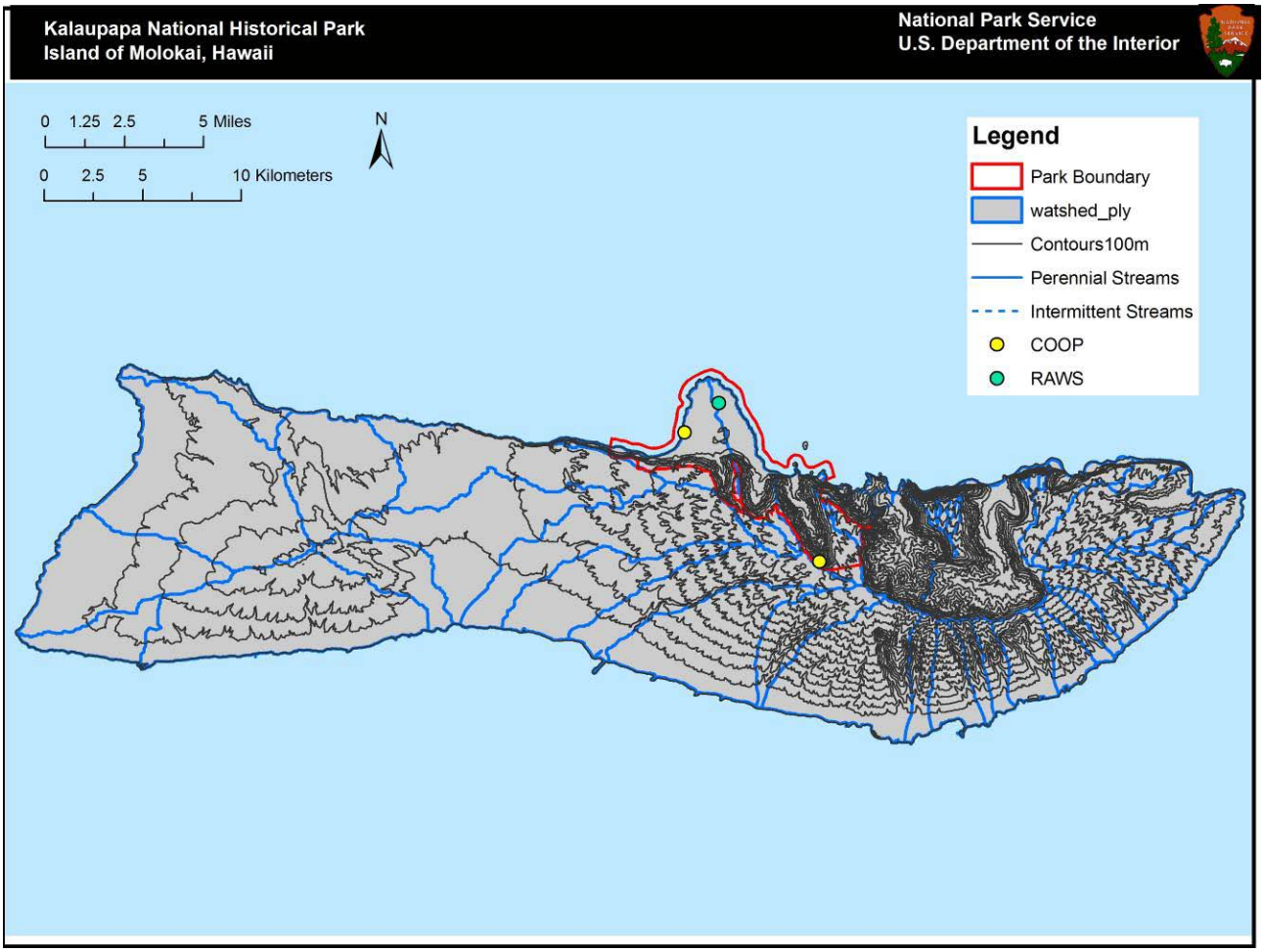


Figure 2.4. Map showing weather station location and watersheds on Molokai.

Haleakala National Park has several weather stations ranging from rain gauges to fully equipped stations with many sensors (Figure 2.5). At this point, there are no plans to set up more stations in this park. However, future support for HaleNet has been mentioned as a priority by park staff; the program is currently supported by grants.

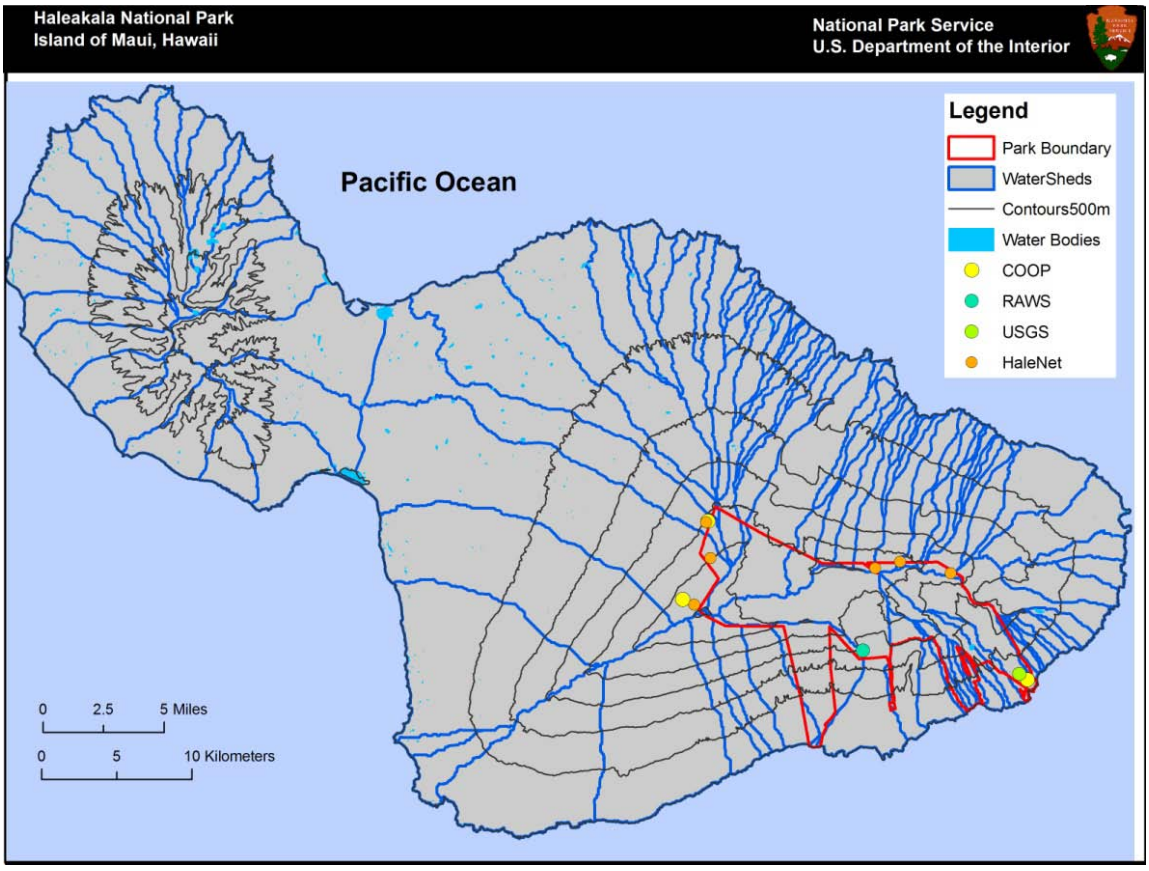


Figure 2.5. Map showing weather station location and watersheds on Maui.

Figure 2.6 shows the location of weather stations in and near the national parks on Hawaii Island with the exception of ALKA. Locations for existing and possible new stations for this trail should be evaluated once the exact trail corridor has been mapped and locations can be determined for which weather data would provide the most useful information to aid in natural resource protection or to provide long-term climate trend information.

The PACN will set up a new weather station at PUHE; site determination was carried out and the compliance process was started in 2009. Given the small size of the park, there is only one climate zone, thus site determination was driven by the desire to avoid data bias due to tall structures or other environmental influences, to avoid disturbing viewsheds and archeological resources, and to keep the station out of sight to protect it from vandalism. The new site is located behind, but a due distance away from, the park headquarters.

Since KAHO already collects data from a COOP rain gauge and a RAWS station within park boundaries, there are no plans for additional stations in this park which has no climatic variability.

PUHO only had a COOP rain gauge; in 2009 the PACN set up a WeatherHawk weather station, which will be replaced by a Campbell Scientific weather station in 2010 or 2011 at the same location. There is no climatic variability in the coastal section of the park (not considering the upland garden, which is slightly wetter); thus, as for PUHE, site determination focused on avoiding environmental data bias, avoiding sensitive cultural sites, and hiding the station from view of visitors. Park staff at PUHE, KAHO, and PUHO have indicated that, should more funding become available, they would be interested in pursuing a partnership with another agency to collect weather data from higher elevations since groundwater supplies at the parks are more influenced by upslope rainfall than coastal rainfall. No USGS, COOP, or RAWS stations currently located at high elevations in the Kawaihae watershed where PUHE is situated, the Keahole and Honokohau watersheds where KAHO is located, or in PUHO's Kiilae watershed. All three parks have anchialine pools, highly specialized and sensitive ecosystems, which are influenced by the tides as well as the freshwater lens. These pools are currently monitored by the PACN freshwater protocol as well as by other monitoring projects in the parks. The PACN groundwater protocol also includes sampling at PUHE, KAHO and PUHO.

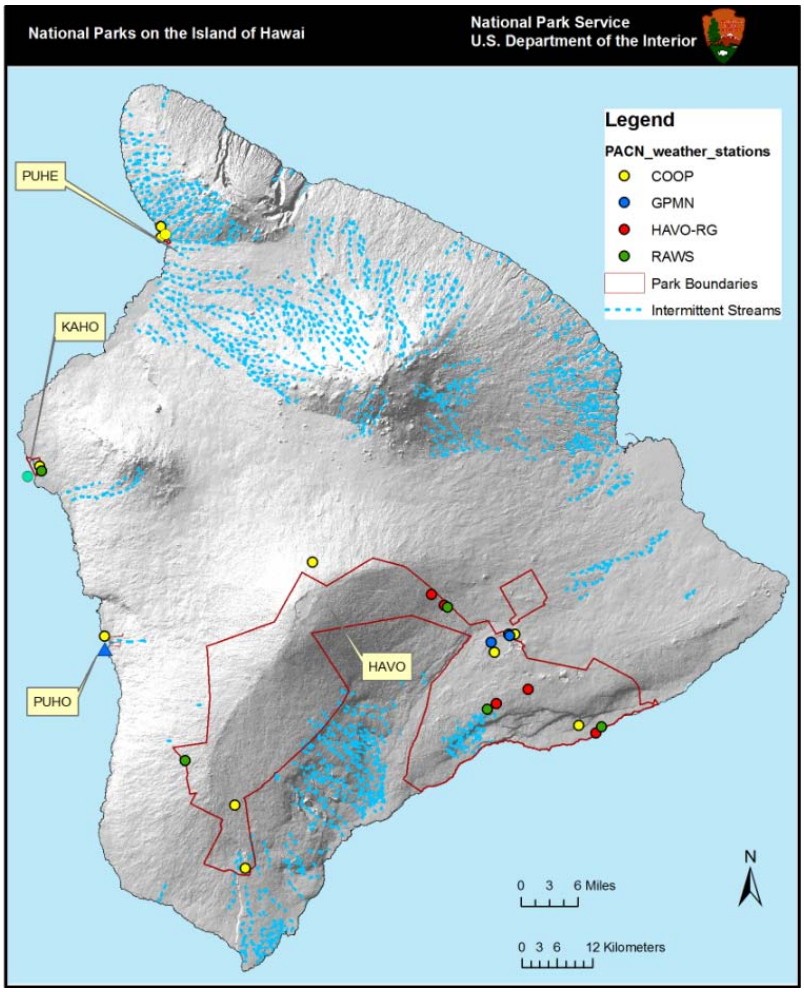


Figure 2.6. Map showing weather station location and watersheds on Hawaii and indicating the locations of Puukohola Heiau National Historic Site (PUHE), Kaloko-Honokohau National Historical Park (KAHO), Puuhonua o Honaunau National Historical Park (PUHO), Hawaii Volcanoes National Park (HAVO).

While there are a number of weather stations in Hawaii Volcanoes National Park, the climatically variable Kahuku unit is still underserved with data. Two COOP rain gauges with only weekly observations are located in this part of the park in addition to a RAWS station that is located on the western Kahuku boundary, which is much drier than the eastern side. Kahuku was only added to the park in 2003, since then, a number of vegetation restoration projects have been started by the park. In addition, the PACN will start vegetation monitoring at various elevations in 2011. Two PACN weather stations will be installed at Kahuku to provide support for these projects and characterize the weather conditions of this area. One station will be at approximately 950 m elevation in a mesic forest area, the other at about 2,000 m elevation in subalpine habitat.

Researchers and park staff have also expressed interest in rainfall data from the discontiguous Olaa Unit which has higher rainfall than most of the rest of HAVO and a very steep rainfall gradient (see PRISM maps in Appendix A). This part of the park is the site of long-term restoration studies as well as plant and invasive animal research. One weather station belonging to the University of Hawaii currently exists near the eastern boundary of this unit.

Sampling Locations

Table 2.1 lists currently active stations that are included in PACN weather/climate monitoring efforts. Variables measured at these stations and other details are given in Appendix C. In some cases, stations located outside park boundaries provide data that can be considered representative of conditions in the park; these data will be included in the data analysis. This table will be modified whenever new stations are installed. While all stations in Table 2.1 are included in some way in the PACN weather/climate monitoring effort, data analysis presented in reports will be restricted to a subset of the stations (for more detail on reporting see Chapter 4).

Table 2.1. Weather stations included in Pacific Island Network weather monitoring efforts.

Station Name	Program	In Park (P) or Nearby (N)	Elevation (m)	Record Length
War in the Pacific National Historical Park (Guam)				
Agat	COOP	P	3.00	Jul. 1978 to present
American Memorial Park (Saipan)				
Capitol Hill 1	COOP	N	252.00	Dec. 1994 to present
Amme CS	PACN	P	8	Set up 2011
National Park of American Samoa (Tutuila)				
Pago Pago WSO AP	COOP	N	3.40	Apr. 1956 to present
Npsa 1	PACN	P	353	Set up 2011
Npsa 2	PACN	P	113	Set up 2011
World War II Valor in the Pacific National Monument (Oahu)				
Honolulu Intl. Arpt	COOP	N	4.0	Sep. 1982 to present

Table 2.1. Weather stations included in Pacific Island Network weather monitoring efforts (continued).

Station Name	Program	In Park (P) or Nearby (N)	Elevation (m)	Record Length
Kalaupapa National Historical Park (Molokai)				
Kalaupapa 563	COOP	P	9	Oct. 1949 to present
Makapulapai	RAWS	P	23	Mar. 1993 to present
Kala 1	PACN	P	521	Set up 2011
Kala 2	PACN	P	1140	Set up 2011
Haleakala National Park (Maui)				
Haleakala Rs 338	COOP	N	2,121	Oct. 1949 to present
Oheo 258.6	COOP	P	37	Jan.1981 to present
Kaupo Gap	RAWS	P	1,228	Jan.1991 to present
Big Bog	HaleNet	P	1,650	Jun. 1992 to present
Haleakala National Park HQ	HaleNet	N	2,120	Jun. 1988 to present
Nene Nest	HaleNet	P	2,590	Mar. 1990 to present
Pohaku Palaha	HaleNet	P	2,460	Jun. 1992 to present
Summit	HaleNet	N	2,990	Apr. 1990 to present
Treeline	HaleNet	N	2,260	Jun. 1992 to present
Oheo Gulch RG	USGS	P	128	Unknown to present
Puukohola Heiau National Historic Site (Hawaii)				
Middle Pen	COOP	N	418	April 1965 to present
Puukohola Heiau 98.1	COOP	N	41	Jan. 1977 to present
Puhe CS	PACN	P	39	Set up 2011
Kaloko-Honokohau National Historical Park (Hawaii)				
Honokohau Harbor 68.14	COOP	N	9	Jan. 1991 to present
Kaloko-Honokohau	RAWS	N	8	Dec. 2004 to present
Puuhonua o Honaunau National Historical Park (Hawaii)				
Puuhonuaohonaunau 27.4	COOP	P	5	Nov. 1977 to present
Puho CS	PACN	P	25	Set up 2011
Hawaii Volcanoes National Park (Hawaii)				
Halemaumau 52	COOP	P	1,110	Oct. 1949 to present
Hawaii Vol NP HQ 54	COOP	P	1,210	Oct. 1949 to present
Kahuku Mill Camp 6.3	COOP	P	668	Feb. 1988 to present
Mauka Rsvr. 3.11	COOP	P	1,521	May 1983 to present
Mauna Loa Slope OBS 39	COOP	N	3,399	May 1982 to present

Table 2.1. Weather stations included in Pacific Island Network weather monitoring efforts (continued).

Station Name	Program	In Park (P) or Nearby (N)	Elevation (m)	Record Length
Hawaii Volcanoes National Park (Hawaii) continued				
Kahuku	RAWS	P	1,796	Nov. 2002 to present
Kealakomo 2	RAWS	P	30	Feb. 2008 to present
Keaumo	RAWS	P	1,683	Feb. 1999 to present
Pali 2	RAWS	P	847	Jul. 1999 to present
The Observatory	GPMN	P	1123	Oct. 1999 to present
Visitor Center	GPMN	P	1,215	Oct. 1986 to present
Ainahou	HAVO-RG	P	967	Oct. 1986 to present
Keamoku	HAVO-RG	P	1,692	Oct. 1986 to present
Kipuka Nene	HAVO-RG	P	1,021	Oct. 1986 to present
Mauna Loa	HAVO-RG	P	2,042	Oct. 1986 to present
Puu Loa	HAVO-RG	P	9	Oct. 1986 to present
Lower Kahuku CS	PACN	P	942	Set up 2011
Nene Cabin CS	PACN	P	1982	Set up 2011
Ala Kahakai National Historic Trail* (Hawaii)				
Hawi 168	COOP	N	177	Oct. 1949 to present
Honaunau 27	COOP	N	287	Oct. 1949 to present
Honokohau Harbor 68.14	COOP	N	9	Jan. 1991 to present
Kainaliu 73.2	COOP	N	457	Oct. 1949 to present
Ke-ahole Point 68.13	COOP	N	6	Feb. 1981 to present
Kealakekua 26.2	COOP	N	451	Jul. 1956 to present
Kealakomo 38.8	COOP	N	99	Apr. 1995 to present
Kohala Mission 175.1	COOP	N	165	Oct. 1949 to present
Kona Village 93.8	COOP	N	6	May 1968 to present
Mahaiula 92.7	COOP	N	293	Jun 1986 to present
Milolii 2.34	COOP	N	357	May 1985 to present
Naalehu 14	COOP	N	244	Oct. 1949 to present
Napoopoo 28	COOP	N	122	Oct. 1949 to present
Opihihale 2 24.1	COOP	N	415	Apr. 1956 to present
Puuhonuaohonaunau 27.4	COOP	N	5	Nov. 1977 to present

Station Name	Program	In Park (P) or Nearby (N)	Elevation (m)	Record Length
Puukohola Heiau 98.1	COOP	N	43	Jan 1977 to present
Sea Mountain 12.15	COOP	N	24	May 1982 to present
Waikoloa 95.8	COOP	N	268	Jul 1975 to present

*All stations for ALKA are identified as 'near the park' because the exact trail corridor has not been determined.

Not included in Table 2.1 are six rain gauges at HALE located throughout Kipahulu and down to Oheo that belong to the ALERT program because metadata for these stations are currently unavailable.

Population Monitored

The existing weather stations provide point-based observations. Although the climatic footprint extends beyond the physical limits of a station, fine-scale climatic patterns will often not be well represented. This is a result of the limited number of stations available and the often complex topography in the larger parks as well as the fact that some parks consist of several discontiguous units, but not all units have weather stations. Several stations included in PACN weather monitoring have a long period of record that provides a basis for evaluating climatic extremes and change.

Observation Frequency

All weather stations in the PACN are operated year-round. However, observation frequency varies among the weather monitoring programs. Observations from NWS-COOP stations generally are 24-hour measures (i.e., daily maximum and minimum temperatures and total precipitation). These data are reported daily and monthly to climate data centers. The RAWS stations take minute-by-minute data and log hourly averages and totals; the data are uploaded via satellite every hour. HaleNet stations log one-minute data as well as hourly averages and totals; the data are transmitted hourly. The GPMP take measurements in one-minute intervals, stations log hourly averages. New stations set up by PACN will log hourly data. The USGS rain gauge at Oheo in HALE records data continuously; logging 15-minute totals and transmitting data via satellite every hour. The tipping bucket rain gauges belonging to the ALERT system in HALE collect and transmit rainfall data continuously.

Observation frequencies for weather stations in the PACN are highly variable because they are determined by the program to which the stations belong. With respect to determining observation frequency requirements for stations to be established in the future it needs to be taken into account that stations serve more than one purpose; they provide data for weather as well as climate analysis. For long-term climate monitoring purposes, daily data are generally sufficient. The World Climate Research Program (WCRP) Expert Team on Climate Change Detection, Monitoring and Indices recommends indices based on daily precipitation amounts only. With respect to detecting temperature trends, recordings of daily maximum and minimum temperatures are necessary, given that it has been shown that warming trends may be different for daytime versus night time temperatures (Giambelluca et al. 2008). Additionally, the daily temperature range, derived as the difference between maximum and minimum temperatures, is

another climate change indicator also used by IPCC. However, for weather data analysis it would be most useful to have hourly records. The effect of tropical cyclones, for instance, would be heavily underestimated if the only available measure was daily precipitation.

Chapter 3: Field Methods

Seasonal preparations and equipment setup are minimal given that the weather stations are operated year-round and that few stations in the PACN are located in areas with distinct seasons. Park staff is involved in recording and reporting observations for COOP stations as well as in conducting minor maintenance of COOP stations and all maintenance for RAWS stations. However, the COOP program requires agency representatives to conduct annual inspections, maintenance, and calibration. Maintenance and calibration of other weather stations in the PACN are generally also the responsibility of external agencies with the exception of stations owned by the PACN. Table 3.1 summarizes this information; names and contact information for personnel are provided in Appendix B.

Table 3.1. Agencies responsible for recording and reporting observations and performing maintenance and calibration for weather stations in the Pacific Island Network.

Monitoring Program	Recording and Reporting of Observations		Maintenance and Calibration	
	Personnel	**Frequency**	**Personnel**	**Frequency**
COOP	Park staff	1x/day	National Weather Service staff	1x/year
RAWS	Automated recording and transmission	1x/hour	Park staff	1x/year
GPMN	USGS Hawaiian Volcano Observatory staff	1x/day	Air Resources Specialists*	2x/year
HaleNet	University of Hawaii at Manoa	1x/hour	University of Hawaii at Manoa	2x/year
PACN Weather stations	Automated recording and transmission	1x/hour	PACN staff	1x/year
USGS rain gauge	USGS staff	1x/hour	USGS staff	1x/year
ALERT	Automated recording and transmission	Continuous	Park staff	Based on need

*under contract with the NPS Air Resources Division

Cooperative Observer Stations

These stations are established, supervised, and inspected by NWS personnel. Annual visits to cooperative stations are made for the purpose of observer training, equipment maintenance, verification of station forms, and network integrity.

Data Recording: These 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 of minimum/maximum temperature and total precipitation are obtained by park personnel by directly reading the instruments (e.g., min-max thermometers, rain gauges) or by reading digital displays connected to electronic sensors. Procedures for reading instrumentation as well as for the maintenance and calibration of equipment performed by the cooperative observer are described in the Cooperative Observer Handbook No.2 (SOP 3). Cooperative observers report damaged or defective equipment and instruments to the NWS representative who then informs the observer about arranging for the repair or replacement.

Data Transmission: Immediately after recording 24-hour temperature and precipitation observations, they are transmitted to designated regional offices of the NWS. Observations are transmitted by phone to a recording device. This method prompts the observer for specific information, and thus does not require a SOP for operation. Punch tapes from the Belfort Rain Gauge (B18) are mailed by the 15th of the following month. The NCDC eventually receives all monthly reports, transcribes the data from paper copies to electronic databases where necessary, archives the data, and distributes error-checked daily values to cooperating agencies (e.g., regional climate centers).

Remote Automated Weather Stations

The existing RAWS stations in the parks are under the supervision of the HAVO Fire Management Office. These stations require maintenance by park staff prior to the beginning of each fire season. Standardized procedures for inspections and maintenance are included in this protocol (SOP 6, 7, 9) to ensure accessibility. These procedures and related documents are also provided on the Interagency RAWS web page under the Field Guide, Forms and Tech Notes link[19]. Programming instructions for the Data Collection Platform are also included in this protocol (SOP 8). Reporting and recording of RAWS sensor performance is being switched from the use of the Automated Sorting, Conversion and Distribution System (ASCADS) to the Computerized Maintenance Monitoring System (CMMS). Information for use of CMMS is available on the RAWS website link[20]. The ASCADS will still be the system of record for all RAWS-generated weather data. During operation, equipment malfunction is reported by the National Interagency Fire Center (NIFC) to a park contact (e.g., a member of the fire management team) by email. Park staff is responsible for immediate resolution of equipment problems as well as for annual maintenance, which includes switching out all sensors and calibration.

Data Recording: Wind Speed – Ten-minute average wind speed is measured just prior to the transmission of the hourly data to GOES. Maximum wind speed (gust) over a 60-minute period is logged.
Wind Direction – Ten-minute average wind direction is measured just prior to the transmission of the hourly data to GOES. The direction of the maximum wind speed (gust) is also recorded.
Precipitation – Measured in increments of .01 inch for each hour.
Barometric Pressure – The station may also be measuring barometric pressure every hour.

[19] http://raws.fam.nwcg.gov/book/
[20] http://www.fs.fed.us/raws/book/cmms/

Soil Moisture, fuel moisture and fuel temperature are measured on some stations.
Air Temperature/Relative Humidity – Current air temperature and a 10-minute average relative humidity are measured. Data from all of the sensors are stored on the data collection platform (DCP) or data logger. The system also holds the program that determines how often and when data are measured.

Data Transmission: RAWS transmit data to NIFC via GOES, which is operated by NOAA. These data are automatically forwarded to several other systems including the Weather Information Management System (WIMS), the Real-time Observation Monitor and Analysis Network (ROMAN) and the WRCC in Reno, Nevada. WIMS is the host site for the National Fire Danger Rating System (NFDRS) and is designed to manage forestry weather information nationwide for the purpose of rating fire danger forecasts. The WRCC is the official repository for RAWS data.

Gaseous Pollutant Monitoring Network (GPMN) Stations

These stations were established by the NPS Air Resources Division. In the PACN there are two of these stations, both at HAVO. Station maintenance and calibration of instruments is conducted every six months by a contractor, Air Resources Specialists Inc. Minor maintenance and operational checks are performed by USGS Hawaiian Volcano Observatory staff and HAVO park staff. Training and manuals for conducting the weekly maintenance are provided by Air Resources Specialists Inc. to the staff involved.

Data Recording: Hourly averages of the meteorological parameters (ambient temperature, precipitation, wind speed and direction, relative humidity, barometric pressure) and SO_2 are recorded to an on-site data logger. Additional data include one-minute averages for SO_2.

Data Transmission: Data are downloaded daily via phone line modem to Air Resources Specialists Inc. in Fort Collins, CO.

Haleakala Climate Network

HaleNet stations are owned by University of Hawaii staff, who also carry out inspections, maintenance, and instrument calibrations. Haleakala National Park provides logistical support in the form of helicopter transportation to maintain the three remote sites (Big Bog, Treeline, Pohaku Palaha) and the repeater (Kuiki).

Data Recording: HaleNet stations record 1-minute data and hourly averages to an onsite data logger (ambient temperature, precipitation, wind speed and direction, relative humidity, barometric pressure, total solar radiation, net radiation, and soil moisture at some stations).

Data Transmission: HaleNet stations transmit data via radio frequency (using repeaters located in the park) to a computer in the park offices.

Pacific Island Network Weather Stations

The PACN weather stations are maintained by PACN and park staff. Station inspections are conducted quarterly for sites that are easily accessible, less frequently at remote sites. Major maintenance including sensor calibration or exchange is conducted once a year or as necessary.

Data Recording: Hourly averages and totals (ambient temperature, precipitation, wind speed and direction, relative humidity, solar radiation) are recorded to an on-site data logger.

Data Transmission: Data are downloaded via satellite or internet connection where available. The GOES satellite is not available for AMME, so an internet connection or the Japan Meteorological Agency (JMA) satellite will be utilized. Data are transmitted to NIFC via GOES. These data are automatically forwarded to several other systems including the Weather Information Management System (WIMS), the Real-time Observation Monitor and Analysis Network (ROMAN) and the WRCC in Reno, Nevada. WIMS is the host site for the National Fire Danger Rating System (NFDRS) and is designed to manage forestry weather information nationwide for the purpose of rating fire danger forecasts. The WRCC will be the official repository for PACN data.

U.S. Geological Survey Rain Gauge

The Oheo tipping bucket rain gauge is owned and maintained by USGS. Maintenance occurs approximately every eight weeks; the equipment is calibrated at least annually.

Data Recording: Rainfall is measured continuously; the recorder at the gauge sums data every 15 minutes.

Data Transmission: The data are transmitted via satellite to the USGS National Water Information System every hour.

Automated Local Evaluation in Real Time

The six ALERT system rain (and stream) gauges are maintained by Haleakala staff. Maintenance procedures are available to Kipahulu staff involved in the operation of the gauges. Currently station maintenance is conducted when data indicated equipment malfunction. A maintenance protocol is under development.

Data Recording: Rainfall is measured continuously with tipping bucket rain gauges.

Data Transmission: The data are transmitted by radio frequencies via repeaters to the park ranger's office at Kipahulu.

Station Documentation

Validity of weather data depends in a large part on the surroundings of a particular station. Vegetation may grow up, or buildings or roads may be constructed in the vicinity of a station imposing artificial patterns and trends on the observed data. The PACN weather/climate monitoring effort includes procedures to document station and site conditions on a regular basis. This includes surveying sites and documenting the conditions by describing them based on a checklist (SOP 12), as well as photo documentation (SOP 13). While park staff and staff from other agencies are conducting maintenance for many of the stations, these site documentation visits are conducted by PACN staff. Only stations within parks are included in this effort, with the exception of HaleNet stations due to access difficulties. The goal is to document station conditions for each station at least every two years.

Chapter 4: Data Management

Data handling, analysis, and reporting are treated as three interrelated steps in managing weather/climate monitoring information. Additional details and context for this chapter may be found in the PACN Data Management Plan (Dicus 2006), which describes the overall information management strategy for the network. The PACN website[21] also contains guidance documents on various information management topics (e.g., report development, GIS applications, GPS use).

Project Information Management Overview

Project information management may be best understood as an ongoing or cyclic process, as shown in Figure 4.1. Specific yearly information management tasks for this project and their timing are described in Chapter 6. Readers may also refer to each respective chapter section below for additional guidance and instructions.

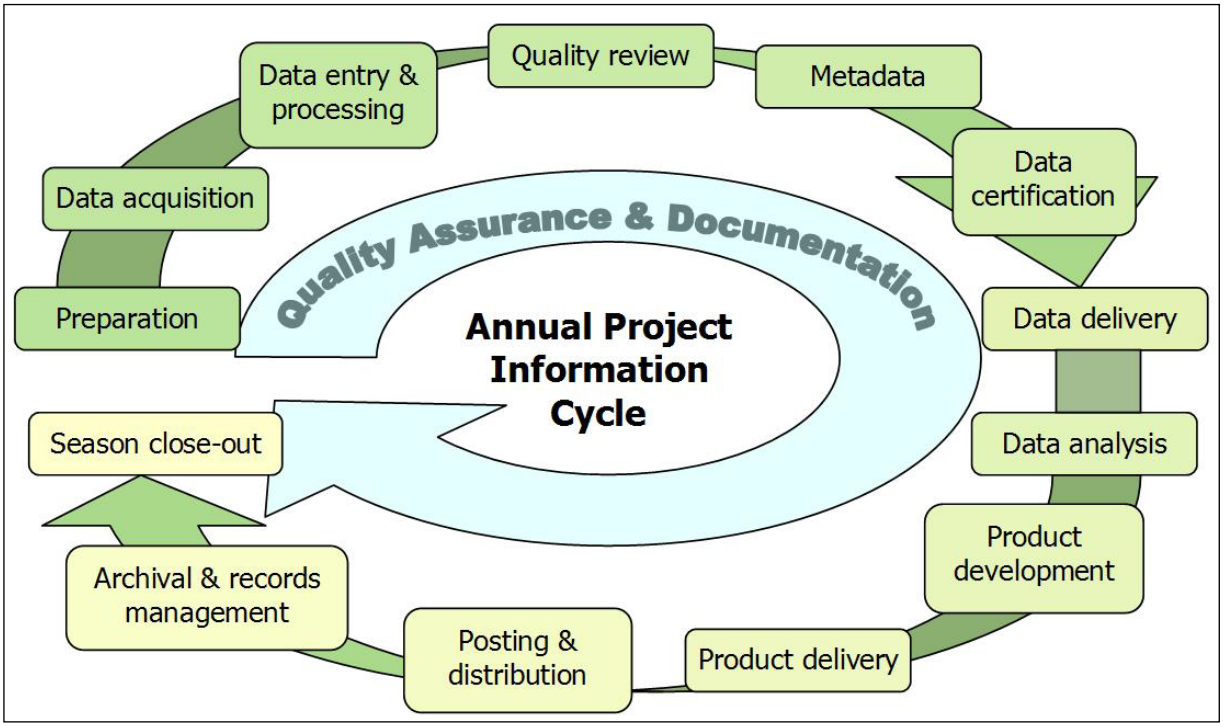


Figure 4.1. Idealized flow diagram of the cyclical stages of project information management. Note that quality assurance and documentation are thematic and not limited to any particular stage of the information life cycle.

[21] http://science.nature.nps.gov/im/units/pacn/data.cfm

The stages of this cycle are described in greater depth in later sections of this chapter, but can be briefly summarized as follows:

- *Preparation* – Training, logistics planning, print forms and maps
- *Data acquisition* – Field trips to acquire data
- *Data entry & processing* – Data entry and uploads into the working copy of the database, GPS data processing, etc.
- *Quality review* – Data are reviewed for quality and logical consistency
- *Metadata* – Documentation of the year's data collection and results of the quality review
- *Data certification* – Data are certified as complete for the period of record
- *Data delivery* – Certified data and metadata are delivered for archival and uploaded to the master project database
- *Data analysis* – Data are summarized and analyzed
- *Product development* – Reports, maps, and other products are developed
- *Product delivery* – Deliver reports and other products for posting and archival
- *Posting & distribution* – Distribute products as planned and/or post to NPS clearinghouses
- *Archival & records management* – Review analog and digital files for retention (or destruction) according to NPS Director's Order 19[22]. Retained files are renamed and stored as needed.
- *Season close-out* – Review and document needed improvements to project procedures or infrastructure, complete administrative reports, and develop work plans for the coming calendar year.

Preparations for Information Management

Set up Project Workspace

A section of the networked PACN server is reserved for this project, and access permissions are established so that only weather project staff members have access to needed files within this workspace. Each year, the project manager should make sure that network accounts are established for each new weather project staff member, and that the data manager is notified to ensure access to the project workspace and databases. If network connections are too slow for efficient data entry and processing, individual staff members may set up a workspace on their own workstation, with periodic data transfer to the PACN server. Additional details about the workspace setup and records management may be found in SOP 14.

Implement Working Database Copy

Each year, the data manager will implement a blank copy of the working database and ensure proper access for weather project staff. Refer to Overview for Database Design for additional information about the database design and implementation strategy.

Overview of Database Design

PACN data management staff designed a customized relational database application to store and manipulate the data associated with this project. The design of the Climate Monitoring Database is consistent with NPS I&M and PACN standards and is documented in the data dictionary in

[22] http://data2.itc.nps.gov/npspolicy/DOrders.cfm

Appendix D. The PACN data management staff is responsible for development and maintenance of the database, including customization of data summarization and export routines.

The database is divided into two components: (a) one for importing, qualifying and error-checking data for the current calendar year (i.e., the "working database copy"), and (b) one that contains the complete set of certified data for the monitoring project (i.e., the "master project database"). A functional comparison of these two components is provided in Table 4.1.

Table 4.1. Functional comparison of the master project database and the working database.

Project Database Functions and Capabilities	Working Database	Master Database
Software platform for back-end data	MS Access	MS SQL Server or MS Access
Contains full list of sampling locations	X	X
Portable for remote data entry	X	
Forms for uploading, entering and editing current year data	X	
Quality assurance and data validation tools	X	X
Preliminary data summarization capabilities	X	
Full analysis, summarization and export tools		X
Pre-formatted report output		X
Contains certified data for all observation years		X
Limited editing capabilities, edits are logged		X
Full automated backups and transaction logging		X

Each of these components is based on an identical underlying data structure (tables, fields and relationships, as documented in Appendix D). The working database is implemented in Microsoft Access to permit greater flexibility when operating on computers with limited or unreliable network access. Eventually, the master database should be implemented in Microsoft SQL Server in order to take advantage of the backup and transaction logging capabilities of this enterprise database software.

Both components have an associated front-end database application ("user interface" with forms and queries) implemented in Microsoft Access. The working database application has separate screens for data importation, data review, and quality validation tools. The master database application contains the analysis and summarization tools, including pre-formatted report output and exports to other software (e.g., for analysis and graphics production). This front-end application arrangement allows for modification and update of the user interface with no disruption to data entry continuity. The improved front-end file can be distributed to data entry staff, which link it to the back-end file, discard the out-dated front-end file, and proceed with their data entry work. Under this arrangement, data entry staff has no need to open the back-end file, thereby reducing the risk of improper deletions or other inadvertent data loss occurring within the protocol-specific data tables. In addition, a multi-user environment can be

accommodated by storing the back-end file on a server available to all users via a computer network.

Prior to the beginning of the calendar year, the project manager will be provided with a copy of a working database to enter, process, and quality-check data for the current calendar year (refer to the next section and SOP 16). Once data for the calendar year have been certified they will be uploaded into the master database, which is then used to inform all reporting and analysis. This upload process is performed by the data manager, using a series of pre-built append queries. The certified working copy of the database for the calendar year will be archived, and a new working copy will be implemented in the next calendar year.

Acquisition of Weather Data

Weather data for the PACN will be acquired from a number of different sources. Below is a summary of the various processes for data acquisition; additional details can be found in SOP 21.

Data from NWS-COOP stations, RAWS, and PACN weather stations will be downloaded annually from the WRCC and saved in a comma delimited text file (.csv extension). The .csv files will be imported into the PACN climate database. These data are validated and certified by the WRCC.

HaleNet data will be acquired annually from Tom Giambelluca at the University of Hawaii at Manoa's Geography Department in a compressed zip file format. Individual text files within the compressed folder will contain daily mean data for a station. The text files will be formatted in Excel for importation into the PACN climate database; these data receive preliminary validation by HaleNet.

GPMN data will be downloaded from the data access website[23] established by Air Resource Specialists, Inc. The downloaded Excel files will be imported into the PACN climate database; these data are validated by Air Resources Specialists Inc.

A copy of all raw data will be stored unedited, and in their original file format, in the PACN Digital Library. Only the data manager and project manager will have access permission to the raw data files. All of the data from this program, including hard copies and electronic format data will be archived in accordance with standards described in the PACN data management plan.

Data Import and Processing

The functional components for importing and entering data into the working database are described in SOP 16. Each data entry form has built-in quality assurance components such as pick lists and validation rules to test for missing data or illogical combinations. Although the database permits users to view the raw data tables and other database objects, users are strongly encouraged only to use these pre-built forms as a way of ensuring the maximum level of quality assurance.

[23] http://12.45.109.6/

Regular Data Backups

Upon opening the working database, the user will be prompted to make a backup of the underlying data (SOP 16). It is recommended that this be done on a regular basis – perhaps every day that new data are entered – to save time in case of mistakes or database file corruption. These periodic backup files should be compressed to save drive space, and may be deleted once enough subsequent backups are made. All such backups may be deleted after the data have passed the quality review and have been certified.

Field Form Handling Procedures

Since weather data will imported into the database from downloaded text files, there will be no field forms for these data. However, site visits, data downloads, station conditions, and the photographic documentation of the stations and sites will be recorded on field data sheets. As these field forms are part of the permanent record for project data, they must be handled in a way that preserves their future interpretability and information content. To minimize the possibility of data loss, hardcopy data forms and field notebooks should be stored in a well organized fashion in a secure location, with scanned data forms stored in a separate location (e.g., on the PACN data server).

Image Handling Procedures

Original images of weather stations and station locations will be downloaded to the image folders within the weather/climate monitoring file structure. Copies of images that may be of interest to others in the PACN will be archived within the PACN Thumbs Plus image database. Refer to SOP 15 for details on how to handle and manage these files.

GPS Data Procedures

GPS data will be collected to mark the location of station locations and tracks to stations if they are located in remote country. Processing of GPS data will follow these general steps: (see also SOP 2 and Table 6.1):

1. GPS data will be downloaded by the station observer from the units at the end of the field visit and stored in the project workspace (see SOP 14).
2. Raw files will be sent in a timely manner to the GIS specialist for processing and correction.
3. The GIS specialist will process the raw GPS data and store the processed data in the project workspace.
4. The GIS specialist will upload corrected coordinate information into the database and create GIS data sets.

The project manager should periodically review the processed GPS data to make sure that any problems are identified early on in the data collection process.

Data Quality Review

Data received from WRCC have already undergone a preliminary quality review and verification process. HaleNet and GPMN data are received after preliminary quality control. Exploratory data analysis, in preparation for annual reports, may reveal logical inconsistencies, outliers or other problems that were not caught in preliminary quality control. The project manager will then resolve these problems if possible and the procedure will be documented in the database. Not all

errors and inconsistencies can be resolved. If that is the case, a description of the errors and why edits were not made is documented and included in the metadata and certification report (see Metadata Procedures and Data Certification and Delivery, as well as SOP 17).

Metadata Procedures

Data documentation is a critical step toward ensuring that data sets are usable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, condition, and other characteristics of a given data set, both tabular and spatial. Additionally, metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata for all PACN monitoring data will conform to Federal Geographic Data Committee (FGDC) guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed, and synthesized.

At the conclusion of the calendar year (according to the schedule in Table 6.1), the project lead and project manager will be jointly responsible for providing a completed, up-to-date metadata interview form to the data manager. The data manager and GIS specialist will facilitate metadata development by consulting on the use of the metadata interview form, by creating and parsing metadata records from the information in the interview form, and by posting such records to national clearinghouses. Refer to SOP 18 for specific instructions on metadata development.

Data Certification and Delivery

Data certification is a benchmark in the project information management process that indicates that: 1) the data are complete for the period of record; 2) they have undergone and passed the quality assurance checks (Quality Review); and 3) that they are appropriately documented and in adequate condition for archiving, posting and distribution as appropriate. Certification is not intended to imply that the data are completely free of errors or inconsistencies, which may or may not have been detected during quality assurance reviews.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. The project manager is primarily responsible for completing a PACN Project Data Certification Form, available from the data manager or on the PACN website. This brief form should be submitted with the certified data according to the timeline in Table 6.1. Refer to SOP 17 and SOP 19 for specific instructions.

Product Delivery, Posting and Distribution

Refer to Table 6.1 and SOP 19 for the complete schedule for product deliverables and the people responsible for them, and for detailed instructions on how to deliver final products. Upon delivery products will be posted to NPS websites and clearinghouses (e.g., Natural Resource Information Portal) as appropriate (refer to SOP 20 for more information). However, because of restrictions on climate data acquired from the Western Regional Climate Center and the Haleakala Climate Network, raw data acquired from these programs will not be posted to the Natural Resource Information Portal.

Archiving and Records Management

All project files should be reviewed, cleaned up, and organized by the project manager on a regular basis (e.g., annually in January). Decisions on what to retain and what to destroy should be made following guidelines stipulated in NPS Director's Order 19[24], which provides a schedule indicating the amount of time that the various kinds of records should be retained (also see SOP 14).

Season Close-out

After the conclusion of the calendar year, the project manager, project lead, data manager, and GIS specialist will meet to discuss the working database application or any needed modifications of the SOP associated with the protocol. Refer to the section on Data Entry and Verification for additional close-out procedures not specifically related to project information management.

[24] http://www.nps.gov/policy/DOrders/DOrder19.html

Chapter 5: Data Analysis and Reporting

Variability in weather patterns and long-term trends for PACN parks will be summarized by tables and figures. Using the programming language R[25], exploratory data analysis such as box plots will be used extensively to display the location (i.e., median), scale (i.e., range of variability), extremes, and statistical distribution of the underlying data. Core climate parameters analyzed will include temperature, precipitation, relative humidity, and wind direction and speed. An annual report on data from park-wide stations will present weather conditions and anomalies for the most recent year and may extend over a 15-month period to keep the winter rainy season for some parks intact. The annual report is distributed by March of the following year or as soon as weather data for the antecedent year are available, and have been quality controlled and processed.

There are three components to the annual report: 1) monthly summaries of reported parameters, 2) annual summaries, and 3) assessments of weather extremes on the annual, monthly, and daily timescales for core weather parameters. Extreme weather events such as meteorological droughts and tropical cyclones will also be included in the annual report if they happen to occur in that year.

Statistical analysis to detect trend shall not be made in the routine annual report. The purpose of the annual report is to describe climate conditions in the most recent year, not tracking long-term changes in weather parameters; thus statistical analyses to detect change will be reported every five years.

Standard Report Format

Reports will use the NPS publications templates, which are pre-formatted Microsoft Word template documents based on current NPS formatting standards. Annual reports will use either the Natural Resource Data Series or the Natural Resource Report series, and trend analysis and other peer-reviewed technical reports will use the Natural Resource Technical Report series. Templates for these report series and documentation of the NPS publication standards are available at the NPS Natural Resources Reports[26] website.

Examples of Routine Data Summaries and Statistical Analyses

Data analysis presented in annual and 5-year trend reports will be restricted to a subset of the stations involved in PACN weather/climate monitoring (Table 2.1.) If data from several stations in an area show similar patterns, analysis for only one station will be featured in the report to represent weather patterns or trends for the area. Other criteria for including stations in reports are the percentage of valid data for the reporting period and the record length for a station.

Below we present tables, figures and discussion summarizing data for a RAWS (Pali 2) and a COOP station (HQ 54) that serve as an example for data analysis presented in annual reports. Both stations are located in Hawaii Volcanoes National Park, Hawaii; given the size of this park and its varying elevation (Table 5.1), one should be aware that weather information from these two sites is not representative for the entire park. Table 5.1 is the daily summary for December

[25] http://www.r-project.org/
[26] http://www.nature.nps.gov/publications/NRPM/index.cfm

2007 at Pali 2. Due to the large number of stations in the PACN annual reports will include only a very limited number of daily summaries, generally to highlight very extreme conditions. If time and resources allow, this type of analysis will be featured in irregularly occurring resource briefs. Again, based on time and resources available, PACN staff may be able to respond to request for similar data summaries for other months and other PACN sites.

While daily summary tables will include several parameters, discussions will focus on the climate variables showing extremes. Take precipitation presented in Table 5.1 as an example. Heavy precipitation with daily amounts of more than two inches occurred on December 4th and persisted through the next five days until December 9th. On the mainland U.S. daily precipitation with amounts above two inches has been defined as a "heavy" event by Karl et al. (1996), Groisman et al. (2001) and many others. Likewise, daily precipitation exceeding four inches has been identified as a "very heavy" event. According to this definition, December 5-7 was characterized by very heavy rainfall. Also note that December 2007 was a very wet month, with more than 25 inches of precipitation.

Presentation and discussion of monthly averages and totals will put the data in perspective by contrasting them with long-term means. Table 5.2 lists the monthly climatic data for 2007 for the same station. Also shown is the percentage of data availability for each month and the number of days when precipitation exceeds a particular threshold. The number of wet days (>0.01 in) is indeed very high in December 2007. How unusual the amount of precipitation in December 2007 is relative to the long-term mean can be appreciated from Table 5.3 and Figure 5.1. While the mean value for December is 5.7 inches, the 2007 amount is 25.3 inches, almost 20 inches above the long-term mean, or 442% of the mean.

Table 5.4 displays daily values of major climate parameters for December 2007 from HQ 54. The COOP station has a few missing observations for temperature readings. This may not present a serious problem when daily observations are summed and averaged to produce the monthly means since the percentage of valid data is rather high (> 93%). Note that no adjustment is made to the average data for periods with missing observations. If the percentage of valid data is low, the monthly mean should not be calculated because of the low sampling frequency in the actual observations. The WRCC only reports monthly averages or totals for stations with 0-5 missing data values per month, while NCDC considers 0-9 missing data values in a month acceptable (Kelly Redmond, WRCC, pers. comm., email, August 2009).

The PACN will use 85% as the cut-off point for analyzing weather stations with daily report data, and stations with weekly recordings will be analyzed for general patterns and presented graphically. Monthly data for 2007 at HQ 54 are shown in Table 5.5.

Table 5.1. Daily weather summary for the Pali 2 station (RAWS) in Hawaii Volcanoes National Park – December 2007.

Dec-07	Solar Radiation	Wind			Air Temperature (°F)			Fuel Temperature (°F)			Relative Humidity (%)			Precip. (in)
Day	Total (ly)	Speed Ave.(mph)	Dir. Vector (°)	Speed Gust(mph) (mph)	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
1	267	3.8	224	17	64.6	72	59	65.7	82	56	100	100	100	0.12
2	559	5.3	66	17	67.8	79	59	72.0	97	58	97	100	75	0.01
3	154	7.1	216	29	66.1	74	63	67.6	88	61	100	100	98	0.16
4	65	8.7	240	36	64.7	68	59	64.5	69	57	100	100	100	2.16
5	41	17.7	204	45	65.8	68	60	65.9	68	60	100	100	100	5.52
6	46	5.7	183	32	59.8	62	58	60.0	63	58	100	100	100	4.08
7	67	8.6	204	39	62.7	65	60	62.8	66	60	100	100	100	5.64
8	121	8.4	188	34	64.5	66	63	65.2	71	62	100	100	100	2.22
9	218	5.1	50	18	64.0	72	61	63.9	78	58	100	100	100	2.31
10	493	11.5	31	27	65.5	76	59	67.0	88	54	91	100	66	0.00
11	304	12.9	22	31	64.4	72	60	65.0	78	58	94	100	80	0.11
12	247	13.7	31	35	63.0	69	60	61.5	69	57	98	100	72	0.32
13	452	16.9	24	44	63.0	72	59	64.8	81	58	96	100	79	0.02
14	529	18.8	18	41	62.3	70	57	65.0	80	57	95	100	77	0.01
15	395	16.5	24	38	62.5	69	59	63.8	80	58	98	100	83	0.04
16	537	18.6	25	44	62.8	69	59	64.5	80	57	94	100	63	0.21
17	514	16.8	29	34	62.0	70	58	64.0	82	56	93	100	73	0.04
18	307	13.7	35	31	61.0	66	56	61.9	74	55	95	100	83	0.00
19	255	11.5	30	26	61.2	68	58	62.1	74	56	99	100	88	0.01
20	528	12.0	25	29	63.3	73	56	66.5	89	55	87	100	54	0.00
21	483	11.6	28	27	64.0	73	57	66.8	90	55	88	100	64	0.03
22	561	12.6	27	30	64.8	74	59	68.1	89	56	91	100	68	0.00
23	501	13.6	30	38	65.4	76	60	68.7	93	59	91	100	63	0.00

Table 5.1. Daily weather summary for the Pali 2 station (RAWS) in Hawaii Volcanoes National Park – December 2007 (continued).

	Solar	Wind			Air Temperature (°F)			Fuel Temperature (°F)			Relative Humidity (%)			Precip. (in)
Day	Radiation Total (ly)	Speed Ave.(mph)	Dir. Vector (°)	Speed Gust(mph) (mph)	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
24	165	10.3	26	29	62.6	67	59	62.0	70	59	99	100	92	2.06
25	412	10.8	32	28	62.6	70	59	63.7	81	57	99	100	90	0.24
26	445	12.8	25	31	62.6	72	58	64.2	82	56	86	100	67	0.01
27	288	12.6	27	29	62.4	68	59	62.8	71	58	84	100	72	0.00
28	163	9.1	58	24	61.2	65	59	60.6	66	58	100	100	96	0.00
29	202	9.1	48	24	60.9	65	58	60.4	69	55	95	100	85	0.00
30	231	4.4	71	14	61.0	67	58	61.2	69	56	99	100	87	0.00
31	316	6.5	61	21	62.7	68	59	63.3	77	57	97	100	90	0.00
Monthly														
Min.	41	3.8	18	14	59.8	62	56	60	63	54	84	100	54	-
Max.	561	18.8	240	45	67.8	79	63	72	97	62	100	100	100	-
Ave.	318	11.2	74	30	63.3	70	59	64.37	77.87	57.32	95.68	100	82.7	0.82
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	25.32
% Valid	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 5.2. Monthly weather summary for the Pali 2 station (RAWS) in Hawaii Volcanoes National Park – December 2007.

2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
% of valid records	100	100	100	100	100	100	100	100	100	100	100	100	100
Total Solar Radiation (ly)	12518	12986	14669	18676	19301	19770	21526	19522	16405	18126	12539	9864	195902
Mean Wind Speed (mph)	9.8	9.7	7.2	10.8	10.6	11.9	12.4	11.7	11.3	12.3	8.1	11.2	10.6
Mean Wind Direction (Deg)	47.3	41.6	64.5	40.2	47.9	40.4	36.5	37.1	37.2	35.0	44.1	34.5	42.2
Max Wind Gust (mph)	44.0	47.0	47.0	41.0	42.0	42.0	40.0	48.0	34.0	37.0	40.0	45.0	42.3
Temperature (°F)													
Min	51.0	50.0	53.0	53.0	57.0	58.0	59.0	58.0	59.0	58.0	55.0	56.0	55.6
Max	83.0	75.0	77.0	77.0	83.0	86.0	89.0	86.0	83.0	85.0	81.0	79.0	82.0
Ave	62.7	62.3	63.4	63.8	65.9	68.2	70.3	68.6	69.1	67.8	65.9	63.3	65.9
Ave. Fuel Temperature (°F)													
Min	37.0	45.0	49.0	51.0	51.0	53.0	50.0	56.0	57.0	56.0	52.0	54.0	50.9
Max	97.0	100.0	105.0	104.0	103.0	104.0	118.0	105.0	102.0	107.0	107.0	97.0	104.1
Ave	64.5	64.8	66.2	67.1	69.3	71.8	73.8	71.6	72.0	71.5	68.5	64.4	68.8
Ave. Relative Humidity (%)													
Min	3	47	19	30	26	21	4	10	29	3	29	54	22.9
Max	100	100	100	100	100	100	100	100	100	100	100	100	100
Ave	93	93	92	82	75	72	64	72	75	69	88	96	81
Precipitation (in)	10.02	0.86	3.5	0.5	0.21	0.02	1.47	1.4	0.76	0.05	10.26	25.32	54.4
No. of days with precip.													
≥0.01	14	6	16	12	4	2	3	11	6	4	15	21	114
≥0.1”	8	4	7	1	1	0	1	3	3	0	10	13	51
≥1.0”	3	0	0	0	0	0	1	0	0	0	5	7	16

Table 5.3. Mean monthly temperature and total precipitation of 2007 compared to the long-term mean (from July 1999 to December 2007) for the Pali 2 station (RAWS) at Hawaii Volcanoes National Park.

2007		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature, °F														
Min	Mean of 2007	51.0	50.0	53.0	53.0	57.0	58.0	59.0	58.0	59.0	58.0	55.0	56.0	55.6
	Long-term mean	51.4	51.0	52.0	54.4	55.6	58.4	59.4	59.5	58.5	58.4	55.3	53.4	55.6
	Difference	-0.4	-1.0	1.0	-1.4	1.4	-0.38	-0.4	-1.50	0.5	-0.4	-0.3	2.6	0.0
Max	Mean of 2007	83.0	75.0	77.0	77.0	83.0	86.0	89.0	86.0	83.0	85.0	81.0	79.0	82.0
	Long-term mean	78.6	78.1	77.5	78.3	83.1	83.5	86.3	85.6	83.1	83.4	81.9	79.75	81.6
	Difference	4.4	-3.1	-0.5	-1.3	-0.1	2.5	2.8	0.4	-0.1	1.6	-0.9	-0.8	0.4
Ave	Mean of 2007	62.8	62.3	63.4	63.8	65.9	68.2	70.3	68.6	69.1	67.8	65.9	63.3	65.9
	Long-term mean	63.1	62.7	63.3	64.1	66.2	68.0	69.7	69.9	68.9	67.8	66.6	64.0	66.2
	Difference	-0.3	-0.4	0.1	-0.3	-0.3	0.2	0.7	-1.3	0.2	0.1	-0.7	-0.7	-0.2
Precipitation, in	2007	10.02	0.86	3.5	0.5	0.21	0.02	1.47	1.4	0.76	0.05	10.26	25.32	54.37
	Long-term mean	10.74	4.49	10.09	2.26	3.2	0.34	0.52	2.07	2.06	5.63	10.95	5.72	58.07
	Difference	-0.72	-3.63	-6.59	-1.76	-2.99	-0.32	0.95	-0.67	-1.3	-5.58	-0.69	19.60	-3.70

Red: warmer than normal; Blue: cooler than normal; green: wetter than normal; brown: drier than normal. The long-term mean is simply calculated as the average of all available data for a particular month.

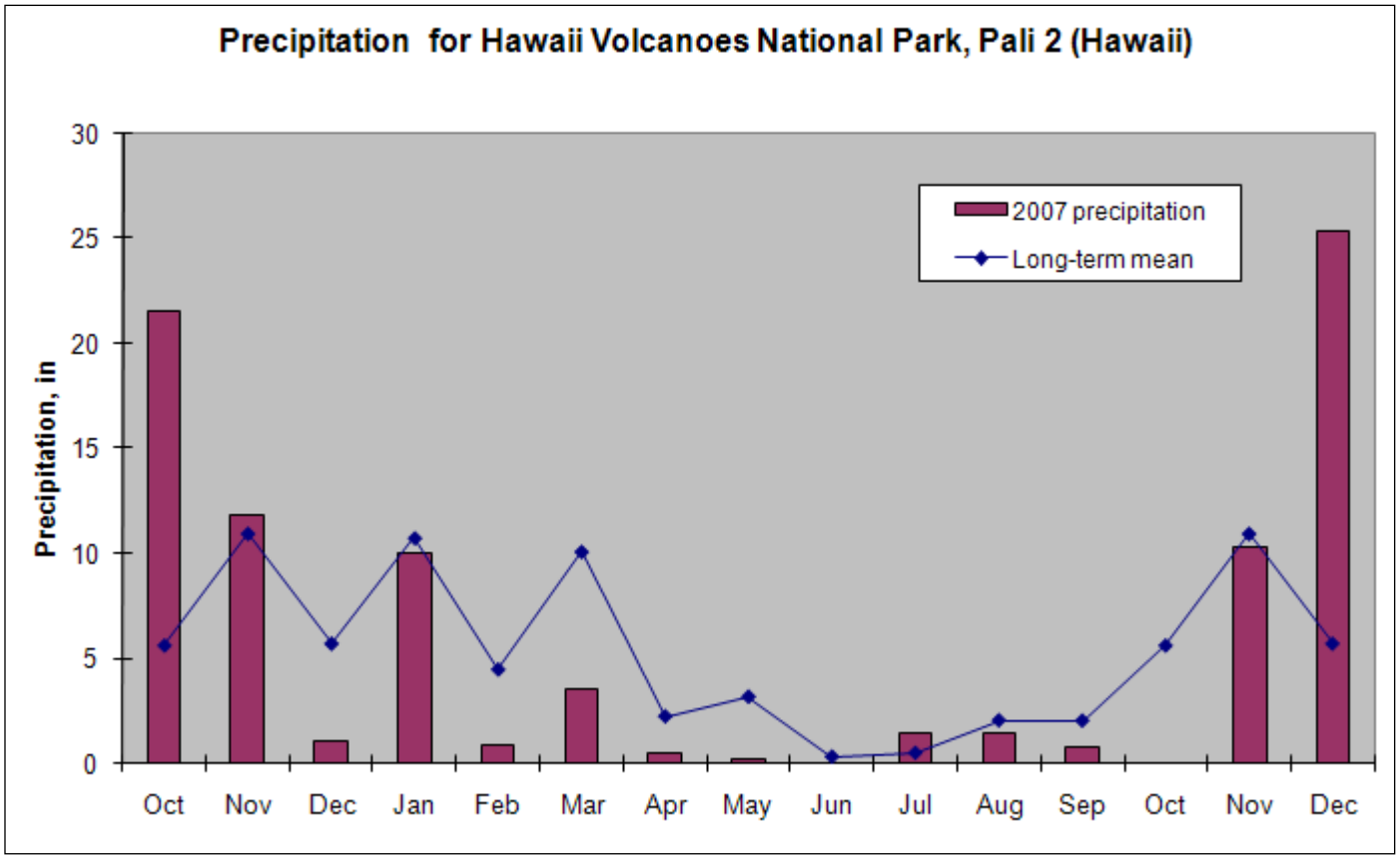


Figure 5.1. Monthly precipitation (Pali 2 RAWS) at Hawaii Volcanoes National Park from October 2006 to December 2007. The long-term monthly mean is calculated from July 1999 through December 2007.

Table 5.4. Daily weather summary for Hawaii Volcanoes National Park – December 2007 (NWS-COOP Station. Hawaii Vol NP HQ 54). The symbol -999 indicates missing data.

Dec-07	Temperature (°F)			Precipitation (in)
Day	Min	Max	Ave	
1	52	71	62	0.01
2	54	71	63	0.02
3	57	78	68	0.00
4	57	73	65	0.40
5	58	75	67	4.37
6	54	62	58	7.72
7	55	59	57	2.42
8	-999	-999	-999	8.80
9	-999	-999	-999	0.16
10	50	70	60	0.03
11	52	69	61	0.05
12	55	65	60	1.22
13	53	64	59	0.73
14	52	65	59	0.56
15	53	59	56	0.75
16	55	61	58	1.67
17	54	62	58	1.16
18	50	63	57	0.12
19	50	58	54	0.46
20	49	62	56	0.15
21	49	68	59	0.03
22	53	67	60	0.3
23	53	67	60	0.06
24	53	70	62	0.29
25	53	71	62	4.33
26	51	62	57	0.63
27	53	66	60	0.14
28	55	60	58	2.11
29	51	59	55	1.20
30	53	59	56	0.49
31	52	66	59	0.02
Minimum	49	58	54	-
Maximum	58	78	67.5	-
Average	52.97	65.59	59.28	-
Total	49	58	54	40.40
% Valid records	93.55	93.55	93.55	100

Table 5.5. Monthly weather summary for Hawaii Volcanoes National Park – 2007 (NWS-COOPStn. Hawaii Vol NP HQ 54). The long-term mean is calculated for the period from October 1949 to December 2007.

2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature (°F)													
Min	50.6	49.4	50.8	50.1	51.5	54.1	55.4	54.6	55.8	54.1	53.1	53.0	52.7
Long-term mean	49.6	49.6	50.4	51.6	52.6	53.8	55.0	55.4	55.0	54.6	53.3	51.1	52.6
Max	67.3	65.6	68.2	67.2	70.4	71.2	73.6	72.5	72.4	70.9	71.0	65.6	69.6
Long-term mean	67.1	66.8	66.7	67.0	68.7	70.2	71.3	72.3	72.3	71.5	69.1	67.1	69.1
Ave.	58.9	57.5	59.5	58.7	60.9	62.6	64.5	63.5	64.1	62.5	62.0	59.3	61.2
Long-term mean	58.4	58.2	58.6	59.3	60.7	62.0	63.2	63.8	63.7	63.1	61.2	59.1	60.9
% of valid records	100.00	93	100	93	100	100	100	100	93	96	100	93	97
Precipitation (in)													
Total	14.2	10.22	6.08	15.71	2.04	4.21	6.84	5.46	5.93	6.31	7.50	40.40	124.86
Long-term mean	13.3	10.16	12.82	10.68	7.23	4.85	6.22	6.98	5.53	6.93	12.89	11.26	109.8
% of valid records	100	100	100	97	100	100	100	100	93	97	100	100	99

Analysis of Long-term Trends and Variability

Every five years the format of the weather/climate monitoring reports will be expanded to include long-term trend analysis. To detect long-term changes in core parameters, a standard linear regression analysis will be employed. The trend, which is defined as the slope of the regression line, shall be assessed for its statistical significance. Assuming that residuals from the regression equation are serially independent and normally distributed with mean zero and a constant but unknown variance, the estimated slope is compared to its standard error (Gilbert 1987). The goal is to test the null hypothesis that the slope is zero based on the fact that the aforementioned ratio is distributed as Student's t with n – 2 degrees of freedom, where n is the sample size. It should be cautioned that if missing data are present in the climate parameters, the linear regression method is inadequate for trend analysis. Instead, the non-parametric Mann-Kendall test should be used to determine the increasing or decreasing trend and Sen's method is recommended to determine the slope of the trend (Gilbert, 1987). The advantages of the non-parametric method are that it allows for incomplete datasets, which are common in climate parameters, as well as for datasets that do not conform to any particular probability distribution. Also unlike the linear regression method, the non-parametric method is insensitive to individual outliers and to the start and end points of the climate series. In the future, the more robust non-parametric method for trend analysis is recommended.

To determine variability in weather data, the box plot is a widely used graphical tool to summarize a set of data. Such a summary includes information about the location and scale of the data set, its range and skewness characteristics.

Tracking Climatic Elements

Table 5.6 lists the results of the trend analysis for COOP weather stations in the PACN. Annual mean values (e.g., temperature) or annual totals (precipitation) are used. The record length for each station is listed in Table 2.1 of the protocol narrative. Only stations with a record length longer than 15 years are analyzed. A computer program for the linear trend analysis and the non-parametric Mann-Kendall test will be used. Take the maximum temperature as an example; most stations show a positive slope, indicative of a warming trend throughout the time and this upward trend is statistically significant at a few stations (e.g., Mauna Loa Slope). Accordingly, the commonly used 5% is the level of change that can be detected in the maximum temperature using the linear regression approach. It is unclear why some sites exhibit significant cooling trends, such as the COOP station in PUHE; the cooling signal at this site is statistically significant for the maximum temperature, the minimum temperature, and the average temperature.

Table 5.6. Trend analysis for precipitation and temperature for COOP weather stations with over 15 years of data in the Pacific Island Network.

Park	Station Name	Precipitation*	Temperature (°F)*		
		(in)	Max	Min	Average
WAPA	Piti	-0.06			
AMME	Capitol Hill 1	0.65	0.01	**0.07**	0.04
NPSA	Pago Pago WSO AP	-0.17	**0.04**	**0.11**	**0.07**
VALR	Aiea Heights 764.6	0.32			
KALA	Kalaupapa 563	0.06	**0.19**	**0.19**	0.13
HALE	Haleakala RCH 432	-0.05			
	Haleakala RS 338	-0.08	**0.03**	**0.05**	0.01
PUHE	Puukohola Heiau 98.1	-0.03	**-0.30**	**-0.08**	**-0.19**
KAHO	Honokohau Harbor 68.14	0.17			
PUHO	Puuhonuaohonaunau 27.4	-0.14			
HAVO	Hawaii Vol NP HQ 54	-0.10	**0.05**	**0.01**	**0.03**
	Mauna Loa Slope OBS 39	-0.11	**0.06**	**0.06**	**0.06**
	Halemaumau 52	0.20			
ALKA	Kohala Mission 175.1	0.13	**0.06**	0.01	**0.04**
	Hawi 168	0.02	0.00	0.08	0.04
	Puukohola Heiau 98.1	-0.03	**-0.30**	**-0.08**	**-0.19**
	Waikoloa 95.8	0.09			
	Kona village 93.8	-0.03			
	Mahaiula 92.7	-0.15			
	Kainaliu73.2	**-0.57**	**-0.02**	**0.03**	0.00
	Honokohau Harbor 68.14	0.17			
	Keahole Point 68.13	0.05	**-0.19**	-0.03	**-0.11**
	Napoopoo 28	**-0.19**	0.08	0.03	0.06
	Puuhonuaohonaunau 27.4	-0.14			
	Honaunau 27	0.03			
	Kealakekua 26.2	-0.55	0.07	0.07	0.02
	Naalehu 14	-0.02	**0.02**	-0.01	0.00
	Opihihale 2 24.1	**-0.25**	**0.03**	0.01	**0.02**
	Milolii 2.34	-0.03			
	Sea Mountain 12.15	-0.03	**-0.07**	0.01	-0.03

* Positive values indicate positive trend; negative values show a downward trend. The numbers in boldface are statistically significant at the 5% test level.

The relationship between a core weather parameter and elevation for stations on a park-wide scale can be understood using a simple graphic. Figure 5.2 displays the relationship between the average annual maximum temperature and elevation for nine stations along the Ala Kahakai National Historic Trail in Hawaii. As is known, when the elevation is lower the temperature is warmer, and vice versa. However, this relationship is not linear, as evidenced by a best-fit nonlinear curve that goes through the points. For this case, almost 66% of the variation of the temperature within the trail can be accounted for by the power equation which only relies on the elevation. In other words, to a large extent, annual maximum temperature for various stations within ALKA can be specified from the knowledge of elevation alone.

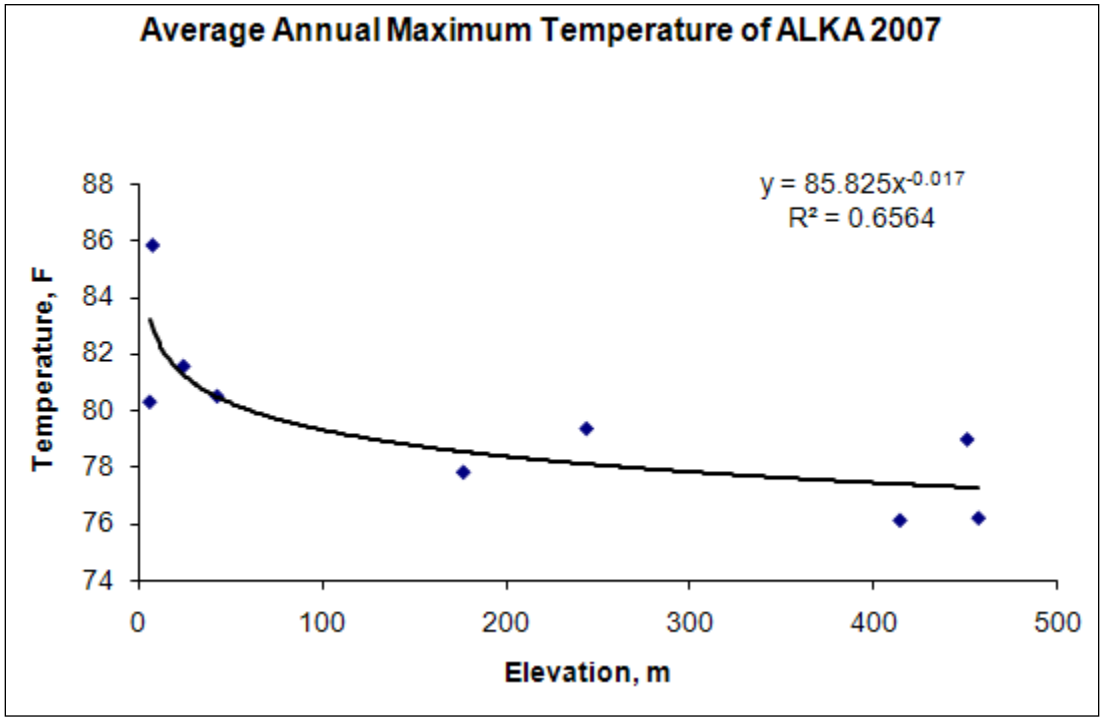


Figure 5.2. Relationship between the average annual maximum temperature and elevation for all stations along the Ala Kahakai National Historic Trail.

In addition to the above outlined trend analysis, 5-year reports will also include a more detailed analysis of the variability of long-term data. As an example, Figure 5.3 shows the box plots of daily wind records at the Hawaii Volcanoes National Park for April. The data length runs from 1999 to 2007 (nine years). Wind direction is partitioned into eight quadrants, each consisting of 45 degrees. The range of the data is represented by the extremes which are the smallest and largest values. Information about scale and skewness is provided by the lower and upper quartiles. The box shows the interquartile range extending from the lower quartile (p=25%) to the upper quartile (p=75%). The interquartile range locates the central 50% of the data distribution and is a robust measure of scale. The line through the box is the median (p=0.5), and the asterisks mark the maximum or minimum values. The percentage of wind in any major direction is also provided. For instance, northerlies are most common in April, occurring 71% of the time, followed by northeasterlies (14% of the time). Northerly flows have the largest variability, from 2.6 to 3.7 m/s, with a median speed of 3.1 m/s. Northerly winds are somewhat positively skewed, as the upper extreme is further away from the upper quartile than the lower extreme is from the lower quartile. Variations of other core parameters such as temperature and precipitation also can be easily presented using box plots.

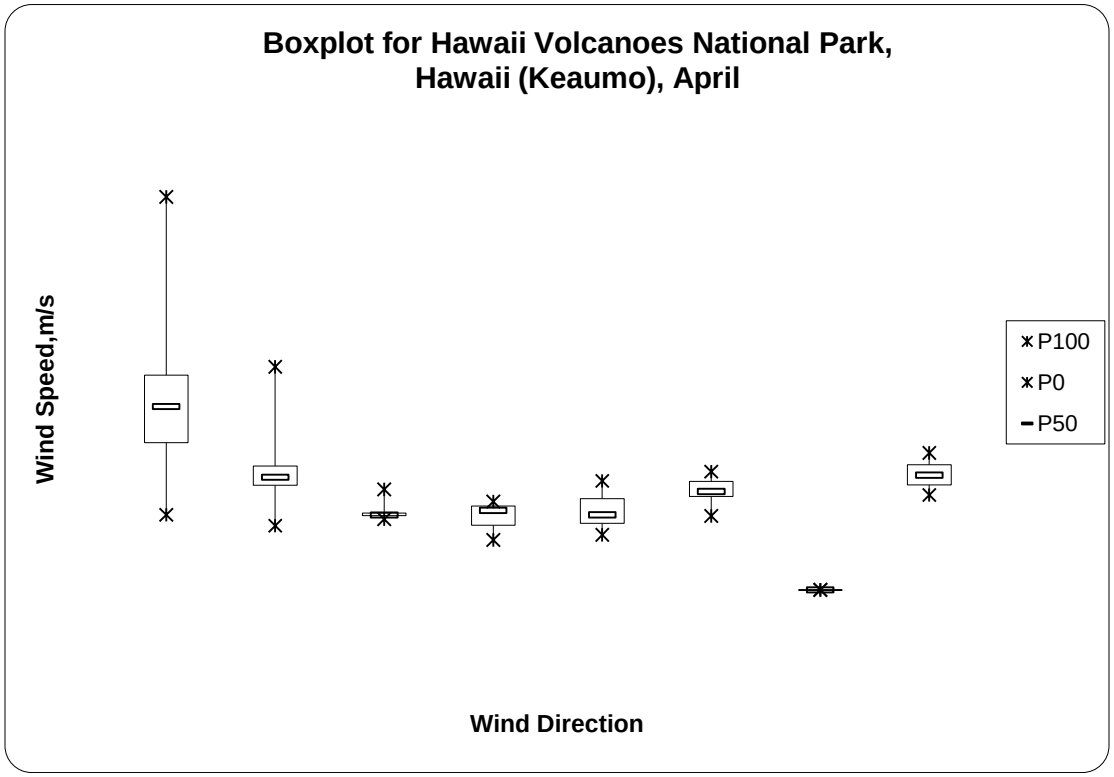


Figure 5.3. Box plot of daily surface wind for April at Hawaii Volcanoes National Park.

Figure 5.4 compares the frequency of major wind directions for April 2007 with the long-term mean. The frequency of northerly winds is higher in April 2009, relative to the corresponding long-term mean (80% versus 71%). On the other hand, northeasterlies and southerlies occur less frequently in April 2009 compared to the long-term mean.

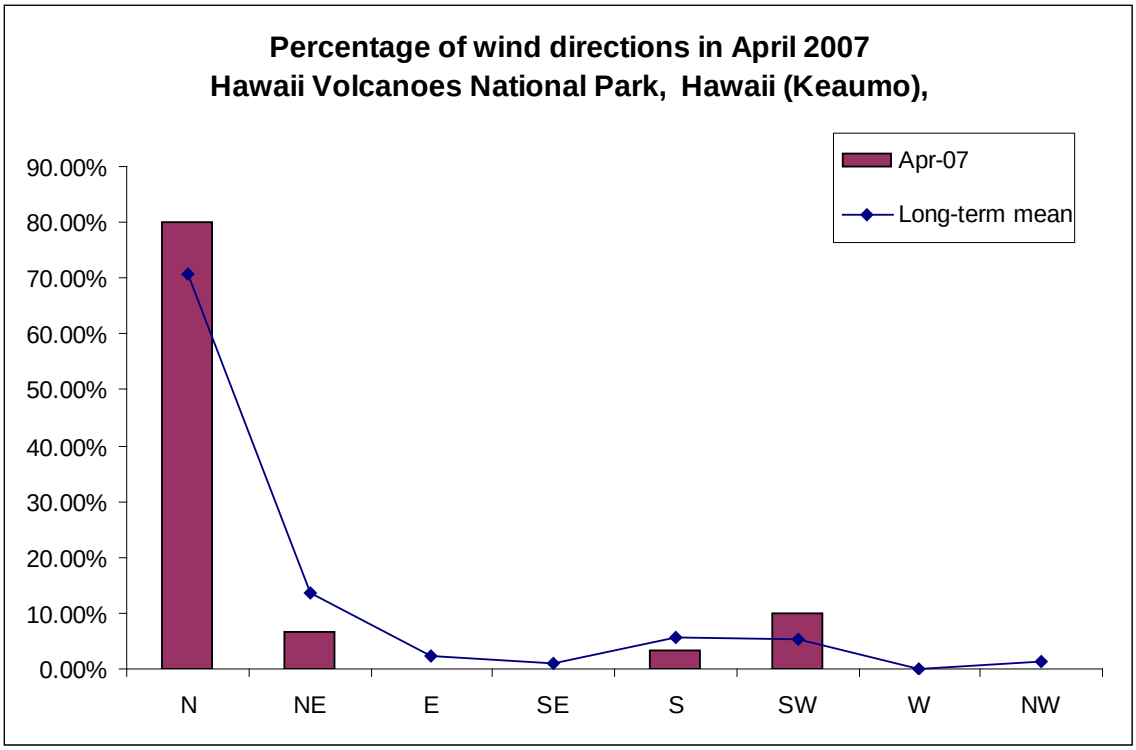


Figure 5.4. Frequencies of major wind directions for April 2007 and the long-term mean wind at Hawaii Volcanoes National Park.

Detection of long-term trends for other parameters such as soil moisture and cloud cover is more difficult due to the general unavailability of these records in the PACN. Solar radiation records are available but are very limited and of short record length (e.g., less than 10 years). Since the purpose of the trend analysis is to depict long-term climate variations, the analysis for solar radiation will not be presented here.

Tracking Extreme Weather Events

Drought has been a recurrent and troublesome problem in the PACN, often depleting water resources, damaging terrestrial wildlife habitat and sometimes causing widespread wildfire. The occurrence of El Niño-Southern Oscillation (ENSO) is responsible for drought in Guam and the Hawaiian Islands as major convection and rainfall regions have shifted from their normal location in the equatorial western Pacific to the central and eastern Pacific (Ropelewski and Halpert 1987, Chu 1989). While ENSO operates on the interannual time scale with a recurrence period varying from three to seven years, rainfall in the tropical Pacific is also highly correlated with the Pacific Decadal Oscillation (PDO). The PDO extremes are characterized by warm (positive) and cold (negative) phases, each persisting for 20 years or longer. Hawaii rainfall is negatively and significantly correlated with the PDO (Chu and Chen 2005).

To monitor meteorological droughts, the Standardized Precipitation Index (SPI), originally developed by Thomas McKee at Colorado State University, is used. The SPI has been embraced by the National Drought Mitigation Center, the Western Regional Climate Center, and the NWS Forecast Office in Honolulu. The SPI relies on monthly precipitation as the only input, in contrast to another popular drought index - the Palmer Drought Severity Index (PDSI), which requires temperature and soil moisture as additional data inputs. Since these additional data are either sparse or non-existent in PACN, the use of SPI seems to be an appropriate choice. Moreover, SPI values can be generated for multiple time scales (e.g., 3-months, 12-months, 24-months). This is especially useful because drought affects various sectors over a wide range of time scales. For example, a 3-months SPI, considered as a short-term drought index, may be useful for agriculture sector while a 12-months SPI, considered as an intermediate drought index, may be relevant for water supply sector (State of Hawaii 2005).

Computation of the SPI involves fitting a gamma probability density function to a set of precipitation totals for a station. The gamma parameters are estimated using the maximum likelihood approximations. The resulting parameters are used to find the cumulative probability of a precipitation event for the given time scale. The cumulative probability is then transformed to the standard Gaussian random variable with mean zero and unit variance, which is the value of SPI. Different drought stages can be defined based on various negative SPI values. For instance, when the SPI is between -1.5 and -1.99, a severe drought is recognized while the SPI is -2.00 or less, drought is regarded as extreme (Table 5.7).

Table 5.7. Standardized precipitation index categories.

SPI value	Category
2.00 and greater	Extremely wet
1.50 to 1.99	Very wet
1.00 to 1.49	Moderately wet
0.99 to -0.99	Near normal
-1.00 to -1.49	Moderately dry
-1.50 to -1.99	Very dry
-2.00 and less	Extremely dry
-99	Missing data

Figure 5.5 shows an example of the three-month SPI for Hawaii Volcanoes National Park from 1949 to 2007. The heavy thick line denotes the five-year running mean to smooth out short-term fluctuations related to ENSO. Droughts have affected Hawaii Volcanoes National Park throughout its history. Over the last 55 years, the 1983 drought was the most intense, with a very large negative SPI (i.e., the extreme drought stage). Focusing on the running mean curve, it is also clear that except for 1991, SPI values tend to be negative during the period from 1983 to 2005, coinciding approximately with the positive phase of the PDO. Thus, a multi-decade drought occurred in the last 20 years or so. For longer time scales, (>24 months), it would be best to consider the PDSI as an analytical tool. Guttman (2007) shows statistical evidence that because of data limitations, SPIs with time scales longer than 24 months may be unreliable.

Since the new PACN weather stations are equipped with temperature gauges, future installation of soil moisture gauges might be of considerable interest for more detailed understanding of drought in Hawaii.

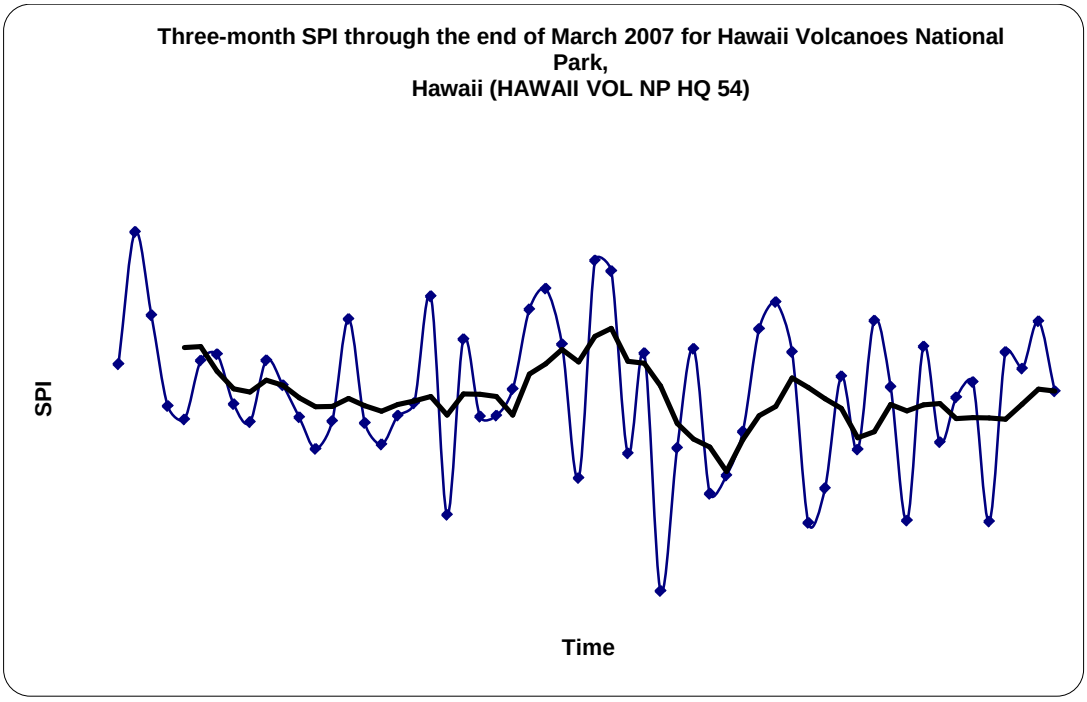


Figure 5.5. Time series of the standardized precipitation index for Hawaii Volcanoes National Park. Thick line denotes the 5-yr running mean.

It should be mentioned that another drought index, the Keetch/Byram Drought Index (KBDI), has been used for over 30 years in some areas of the United States (e.g., the southeast U.S.). The KBDI, which conceptually describes the soil moisture deficit, is used to assess wildfire potential as part of the revised 1988 U.S. National Fire Danger Rating System (Heim 2002). In the southeast U.S., the KBDI is used as a stand-alone index for assessing fire danger (Johnson and Forthum 2001). The index was developed to function throughout a wide range of climatic and rainfall conditions in forested or wildland areas. The relationship between the KBDI and fire activity, as measured by total area burned, in the Hawaiian Islands was explored (Dolling et al. 2005, Dolling et al. 2009). A strong relationship between the KBDI and fire activity is found for the islands of Oahu, Maui, and Hawaii. However, because soil moisture data for stations located in or near the national parks of the PACN are unavailable, trend reports will not make use of the KBDI.

Annual reports of tropical cyclones in the western North Pacific and the central North Pacific are compiled by the Joint Typhoon Warning Center[27] and the NWS/Central Pacific Hurricane Center[28] in Honolulu. Tropical cyclone activity (e.g., frequency, genesis location, track) in the Pacific basin is influenced by ENSO (Chu 2004). On a longer time scale, its activity has also been shown to undergo decadal timescale variability (Yumoto and Matsuura 2001, Zhao and Chu

[27] https://metocph.nmci.navy.mil/
[28] http://www.prh.noaa.gov/hnl/cphc/

2006). This is seen clearly over the central North Pacific (Figure 5.6), which encompasses the Hawaiian Islands. Here tropical cyclones refer to tropical depressions, tropical storms and hurricanes. Reliable tropical cyclone statistics in the central North Pacific began in 1966 when satellite reconnaissance was initiated in the region. According to the National Weather Service, the central North Pacific extends from the equator northward and from 140°W to the dateline.

As shown in Figure 5.6, tropical cyclone frequency since 1966 has been characterized mainly by three epochs, the inactive 1966-81 epoch, the active 1982-94 epoch, and the inactive 1995-2007 epoch (Chu and Zhao 2004). Therefore, the central North Pacific has experienced fewer hurricane occurrences during the last 13 years. Recently, Chu and Wu (2008) compiled historical tropical cyclone tracks over the central North Pacific, in which storm tracks and their intensity for each individual year and every ten years are shown. For the western North Pacific, which encompasses Guam and Saipan, tropical cyclone records begin in 1945 and for the South Pacific the monitoring starts in 1939. It is recommended that time series of tropical cyclone counts such as the one presented in Figure 5.6, among others, be included in the 5-year report.

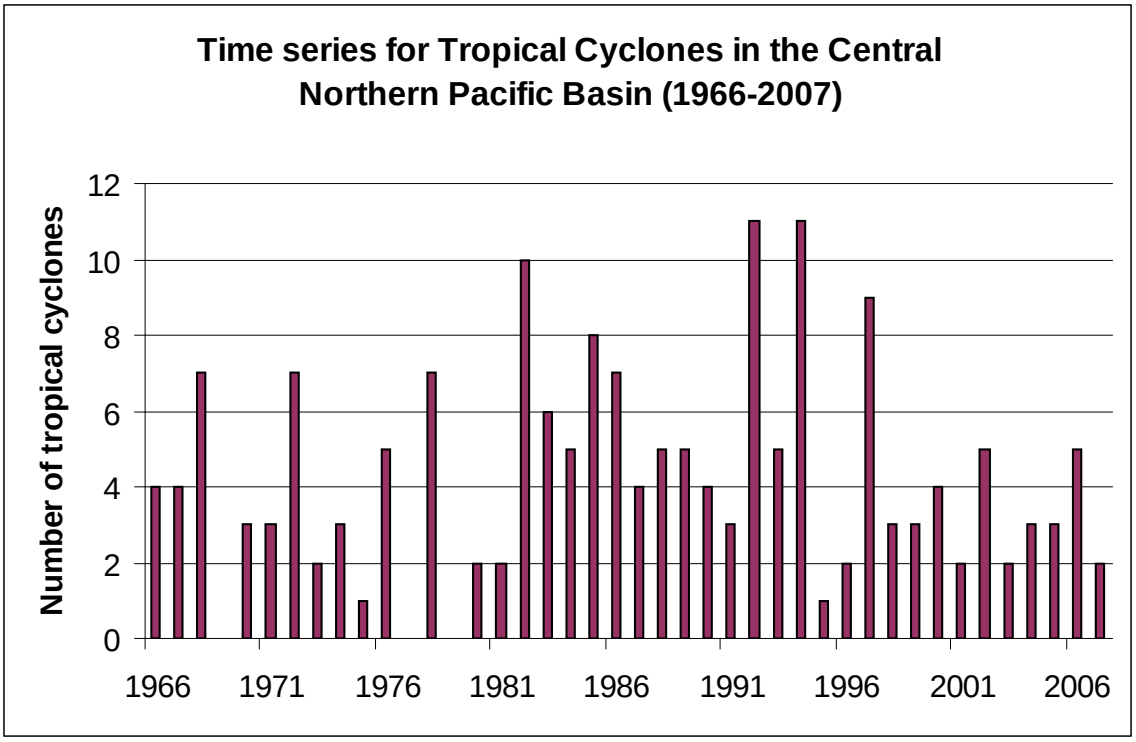


Figure 5.6. Time series of annual tropical cyclone counts over the central north Pacific since 1966.

Chapter 6: Personnel Requirements and Training

The weather/climate monitoring protocol will be implemented with the help of PACN as well as park personnel and cooperators. Roles and responsibilities are summarized in Table 6.1 below, but are, in some instances, described in greater detail in the chapters on field methods and data management. Appendix B identifies individuals who have served in these roles and provides contact information of personnel.

Table 6.1. Roles and responsibilities for Weather/Climate Monitoring in the Pacific Island Network.

Role	Responsibilities	Position
Project lead	▪ Provides project oversight and administration ▪ Tracks project budget, requirements, objectives, and progress toward meeting objectives ▪ Facilitates communications between NPS and cooperators ▪ Coordinates and ratifies changes to the protocol ▪ Reviews reports, data, and other deliverables for completeness and compliance with I&M program specifications	PACN data manager
Project manager/ data analyst	▪ Plans and coordinates project operations ▪ Acquires and maintains field equipment ▪ Maintains and archives project records ▪ Certifies data for quality and completeness ▪ Creates and maintains station documentation, prepares metadata ▪ Performs data summaries and analysis ▪ Interprets data and prepares reports and other deliverables ▪ Suggests changes to protocol as needed	Biological science technician
Station observer	▪ Records observations of all park-owned weather stations that are not downloaded via satellite ▪ Exports COOP station data to NCDC; delivers GPMN data to Air Resources Specialist, Inc. ▪ Completes station inspections and station maintenance	Park personnel, USGS-HVO personnel, I&M personnel, cooperators
Data manager	▪ Consults on data management activities ▪ Facilitates data import and archiving ▪ Facilitates posting of data, metadata, reports and other products to the Natural Resource Information Portal, other national databases and clearinghouses as well as the PACN website ▪ Maintains and updates database application ▪ Provides database training as needed	PACN data manager
GIS specialist	▪ Consults on spatial data collection, GPS use, and spatial analysis techniques ▪ Facilitates spatial data development and creation of maps ▪ Oversees development of metadata for spatial data products ▪ Works with data analyst on analysis of spatial data ▪ Primary steward of GIS data and products	PACN GIS specialist (HAVO)
Network program manager	▪ Reviews annual report for completeness and compliance with I&M standards and expectations	PACN program manager (HAVO)

Qualifications

Each position requires minimum background knowledge, skills, and abilities. The project lead will need to be familiar with the standards and requirements for the NPS I&M program. In addition, the project lead will need to be familiar with the various weather monitoring programs that are included in this monitoring effort in order to assist with all aspects of the protocol.

The project manager/data analyst position requires, at a minimum a bachelor's degree and experience in a related discipline (e.g., physical or biological sciences, climatology). Personnel in this position must be familiar with data collection, data management, post-processing of data, as well as data analysis, summarization and interpretation.

Training

Weather Station Observations and Maintenance

All station observers will be trained in and responsible for being familiar with all relevant SOPs for data collection, recording, and transmission. Training is specific to the weather monitoring program to which the stations belong. Most station observers are not under the supervision of the PACN; thus, ensuring that field personnel are trained properly is the responsibility of various people in different agencies.

The NWS Observing Handbook No.2 (SOP 3) details procedures for recording and reporting measurements from COOP stations. New observers are required to review this document as well as instructions for completing the recording and reporting datasheets (SOP 4, 5). Additional training material is available at the COOP training materials and resources[29] website. Typically park staff with experience in COOP station operations instruct new observers on procedures.

Instructions for the maintenance and calibration of RAWS are provided on the Interagency RAWS website and are included in this protocol for easy access (SOP 6, 7, 8 and 9). New observers are required to familiarize themselves with these documents. Training courses for weather station maintenance can also be taken; courses are announced on the RAWS website[30]. Training is also provided by park staff with experience in RAWS operations.

Training and station observation procedures for the GPMN stations are provided by Air Resource Specialists, Inc., the company that is contracted by NPS to perform maintenance at these stations. HaleNet is owned and operated by University of Hawaii faculty; no training is required for park staff. Similarly, the USGS rain gauge at HALE is maintained by USGS staff; thus, no training is required for park staff. Training for ALERT stations maintenance at HALE will be provided by staff already familiar with the station maintenance; maintenance protocols are being written.

After the new PACN stations are acquired, the I&M technician will be trained by WRCC and Campbell Scientific in weather station set-up and data logger instrumentation. The project lead for PACN weather/climate monitoring will ensure that personnel involved in PACN station

[29] http://www.nws.noaa.gov/om/coop/training.htm
[30] http://www.fs.fed.us/raws/training/2008training.shtml

maintenance is familiar with all relevant SOP. Detailed instructions for station maintenance of PACN weather stations are included in SOP 10-12.

Data Acquisition and Archiving

Instructions and procedures for downloading and archiving weather station data are described in SOP 16, 17, and 21. Procedures are automated and require no special skills or technical expertise. Staff responsible for acquisition and archiving will be required to familiarize themselves with these documents and will work closely with the PACN data manager.

Chapter 7: Operational Requirements

Annual Workload and Field Schedule

The annual schedule for PACN weather/climate monitoring is given in Table 7.1. Weather station observations and maintenance will be carried out by staff of individual parks, the PACN and cooperators as described in detail in Chapter 3 and Appendix B. In summary, data are logged continuously, downloads occur on varying schedules depending on the monitoring program to which the station belongs. PACN stations will be maintained mainly by PACN staff, but park staff may provide assistance in some parks. Park staff is recording daily observations of NWS-COOP stations and perform maintenance for RAWS stations. Weather stations at HAVO associated with the NPS Gaseous Pollutant Monitoring Network are operated by USGS-HVO staff. The Haleakala Climate Network stations are operated and the maintenance schedule is arranged by Tom Giambelluca (University of Hawaii at Manoa).

Protocol document review will occur at a minimum once a year, ideally after the annual report has been generated. The project lead and others involved in PACN weather/climate monitoring will review the narrative, all SOP, the associated database, and other products. If needed, updates will be made and revisions logged according to procedures outlined in SOP 1.

In Table 7.1, the project lead and the data manager are currently the same person. We have left the duties separate as in the future the positions may be separate as they have been in the past.

Table 7.1. Annual schedule for the Pacific Island Network Weather/Climate Monitoring Protocol.

Timing	Activity	Responsibility
Year-round	Data collection, station visits daily or monthly depending on the type of station as detailed in Chapter 3.	Station observers
Year-round	Interim weather/climate update reports generated based on need, such as reports of droughts, typhoons, or other extreme climate events affecting PACN parks*.	Project manager** GIS Analyst`
Year-round	Monthly (or every other month) downloads and verification of PACN station data.	Project manager
Year-round	As needed after field trips download and process spatial and digital images.	Project manager GIS Analyst
January	Implement working database copy for new calendar year.	Project lead (data manager)
February	Data acquisition and data entry into working copy of database; transcription verification†.	Project manager
February	Quality review and data validation for PACN station data using database tools.	Project manager
February	Update project metadata records for previous years' data.	Project lead (data manager) and project manager
February	Certify the previous years' data and complete certification report.	Project lead (data manager) and project manager
February	Upload certified data into master project database, store data files in PACN Digital Library††.	Project lead (data manager)
February	Annual or 5-year report data analysis; initiate write up.	Project manager
March	Complete annual report write-up; submit for review.	Project manager
April	Complete 5-year report write-up (if applicable); submit for review.	Project manager
May	Review and revise as necessary: protocol narrative, appendices, SOP, and database.	Project lead (data manager) and project manager
May/June	Write contracts/agreements necessary to continue PACN weather/climate monitoring.	Project lead (data manager)
June	Plan schedule and logistics for annual maintenance trips, including ordering any new equipment and supplies.	Project lead (data manager) and project manager
Summer	PACN annual station maintenance. Exact schedules will vary depending on coordination of trips with other monitoring projects, weather conditions, and other factors.	Project manager
September	Close out year-end budget; finalize equipment purchases for previous fiscal year.	Project lead (data manager)

* Based on staff availability
** Refers to the project manager/data analyst position described in table 6.1
† If verified data for the end of the previous year are not yet available from WRCC, the timeline for data analysis and report submission will be pushed back.

††The PACN Digital Library is a hierarchical digital filing system stored on the PACN file server. Network users have read-only access to these files, except where information sensitivity may preclude general access.

Permits and Compliance

Permits will be obtained and environmental compliance procedures will be followed whenever new weather stations are set up in the parks and, if necessary, for conducting fieldwork. The project lead will ensure full compliance with all existing and future regulations according to federal as well as state/commonwealth/territory guidelines as outlined below.

Federal

NPS: NPS research permits will be obtained, in advance of any field activities, for each park where monitoring occurs. Permits will be evaluated on an annual basis, or other timeframe as stipulated in the permit itself. The research permit review process also includes NEPA compliance documentation, as discussed further below. The project lead (or designee) will maintain all appropriate documentation.

NEPA: At present, under the National Environmental Policy Act (NEPA), we anticipate that this protocol falls under a Categorical Exclusion (CE) where "a category of actions which do not individually or cumulatively have a significant effect …and for which, therefore, neither an environmental assessment nor an environmental impact statement is required" (40 CFR 1508.4). Under Directors Order 12 a CE (or CX) is "an action with no measurable environmental impact which is described in one of the categorical exclusion lists in section 3.3 or 3.4 and for which no exceptional circumstances (section 3.5) exist." NEPA compliance review and documentation will occur as part of the NPS research permitting process.

NHPA: Compliance with the National Historic Preservation Act (NHPA) must be assured before new stations are established. Set up of new stations will require the use of guy-wires and steel rods to secure the station. Local park staff will be consulted during the site selection process to avoid adverse effects on cultural resources and ensure compliance with NHPA.

State, Territorial, Commonwealth and Others

Fieldwork or set-up of new weather stations in the national parks will not require permits from state, territorial or commonwealth agencies in Hawaii, Guam, Saipan, or American Samoa.

Village permission: guidelines by NPSA cultural resource staff stipulate that village mayors should be contacted personally to describe any fieldwork prior to initiating it. Permission should be obtained not only in the event that a new station is set up but also for conducting fieldwork such as station maintenance. Typically, no work can be conducted in or near villages on Sundays. Sa, time for prayer, is observed daily at dusk (around 1800 hrs); anyone entering or traveling through villages by vehicle or on foot at this hour must stop until Sa is over. Ringing bells in the villages indicate the beginning and ending of Sa. On the main roads of Tutuila it is not necessary to stop. On Tau, Ofu and Olosega, people are requested to remain indoors during the time of Sa.

The existing COOP stations are supplied with sensors necessary to meet the goals and objectives of the administrating agency. There is no annual cost associated for equipment for these stations as they are funded by the NWS Cooperative Observer Program.

The RAWS must meet national standards to participate in the Interagency RAWS program (National Wildfire Coordinating Group 2008). Additional sensors can be added to meet park needs. New RAWS, if approved by the NIFC, are funded by the NIFC, otherwise they are funded by the parks. Broken sensors belonging to Fire RAWS can be replaced through an exchange program with the NIFC if the damaged sensor is returned within a certain time of receiving the replacement. Parks are responsible for providing staff to perform the annual maintenance and calibration of RAWS and for emergency service. Otherwise no operating costs are incurred by the parks. The new RAWS already purchased for WAPA, but not yet installed, is not part of Fire RAWS; thus replacement sensors are not covered by the free exchange program. In addition, since there is currently no staff available to perform annual maintenance this task will likely have to be contracted out. The PACN weather/climate monitoring budget includes $1,000 annually towards maintenance cost for this station.

The GPMN stations are funded entirely by the NPS Air Resources Division with the exception that parks are expected to provide staff for minor maintenance. All costs for USGS rain gauges including personnel are carried by USGS. HaleNet is funded almost entirely by grants obtained by Tom Giambelluca (UH Manoa) and USGS. The Replacement and Calibration schedule for PACN weather stations sensors is described in SOP 12. A total cost of $2,160 is budgeted for annual equipment costs for these nine stations. Additionally, calibration of pyranometers, wind sensors, dataloggers, and GOES transmitters need to occur every 2 -3 years at an additional expense of $495 per station. Because this calibration is expensive it will be staggered so that only 2-3 stations are being calibrated per year.

Facility and supply needs for the positions involved in the PACN weather/climate monitoring effort (Table 6.1) are already included in the PACN base budget. Station observers will not require office space because this task is carried out by existing staff of the parks or other agencies.

Budget Considerations

Annual expense estimates for implementation of PACN weather/climate monitoring are summarized by park in Table 7.2. These expenses are based on year-round data collection. However, this budget assumes that existing stations will be maintained by park staff or other agencies as outlined in Table 3.1. Furthermore, it assumes that data downloads for the new PACN stations in parks not located on the island of Hawaii will be conducted by park staff. Thus, costs for these tasks are not included in this budget.

Costs for equipment total $4,160 annually and break down as detailed above.

Salary estimates include COLA and benefits estimated based on the percentage of FTE devoted to weather/climate monitoring for each position according to the 2010 pay schedule. Personnel salaries for the project lead (data manager) and GIS specialist were assumed to be GS-11, step 5. Salary for the program manager was estimated based on GS-07, step 1. The project manager salary was based on an hourly rate of $17.05. Table 7.2 provides further details of the budget and breaks the costs out between PACN fixed costs and costs covered by the PACN vital sign monitoring budget.

Table 7.2. Annual budget for Weather/Climate Monitoring in the Pacific Island Network.

Parks	ALKA	AMME	HALE	HAVO	KAHO	KALA	NPSA	PUHE	PUHO	VALR	WAPA	All
Salaries												
Project lead	$384	$384	$384	$384	$384	$384	$384	$384	$384	$384	$384	$4,224
Data analyst	$650	$455	$650	$650	$455	$520	$455	$455	$455	$455	$455	$5,655
Station observer	-	-	-	$1,200	-	-	-	$480	$480	-	-	$2,160
Data manager	$192	$192	$192	$192	$192	$192	$192	$192	$192	$192	$192	$2,112
GIS specialist	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$2,200
Program manager	$132	$132	$132	$132	$132	$132	$132	$132	$132	$132	$132	$1,452
Sub-total	$1,558	$1,363	$1,558	$2,758	$1,363	$1,428	$1,363	$1,843	$1,843	$1,363	$1,363	$17,803
Travel												
Camping	-	-	-	-	-	-	-	-	-	-	-	-
Hotel	-	-	-	-	-	-	-	-	-	-	-	-
Per Diem	-	-	-	-	-	-	-	-	-	-	-	-
Airfare	-	-	-	-	-	-	-	-	-	-	-	-
Vehicle	-	-	-	$1,200	-	-	-	$1,200	$1,200	-	-	$3,600
Climate Conference	-	-	-	-	-	-	-	-	-	-	-	-
Sub-total	-	-	-	$1,200	-	-	-	$1,200	$1,200	-	-	$3,600
Other												
Equipment*	-	$405	-	$645	-	$645	$645	$405	$405	-	$1,000	$4,150
Total	$1,558	$1768	$1558	$4,603	$1,363	$2,073	$2,008	$3,448	$3,448	$1,363	$2,363	$25,553
Amount of total from PACN fixed costs (gray highlighted rows only)												$9,988
Amount of total from PACN monitoring budget (all other rows)												$15,565

* costs for this category are mainly designated for replacement parts, contributions to a maintenance contract, or new software specifically for weather stations.

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Appendix A: Maps

This appendix consists of two parts: the first set of maps shows locations of weather stations. These are followed by the PRISM maps which show the results of PRISM data analysis for several climate variables.

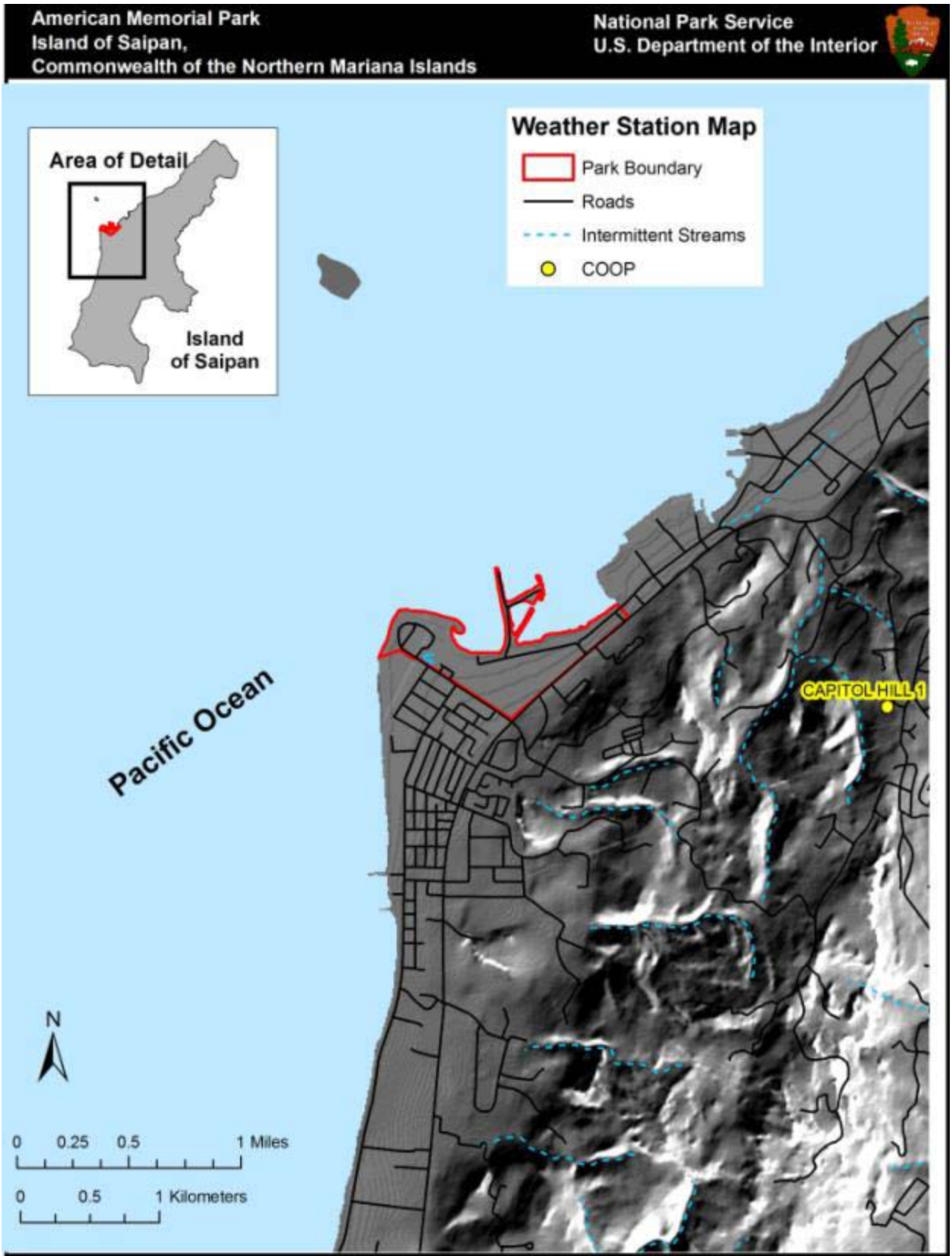
Station Location Maps

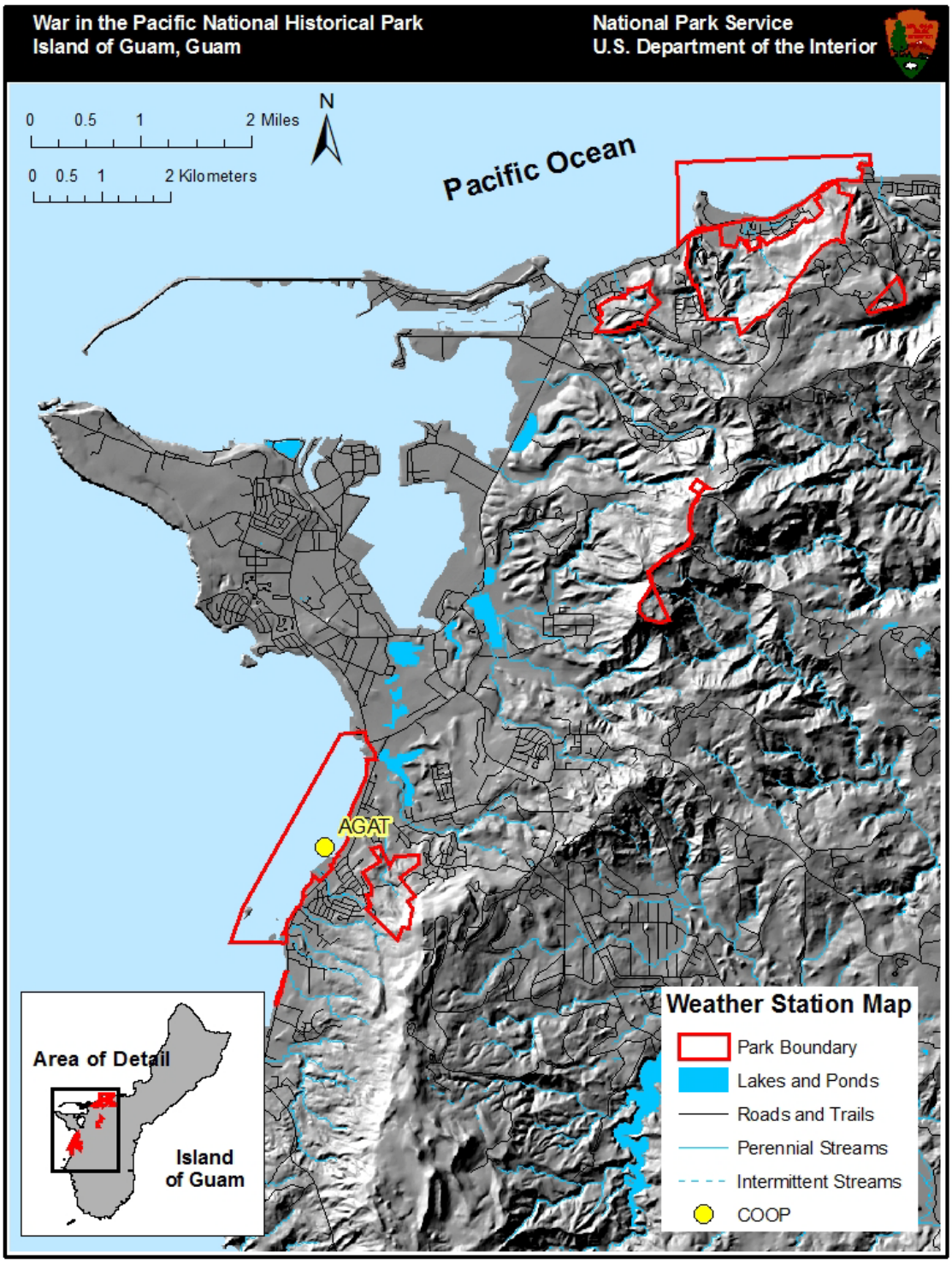
These maps show locations of weather stations in and near the PACN national parks. While all these stations are part of the PACN climate monitoring effort, annual reports will only include data analysis for a subset of the stations. Stations may belong to any of the following climate monitoring programs:

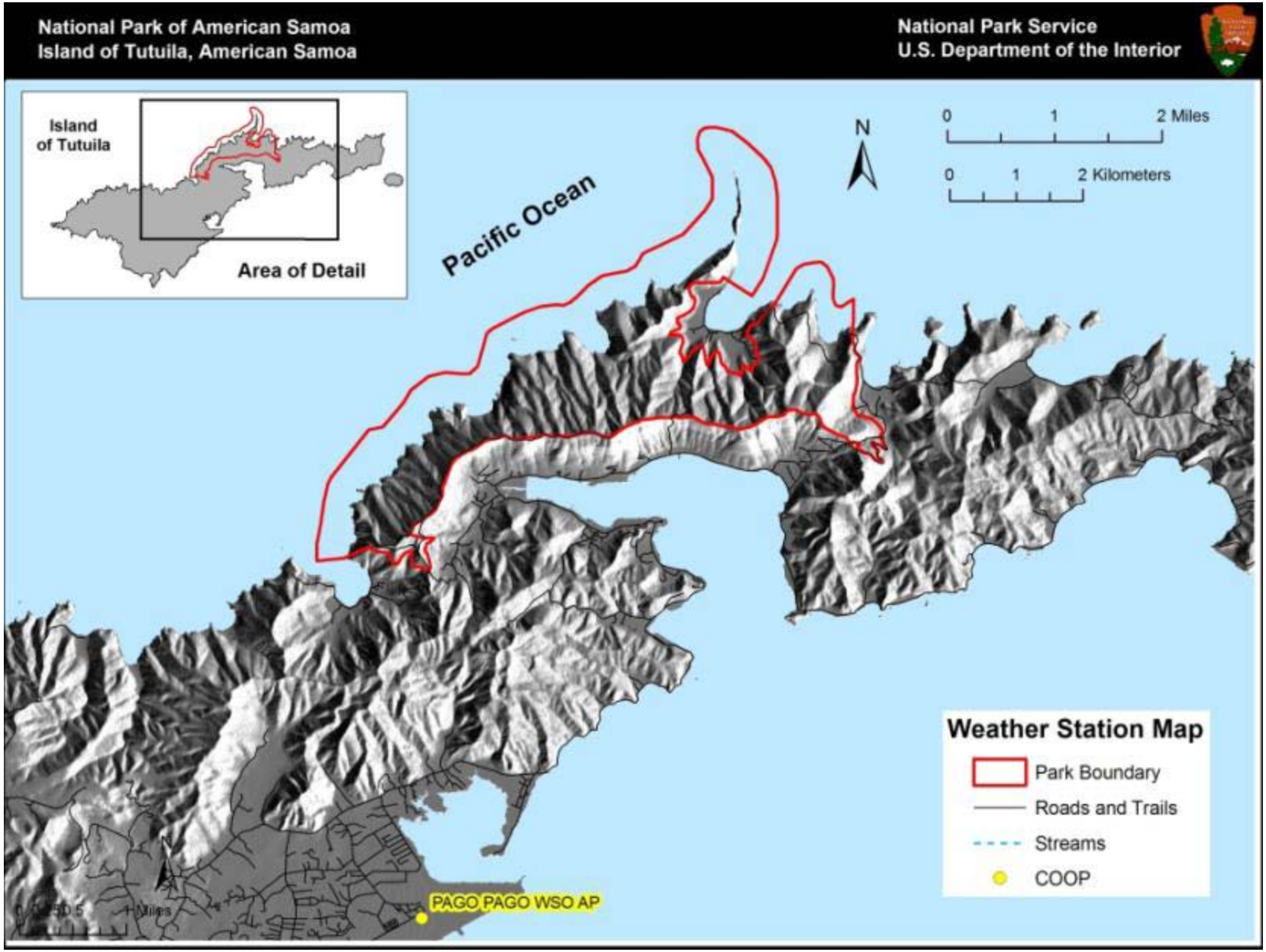
National Weather Service Cooperative Observer Program (COOP)
Remote Automated Weather Stations (RAWS)
Gaseous Pollutant Monitoring Network (GPMN)
Haleakala Climate Network (HaleNet)
Hawaii Volcanoes National Park Rain Gauges (HAVO-RG)
Pacific Island Network (PACN)

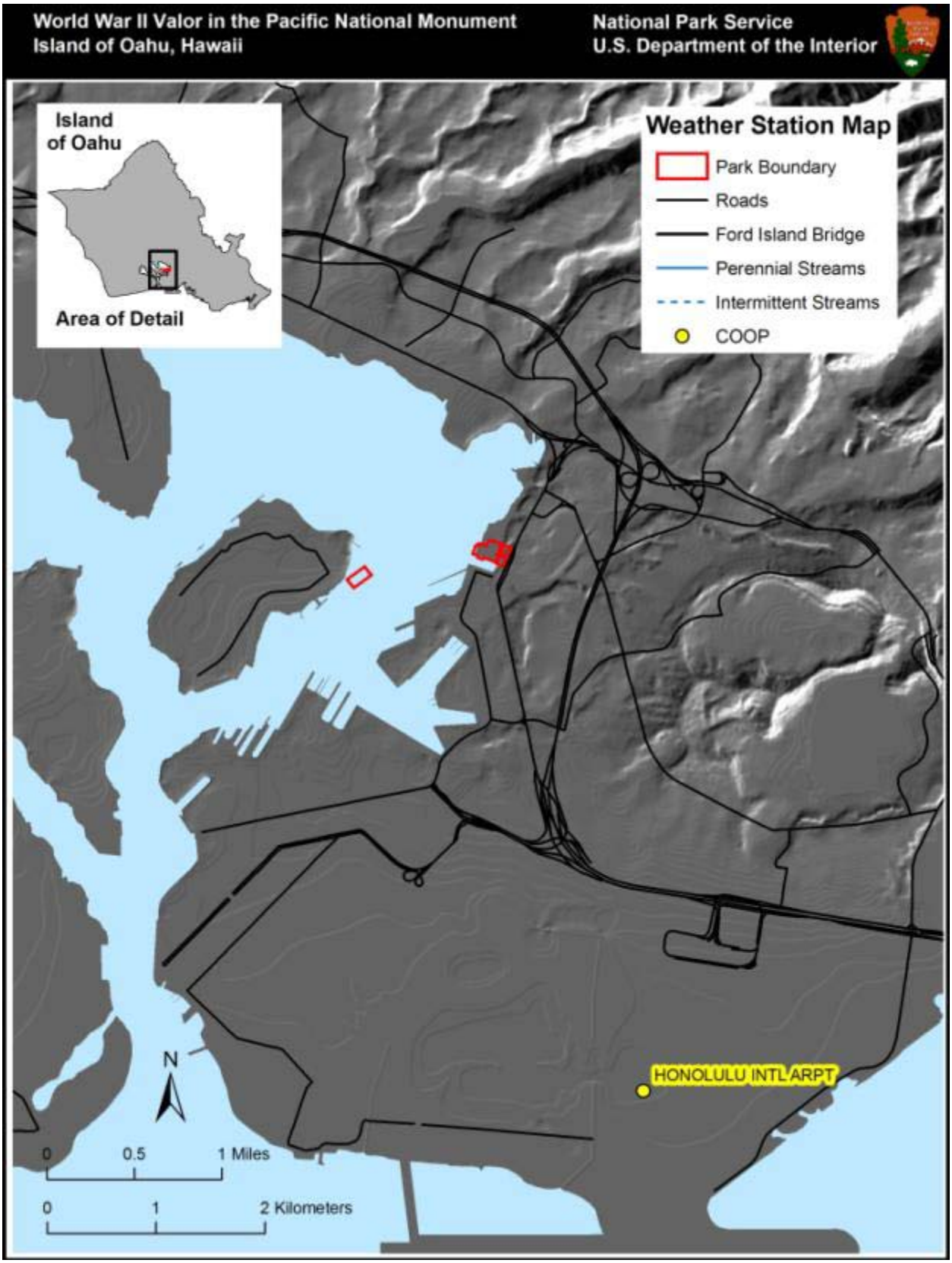
The following maps are included:

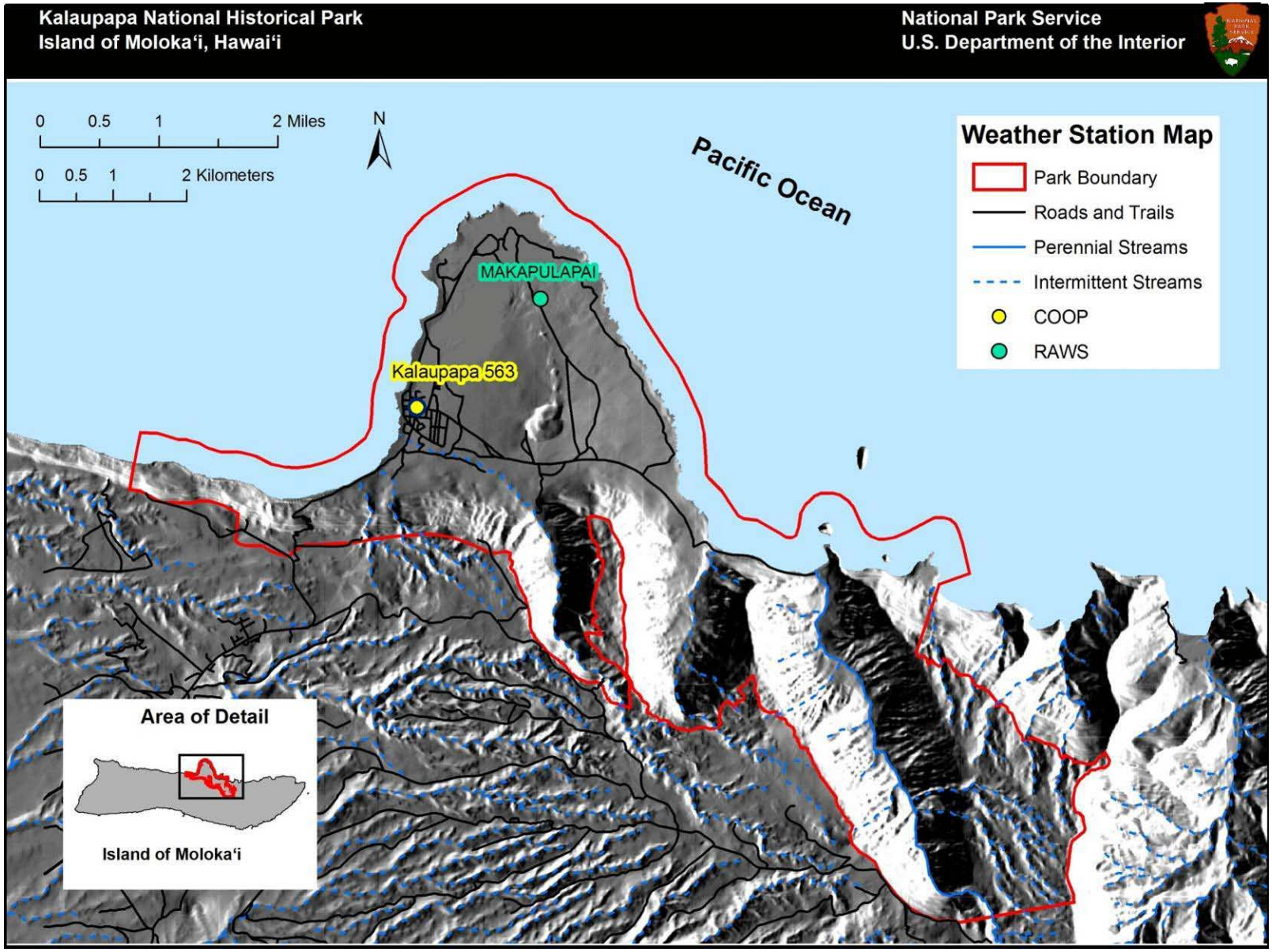
AMME
WAPA
NPSA
VALR
KALA
HALE
PUHE
KAHO
PUHO
HAVO – Kahuku
HAVO - Other
ALKA

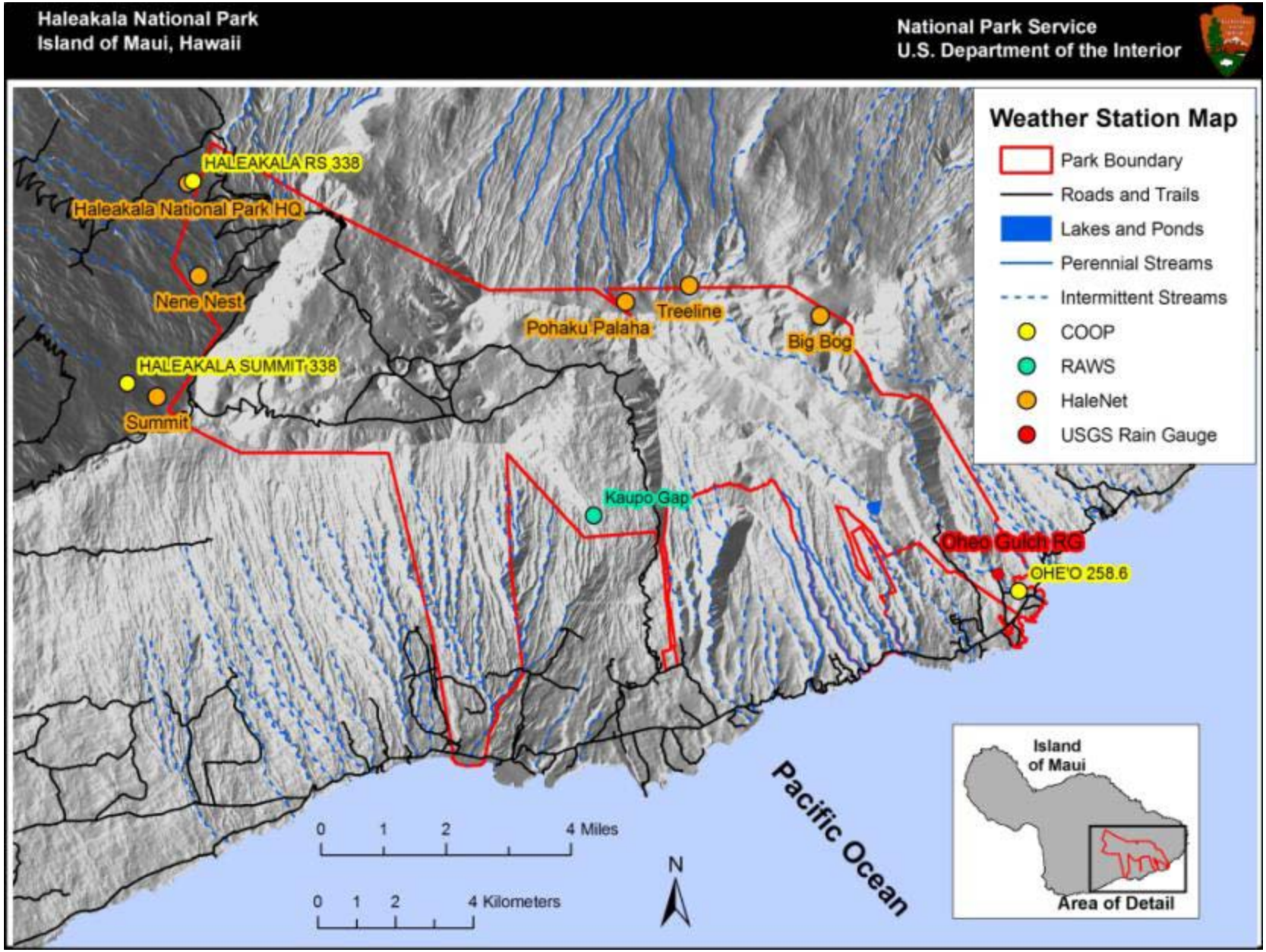

American Memorial Park
Island of Saipan,
Commonwealth of the Northern Mariana Islands
National Park Service
U.S. Department of the Interior
Weather Station Map
Park Boundary
Roads
Intermittent Streams
COOP
Area of Detail
Island of Saipan
Pacific Ocean
CAPITOL HILL 1
N
0 0.25 0.5 1 Miles
0 0.5 1 Kilometers

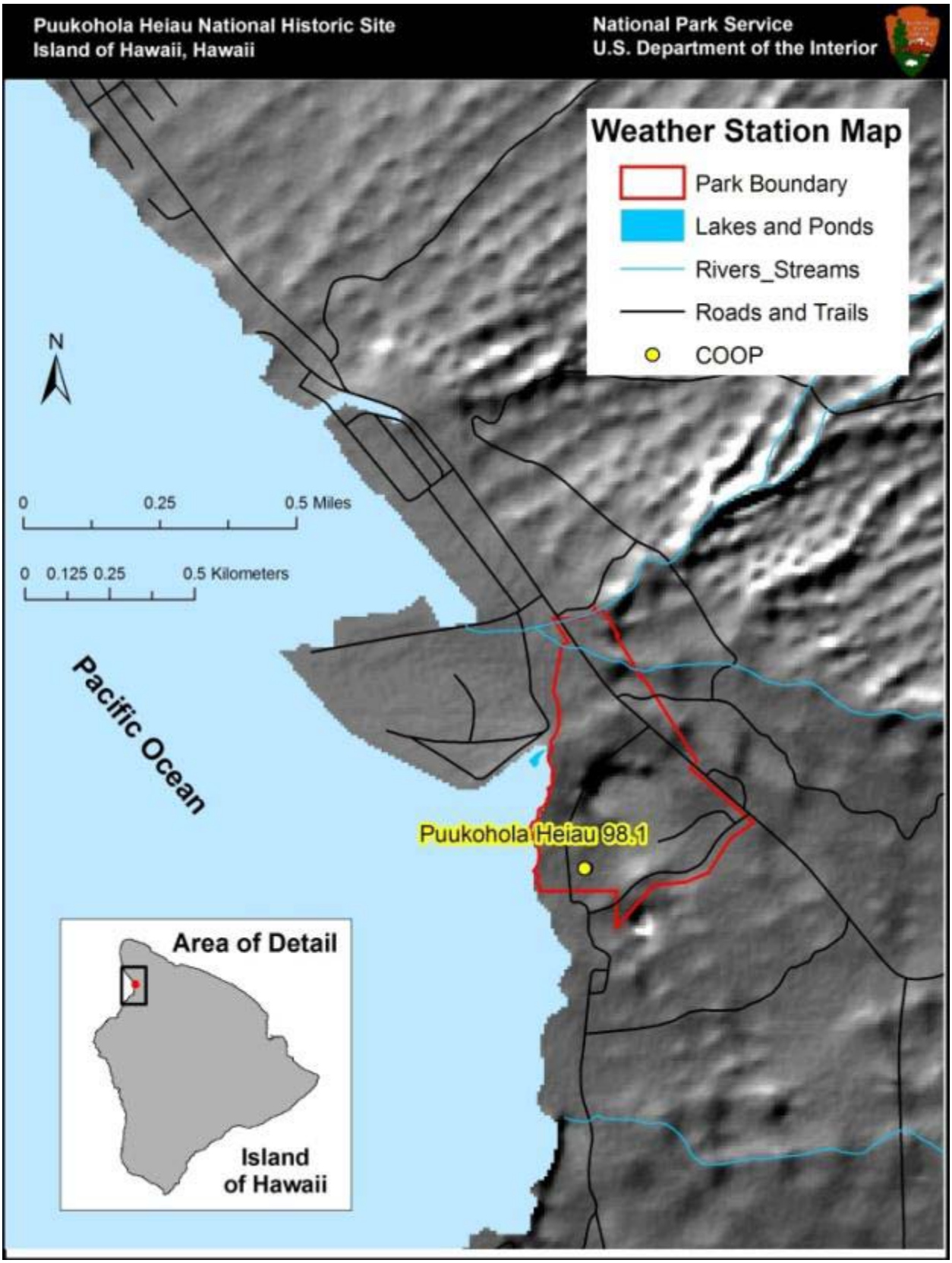

War in the Pacific National Historical Park
Island of Guam, Guam
National Park Service
U.S. Department of the Interior
0 0.5 1 2 Miles
0 0.5 1 2 Kilometers
N
Pacific Ocean
AGAT
Area of Detail
Island of Guam
Weather Station Map
Park Boundary
Lakes and Ponds
Roads and Trails
Perennial Streams
Intermittent Streams
COOP

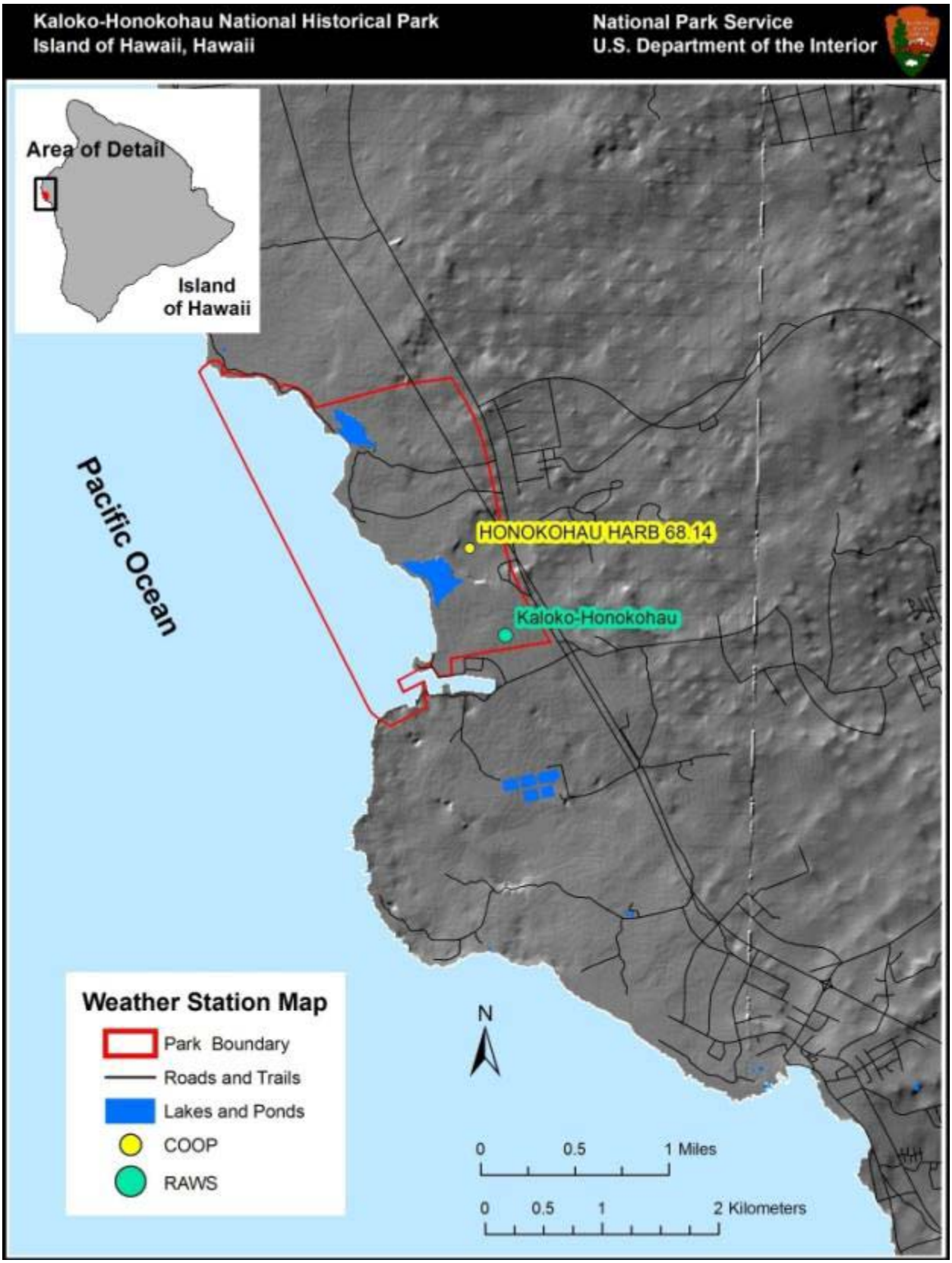

National Park of American Samoa
Island of Tutuila, American Samoa
National Park Service
U.S. Department of the Interior
Island of Tutuila
Area of Detail
Pacific Ocean
N
0 1 2 Miles
0 1 2 Kilometers
Weather Station Map
Park Boundary
Roads and Trails
Streams
COOP
PAGO PAGO WSO AP

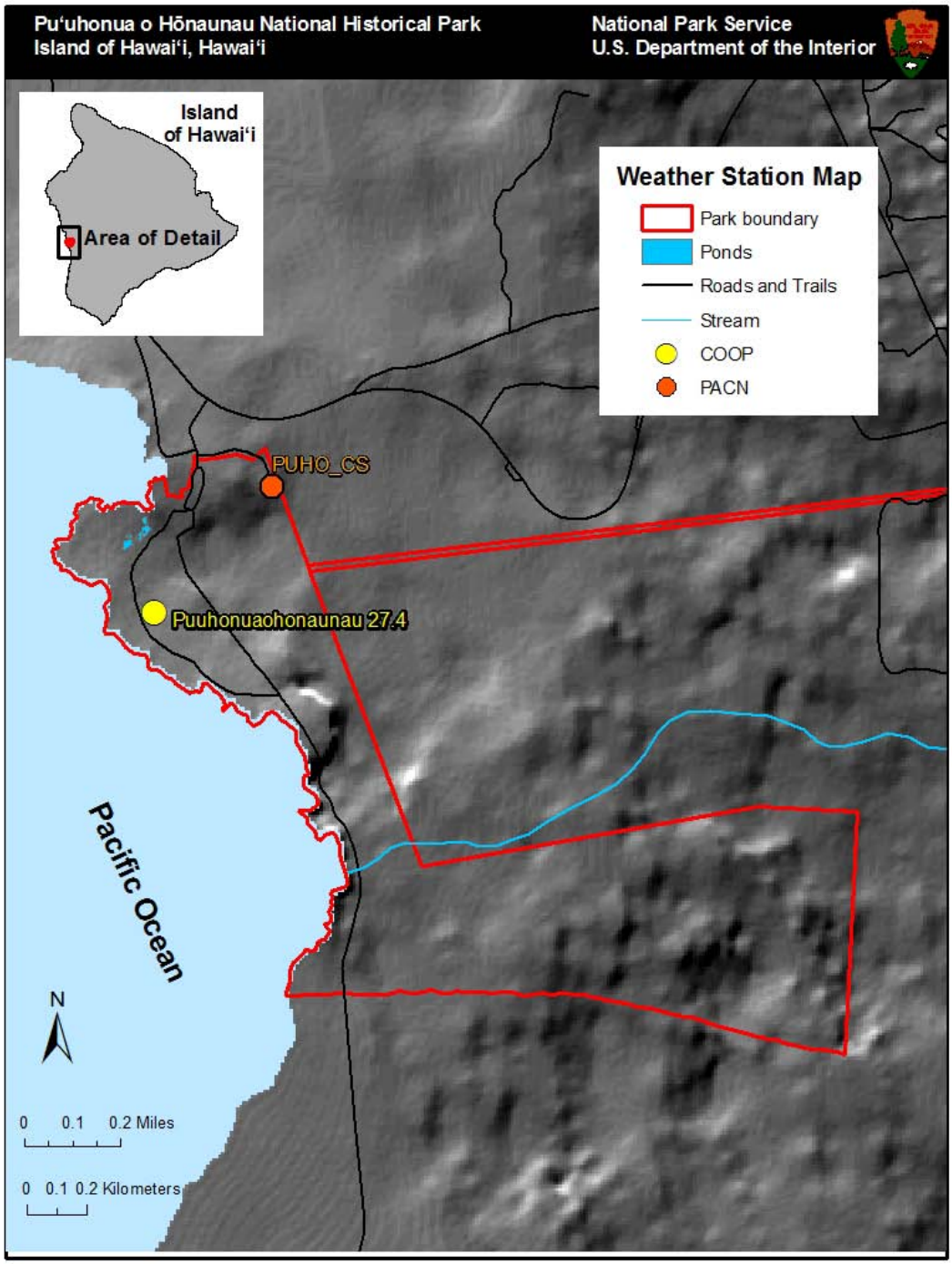

World War II Valor in the Pacific National Monument
Island of Oahu, Hawaii
National Park Service
U.S. Department of the Interior
Island of Oahu
Area of Detail
Weather Station Map
Park Boundary
Roads
Ford Island Bridge
Perennial Streams
Intermittent Streams
COOP
HONOLULU INTL ARPT
N
0
0.5
1 Miles
0
1
2 Kilometers

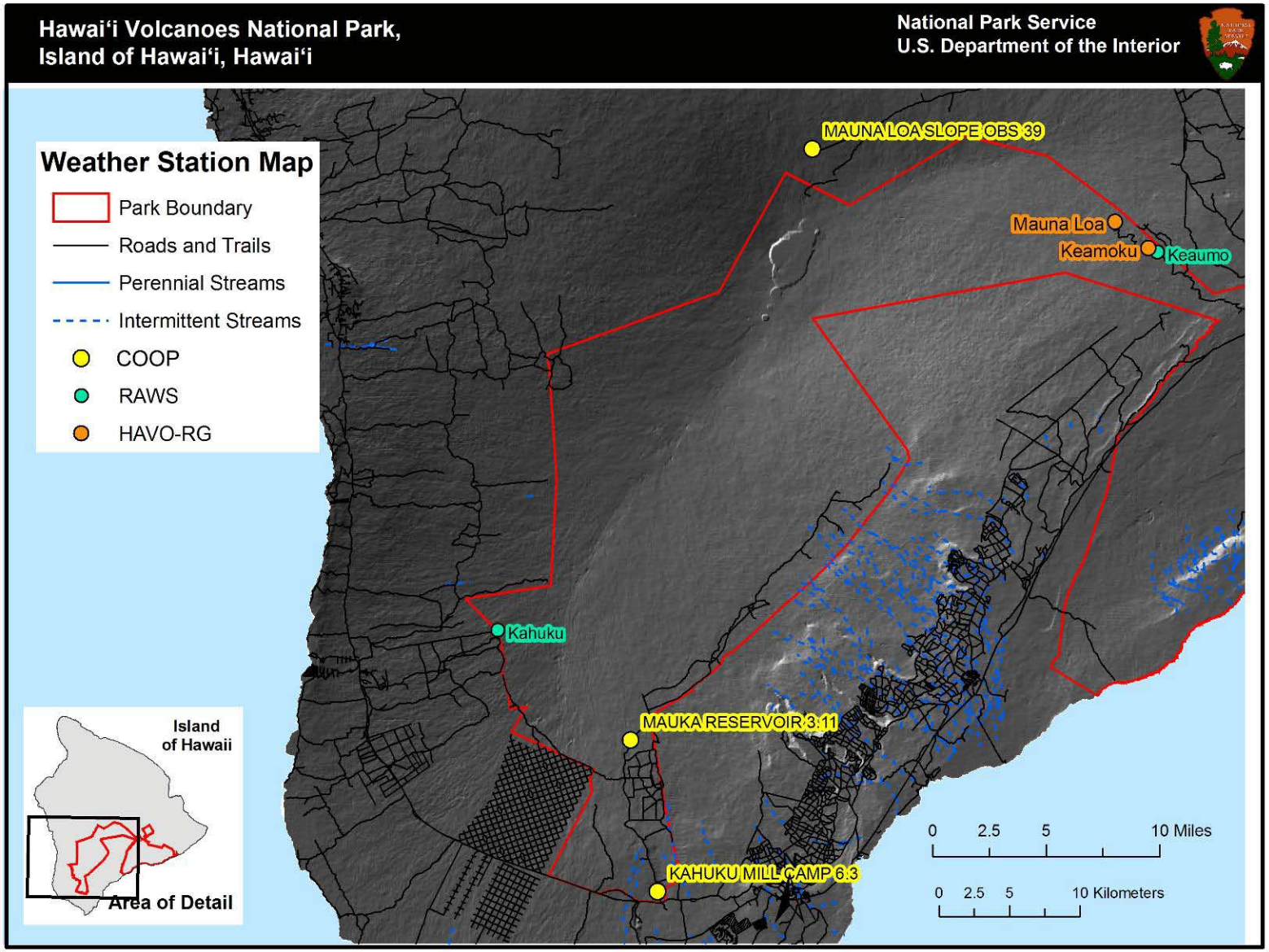

Kalaupapa National Historical Park
Island of Moloka'i, Hawai'i
National Park Service
U.S. Department of the Interior
0 0.5 1 2 Miles
0 0.5 1 2 Kilometers
N
Pacific Ocean
MAKAPULAPAI
Kalaupapa 563
Weather Station Map
Park Boundary
Roads and Trails
Perennial Streams
Intermittent Streams
COOP
RAWS
Area of Detail
Island of Moloka'i

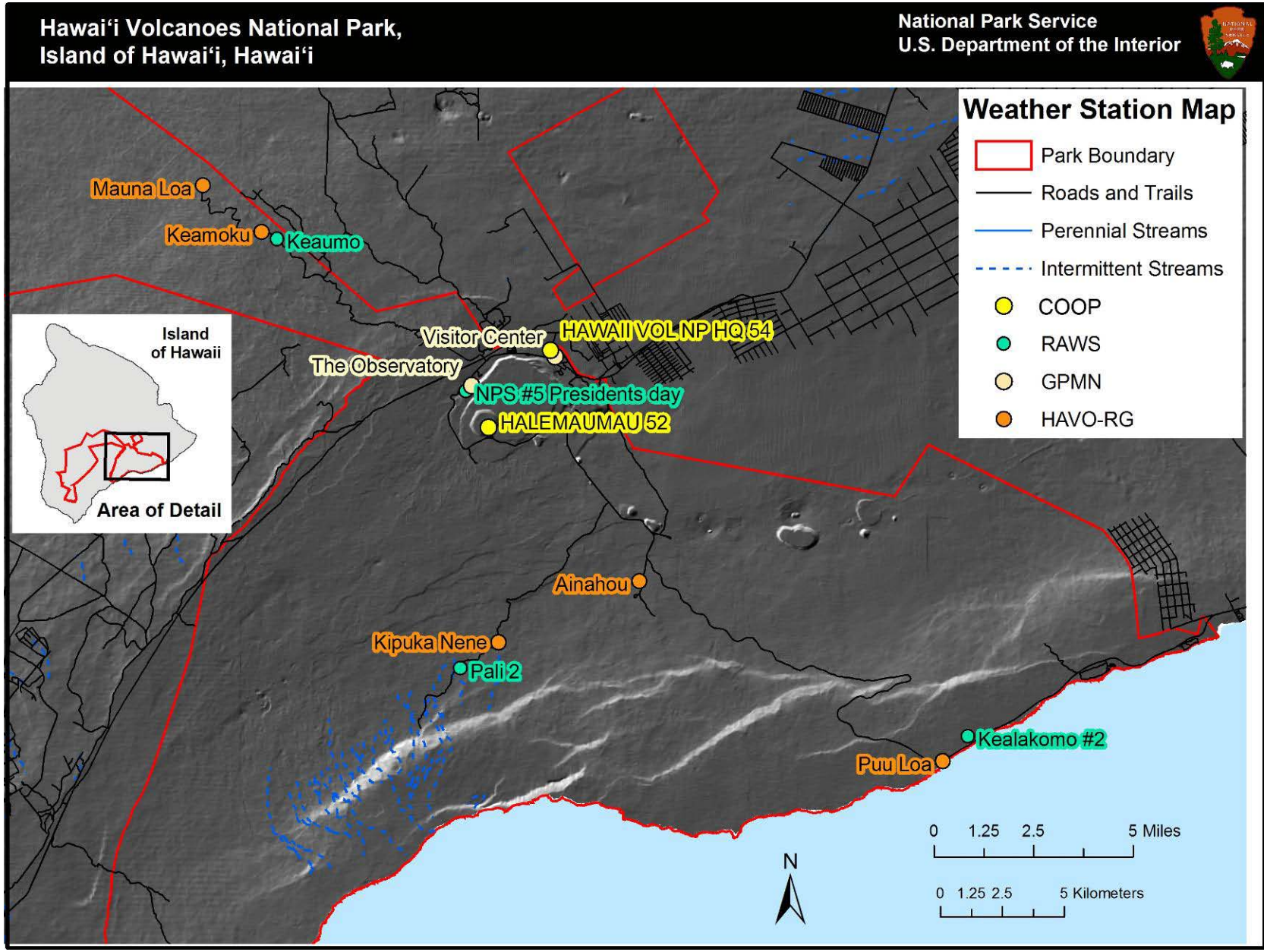

Haleakala National Park
Island of Maui, Hawaii
National Park Service
U.S. Department of the Interior
Weather Station Map
Park Boundary
Roads and Trails
Lakes and Ponds
Perennial Streams
Intermittent Streams
COOP
RAWS
HaleNet
USGS Rain Gauge
HALEAKALA RS 338
Haleakala National Park HQ
Nene Nest
HALEAKALA SUMMIT 338
Summit
Pohaku Palaha
Treeline
Big Bog
Kaupo Gap
Oheo Gulch RG
OHE'O 258.6
Pacific Ocean
0 1 2 4 Miles
0 1 2 4 Kilometers
N
Island of Maui
Area of Detail

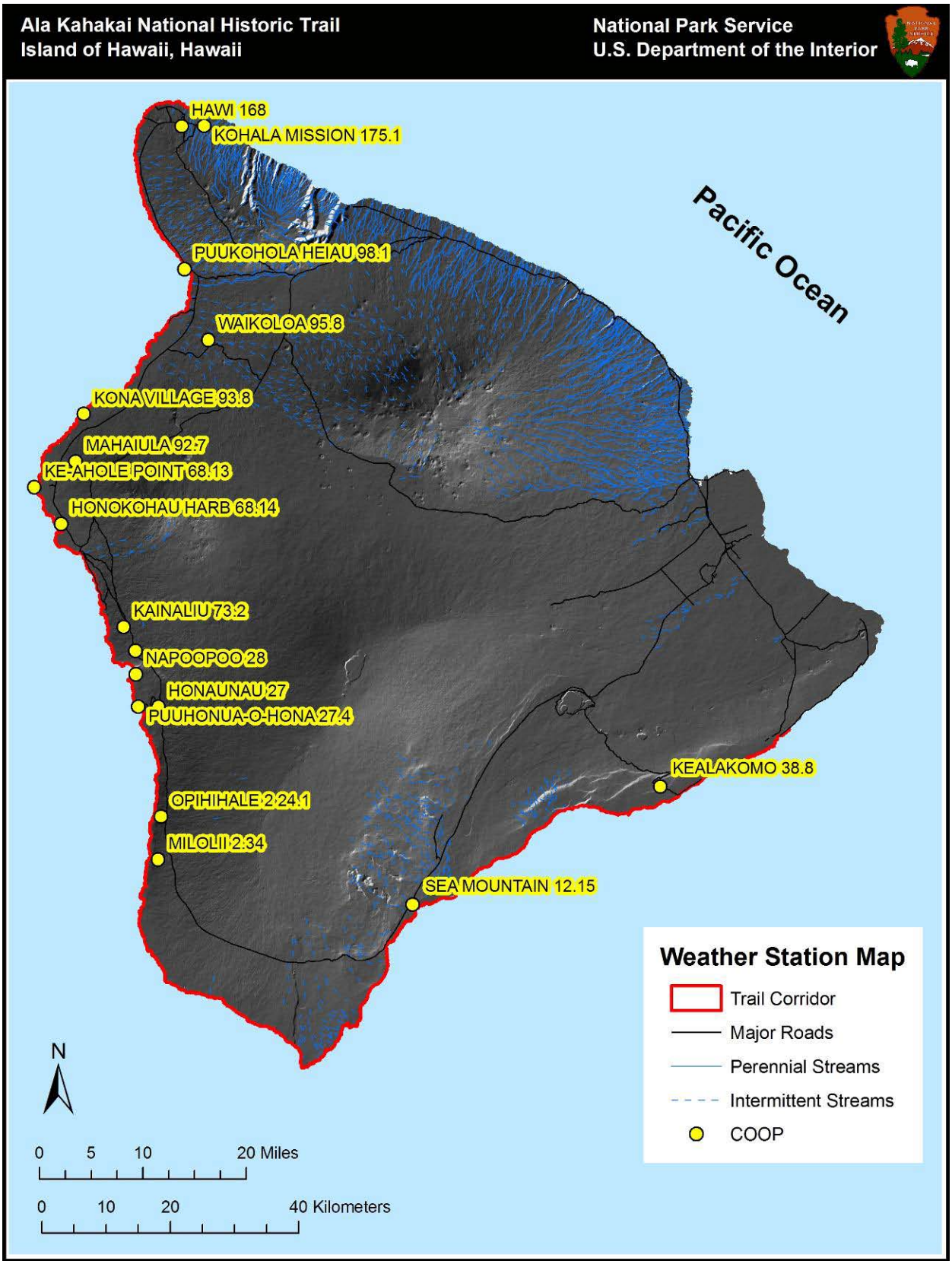

Puukohola Heiau National Historic Site
Island of Hawaii, Hawaii
National Park Service
U.S. Department of the Interior
Weather Station Map
Park Boundary
Lakes and Ponds
Rivers_Streams
Roads and Trails
COOP
N
0 0.25 0.5 Miles
0 0.125 0.25 0.5 Kilometers
Pacific Ocean
Puukohola Heiau 98.1
Area of Detail
Island of Hawaii


Kaloko-Honokohau National Historical Park
Island of Hawaii, Hawaii
National Park Service
U.S. Department of the Interior
Area of Detail
Island of Hawaii
Pacific Ocean
HONOKOHAU HARB 68.14
Kaloko-Honokohau
Weather Station Map
Park Boundary
Roads and Trails
Lakes and Ponds
COOP
RAWS
N
0 0.5 1 Miles
0 0.5 1 2 Kilometers


Pu'uhonua o Hōnaunau National Historical Park
Island of Hawai'i, Hawai'i
National Park Service
U.S. Department of the Interior
Island of Hawai'i
Area of Detail
Weather Station Map
Park boundary
Ponds
Roads and Trails
Stream
COOP
PACN
PUHO_CS
Puuhonuaohonaunau 27.4
Pacific Ocean
N
0 0.1 0.2 Miles
0 0.1 0.2 Kilometers


Hawai'i Volcanoes National Park,
Island of Hawai'i, Hawai'i
National Park Service
U.S. Department of the Interior
Weather Station Map
Park Boundary
Roads and Trails
Perennial Streams
Intermittent Streams
COOP
RAWS
HAVO-RG
MAUNA LOA SLOPE OBS 39
Mauna Loa
Keamoku
Keaumo
Kahuku
MAUKA RESERVOIR 3:11
KAHUKU MILL CAMP 6.3
Island of Hawaii
Area of Detail
0 2.5 5 10 Miles
0 2.5 5 10 Kilometers


Hawai'i Volcanoes National Park,
Island of Hawai'i, Hawai'i
National Park Service
U.S. Department of the Interior
Weather Station Map
Park Boundary
Roads and Trails
Perennial Streams
Intermittent Streams
COOP
RAWS
GPMN
HAVO-RG
Mauna Loa
Keamoku
Keaumo
Visitor Center
HAWAII VOL NP HQ 54
The Observatory
NPS #5 Presidents day
HALEMAUMAU 52
Island of Hawaii
Area of Detail
Ainahou
Kipuka Nene
Pali 2
Kealakomo #2
Puu Loa
N
0 1.25 2.5 5 Miles
0 1.25 2.5 5 Kilometers


Ala Kahakai National Historic Trail
Island of Hawaii, Hawaii
National Park Service
U.S. Department of the Interior
HAWI 168
KOHALA MISSION 175.1
PUUKOHOLA HEIAU 98.1
WAIKOLOA 95.8
KONA VILLAGE 93.8
MAHAIULA 92.7
KE-AHOLE POINT 68.13
HONOKOHAU HARB 68.14
KAINALIU 73.2
NAPOOPOO 28
HONAUNAU 27
PUUHONUA-O-HONA 27.4
KEALAKOMO 38.8
OPIHIHALE 2 24.1
MILOLII 2 34
SEA MOUNTAIN 12.15
Pacific Ocean
Weather Station Map
Trail Corridor
Major Roads
Perennial Streams
Intermittent Streams
COOP
N
0 5 10 20 Miles
0 10 20 40 Kilometers

PRISM Maps

Maps for annual mean precipitation, maximum and minimum temperatures were created based on datasets developed by the Oregon State University, PRISM (Parameter-elevation Regressions on Independent Slopes Model) Group. PRISM is especially suited to mapping climate in complex island landscapes (Daly et al. 2003). The model generates gridded estimates of climate parameters such as temperature and precipitation. It uses a moving-window regression of climate vs. elevation that is calculated for each grid cell in a digital elevation grid. Stations surrounding the grid cell provide data points for the regression. The following maps were generated with data covering the time period for 1971-2000. A detailed description of the data collection and analysis process for these data can be found in (Daly et al. 2006). Online access to the data is available via the PRISM group[31] website or the Natural Resource Information Portal.[32] Though maps in this appendix include only the above named parameters, data are also available for mean temperature and dew point temperature. In addition, data for monthly values and for islands outside the Pacific Island Network region are available.

For ease of comparison between different islands or parks, legends in individual maps include the range of values seen across the Pacific Island Network region. Individual maps were created for HALE, HAVO and KALA because these parks include steep precipitation or temperature gradients.

The following maps are included:

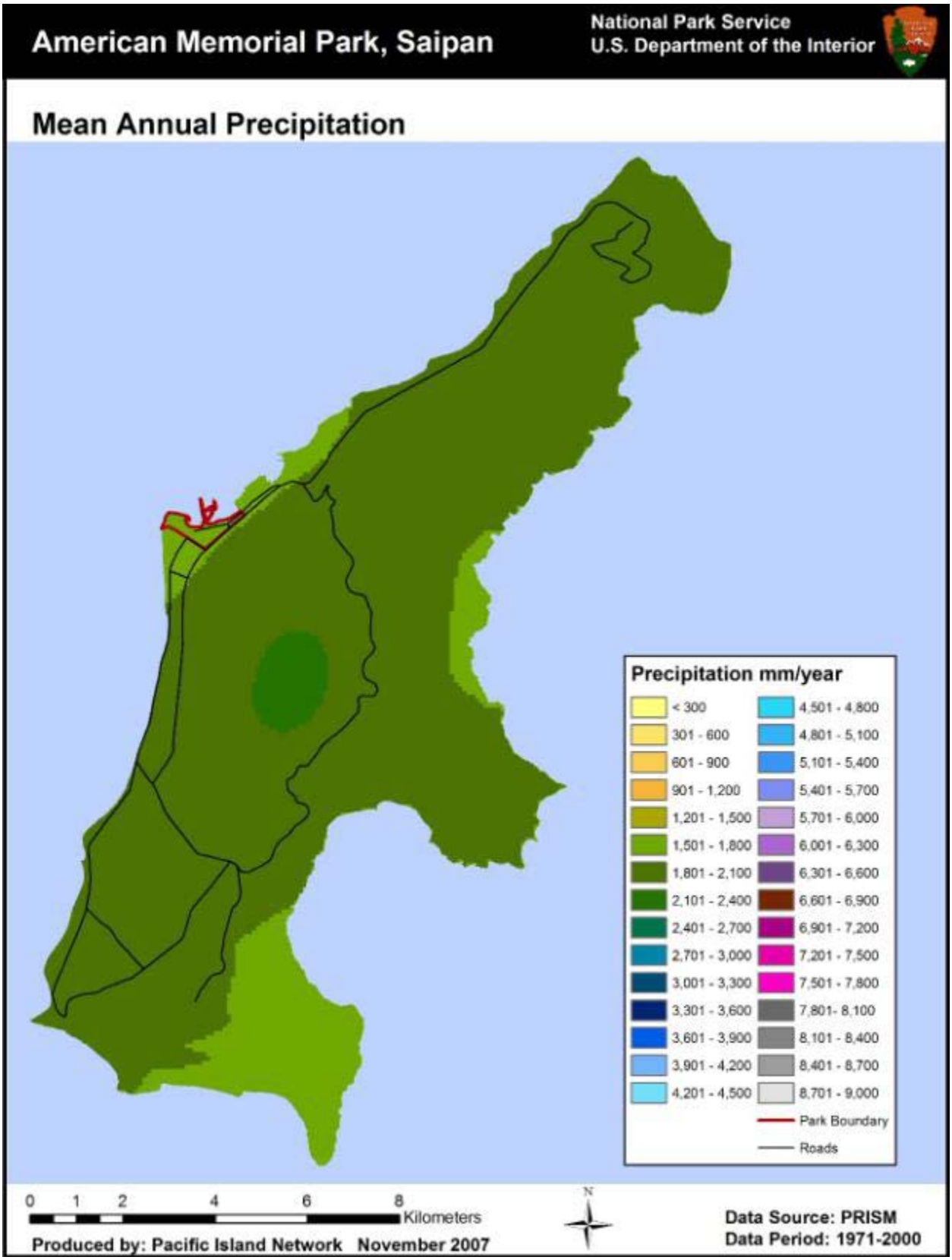
AMME:	precipitation	max. temperature	min. temperature
WAPA:	precipitation	max. temperature	min. temperature
NPSA: (Tutuila)	precipitation	max. temperature	min. temperature
NPSA: (Manua)	precipitation	max. temperature	min. temperature
Hawaiian Islands	precipitation	max. temperature	min temperature
KALA :	precipitation	max. temperature	min. temperature
HALE:	precipitation	max. temperature	min. temperature
HAVO:	precipitation	max. temperature	min. temperature

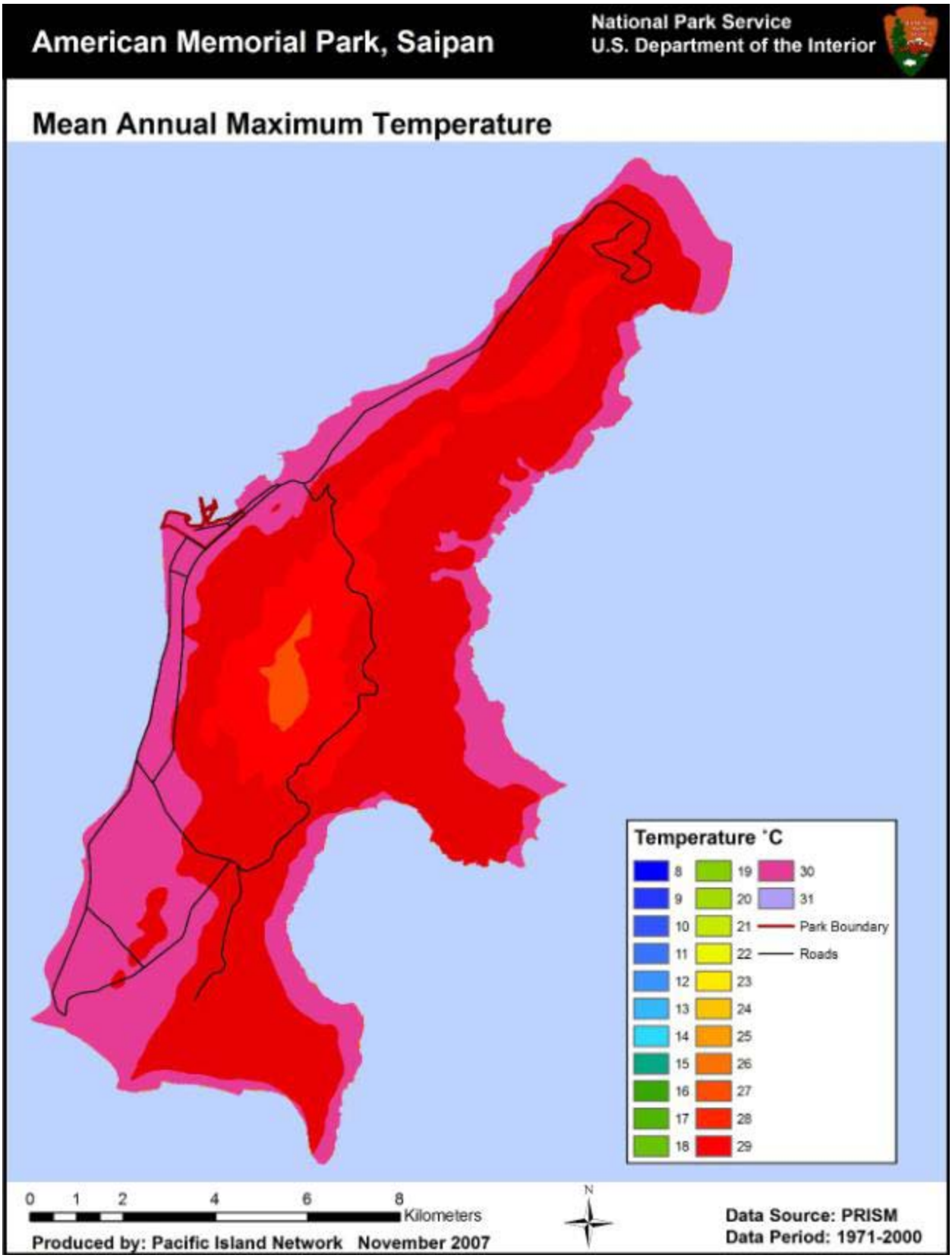
Daly, C., E. H. Helmer, and M. Quiñones. 2003. Mapping the climate of Puerto Rico, Vieques and Culebra. International Journal of Climatology **23**:1359-1381.

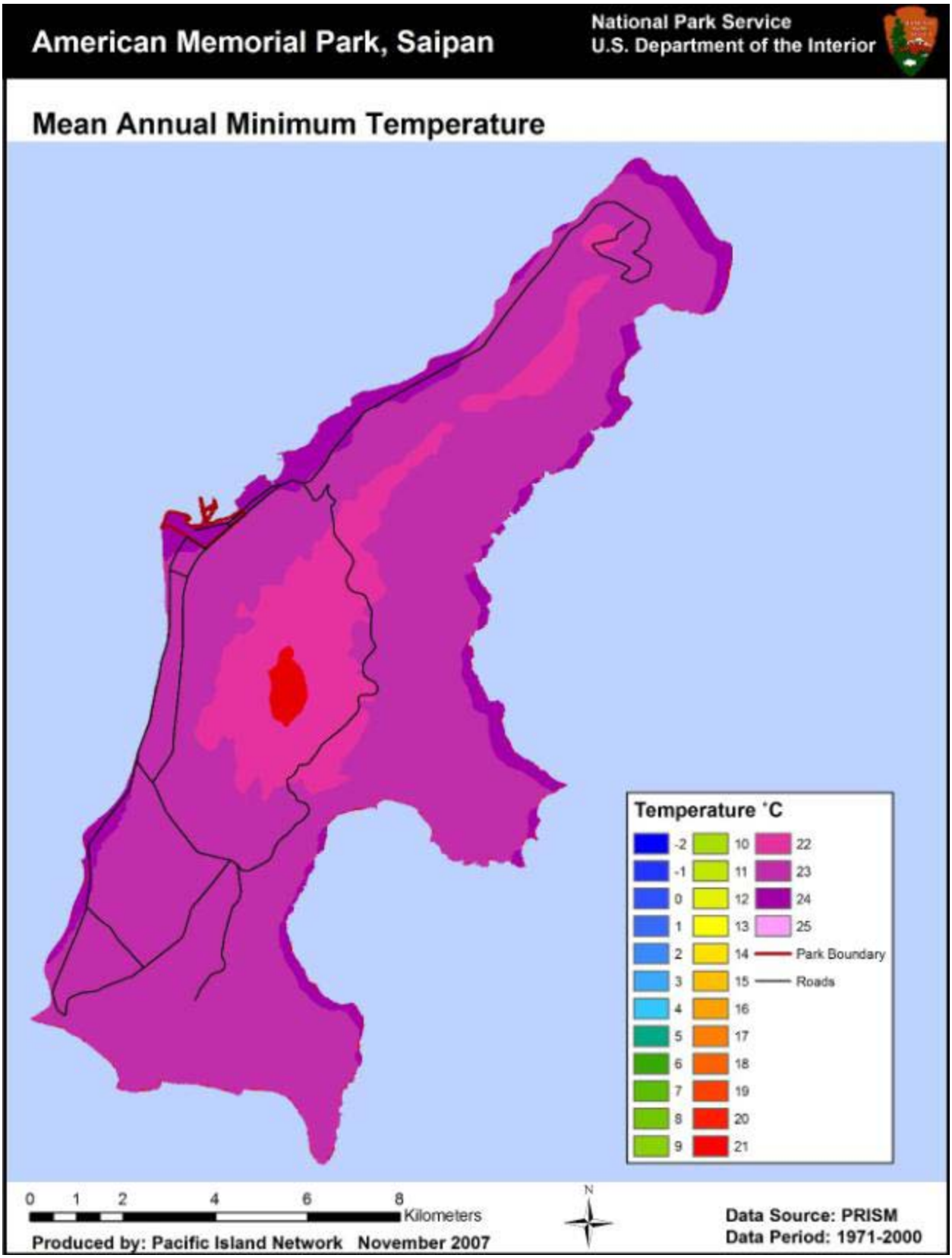
Daly, C., J. Smith, M. Doggett, M. Halbleib, and W. Gibson. 2006. High resolution climate maps for the Pacific Basin Islands, 1971-2000. Draft final report., PRISM Group, Oregon State University.

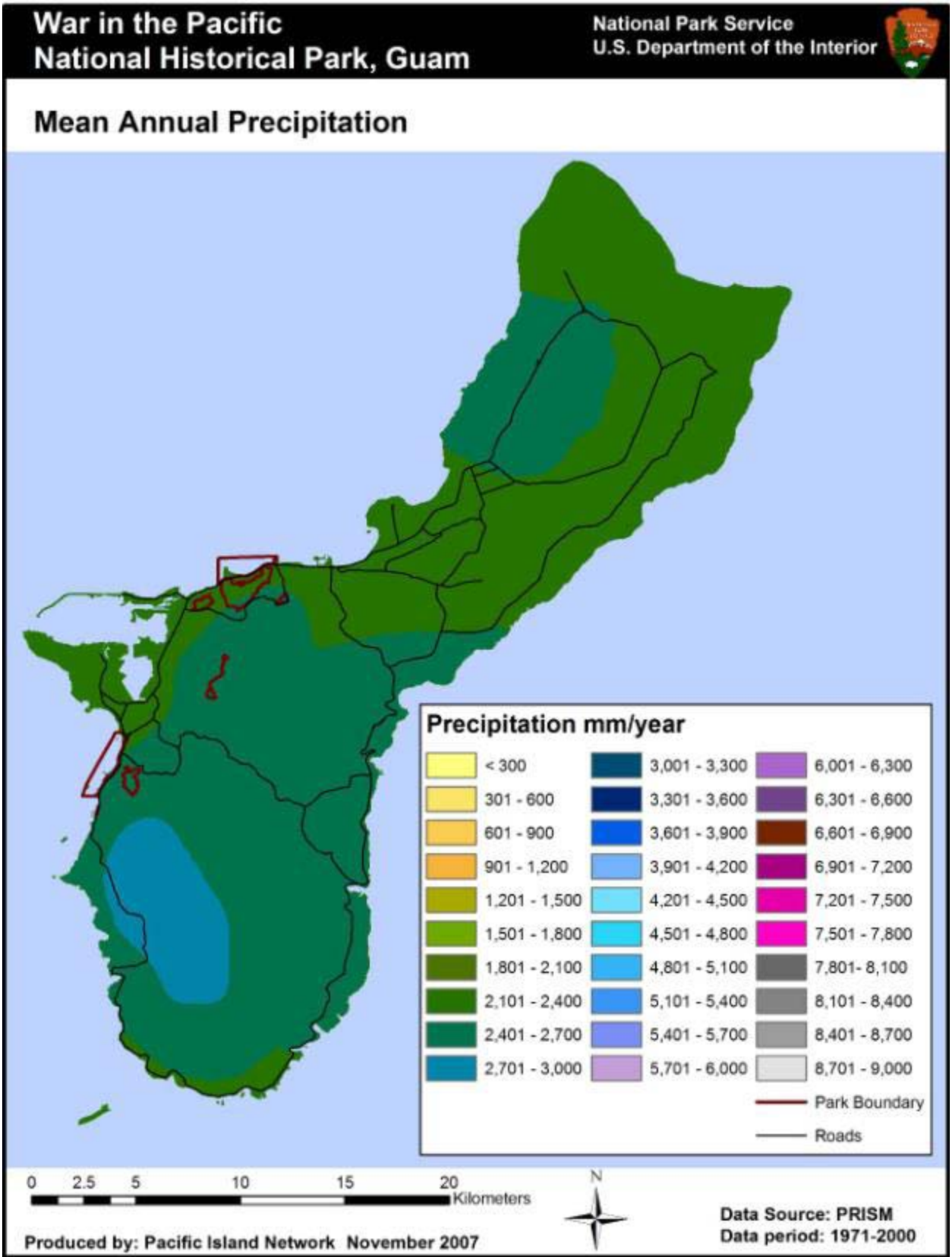
[31] http://www.prism.oregonstate.edu/products/pacisl.phtml

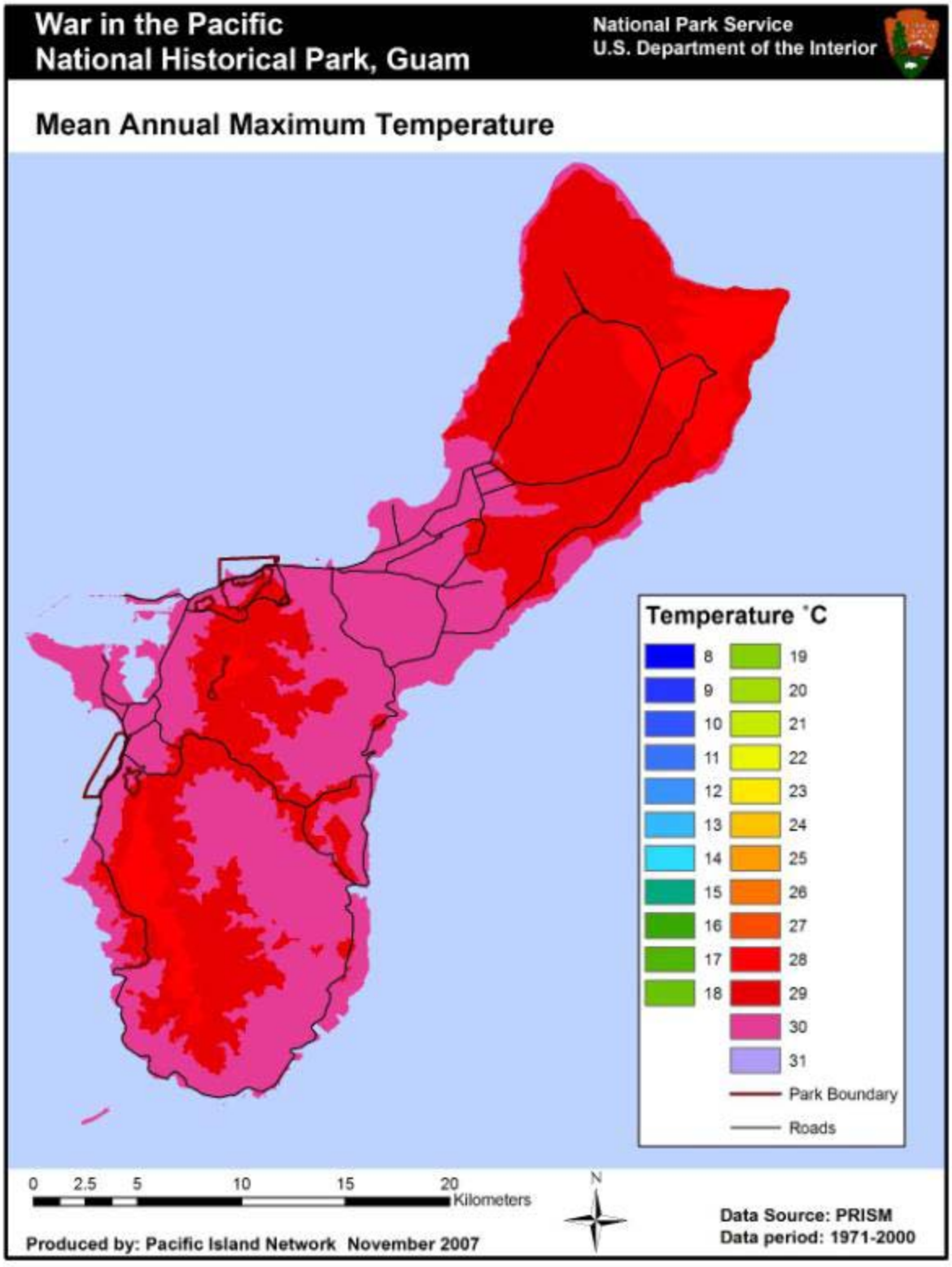
[32] http://nrinfo.nps.gov/Home.mvc

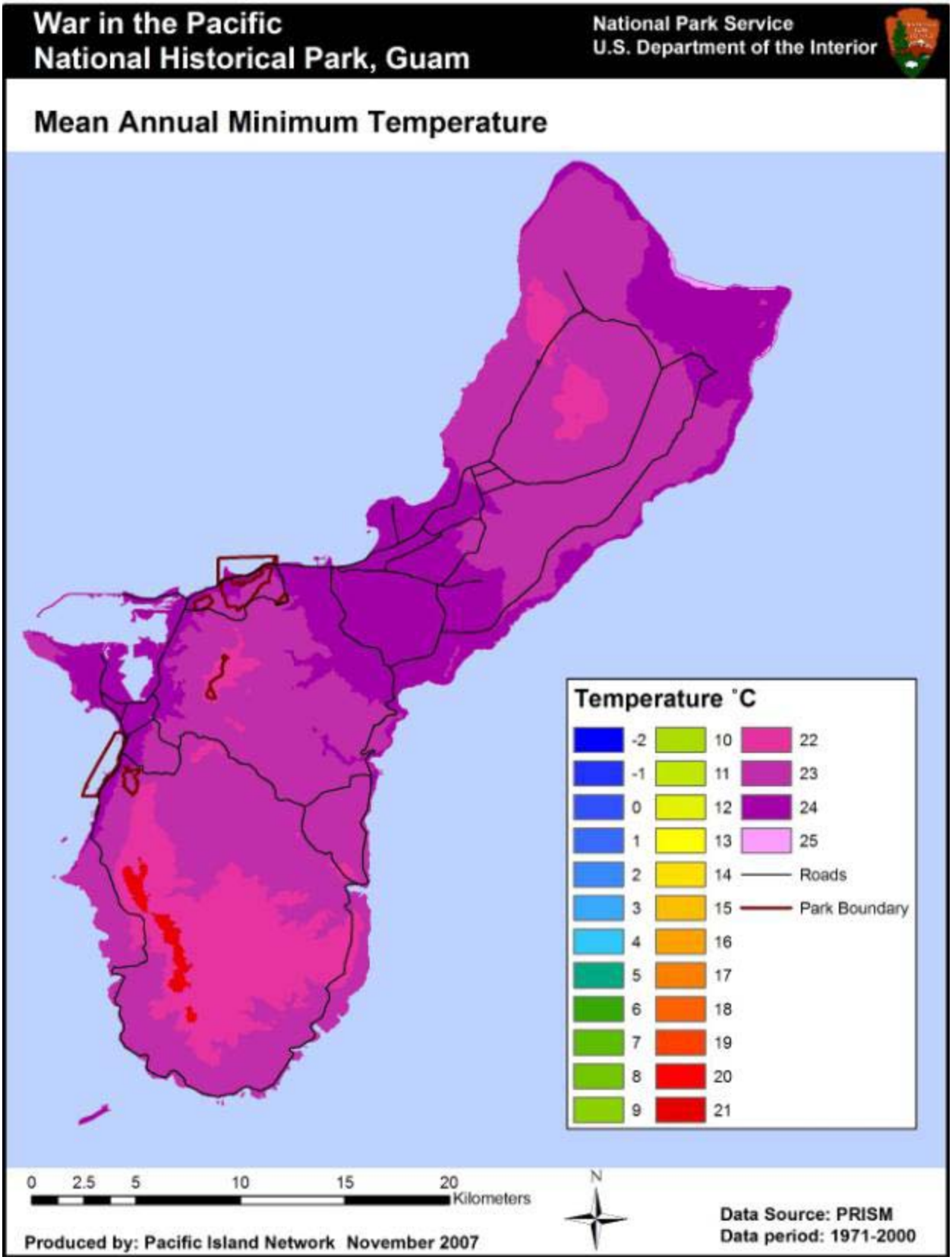

American Memorial Park, Saipan
National Park Service
U.S. Department of the Interior
Mean Annual Precipitation
Precipitation mm/year
< 300
301 - 600
601 - 900
901 - 1,200
1,201 - 1,500
1,501 - 1,800
1,801 - 2,100
2,101 - 2,400
2,401 - 2,700
2,701 - 3,000
3,001 - 3,300
3,301 - 3,600
3,601 - 3,900
3,901 - 4,200
4,201 - 4,500
4,501 - 4,800
4,801 - 5,100
5,101 - 5,400
5,401 - 5,700
5,701 - 6,000
6,001 - 6,300
6,301 - 6,600
6,601 - 6,900
6,901 - 7,200
7,201 - 7,500
7,501 - 7,800
7,801- 8,100
8,101 - 8,400
8,401 - 8,700
8,701 - 9,000
Park Boundary
Roads
0 1 2 4 6 8
Kilometers
N
Produced by: Pacific Island Network November 2007
Data Source: PRISM
Data Period: 1971-2000

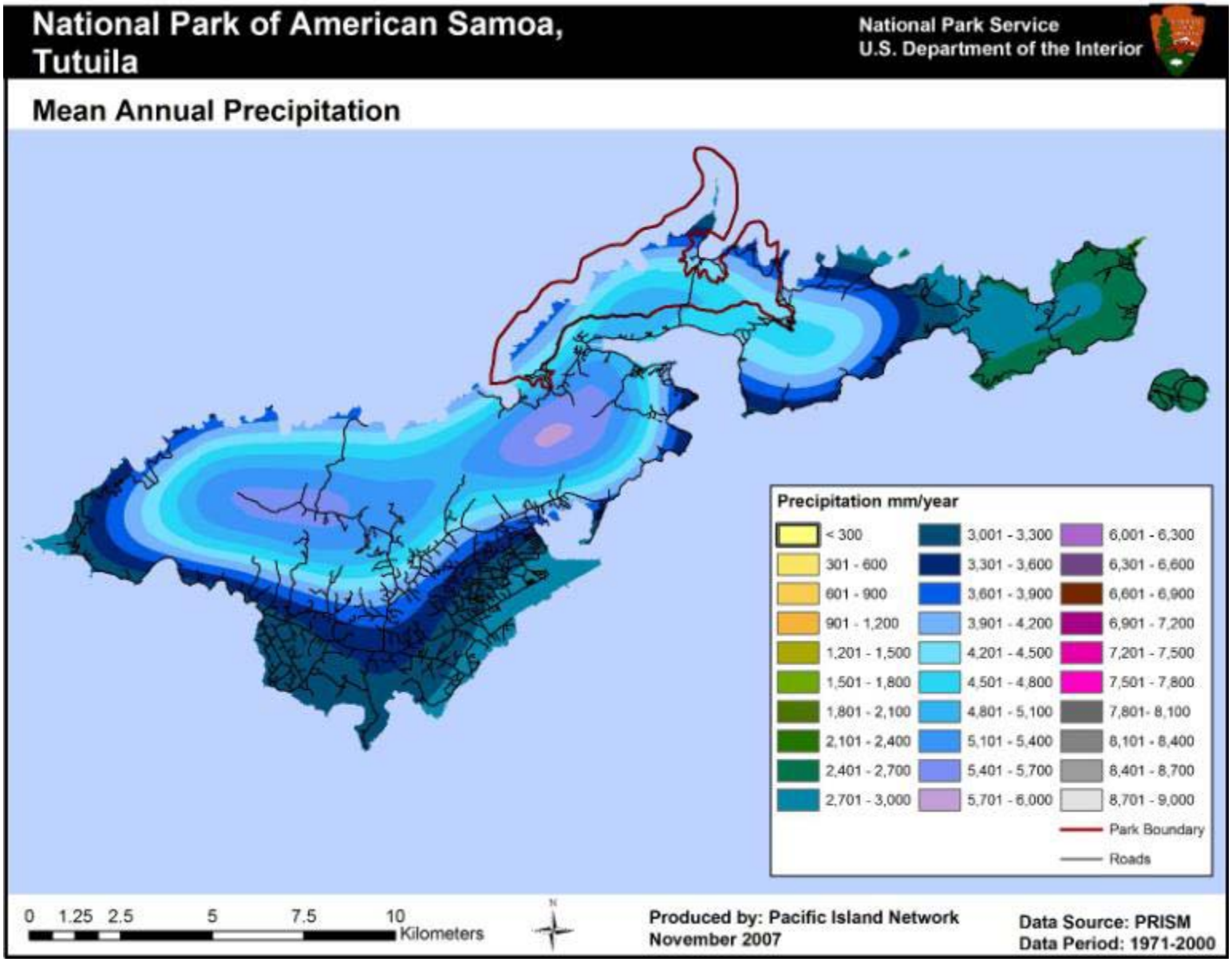

American Memorial Park, Saipan
National Park Service
U.S. Department of the Interior
Mean Annual Maximum Temperature
Temperature °C
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
Park Boundary
Roads
0 1 2 4 6 8
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007

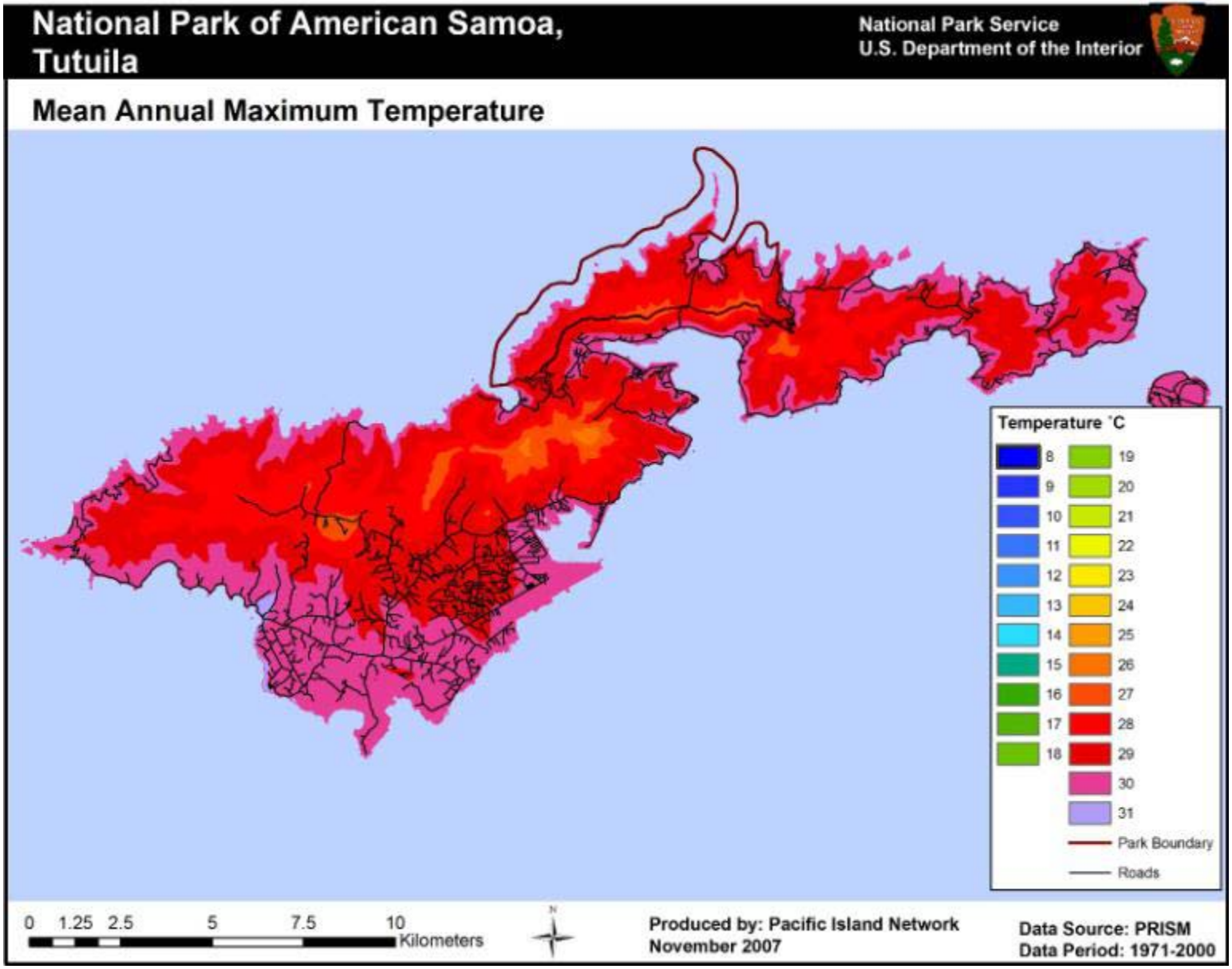

American Memorial Park, Saipan
National Park Service
U.S. Department of the Interior
Mean Annual Minimum Temperature
Temperature °C
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Park Boundary
Roads
0 1 2 4 6 8
Kilometers
N
Produced by: Pacific Island Network November 2007
Data Source: PRISM
Data Period: 1971-2000

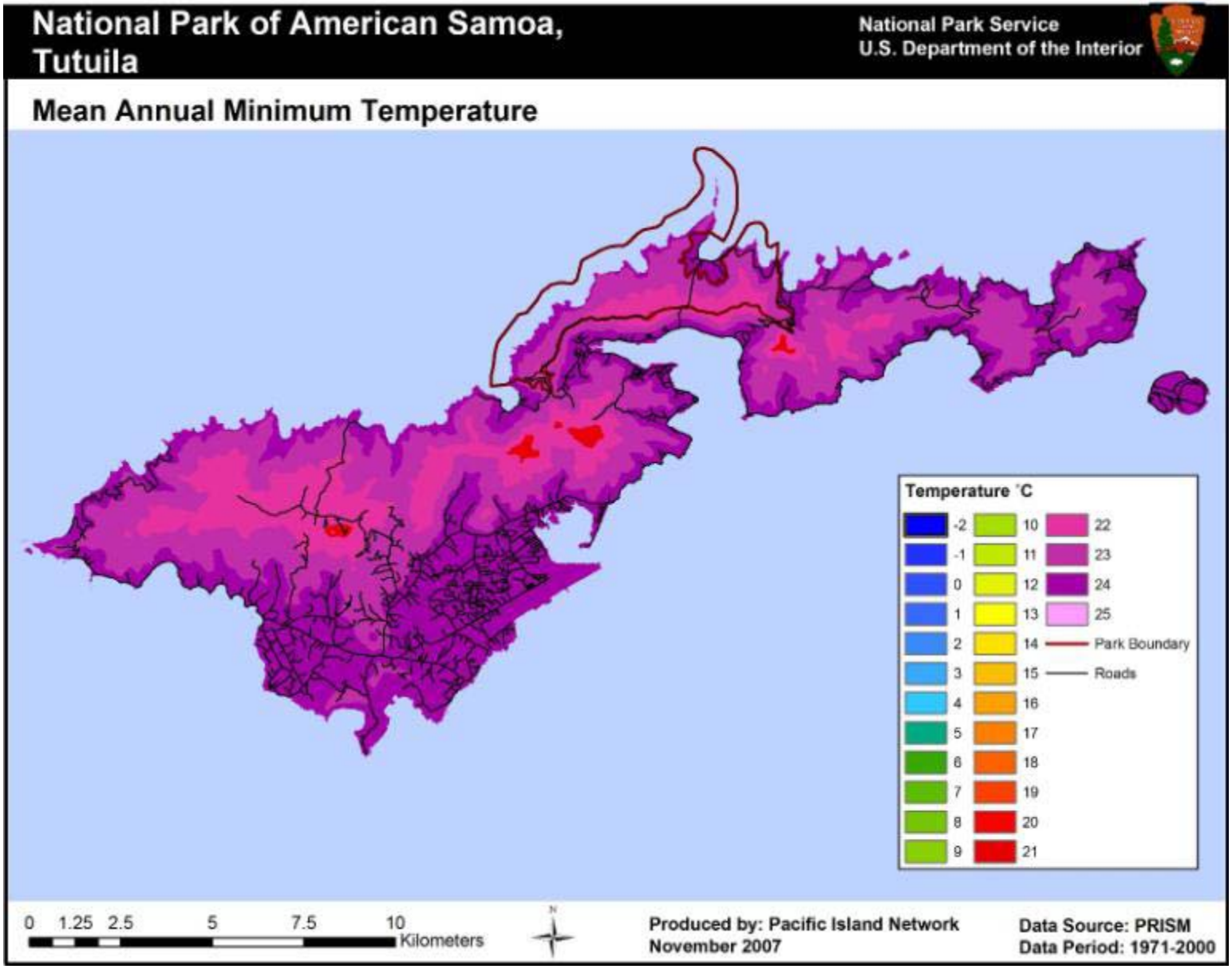

War in the Pacific
National Historical Park, Guam
National Park Service
U.S. Department of the Interior
Mean Annual Precipitation
Precipitation mm/year
< 300
301 - 600
601 - 900
901 - 1,200
1,201 - 1,500
1,501 - 1,800
1,801 - 2,100
2,101 - 2,400
2,401 - 2,700
2,701 - 3,000
3,001 - 3,300
3,301 - 3,600
3,601 - 3,900
3,901 - 4,200
4,201 - 4,500
4,501 - 4,800
4,801 - 5,100
5,101 - 5,400
5,401 - 5,700
5,701 - 6,000
6,001 - 6,300
6,301 - 6,600
6,601 - 6,900
6,901 - 7,200
7,201 - 7,500
7,501 - 7,800
7,801- 8,100
8,101 - 8,400
8,401 - 8,700
8,701 - 9,000
Park Boundary
Roads
0 2.5 5 10 15 20 Kilometers
N
Data Source: PRISM
Data period: 1971-2000
Produced by: Pacific Island Network November 2007

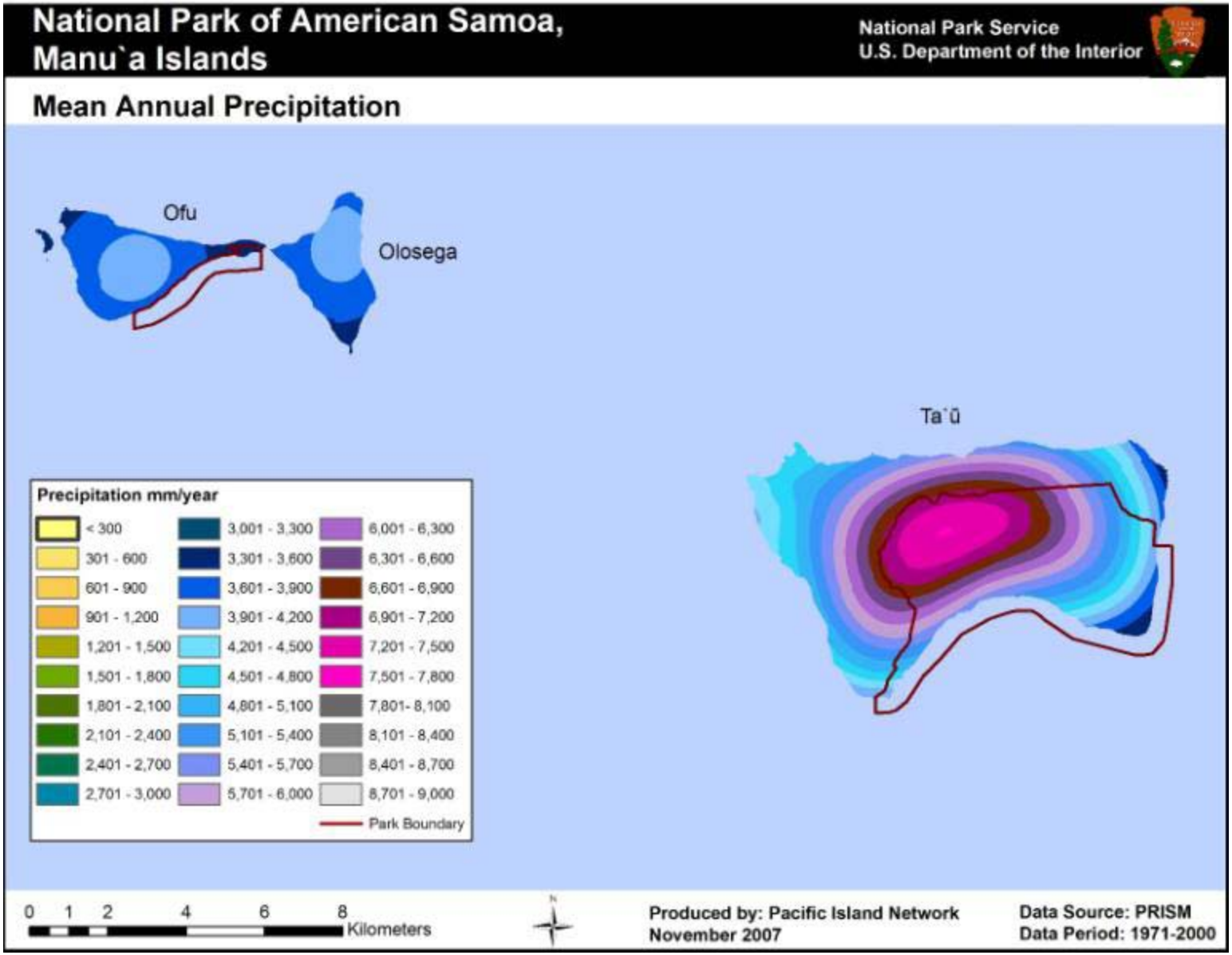

War in the Pacific
National Historical Park, Guam
National Park Service
U.S. Department of the Interior
Mean Annual Maximum Temperature
Temperature °C
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
Park Boundary
Roads
0 2.5 5 10 15 20
Kilometers
N
Data Source: PRISM
Data period: 1971-2000
Produced by: Pacific Island Network November 2007

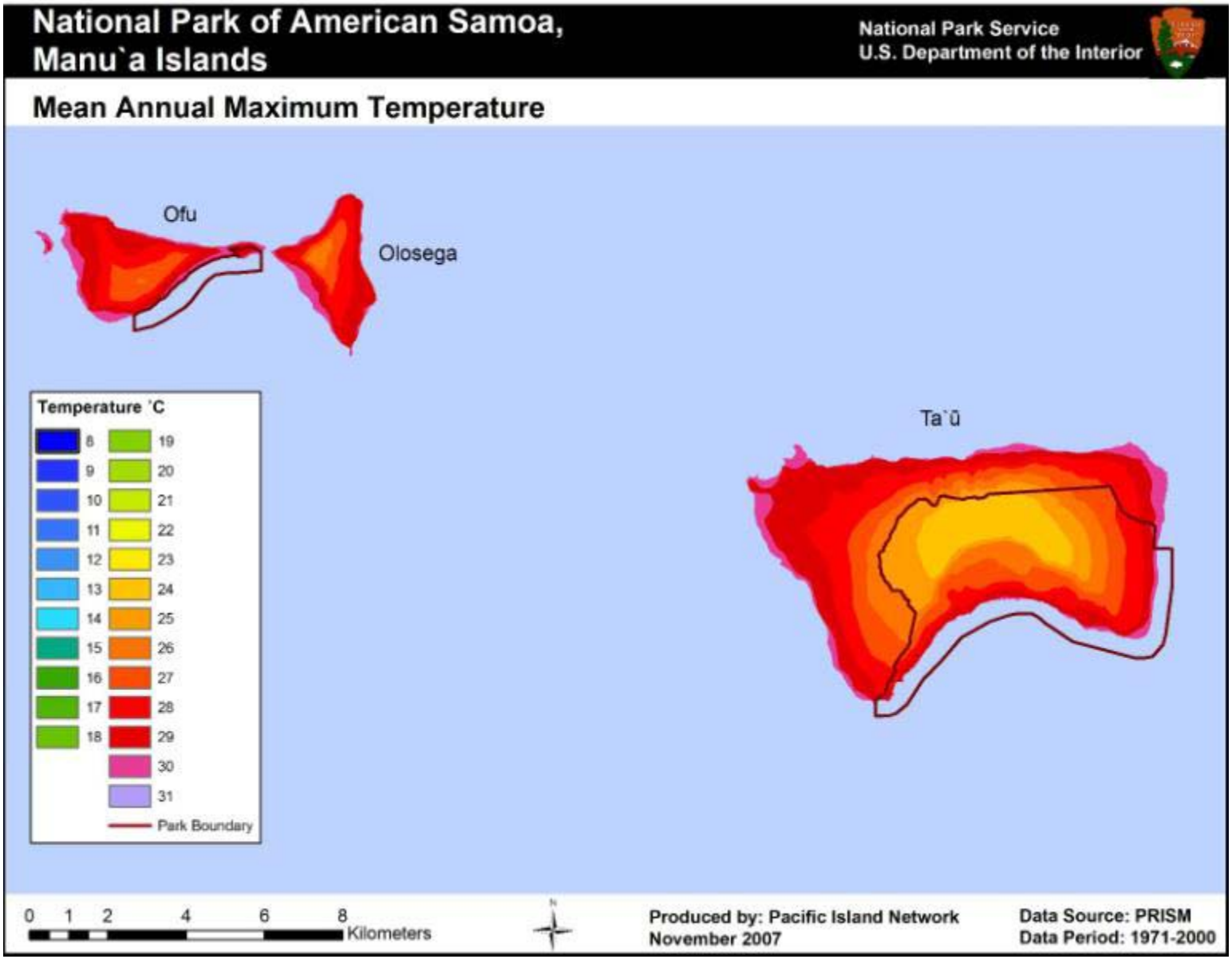

War in the Pacific
National Historical Park, Guam
National Park Service
U.S. Department of the Interior
Mean Annual Minimum Temperature
Temperature ˚C
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Roads
Park Boundary
0 2.5 5 10 15 20
Kilometers
N
Data Source: PRISM
Data period: 1971-2000
Produced by: Pacific Island Network November 2007

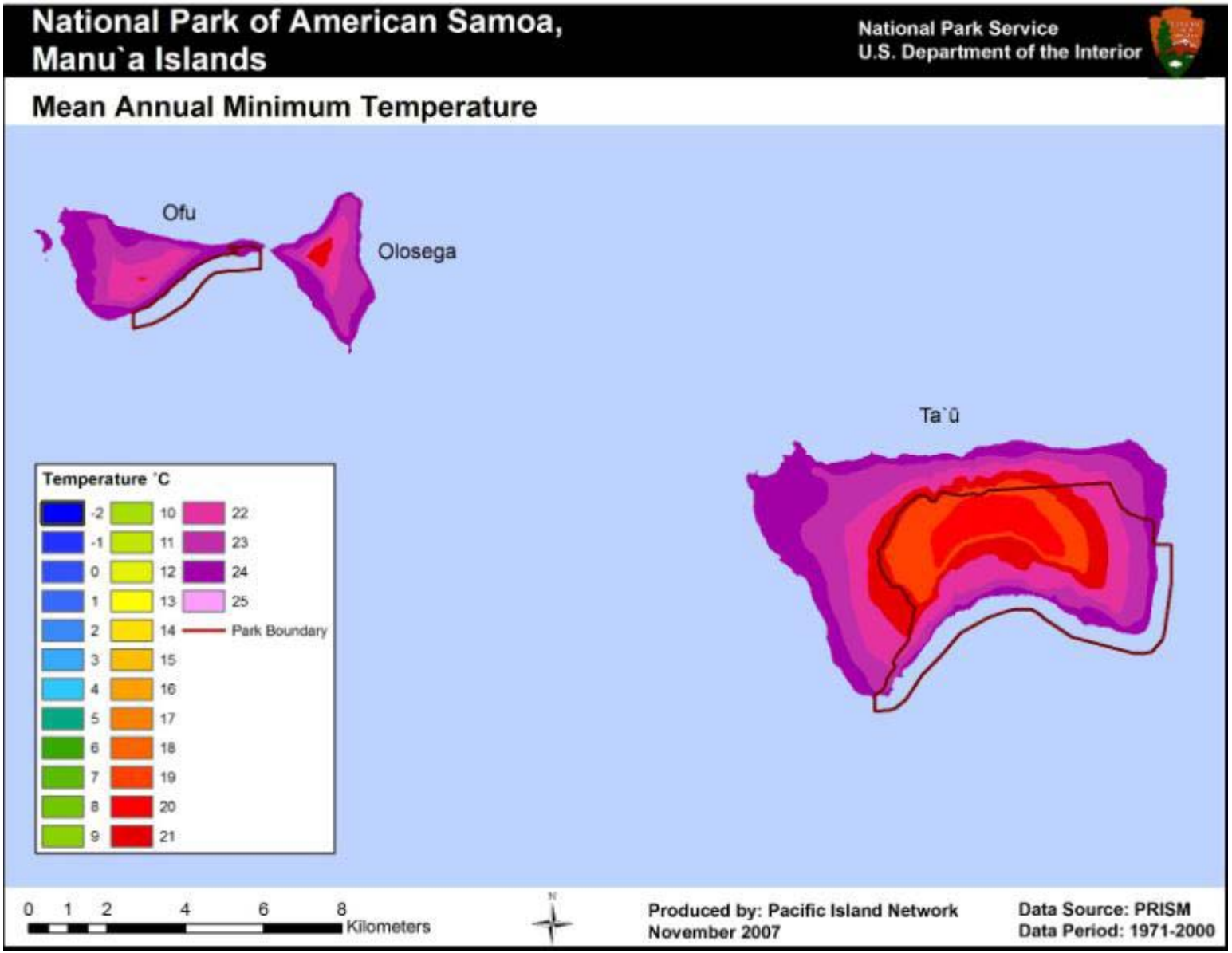

National Park of American Samoa,
Tutuila
National Park Service
U.S. Department of the Interior
Mean Annual Precipitation
Precipitation mm/year
< 300
301 - 600
601 - 900
901 - 1,200
1,201 - 1,500
1,501 - 1,800
1,801 - 2,100
2,101 - 2,400
2,401 - 2,700
2,701 - 3,000
3,001 - 3,300
3,301 - 3,600
3,601 - 3,900
3,901 - 4,200
4,201 - 4,500
4,501 - 4,800
4,801 - 5,100
5,101 - 5,400
5,401 - 5,700
5,701 - 6,000
6,001 - 6,300
6,301 - 6,600
6,601 - 6,900
6,901 - 7,200
7,201 - 7,500
7,501 - 7,800
7,801- 8,100
8,101 - 8,400
8,401 - 8,700
8,701 - 9,000
Park Boundary
Roads
0 1.25 2.5 5 7.5 10
Kilometers
N
Produced by: Pacific Island Network
November 2007
Data Source: PRISM
Data Period: 1971-2000

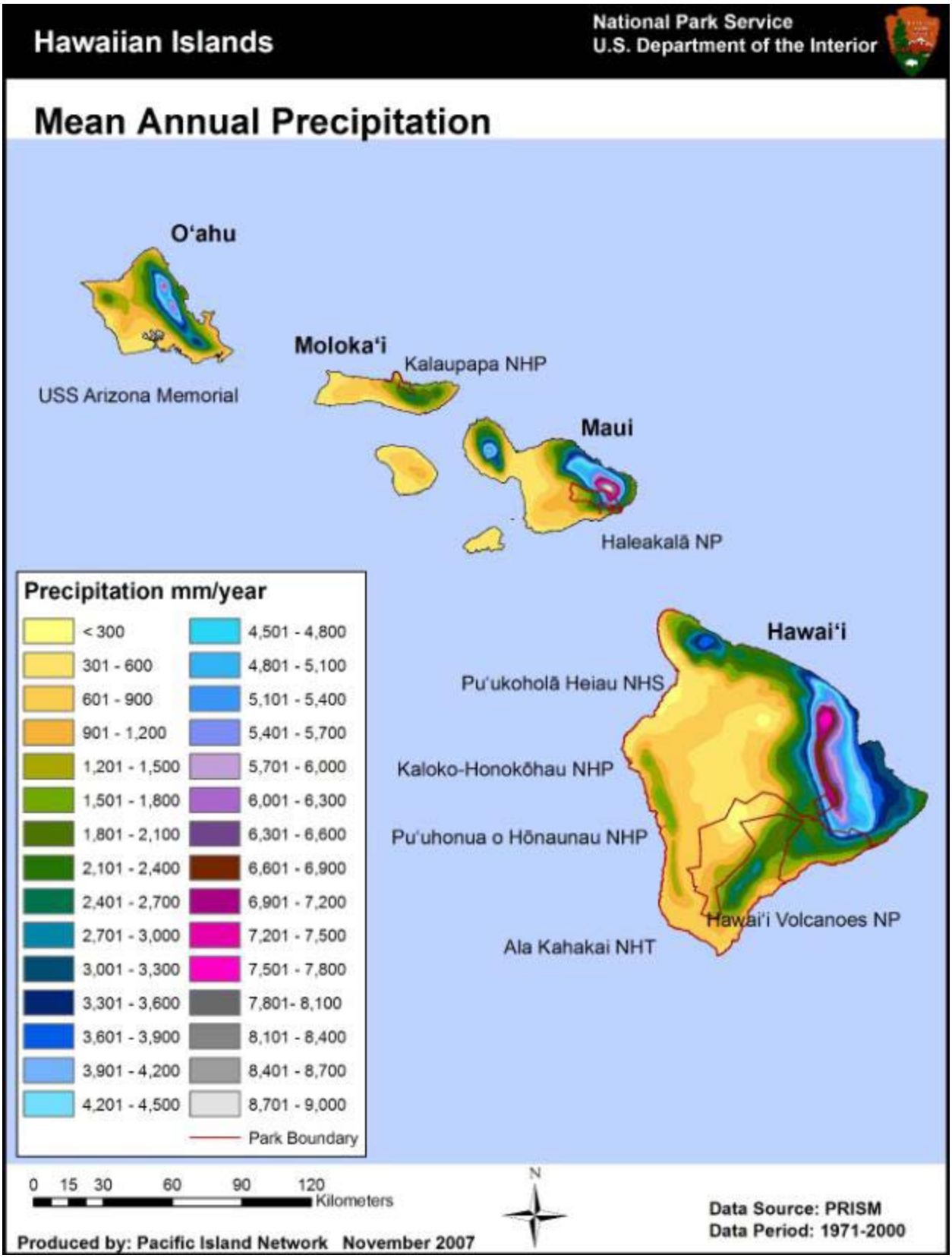

National Park of American Samoa,
Tutuila
National Park Service
U.S. Department of the Interior
Mean Annual Maximum Temperature
Temperature °C
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
Park Boundary
Roads
0 1.25 2.5 5 7.5 10
Kilometers
N
Produced by: Pacific Island Network
November 2007
Data Source: PRISM
Data Period: 1971-2000

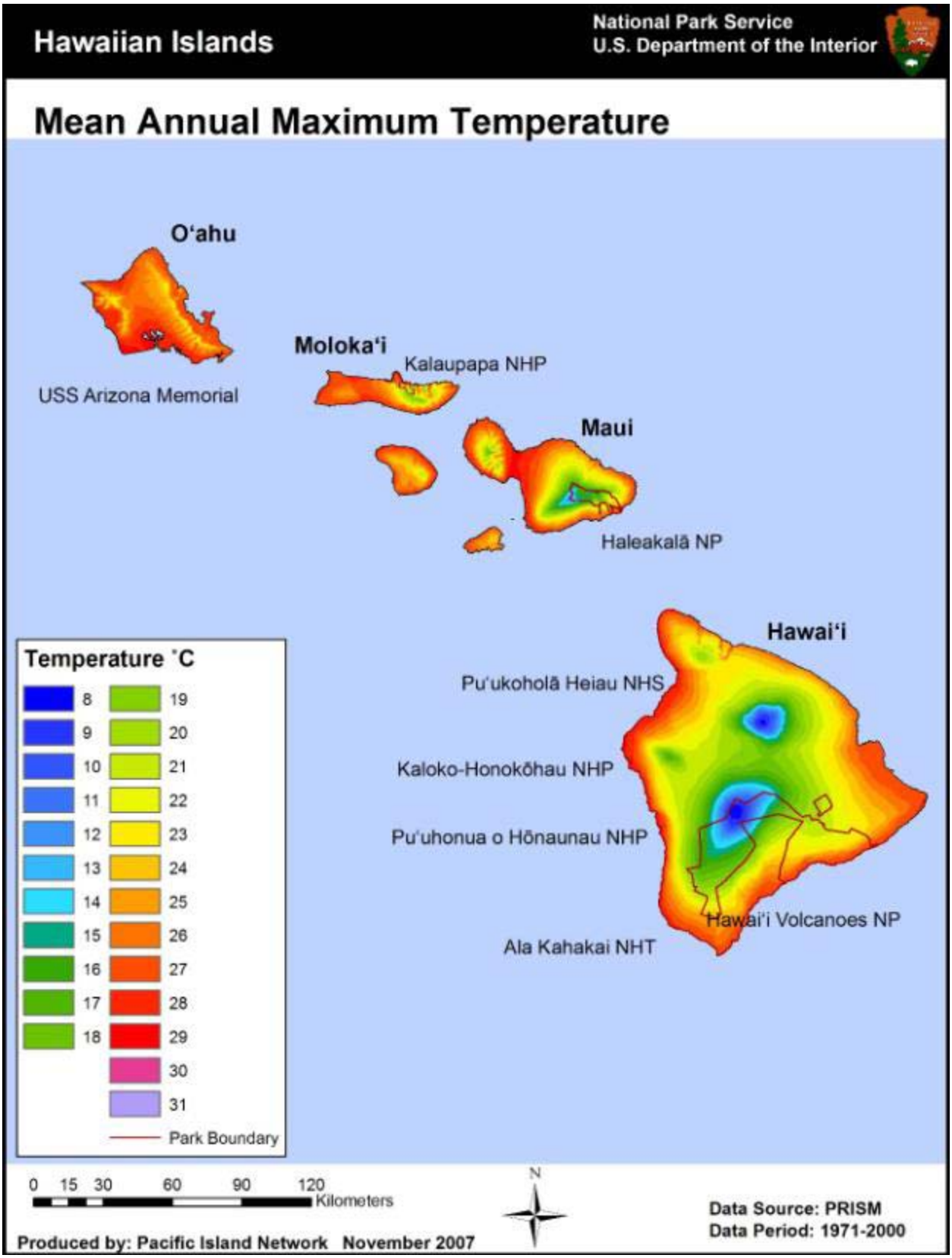

National Park of American Samoa,
Tutuila
National Park Service
U.S. Department of the Interior
Mean Annual Minimum Temperature
Temperature °C
-2
-1
0
1
2
3
4
5
6
7
8
9
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11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Park Boundary
Roads
0 1.25 2.5 5 7.5 10
Kilometers
N
Produced by: Pacific Island Network
November 2007
Data Source: PRISM
Data Period: 1971-2000

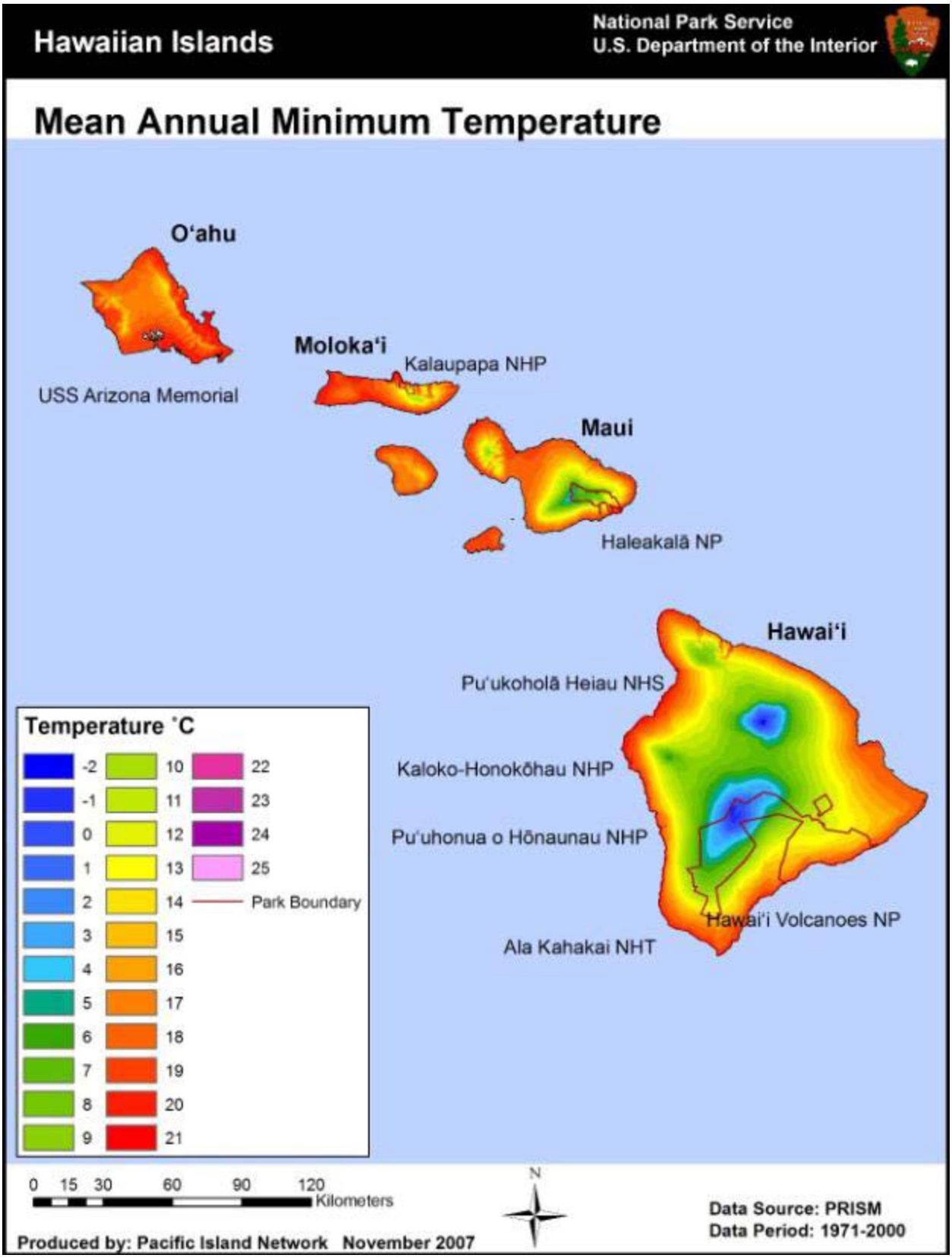

National Park of American Samoa,
Manu`a Islands
National Park Service
U.S. Department of the Interior
Mean Annual Precipitation
Ofu
Olosega
Ta`ū
Precipitation mm/year
< 300
301 - 600
601 - 900
901 - 1,200
1,201 - 1,500
1,501 - 1,800
1,801 - 2,100
2,101 - 2,400
2,401 - 2,700
2,701 - 3,000
3,001 - 3,300
3,301 - 3,600
3,601 - 3,900
3,901 - 4,200
4,201 - 4,500
4,501 - 4,800
4,801 - 5,100
5,101 - 5,400
5,401 - 5,700
5,701 - 6,000
6,001 - 6,300
6,301 - 6,600
6,601 - 6,900
6,901 - 7,200
7,201 - 7,500
7,501 - 7,800
7,801- 8,100
8,101 - 8,400
8,401 - 8,700
8,701 - 9,000
Park Boundary
0 1 2 4 6 8
Kilometers
N
Produced by: Pacific Island Network
November 2007
Data Source: PRISM
Data Period: 1971-2000

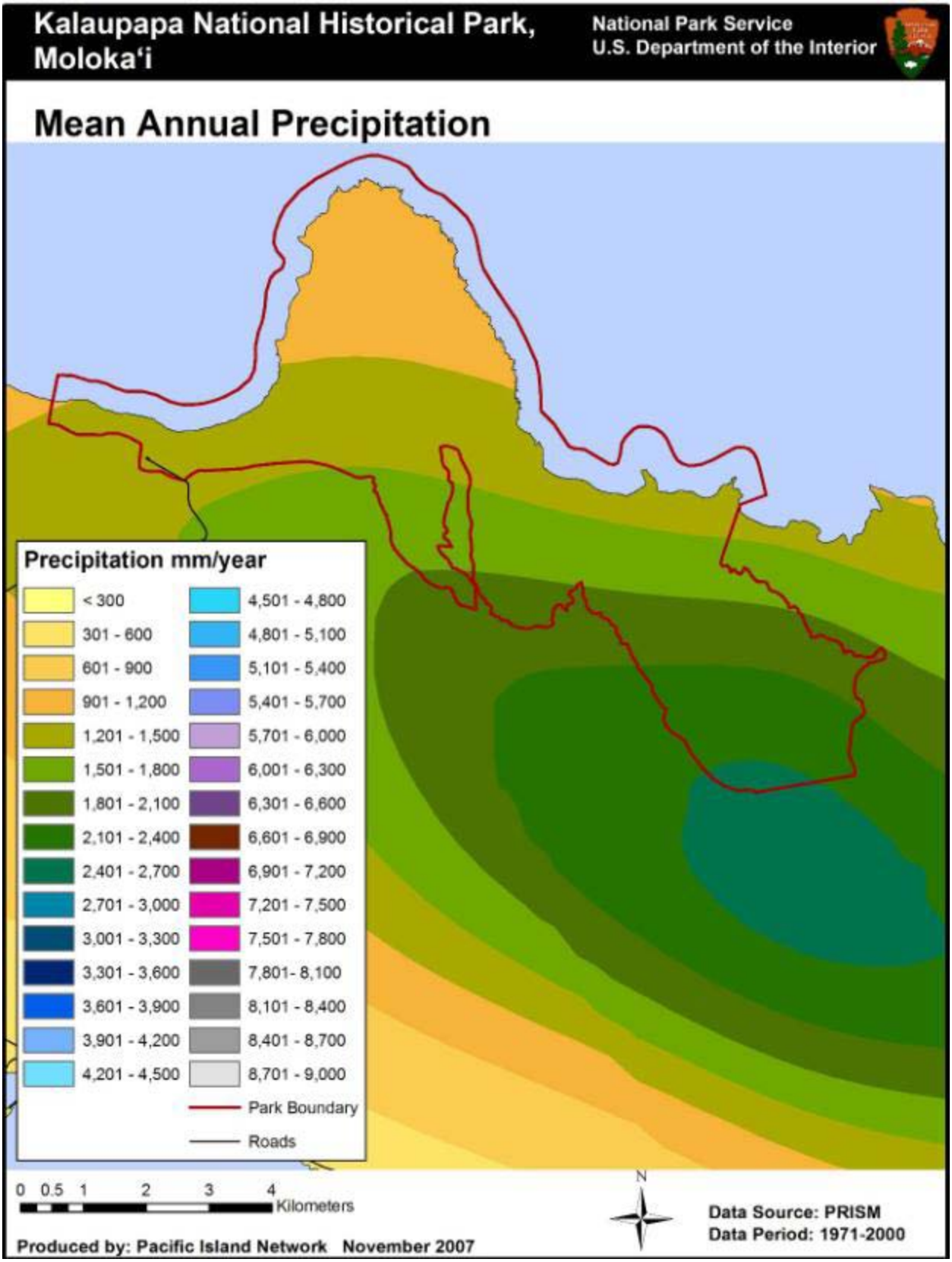

National Park of American Samoa,
Manu`a Islands
National Park Service
U.S. Department of the Interior
Mean Annual Maximum Temperature
Ofu
Olosega
Ta`ū
Temperature °C
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
Park Boundary
0 1 2 4 6 8
Kilometers
Produced by: Pacific Island Network
November 2007
Data Source: PRISM
Data Period: 1971-2000

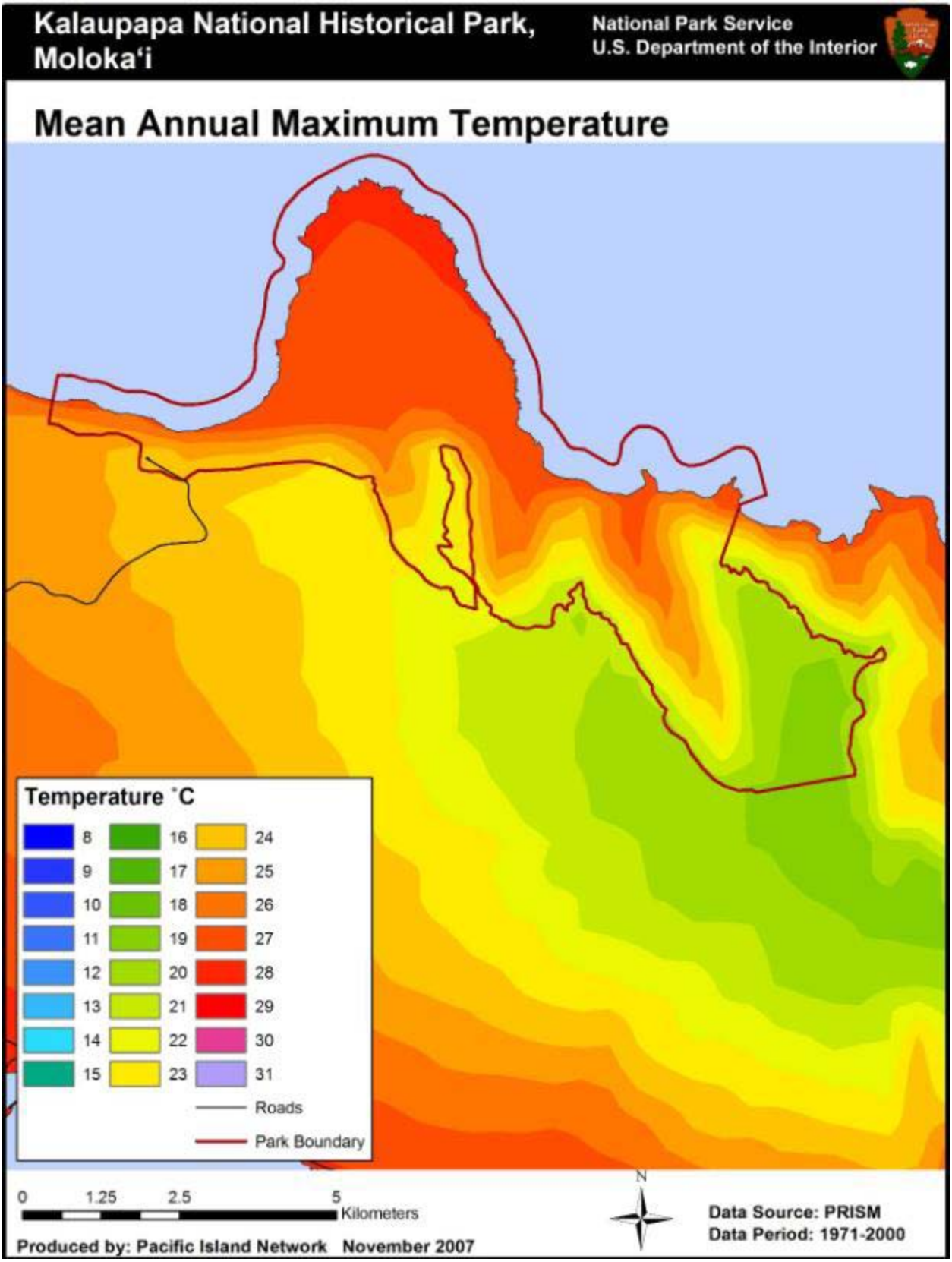

National Park of American Samoa,
Manu`a Islands
National Park Service
U.S. Department of the Interior
Mean Annual Minimum Temperature
Ofu
Olosega
Ta`ū
Temperature ˚C
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Park Boundary
0 1 2 4 6 8
Kilometers
N
Produced by: Pacific Island Network
November 2007
Data Source: PRISM
Data Period: 1971-2000

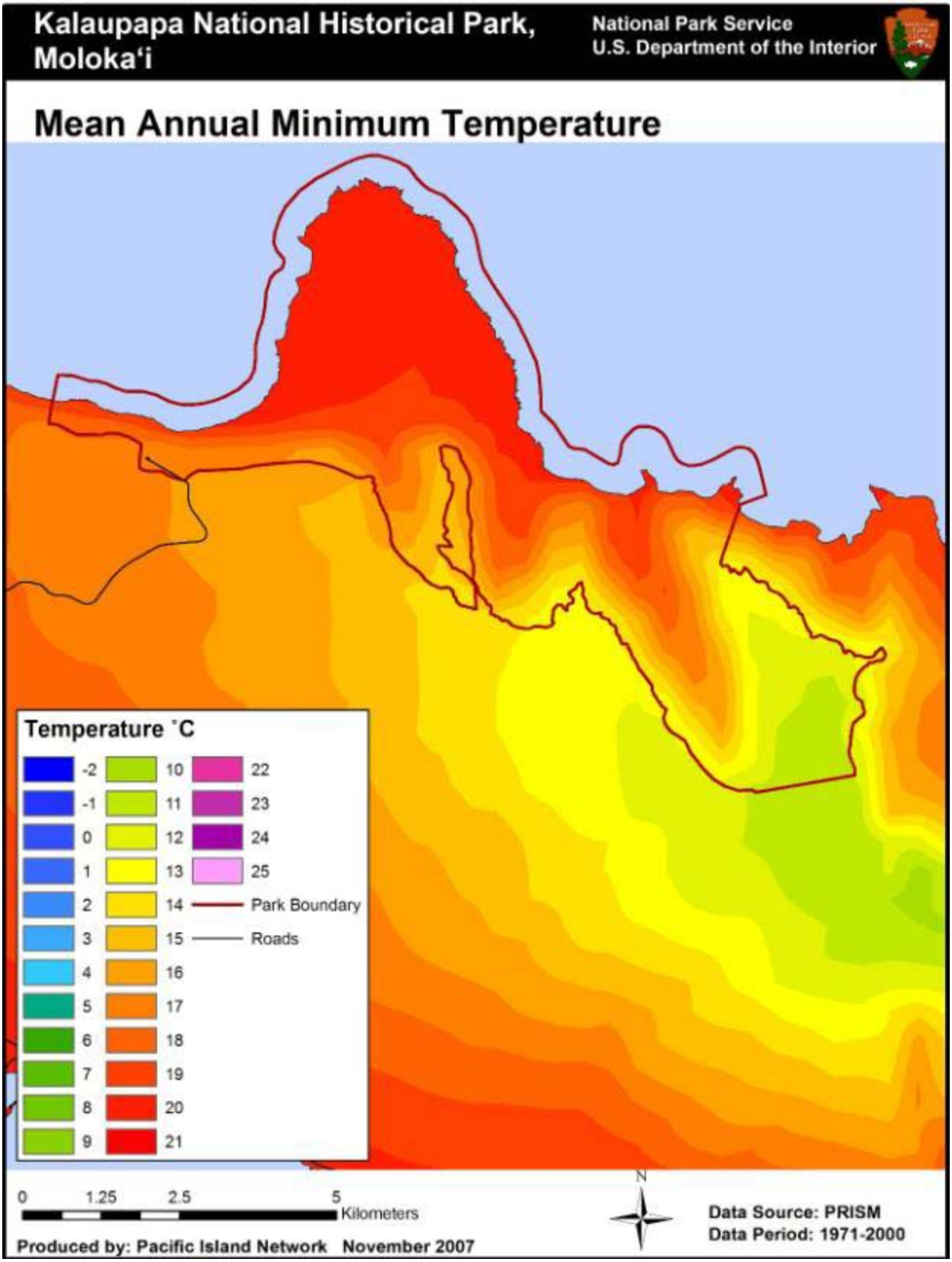

Hawaiian Islands
National Park Service
U.S. Department of the Interior
Mean Annual Precipitation
O'ahu
USS Arizona Memorial
Moloka'i
Kalaupapa NHP
Maui
Haleakalā NP
Hawai'i
Pu'ukoholā Heiau NHS
Kaloko-Honokōhau NHP
Pu'uhonua o Hōnaunau NHP
Hawai'i Volcanoes NP
Ala Kahakai NHT
Precipitation mm/year
< 300
301 - 600
601 - 900
901 - 1,200
1,201 - 1,500
1,501 - 1,800
1,801 - 2,100
2,101 - 2,400
2,401 - 2,700
2,701 - 3,000
3,001 - 3,300
3,301 - 3,600
3,601 - 3,900
3,901 - 4,200
4,201 - 4,500
4,501 - 4,800
4,801 - 5,100
5,101 - 5,400
5,401 - 5,700
5,701 - 6,000
6,001 - 6,300
6,301 - 6,600
6,601 - 6,900
6,901 - 7,200
7,201 - 7,500
7,501 - 7,800
7,801- 8,100
8,101 - 8,400
8,401 - 8,700
8,701 - 9,000
Park Boundary
0 15 30 60 90 120
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007

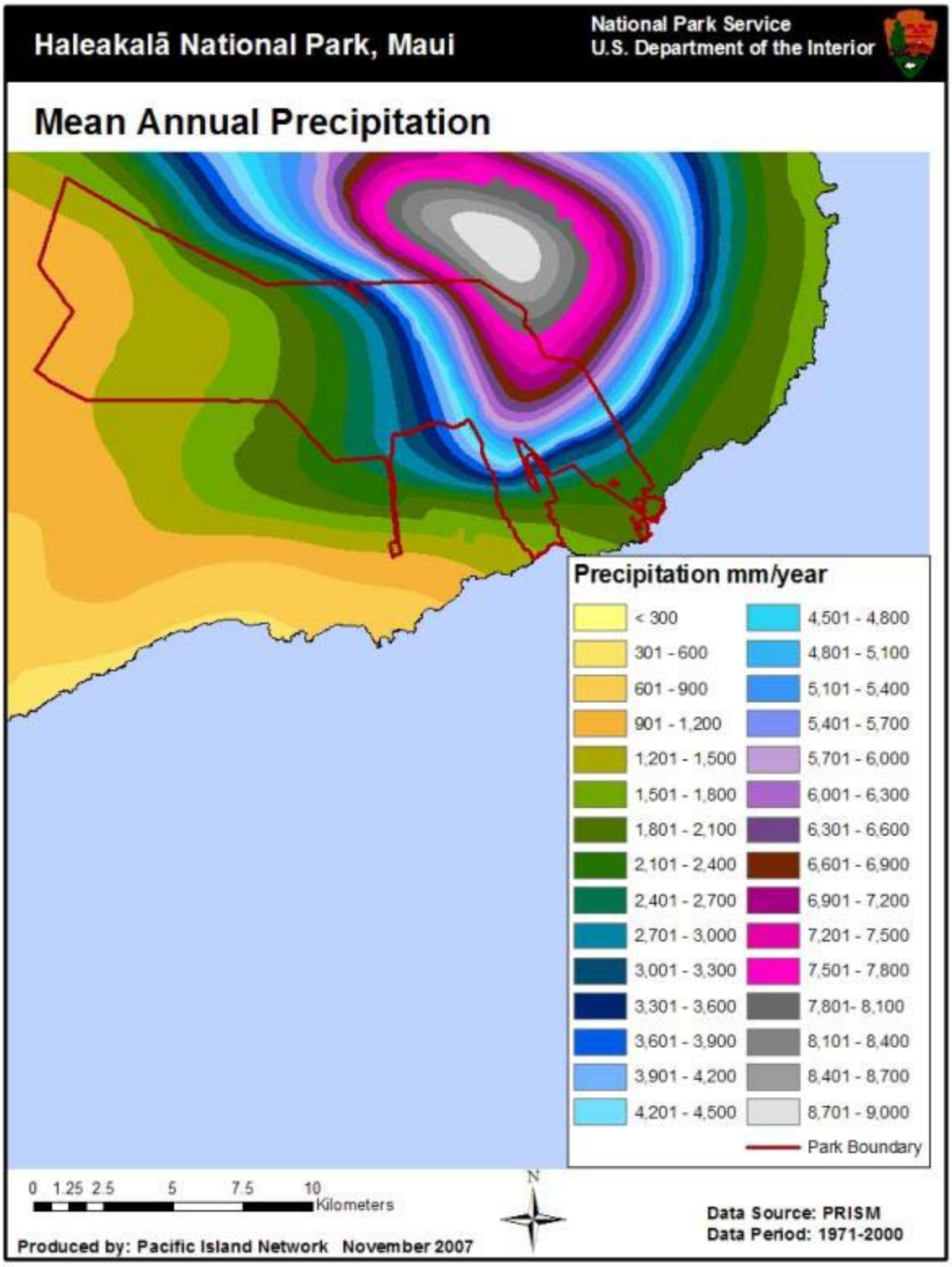

Hawaiian Islands
National Park Service
U.S. Department of the Interior
Mean Annual Maximum Temperature
O'ahu
USS Arizona Memorial
Moloka'i
Kalaupapa NHP
Maui
Haleakalā NP
Hawai'i
Pu'ukoholā Heiau NHS
Kaloko-Honokōhau NHP
Pu'uhonua o Hōnaunau NHP
Hawai'i Volcanoes NP
Ala Kahakai NHT
Temperature °C
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
Park Boundary
0 15 30 60 90 120
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007

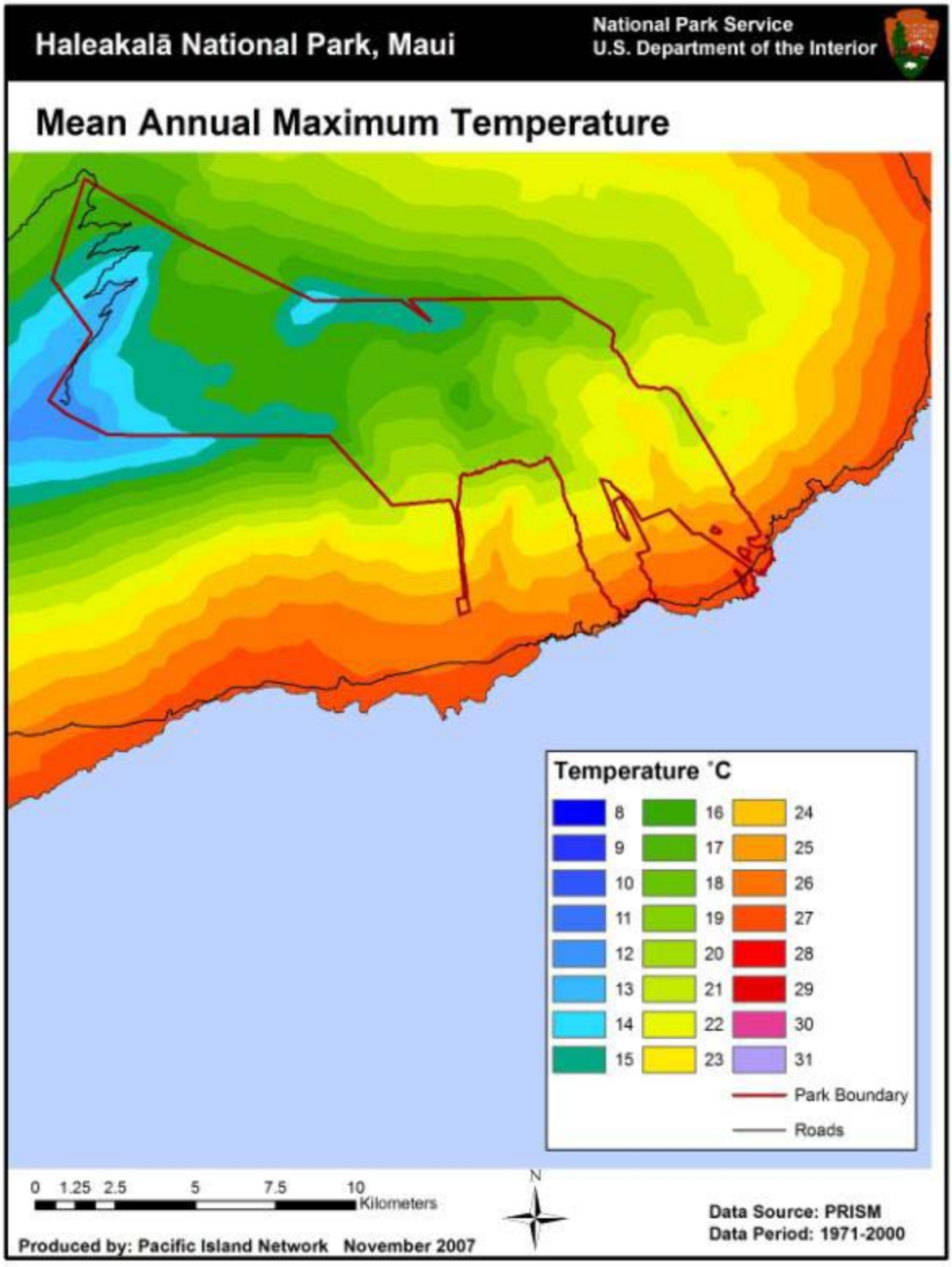

Hawaiian Islands
National Park Service
U.S. Department of the Interior
Mean Annual Minimum Temperature
O'ahu
USS Arizona Memorial
Moloka'i
Kalaupapa NHP
Maui
Haleakalā NP
Hawai'i
Pu'ukoholā Heiau NHS
Kaloko-Honokōhau NHP
Pu'uhonua o Hōnaunau NHP
Hawai'i Volcanoes NP
Ala Kahakai NHT
Temperature °C
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Park Boundary
0 15 30 60 90 120
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007

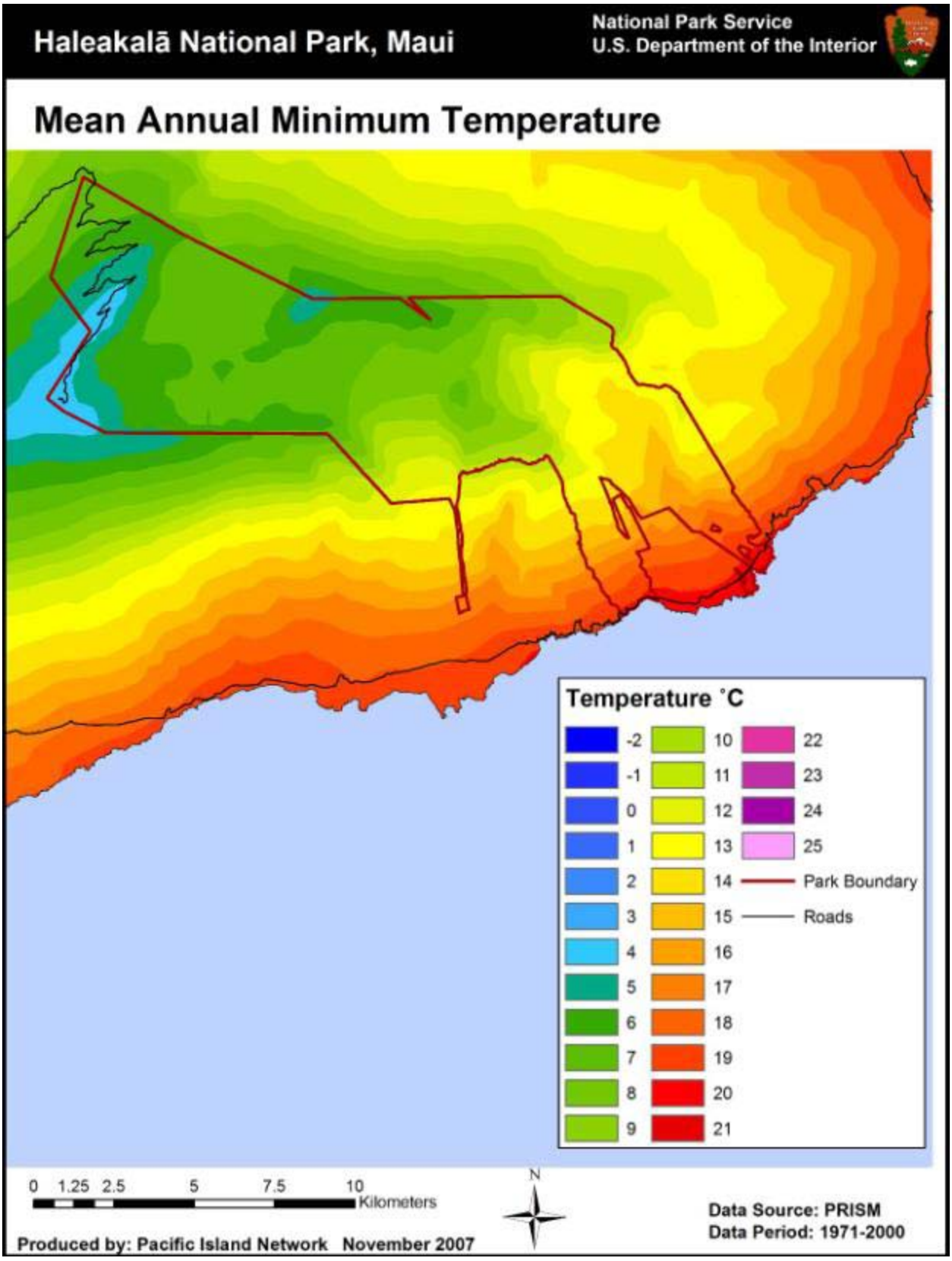

Kalaupapa National Historical Park, Moloka'i
National Park Service
U.S. Department of the Interior
Mean Annual Precipitation
Precipitation mm/year
< 300
301 - 600
601 - 900
901 - 1,200
1,201 - 1,500
1,501 - 1,800
1,801 - 2,100
2,101 - 2,400
2,401 - 2,700
2,701 - 3,000
3,001 - 3,300
3,301 - 3,600
3,601 - 3,900
3,901 - 4,200
4,201 - 4,500
4,501 - 4,800
4,801 - 5,100
5,101 - 5,400
5,401 - 5,700
5,701 - 6,000
6,001 - 6,300
6,301 - 6,600
6,601 - 6,900
6,901 - 7,200
7,201 - 7,500
7,501 - 7,800
7,801- 8,100
8,101 - 8,400
8,401 - 8,700
8,701 - 9,000
Park Boundary
Roads
0 0.5 1 2 3 4
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007

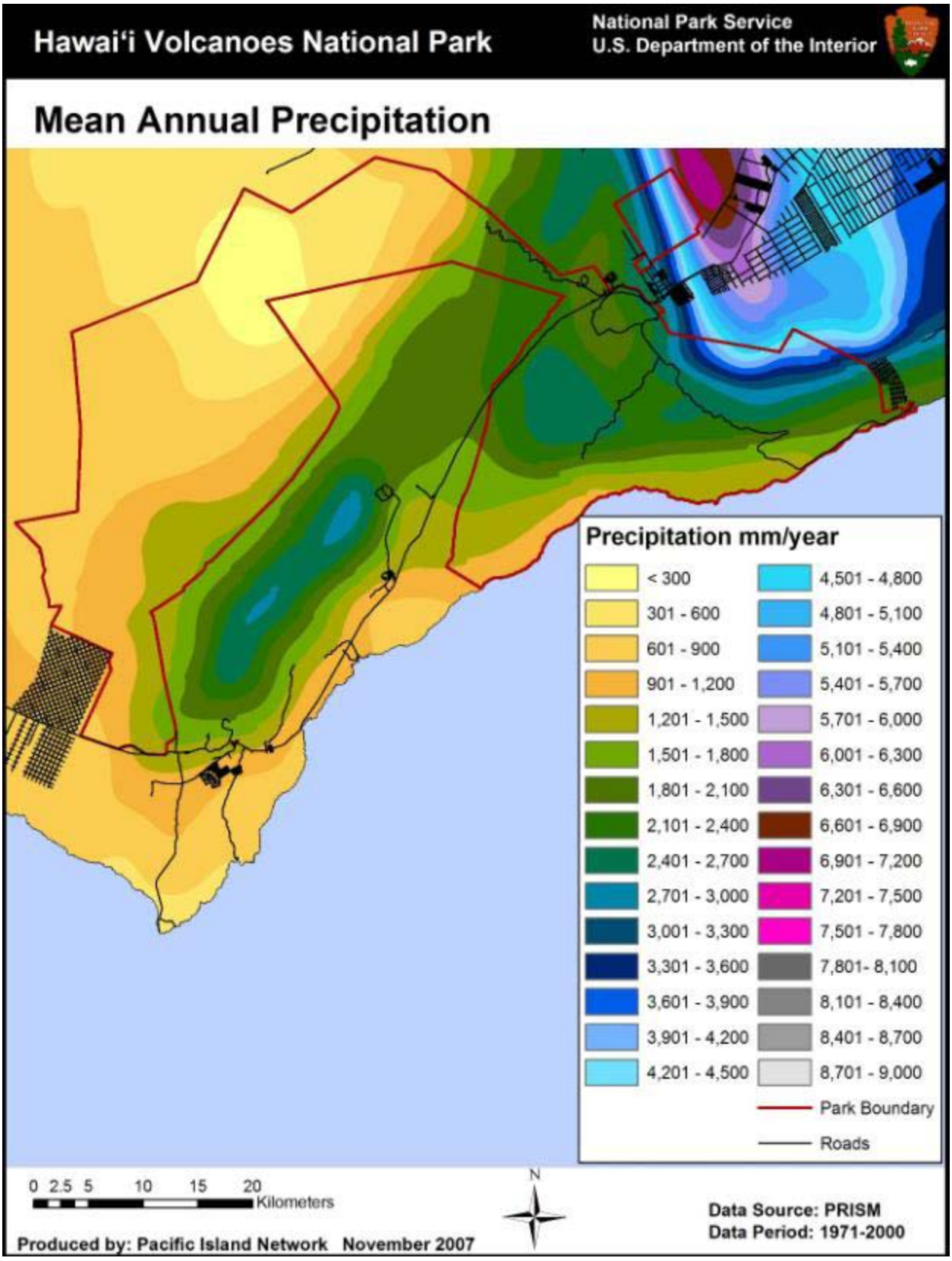

Kalaupapa National Historical Park, Moloka'i
National Park Service
U.S. Department of the Interior
Mean Annual Maximum Temperature
Temperature °C
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
Roads
Park Boundary
0
1.25
2.5
5
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007

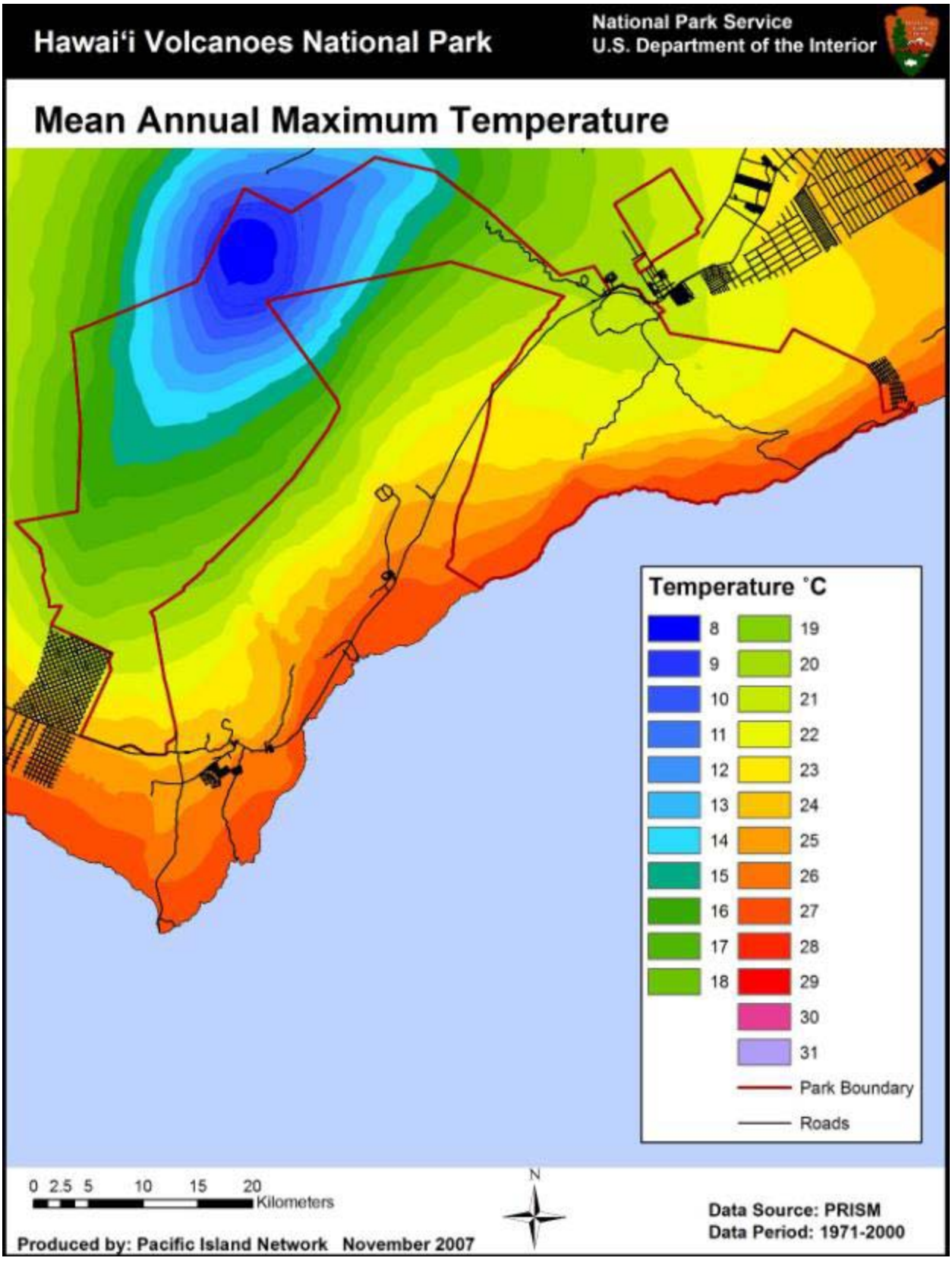

Kalaupapa National Historical Park, Moloka'i
National Park Service
U.S. Department of the Interior
Mean Annual Minimum Temperature
Temperature ˚C
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Park Boundary
Roads
0
1.25
2.5
5
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007

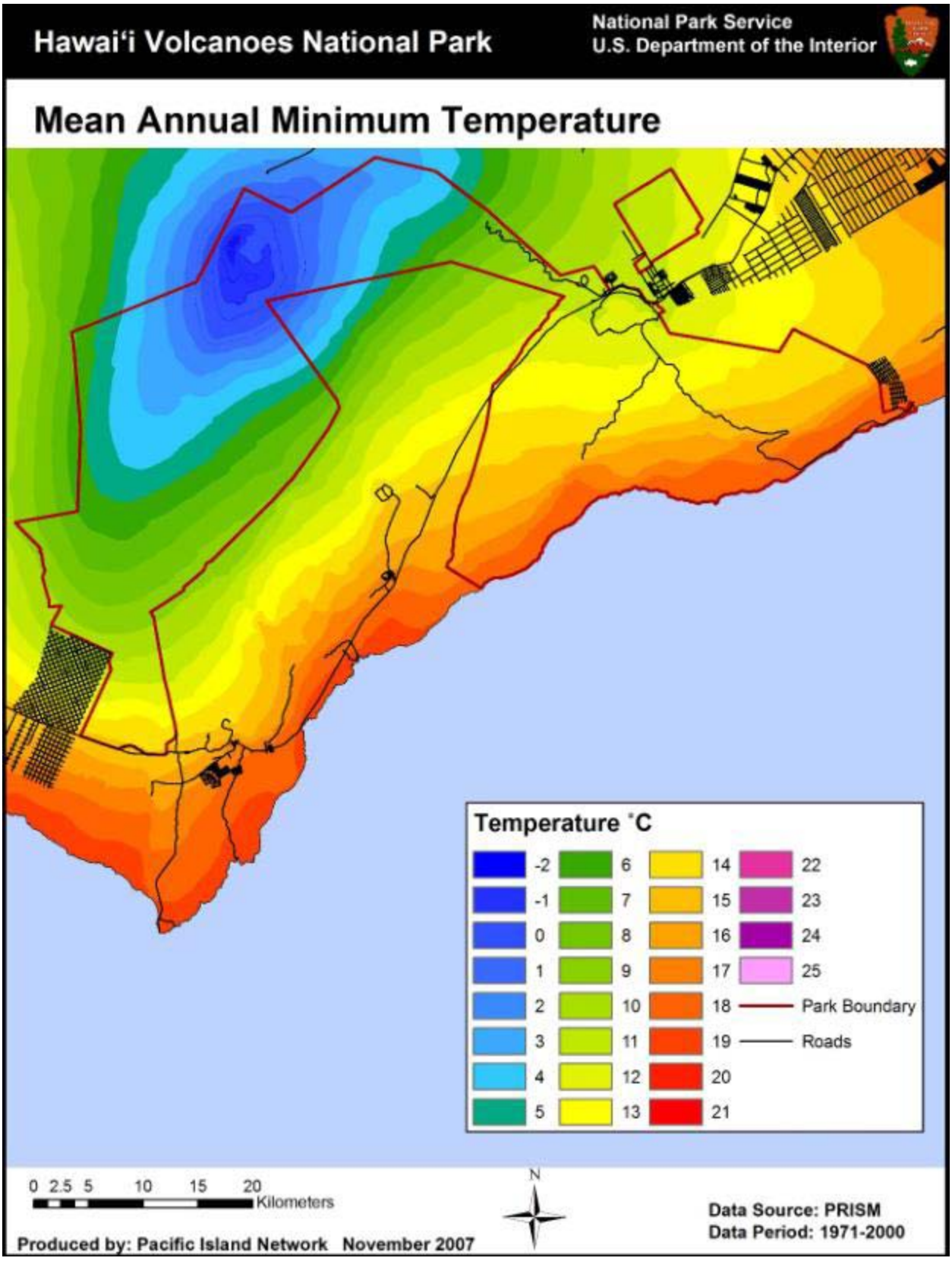

Haleakalā National Park, Maui
National Park Service
U.S. Department of the Interior
Mean Annual Precipitation
Precipitation mm/year
< 300
301 - 600
601 - 900
901 - 1,200
1,201 - 1,500
1,501 - 1,800
1,801 - 2,100
2,101 - 2,400
2,401 - 2,700
2,701 - 3,000
3,001 - 3,300
3,301 - 3,600
3,601 - 3,900
3,901 - 4,200
4,201 - 4,500
4,501 - 4,800
4,801 - 5,100
5,101 - 5,400
5,401 - 5,700
5,701 - 6,000
6,001 - 6,300
6,301 - 6,600
6,601 - 6,900
6,901 - 7,200
7,201 - 7,500
7,501 - 7,800
7,801- 8,100
8,101 - 8,400
8,401 - 8,700
8,701 - 9,000
Park Boundary
0 1.25 2.5 5 7.5 10
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007


Haleakalā National Park, Maui
National Park Service
U.S. Department of the Interior
Mean Annual Maximum Temperature
Temperature °C
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
Park Boundary
Roads
0 1.25 2.5 5 7.5 10
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007


Haleakalā National Park, Maui
National Park Service
U.S. Department of the Interior
Mean Annual Minimum Temperature
Temperature ˚C
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Park Boundary
Roads
0 1.25 2.5 5 7.5 10
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007


Hawai'i Volcanoes National Park
National Park Service
U.S. Department of the Interior
Mean Annual Precipitation
Precipitation mm/year
< 300
301 - 600
601 - 900
901 - 1,200
1,201 - 1,500
1,501 - 1,800
1,801 - 2,100
2,101 - 2,400
2,401 - 2,700
2,701 - 3,000
3,001 - 3,300
3,301 - 3,600
3,601 - 3,900
3,901 - 4,200
4,201 - 4,500
4,501 - 4,800
4,801 - 5,100
5,101 - 5,400
5,401 - 5,700
5,701 - 6,000
6,001 - 6,300
6,301 - 6,600
6,601 - 6,900
6,901 - 7,200
7,201 - 7,500
7,501 - 7,800
7,801- 8,100
8,101 - 8,400
8,401 - 8,700
8,701 - 9,000
Park Boundary
Roads
0 2.5 5 10 15 20
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007


Hawai'i Volcanoes National Park
National Park Service
U.S. Department of the Interior
Mean Annual Maximum Temperature
Temperature °C
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
Park Boundary
Roads
0 2.5 5 10 15 20
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007


Hawai'i Volcanoes National Park
National Park Service
U.S. Department of the Interior
Mean Annual Minimum Temperature
Temperature °C
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Park Boundary
Roads
0 2.5 5 10 15 20
Kilometers
N
Data Source: PRISM
Data Period: 1971-2000
Produced by: Pacific Island Network November 2007

Appendix B. Personnel Names and Contact Information

This appendix to the protocol narrative identifies past and current names and contact information of various personnel identified in the protocol narrative. Titles of positions in Table B.1 are based on those in Chapter 6. Current personnel are listed in Table B.1 with the exception of station observers (personnel collecting data and performing maintenance) which are listed in Table B.3. As personnel change, new names will be added to Tables B.1. and B.3 and Tables B.2. and B.4. will be filled in with information of previous staff.

Table Field Definitions

Name: Name of individual holding position. If no individual is assigned for a time period, designate as "Vacant". If a responsibility is delegated, such as the PACN Data Manager delegates the role to a subordinate, identify the individual to whom responsibility is delegated. The most recent/present individual with this responsibility is always listed first, followed in chronological order by predecessors.

Start Date: Initial date the named individual assumed this responsibility. Note, only a single, contiguous time period is referenced for each table row. If one individual assumes the same role for multiple non-continuous time periods, each period of time shall be referenced in a separate table row.

End Date: Terminal date the named individual relinquished and was relieved of this responsibility.

Role: Formal or Acting: Boolean response indicating if this responsibility was assigned as part of standard job duties (formal), or assigned in a temporary capacity and temporary time period while other arrangements were being made (acting).

Physical Duty Station Address: Mailing address.

Park Assigned: Park or office where named individual is formally stationed.

Job Title: Official OPM type, including grade, if appropriate.

Email: Email address used.

Phone: Phone number used.

Table B.1. Contact information for individuals currently holding positions listed in Chapter 5

Role	Name and Position	Park Assigned	Start Date	End Date	Formal/ Acting	Physical Duty Station Address	Email	Phone
Project lead	Kelly Kozar PACN data manager	HAVO	1-Nov-07	Present	Formal	PO Box 52, 1 Crater Rim Drive, Q16, Hawaii National Park, HI 96718	Kelly_Kozar@nps.gov	808-985-6186
Project manager/ data analyst	Tonnie Casey PACN biological technician	HAVO	20-Jun-10	Present	Formal	PO Box 52, 1 Crater Rim Drive, Q21, Hawaii National Park, HI 96718	Tonnie_Casey@nps.gov	808-985-6184
PACN data manager	Kelly Kozar PACN data manager	HAVO	1-Jul-06	Present	Formal	PO Box 52, 1 Crater Rim Drive, Q16, Hawaii National Park, HI 96718	Kelly_Kozar@nps.gov	808-985-6186
GIS specialist	Ben McMillan PACN GIS specialist	HAVO	1-April-10	Present	Formal	PO Box 52, 1 Crater Rim Drive, Q16, Hawaii National Park, HI 96718	Ben_McMillan@nps.gov	808-985-6184
Program manager	Greg Kudray PACN program manager	HAVO	9-Jun-08	Present	Formal	PO Box 52, 1 Crater Rim Drive, Q22, Hawaii National Park, HI 96718	Greg_Kudray@nps.gov	808-985-6183
Biological Technician	Visa Vaivai	NPSA		Present	Formal	Pago Plaza, Suite 114, Pago Pago, American Samoa 96799	Visa_Vaivai@nps.gov	(684) 699-9418
Biological Technician	Kimberly Tice	KALA		Present	Formal	P.O. Box 2222 Kalaupapa, HI 96742	Kimberly_Tice@nps.gov	(808)567-6802X1510
Biological Technician	VACANT	WAPA				Guam		

Table B.2. Historical record of individuals holding positions listed in Chapter 5

Role	Name and Position	Park Assigned	Start Date	End Date	Formal/ Acting	Physical Duty Station Address	Email	Phone
Project lead	Fritz Klasner PACN Ecologist	HAVO	1-Jul-06	1-Jun-07	Formal	PO Box 52, 1 Crater Rim Drive, Q16, Hawaii National Park, HI 96718	Fritz_Klasner@nps.gov	808-985-6181
Project manager/ data analyst	Karin Schlappa CESU cooperator	HAVO	1-Jul-06	6-Jul-10	Formal	PO Box 52, 1 Crater Rim Drive, Q21, Hawaii National Park, HI 96718	Karin_Schlappa@contractor.nps.gov	808-985-6192
GIS specialist	Viet Doan CESU spatial data associate	HAVO	1-Jul-06	30-Mar-10	Formal	PO Box 52, 1 Crater Rim Drive, Q16, Hawaii National Park, HI 96718	Viet_Doan@contractor.nps.gov	808-985-6184

Table B.3. Contact information for station observers

Park	Weather Monitoring Program	Name and Affiliation	Start Date	End Date	Email	Phone
HALE	COOP	Matt Brown, resource management chief Jessica Mjelde, visitor use assistant (Haleakala RS COOP) Byron Cook, park ranger (Oheo COOP)		present Present present	Matt_Brown@nps.gov Jessica_Mjelde@nps.gov Byron_Cook@nps.gov	808-572-4490 808-641-0198 808-248-7375
HALE	RAWS	Steve Anderson, HALE nat. resources prog. Manager Jessica Mjelde, visitor use assistant		present present	Stephen_J_Anderson@nps.gov Jessica_Mjelde@nps.gov	808-572-4480 808-641-0198
HALE	HaleNet	Thomas Giambelluca, Mike Nullet University of Hawaii at Manoa		present	thomas@hawaii.edu mnullet@hawaii.edu	808-956-7683 808-956-6453

HALE	ALERT	Matt Brown, resource management chief Perry Bednorz, park ranger	present	Matt_Brown@nps.gov Perry_Bednorz@nps.gov	808-572-4490 808-248-7041
HAVO	RAWS & COOP	Al Aviles HAVO, forestry technician	present	Al_Aviles@nps.gov	808-985-6044
HAVO	GPMN	Tamar Elias USGS-HVO, chemist Dave Meisters Air Resource Specialists, Inc.	present	telias@usgs.gov dmeisters@air-resource.com	808-967-8826 970-484-7941
KAHO	COOP	Jon Jokiel KAHO, interpretation staff	present	Jon_Jokiel@nps.gov	808-329-6881 ext.1329
KAHO	RAWS	Jon Jokiel KAHO, park ranger -interpretation Al Aviles HAVO, forestry technician	present	Jon_Jokiel@nps.gov Al_Aviles@nps.gov	808-329-6881 ext.1329 808-985-6044
KALA	COOP	Eric Brown KALA, marine ecologist	present	Eric_Brown@nps.gov	808-567-6082 x40
KALA	RAWS	Al Aviles HAVO, forestry technician	present	Al_Aviles@nps.gov	808-985-6044
PUHE	COOP	Ben Saldua PUHE, park ranger	present	Ben_Saldua@nps.gov	808-882-7218
PUHO	COOP	Cody Seeler PUHO, park ranger	present	Cody_Seeler@nps.gov	808-328-2288
WAPA	COOP	Unknown (not park staff)			

Table B.4. Historical record of individuals serving as station observers

Park	Weather Monitoring Program	Name and Affiliation	Start Date	End Date	Email	Phone

Appendix C: Weather Station Detail

This appendix consists of three parts: The first table shows the climate variables measured at each station included in PACN climate monitoring efforts (i.e., this includes stations inside as well as outside the parks). Following that are tables listing the equipment and measurement units for station in the various climate monitoring programs (for stations located inside the national parks only). Following the tables is the detailed equipment list for the Campbell Scientific weather stations.

Variables Measured at Individual Stations

Lat=Latitude in decimal degrees, Lon=Longitude in decimal degrees. T=air temperature, P=precipitation (rain only), RH=relative humidity, W=wind speed and direction, SR=total solar radiation, BP=barometric pressure, FT=fuel temperature

Park	Station Name	Network	Lat	Lon	T	P	RH	W	SR	FT	BP
WAPA	Agat	COOP	13.39	144.66		X					
AMME	Capitol Hill 1	COOP	15.22	145.75	X	X					
NPSA	Pago Pago WSO AP	COOP	14.33	-170.72	X	X		X			
VALR	Honolulu Intl Arpt	COOP	21.32	-157.93	X	X					
KALA	Kalaupapa 563	COOP	21.18	-156.98	X	X					
KALA	Makapulapai	RAWS	21.20	-156.97	X	X	X	X	X	X	
HALE	Haleakala Rs 338	COOP	20.77	-156.25	X	X					
HALE	Haleakala Summit	COOP	20.72	-156.27		X					
HALE	Haleakala Rs 338	COOP	20.76	-156.25		X					
HALE	Oheo 258.6	COOP	20.67	-156.05		X					
HALE	Kaupo Gap	RAWS	20.68	-156.15	X	X	X	X	X	X	
HALE	Big Bog	HaleNet	20.73	-156.10	X	X	X	X	X		
HALE	Haleakala National Park HQ	HaleNet	20.76	-156.25	X	X	X	X	X		
HALE	Nene Nest	HaleNet	20.74	-156.25	X	X	X	X	X		
HALE	Pohaku Palaha	HaleNet	20.73	-156.14	X	X	X	X	X		
HALE	Summit	HaleNet	20.71	-156.26	X	X	X	X	X		

Park	Station Name	Network	Lat	Lon	T	P	RH	W	SR	FT	BP
HALE	Treeline	HaleNet	20.74	-156.13	X	X	X	X	X		
HALE	Oheo Gulch RG	USGS	20.67	-156.05		X					
PUHE	Kawaihae 98.2	COOP	20.05	-155.83	?	X					
PUHE	Puukohola Heiau 98.1	COOP	20.03	-155.82	X	X					
KAHO	Honokohau Harbor 68.14	COOP	19.68	-156.02		X					
KAHO	Kaloko-Honokohau	RAWS	19.67	-156.02	X	X	X	X	X		X
PUHO	Puuhonuaohonaunau 27.4	COOP	19.42	-155.92		X					
PUHO	Puho	PACN	19.43	-155.93	X	X	X	X	X		
HAVO	Halemaumau 52	COOP	19.40	-155.28		X					
HAVO	Hawaii Vol NP HQ 54	COOP	19.43	-155.27	X	X					
HAVO	Kahuku Mill Camp 6.3	COOP	19.07	-155.68		X					
HAVO	Mauka Rsvr. 3.11	COOP	19.17	-155.70		X					
HAVO	Mauna Loa Slope OBS 39	COOP	19.53	-155.58	X	X					
HAVO	Kahuku	RAWS	19.32	-155.78	X	X	X	X	X	X	
HAVO	Kealakomo 2	RAWS	19.29	-155.11	X	X	X	X	X	X	
HAVO	Keaumo	RAWS	19.47	-155.36	X	X	X	X	X	X	
HAVO	Pali 2	RAWS	19.32	-155.29	X	X	X	X	X	X	
HAVO	The Observatory	GPMN	19.43	-155.25	X	X	X	X	X	X	X
HAVO	Visitor Center	GPMN	19.43	-155.26	X	X	X	X	X	X	
ALKA	Hawi 168	COOP	20.25	-155.83	X	X					
ALKA	Honaunau 27	COOP	19.42	-155.88		X					
ALKA	Honokohau Harbor 68.14	COOP	19.68	-156.02		X					
ALKA	Kainaliu 73.2	COOP	19.53	-155.93	X	X					
ALKA	Ke-ahole point 68.13	COOP	19.73	-156.07	X	X					
ALKA	Kealakekua 26.2	COOP	19.50	-155.92	X	X					

Park	Station Name	Network	Lat	Lon	T	P	RH	W	SR	FT	BP
ALKA	Kealakomo 38.8	COOP	19.30	-155.15		X					
ALKA	Kohala Mission 175.1	COOP	20.23	-155.80	X	X					
ALKA	Kona village 93.8	COOP	19.83	-155.98		X					
ALKA	Mahaiula 92.7	COOP	19.77	-156.00		X					
ALKA	Milolii 2.34	COOP	19.27	-155.88		X					
ALKA	Naalehu 14	COOP	19.07	-155.60	X	X					
ALKA	Napoopoo 28	COOP	19.47	-155.92	X	X					
ALKA	Opihihale 2 24.1	COOP	19.27	-155.88	X	X					
ALKA	Puuhonuaohonaunau	COOP	19.42	-155.92		X					
ALKA	Puukohola Heiau 98.1	COOP	20.03	-155.82	X	X					
ALKA	Sea mountain 12.15	COOP	19.13	-155.52	X	X					
ALKA	Waikoloa 95.8	COOP	19.92	-155.80		X					

Equipment and Measurement Units

Cooperative Observer Program (COOP) Stations

The 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 mounted 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. 1.2 m above the ground.

The thermistor system consists of an electronic thermistor that records the maximum and minimum temperature since initializing internal memory, and current temperature. These systems are read from a digital display on a control panel that is typically located inside a building. 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 memory.

The standard rain gauge deployed in COOP stations 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. This set-up is supported by three 1-m metal legs. Precipitation is observed by manually measuring precipitation accumulation with a graduated, metal measuring stick.

Some stations use an electronic rain gauge (tipping bucket – Campbell Scientific); the measurements are recorded to a data logger every 15 minutes. At least one station in the PACN (HAVO) also includes a Belfort rain gauge that consists of an 8 inch (top diameter) funnel that directs precipitation into an internal collection bucket. A weighing device automatically measures precipitation levels, which are recorded onto a moving paper scroll in 0.1 inch increments. An internal electronic timer advances the paper scroll. The scroll is replaced at the first of the month.

Remote Automated Weather Station (RAWS)

Station Name	Air temperature (˚F) & Relative Humidity (%)	Precipitation (in)	Wind Speed (mph)	Wind Direction (degrees)	Barometric Pressure (mbar)	Solar Radiation (ly)	Fuel moisture/ Fuel temperature (˚F)
Kahuku	Vaisala 435A	Vaisala 444A	Vaisala 430A	Vaisala 431A	Vaisala 439C	Vaisala 441A	Vaisala 439C
Keaumo	Vaisala 435A	Vaisala 444A	Vaisala 430A	Vaisala 431A	Vaisala 439C	Vaisala 441A	Vaisala 439C
Pali 2	Vaisala 435A	Vaisala 444A	Vaisala 430A	Vaisala 431A	Vaisala 439C	Vaisala 441A	Vaisala 439C
Makapulapai	Vaisala 435A	Vaisala 444A	Vaisala 430A	Vaisala 431A	Vaisala 439C	Vaisala 441A	Vaisala 439C
Kaupo Gap	Vaisala 435A	Vaisala 444A	Vaisala 430A	Vaisala 431A	Vaisala 439C	Vaisala 441A	Vaisala 439C
Kaloko-Honokohau	THS-1	RG-T	014/WSM-2	024/WD	FS-11	SDI-SR-PYR	FS-11

*Gaseous Pollutant Monitoring Network (GPMN)**

Station Name	Air temperature (˚C) & RH (%)	Precipitation (mm)	Wind Speed (m/s)	Wind Direction (degrees)	Barometric Pressure	Solar Radiation (W/m^2)
Visitor Center	Vaisala HMP45C	Climatronics	Climatronics F460	Climatronics F460	N/A	Licor sensor & Climatronics translator
The Observatory	Vaisala HMP45C	Climatronics	Climatronics F460	Climatronics F460	Vaisala	Licor sensor & Climatronics translator

*not all model details available

Haleakala Climate Network (HaleNet)

Information about equipment for HaleNet Stations can be found from the Instruments link[33] at the HaleNet website (current as of 2000). Units of measurement are shown below.

HaleNet	Air temperature (˚C) & RH (%)	Precipitation (mm)	Wind Speed (m/s)	Wind Direction (degrees)	Barometric Pressure (mbar)	Solar Radiation (W/m^2)

PACN Weather Stations

All PACN weather stations were purchased from Campbell Scientific.

Station Name	Air temperature (˚F) & Relative Humidity (%)	Precipitation (in)	Wind Speed (mph)	Wind Direction (degrees)	Solar Radiation (ly)
Nene Cabin CS	Vaisala HMP50 Temp/RH	TX Electronic TE525	RM Young 03002	RM Young 03002	LI-200X Pyranometer
Lower Kahuku CS	Vaisala HMP50 Temp/RH	TX Electronic TE525	RM Young 03002	RM Young 03002	LI-200X Pyranometer
Kala 1 CS	Vaisala HMP50 Temp/RH	TX Electronic TE525	RM Young 03002	RM Young 03002	LI-200X Pyranometer
Kala 2 CS	Vaisala HMP50 Temp/RH	TX Electronic TE525	RM Young 03002	RM Young 03002	LI-200X Pyranometer
Npsa 1 CS	Vaisala HMP50 Temp/RH	TX Electronic TE525	RM Young 03002	RM Young 03002	LI-200X Pyranometer
Npsa 2 CS	Vaisala HMP50 Temp/RH	TX Electronic TE525	RM Young 03002	RM Young 03002	LI-200X Pyranometer
Puhe CS	Vaisala HMP50 Temp/RH	TX Electronic TE525	RM Young 03002	RM Young 03002	LI-200X Pyranometer
Puho CS	Vaisala HMP50-L6 Temp/RH	TX Electronic TE525-L25	RM Young 03002-L12	RM Young 03002-L12	LI-COR Pyranometer
Amme CS	Vaisala HMP50-L6 Temp/RH	TX Electronic TE525-L25	RM Young 03002-L12	RM Young 03002-L12	LI-COR Pyranometer

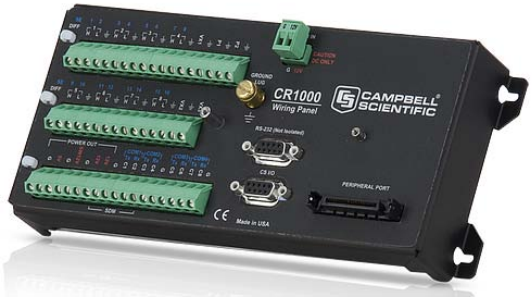
[33] http://webdata.soc.hawaii.edu/climate/HaleNet/Index.htm

Campbell Scientific Equipment List

Datalogger

Model CR1000

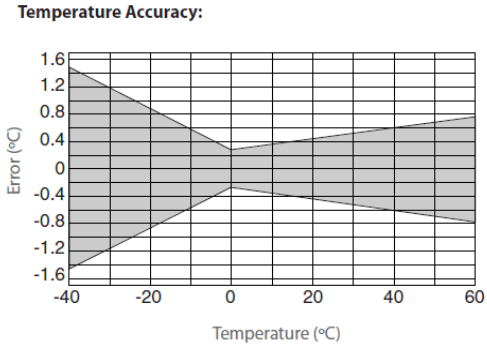
Extended temperature Range: -25° to +50° C
4 Mbyte memory
Program execution rate: 100 Hz
Number of Channels: 8 differential inputs, 2 pulse counters, 3 excitation, and 8 control ports
Power requirements: 9.6 – 16 volts
Current drain: ~0.6 mA (sleep mode), 1 to 16 mA (w/o RS-232 communications), 17 to 28 mA (w/RS-232 communications)
Manual: http://www.campbellsci.com/documents/manuals/cr1000.pdf



Air Temperature and Relative Humidity

Model HMP50

Sensors: Temperature: 1000 Ω PRT
Relative humidity: Vaisala's INTERCAP capacitive chip
Relative Humidity range: 0 to 98% RH, non-condensing
Relative Humidity accuracy: ±3%, 0 to 90% range;
±5%, 90 to 98% range
Temperature Range: -40° to +60°C
Temperature Accuracy:



Manual: http://www.campbellsci.com/documents/manuals/hmp50.pdf

Solar Radiation

Model LI200X silicon pyranometer



Sensor: Silicon photocell
Sensitivity: 0.2 kW m-2 mV-1

Requirements: LI2003S base and leveling fixture
Manual: http://www.campbellsci.com/documents/manuals/li200x.pdf



Wind Speed and Direction

Model Gill Instruments WindSonic

Sensors: Gill 2-D Sonic Wind Sensor with RS-232 Output
Temperature range: -35° to +70°C
Wind Speed Range: 0 to 60 m s^{-1}
Wind Speed Accuracy: ± 2% of reading
Wind Speed Resolution: 0.01 m s^{-1}
Wind Direction Range: 0° to 360°
Wind Direction Accuracy: ±3°
Wind Direction Resolution: 1°
Manual: http://www.campbellsci.com/documents/manuals/windsonic.pdf



Precipitation

Model TE525 Tipping Bucket Rain Gauge

Sensor: magnetic switch
Orifice: 6” diameter
Sensitivity: 0.01”/tip
Manual: http://www.campbellsci.com/documents/manuals/te525.pdf



Communication

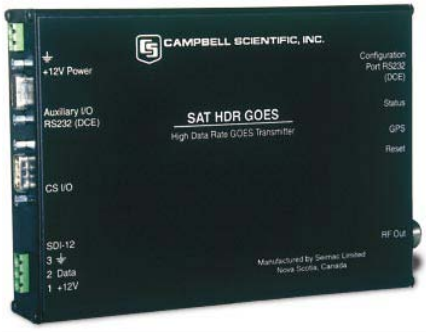
SAT HDR GOES transmitter

On-Board memory: Non-volatile flash for setup parameters. 16Kbytes for self-timed data

Power requirements: 9.6 to 16 VDC, 1 mA quiescent, 350 mA during GPS fix and less than 4 Amps during transmission.

Transmit power: 7.9 watts for 100 and 300 bps, 15.9 watts for 1200 bps

Temperature Rating: -40° to 50°C



There is a list of additional equipment that is necessary when using a GOES transmitter including a GOES antenna, GPS antenna, and appropriate cables. Inquire with the manufacturer to ensure you have the complete system.

Power

Battery

These stations are powered by battery with solar panels as the charging mechanism. Two 100 amp hour 12 Volt batteries are used in the power set–up and run in parallel. The station does not require this much power, but if one battery goes bad there is another one to run the station. A deep-cycle battery is preferred.

Solar Panels

The stations will run on a 10 Watt solar panel.

Charging Regulator

A charging regulator is necessary to ensure the batteries are only charged to capacity and not above. The CH100 charging regulator is available for Campbell Scientific, Inc. and is set-up to work with the cable connectors from the GOES transmitter and the datalogger power connections.

Other

ALERT (Automated Local Evaluation in Real Time) stations use a Hydrolynx 5054 Self Reporting Rain Station with a Hydrolynx 5050P tipping bucket; rainfall is measured in inches.

The USGS rain gauge at HALE is consists of a Hydrologic Services 8-inch (200 mm) TB-3 tipping bucket; rainfall at this station is recorded in inches.

HAVO rain gauges consist of the same manually operated funnel top cylindrical rain gauges that are described above under the COOP equipment.

Appendix D. Weather Database Documentation

The database for this project consists of four types of tables: core tables describing the "who, where and when" of data collection, project-specific tables, lookup tables that contain domain constraints for other tables, and cross reference tables that link lookup tables with data tables. Although core tables are based on PACN standards, they may contain fields, domains or descriptions that have been added or altered to meet project objectives.

The database includes the following standard tables:

tbl_Sites	Sample sites – individual parks
tbl_Stations	Sample locations – weather station location

The following are project-specific data tables:

tbl_Data_COOP	NWS COOP data downloaded from WRCC
tbl_Data_GPMN	GPMN data downloaded from the Air Resource Specialists, Inc. data access website
tbl_HaleNet	Weather data acquired from HaleNet
tbl_Data_RAWS	RAWS data downloaded from WRCC
tbl_Data_Campbell_Sci	Data from the PACN Campbell Scientific stations
tbl_Equipment	Weather station equipment
tbl_Images	Images associated with sample locations
tbl_Observation_Frequency	Stores imported weather station frequency observation data

The following are a few of the more prominent, standard lookup tables:

tlu_Contacts	Look up table of contacts associated with the protocol.
tlu_Measurement_Flag	Lookup table for measurement flag descriptions
tlu_Quality_Flag	Lookup table for quality control flags
tlu_Station_Type	Lookup table for station types
tlu_Enumerations	Enumerated lookup table

The following are a few of the more prominent, standard lookup tables:

xref_Station_Equip	Cross reference table between stations and equipment

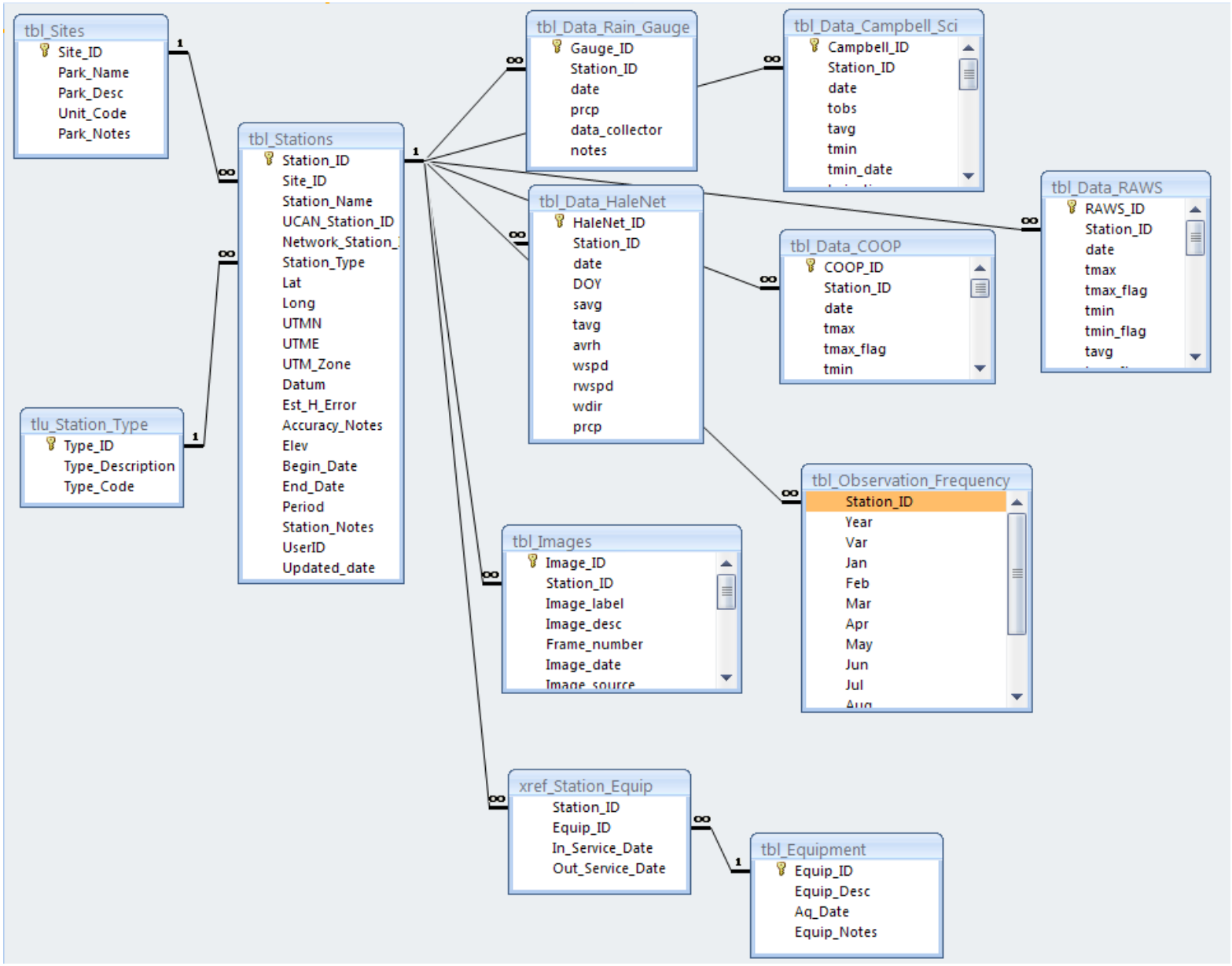


Figure 1. Data model for the PACN weather monitoring database.

Database Tables

tbl_Data_COOP: NWS COOP data downloaded from the WRCC

Field	*Primary?*	*Data Type*	*Size*	*Description*
COOP_ID	Yes	Text	50	Unique record identifier
Station_ID	No	Text	50	Link to tbl_Stations
avrh	No	Double	8	Average percent relative humidity
date	No	Date/Time	8	Date the weather data was recorded
dptp	No	Double	8	Average daily dew-point temperature (Fahrenheit)
evap	No	Double	8	Evaporation rate
evap_flag	No	Text	255	Evaporation rate data measurement flag
mnpn	No	Double	8	Minimum temperature, evaporation pan
mnrh	No	Double	8	Minimum percent relative humidity
mxpn	No	Double	8	Maximum temperature, evaporation pan
mxrh	No	Double	8	Maximum percent relative humidity
pkwd	No	Double	8	Direction of maximum wind gust (degrees)
pkws	No	Double	8	Peak wind speed (mph)
prcp	No	Double	8	Total daily precipitation (inches)
prcp_flag	No	Text	255	Total daily precipitation data measurement flag
pres	No	Double	8	Barometric pressure in millibars
slvp	No	Double	8	Average daily sea level pressure
srad	No	Double	8	Total solar radiation (Langleys)
tavg	No	Double	8	Daily average temperature (Fahrenheit)
tavg_flag	No	Text	255	Daily average temperature data measurement flag
tmax	No	Double	8	Daily maximum temperature (Fahrenheit)
tmax_flag	No	Text	255	Daily maximum temperature data measurement flag
tmin	No	Double	8	Daily minimum temperature (Fahrenheit)
tmin_flag	No	Text	255	Daily minimum temperature data measurement flag
tmpw	No	Double	8	Average daily wet-bulb temperature (Fahrenheit)
tobs	No	Double	8	Time of observation
tobs_flag	No	Text	255	Time of observation data measurement flag
wdmv	No	Double	8	Wind movement

tbl_Data_GPMN: GPMN data downloaded from the Air Resource Specialists, Inc. data access website

Field	*Primary?*	*Data Type*	*Size*	*Description*
GPMN_ID	Yes	Text	255	Unique record identifier
Station_ID	No	Text	50	Link to tbl_Stations
date	No	Date/Time	8	Date of observation
prcp	No	Double	8	Rainfall (mm per hour)
pres	No	Double	8	Barometric pressure in millibars
rh	No	Double	8	Percent relative humidity
sd_wdir	No	Double	8	Standard deviation for wind direction
swpd	No	Double	8	Scalar wind speed (meters per second)
temp	No	Double	8	Temperature (Celsius)
time	No	Date/Time	8	Time of observation
vwdir	No	Double	8	Vector wind direction (degrees)
vwsp	No	Double	8	Vector wind speed (meters per second)

tbl_Data_HaleNet: Weather data acquired from HaleNet

Field	*Primary?*	*Data Type*	*Size*	*Description*
HaleNet_ID	Yes	Text	50	Unique record identifier
Station_ID	No	Text	50	Link to tbl_Stations
Date	No	Date/Time	8	Date of the observation
DOY	No	Double	8	Day of the year
RF	No	Double	8	Rainfall (mm)
RH	No	Double	8	Relative humidity (%)
Ta	No	Double	8	Air temperature (degrees Celsius)
Ts	No	Double	8	Soil temperature, avg 2 and 6 cm (degrees Celsius)
WD	No	Double	8	Wind direction (degrees)
WS	No	Double	8	Wind speed (m/s)
WSr	No	Double	8	Resultant wind Speed (m/s)

tbl_Data_RAWS: RAWS data downloaded from the WRCC

Field	***Primary?***	***Data Type***	***Size***	***Description***
Field	***Primary?***	***Data Type***	***Size***	***Description***
RAWS_ID	Yes	Text	50	Unique record identifier
Station_ID	No	Text	50	Link to tbl_Stations
avrh	No	Double	8	Average percent relative humidity
date	No	Date/Time	8	Date the weather data was recorded
dptp	No	Double	8	Dew point temperature (Fahrenheit)
evap	No	Double	8	Evaporation rate
evap_flag	No	Text	50	Evaporation rate data measurement flag
mnpn	No	Double	8	Minimum temperature, evaporation pan
mnrh	No	Double	8	Minimum percent relative humidity
mxpn	No	Double	8	Maximum temperature, evaporation pan
mxrh	No	Double	8	Maximum percent relative humidity
pkwd	No	Double	8	Direction of maximum wind gust (degrees)
pkws	No	Double	8	Peak wind speed (mph)
prcp	No	Double	8	Total daily precipitation (inches)
prcp_flag	No	Text	255	Total daily precipitation data measurement flag
pres	No	Double	8	Barometric pressure in millibars
slvp	No	Double	8	Average daily sea level pressure
srad	No	Double	8	Total solar radiation (Langleys)
tavg	No	Double	8	Daily average temperature (Fahrenheit)
tavg_flag	No	Text	255	Daily average temperature data measurement flag
tmax	No	Double	8	Daily maximum temperature (Fahrenheit)
tmax_flag	No	Text	255	Daily maximum temperature data measurement flag
tmin	No	Double	8	Daily minimum temperature (Fahrenheit)
tmin_flag	No	Text	255	Daily minimum temperature data measurement flag
tmpw	No	Double	8	Average daily wet-bulb temperature (Fahrenheit)
tobs	No	Date/Time	8	Time of observation
tobs_flag	No	Text	255	Time of observation data measurement flag
wdmv	No	Double	8	Wind movement

tbl_Data_Campbell_Sci: Data from the PACN Campbell Scientific stations

Field	*Primary?*	*Data Type*	*Size*	*Description*
Campbell_ID	Yes	Text	50	Unique record identifier
Station_ID	No	Text	50	Link to tbl_Stations
batt	No	Double	8	The battery charge in volts
batt_min	No	Double	8	The minimum battery charge
date	No	Date/Time	8	Date the weather data was recorded
ETo	No	Double	8	Calculated evapotranspiration value
pres	No	Double	8	Barometric pressure in millibars
rain_rate	No	Double	8	Rain rate
rh	No	Long Integer	4	Percent relative humidity
savg	No	Long Integer	4	Solar average
tavg	No	Double	8	Daily average temperature (Fahrenheit)
tmax	No	Double	8	Daily maximum temperature (Fahrenheit)
tmax_date	No	Date/Time	8	Date of maximum temperature reading
tmax_time	No	Date/Time	8	Time of maximum temperature reading
tmin	No	Double	8	Daily minimum temperature (Fahrenheit)
tmin_date	No	Date/Time	8	Date of minimum temperature reading
tmin_time	No	Date/Time	8	Time of minimum temperature reading
tobs	No	Date/Time	8	Time of observation
wdir	No	Long Integer	4	Wind direction
wspdavg	No	Double	8	Average wind speed (mph)
wspdmax	No	Double	8	Maximum wind speed (mph)
wspdmax_date	No	Date/Time	8	Date of maximum wind speed reading
wspdmax_time	No	Date/Time	8	Time of maximum wind speed reading
yr_rain	No	Double	8	Yearly rain

tbl_Equipment: Weather station equipment

Field	*Primary?*	*Data Type*	*Size*	*Description*
Equip_ID	Yes	Text	50	Unique record identifier
Aq_Date	No	Date/Time	8	Acquisition date
Equip_Desc	No	Text	255	Description of equipment
Equip_Notes	No	Memo	0	Equipment notes - detailed equipment descriptions

tbl_Images: Images associated with weather stations.

Field	*Primary?*	*Data Type*	*Size*	*Description*
Image_ID	Yes	Text	50	Unique identifier for each image record
Station_ID	No	Text	50	Link to tbl_Stations
Image_label	No	Text	25	Image caption or label
Image_desc	No	Text	255	Brief description of the image bearing, perspective, etc.
Frame_number	No	Text	10	Frame number for photographic images
Image_date	No	Date/Time	8	Date on which the image was created, if different from the sampling event date
Image_source	No	Text	50	Name of the person or organization that created the image
Image_quality	No	Byte	1	Quality of the image
Is_edited_version	No	Boolean	1	Indicates whether this version of the image is the edited (originals = False)
Object_format	No	Text	20	Format of the image
Orig_format	No	Text	20	Format of the original image
Image_edit_notes	No	Text	200	Comments about the editing or processing performed on the image
Image_is_active	No	Boolean	1	Indicates whether the image is still being used for
Image_root_path	No	Text	100	Drive space location of the main project folder or image library
Image_project_path	No	Text	100	Location of the image from the main project folder or
Image_filename	No	Text	100	Name of the image including extension (.jpg) but without the image path navigation or interpretation
Image_notes	No	Memo	0	Comments about the image library

tbl_Observation_Frequency: Percentage of actual weather data recording in a month (daily recordings = 100%)

Field	*Primary?*	*Data Type*	*Size*	*Description*
Station_ID	No	Text	255	Link to tbl_Stations
Var	No	Text	255	Weather variable
Year	No	Text	255	Year for the data
Jan	No	Double	8	January data
Feb	No	Double	8	February data
Mar	No	Double	8	March data
Apr	No	Double	8	April data
May	No	Double	8	May data
Jun	No	Double	8	June data
Jul	No	Double	8	July data
Aug	No	Double	8	August data
Sept	No	Double	8	September data
Oct	No	Double	8	October data
Nov	No	Double	8	November data
Dec	No	Double	8	December data

tbl_Sites: Park units

Field	*Primary?*	*Data Type*	*Size*	*Description*
Site_ID	Yes	Text	50	M. Site identifier
Park_Desc	No	Text	255	M. Description for a site
Park_Name	No	Text	100	M. Unique name or code for a site
Park_Notes	No	Memo	0	MA. General notes on the site
Unit_Code	No	Text	4	M. Park, Monument or Network code

tbl_Stations: Weather station information

Field	*Primary?*	*Data Type*	*Size*	*Description*
Station_ID	Yes	Text	50	Unique record identifier
Site_ID	No	Text	50	Station ID
Elev	No	Integer	2	Elevation in meters
Lat	No	Text	10	Station latitude
Long	No	Text	10	Station longitude
Period	No	Text	20	Period of record
Station_Name	No	Text	25	Station name
Station_Type	No	Text	50	Type of weather station
Updated_date	No	Date/Time	8	Date the site information was entered/edited
UserID	No	Text	50	Name of user entering/editing station information
UTME	No	Text	10	Station coordinate UTM East
UTMN	No	Text	10	Station coordinate UTM North

tlu_Contacts: Lookup table of contacts associated with the protocol.

Field	*Primary?*	*Data Type*	*Size*	*Description*
Contact_ID	Yes	Text	50	Unique record identifier consisting of the last name, underscore, and first name of contact.
Contact_created	No	Text	50	Date the contact record was created
Contact_is_active	No	Boolean	1	Is the contact currently associated with the protocol
Contact_location	No	Text	255	Contact's work locations
Contact_notes	No	Memo	0	Notes about contact
Contact_updated	No	Date/Time	8	Date the contact record was updated
Email	No	Text	50	The email address of contact
Fax	No	Text	25	Fax number
First_name	No	Text	20	First name of contact
Home_voice	No	Text	25	Home phone number
Last_name	No	Text	24	Last name of contact
Middle_init	No	Text	1	Middle initial of contact
Mobile_voice	No	Text	25	Mobile phone number
Organization	No	Text	50	The organization the contact is associated with
Position_title	No	Text	50	Position title of contact
Work_voice	No	Text	25	Work phone number

tlu_Enumerations Enumerated lookup table

Field	*Primary?*	*Data Type*	*Size*	*Description*
Enum_Group	Yes	Text	50	Category for lookup value
Enum_Code	No	Text	50	Code for lookup values
Enum_Description	No	Memo	0	Lookup value description
Sort_Order	No	Integer	2	Order in which to sort lookup values

tlu_Measurement_Flag: Lookup table for measurement flag descriptions

Field	*Primary?*	*Data Type*	*Size*	*Description*
Meas_Code	Yes	Text	1	Measurement code from ASCII Record
Meas_Desc	No	Text	60	Measurement description

tlu_Quality_Flag: Lookup table for quality control flags

Field	*Primary?*	*Data Type*	*Size*	*Description*
Qual_Flag	Yes	Text	1	Quality Flag from ASCII file
Qual_Desc	No	Text	60	Description of value

tlu_Station_Type: Lookup table for station types

Field	*Primary?*	*Data Type*	*Size*	*Description*
Type_ID	Yes	Text	50	Unique record identifier
Type_Description	No	Text	100	Type of weather station; i.e. NWS COOP, RAWS, PACN

xref_Station_Equip: Cross reference table between stations and equipment

Field	*Primary?*	*Data Type*	*Size*	*Description*
Equip_ID	No	Text	50	Link to tbl_Equipment
Station_ID	No	Text	50	Link to tbl_Stations
In_Service_Date	No	Date/Time	8	Date equipment use began
Out_Service_Date	No	Date/Time	8	Date equipment use ended

Standard Operating Procedure (SOP) #1
Revising the Protocol

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose

This standard operating procedure explains how to make and document changes to the PACN Weather/Climate Monitoring Protocol narrative, appendices, and associated standard operating procedures (SOPs). Anyone editing the protocol narrative, appendices, or one of the SOPs needs to follow the procedure outlined below to eliminate confusion about how data are collected, managed, analyzed, or reported.

The Weather/Climate Monitoring Protocol narrative and associated SOPs for the Pacific Island Network represents our effort to document and employ scientifically rigorous methodologies for collecting, managing, analyzing, and reporting monitoring data and information. However, all protocols regardless of initial rigor require editing as new and different information becomes available. Required edits should be made in a timely manner and appropriate reviews undertaken. Careful documentation of changes to the protocol, and a library of previous protocol versions are essential for maintaining consistency in data collection and for appropriate treatment of the data during data summary and analysis. The MS Access database for each monitoring component contains a field that identifies which version of the protocol was being used when the data were collected.

In this context of revising the protocol, the rationale for dividing a protocol into a narrative with supporting SOPs is based on the following:

- The protocol narrative is a general overview of the protocol that gives the history and justification for monitoring and an overview of the sampling methods, but does not provide all of the methodological details. The protocol narrative will only be revised if major changes are made to the protocol.

- The SOPs, in contrast, are very specific step-by-step instructions for performing a given task. They are expected to be revised more frequently than the protocol narrative.
- Revisions of SOPs in most cases do not require revision of the protocol narrative to reflect the specific changes made to the SOP.
- All versions of the protocol narrative and SOPs will be archived in a protocol library.

Review of changes

All edits require review for clarity and technical soundness. Small changes or additions to existing methods should be reviewed in-house by Pacific Island Network staff. However, if there is a complete or major change in methods, then an outside review may be required. If there is a major change in methodology, either to the entire protocol or an individual SOP or narrative components, The Pacific West Region Inventory and Monitoring program coordinator should be consulted to determine the appropriate level of peer review required. Typically, regional and national staff of the NPS, and outside experts in government, private sector, and academia with familiarity in climate monitoring will be asked to serve as reviewers.

Use of version numbers and the change history log

Document edits and protocol versions in the change history log that appears at the beginning of the protocol narrative and each SOP. The change history log changes only in the protocol narrative or SOP that is edited. Version numbers increase incrementally by decimals (e.g. version 1.6, version 1.7) for minor changes. Major revisions should be designated with the next whole number (e.g., version 1.3 to version 2.0). Record the new version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes.

Notification & Metadata changes

Inform the data manager about changes to the protocol narrative or SOP so the new version number can be incorporated in the metadata of the project database. Any changes to associated database design and organization need to be documented in the metadata of the project database(s). Post new versions on the Internet and forward copies to all individuals with a previous version of the effected protocol narrative or SOP including the PACN data manager for inclusion in the network's protocol library.

Standard Operating Procedure (SOP) # 2:
Use of Garmin Global Positioning System (GPS) Units

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This SOP explains how to use a Garmin GPS receiver to navigate to sites and collect field data. This SOP also describes how to download/upload GPS data using DNRGarmin, free software that is the Pacific Islands NPS standard for incorporating Garmin GPS data into GIS. This SOP is written specifically for Garmin GPSMap76CSx model, but it may be used for any other Garmin GPS models that can average a waypoint and collect track logs. The data transfer process uses DNR Garmin 5.4.1 and ArcGIS 9.3 software.

Pre-Field Preparation

Equipment
The following equipment should be taken into the field:

- GPS receiver.
- Map.
- Fresh AA batteries (at least 2).
- Compass with declination adjustment (if desired).
- Waypoint(s) preloaded (if necessary).
- Waypoint metadata form and pencil/pen.
- Notebook for recording description of waypoints.

Garmin GPS Preparation
1. Read and become familiar with Garmin GPS user manual, hardware, and software.

2. Load freshly charged batteries and have extra charged sets available. Put extra batteries in a water tight “dry bag” or a re-sealable plastic bag.

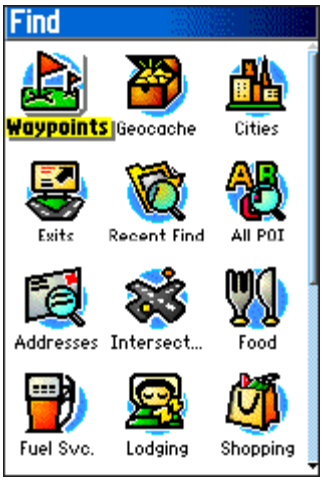
3. Download a fresh Almanac into your Garmin GPS if the unit has not been used for more than 1 week. Or if the GPS unit has been traveled a distance of 150 miles or more from the last location (i.e. travel between PACN islands). A fresh Almanac automatically sets the correct time/date and time zone for your GPS, as well as other local settings acquired from the satellites. To download an Almanac, turn on your Garmin GPS and stand in an open area (i.e. away from buildings, tree canopy, and obstructions) for about 20-30 minutes depends on cloud cover.

4. Get familiar with the Main Menu page and the Set Up page on your Garmin GPS.



5. Make sure your Garmin GPS interface is set correctly. From Main Menu page → Setup → Interface. Select *Garmin* for “Serial Data Format” field.
6. Make sure that WAAS is enabled. From Main Menu page → Setup → System. Set “WAAS” field to *Enabled*.

7. If necessary, delete old waypoints or tracks from your GPS memory (make sure data has been downloaded and saved on your computer).
   - To delete all waypoints, press FIND → Waypoints. Press ENTER, then press MENU. Select *Delete…*and press ENTER. Select *All Symbols* and press ENTER.
   - To delete all tracks, from Main Menu page → Tracks. Press ENTER, then press MENU. Select *Delete All Saved* and press ENTER. Select *Yes* and press ENTER.

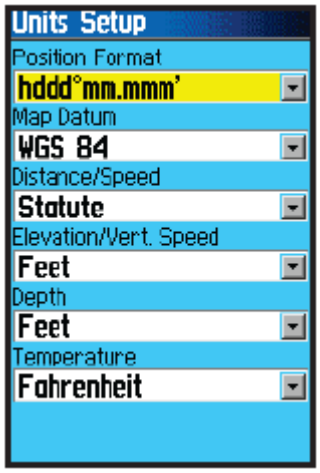




8. If necessary, upload GIS data (e.g. shapefiles) to the GPS unit using DNR Garmin software (see "Download_Upload_GARMIN_ArcGIS" SOP for instructions).

9. If you plan to GPS a line showing where you traverse (i.e. a track), then make sure to set up the Track Log. From Main Menu page → Tracks → Setup. Check the box *Wrap When Full* if you want Track Log records over oldest data with new data, otherwise leave the box unchecked. Set "Record Method" field to *Time*. Set "Interval" (i.e. logging rate for data collection) field to *00:00:05* (5 seconds is recommended for data collection while walking).

10. Set the coordinate system. From Main Menu page → Setup → Units. For the field "Position Format", select either *hddd.ddddd*, or *hdd mm.mmm*, or *hddd mm ss.s* if you want your waypoints collected in LAT/LONG. Otherwise select *UTM UPS*.
    Note: Standard unit for Distance, Elevation, and Depth is *Metric* or *Meters* for all PACN islands.



11. Set the Map Datum. From Main Menu page → Setup → Units. Set "Map Datum" field to either *NAD83* or *WGS84* depends on island location. Standard Map Datum settings for PACN islands are in Table 1 below.

    Table 1. Coordinate systems and datum for PACN islands

Island	Datum	Coordinate system
Hawaii Island	NAD83	UTM zone_5N
Maui Island	NAD83	UTM zone_4N
Molokai Island	NAD83	UTM zone_4N
Oahu Island	NAD83	UTM zone_4N
Guam	WGS84	UTM zone_55N
Saipan	WGS84	UTM zone_55N
American Samoa (all islands)	WGS84	UTM zone_2S

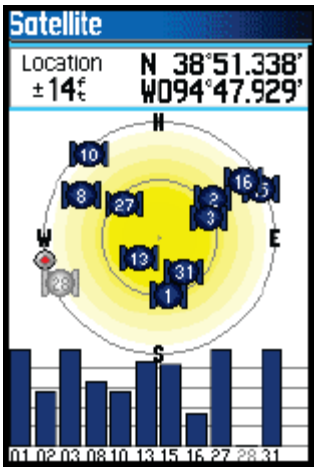
12. If necessary, check North Reference setting. From Main Menu page → Setup → Heading. Set "North Reference" field to *True*.

13. After using Garmin GPS in the field, make sure to put the unit in its carrying pack and store in a dry location.

Data Collection Preparation

1. Turn on your Garmin GPS unit. Press PAGE button several times to access the Satellite page, then press MENU and select *Use With GPS On*, press ENTER.

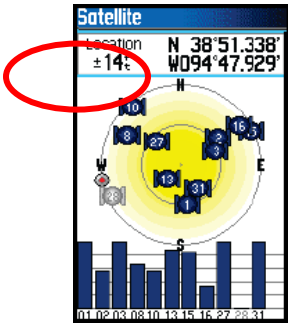
2. Hold GPS unit in front of you. Keep it flat and leveled. Wait for the satellites to appear on the Satellites page. Note: A minimum of **4 satellites** is required to ensure data accuracy.



IMPORTANT NOTE: Garmin GPS will collect data regardless of how many satellites being detected or no matter what the GPS positioning quality is, therefore you must check the Satellites page frequently while collecting data. A good rule of thumb is ONLY collecting data when the 3D satellite fix mode signal is shown on the Status bar at the top of the screen of your GPS unit. Avoid collecting data when Garmin GPS is in 2D fix mode.



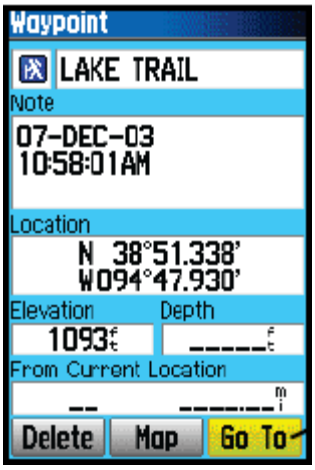
Also, check the Location accuracy error from time to time to ensure the GPS positioning quality when you collect data.



Navigating To Waypoints

1. Press FIND → Waypoints, press ENTER.

2. Use the Rocker key (move Up/Down or Left/Right) to enter the name of the waypoint or just select *OK*. Scroll down the list and select the waypoint that you want to navigate to, press ENTER. Select *Go To* at the bottom of the page and press ENTER.

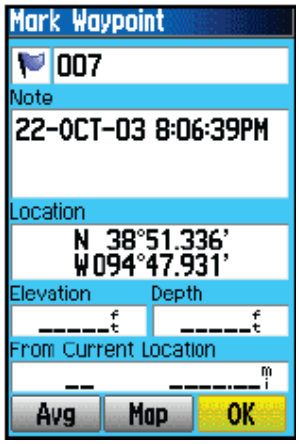


3. Map page should open automatically (if not, press PAGE button several times to access the Map page). Start walking and follow the compass direction on the Map page to navigate to the waypoint.

Collecting Waypoints

1. Stand still at the location where you want to GPS.

2. Press and hold ENTER/MARK button until the Mark Waypoint page appear.



3. At the top of the Mark Waypoint page, enter a waypoint name, using the Rocker key. Tip: To save time in the field, write down any notes/comments about this waypoint into a notebook. You may enter this information later back at the office, after downloading the waypoints into ArcGIS.

4. Select OK at bottom of the page and press ENTER.

5. Go to your next location and repeat the above steps.

Collecting Tracks

1. Turn Track Log to ON. From Main Menu page → Tracks. Select *On* and press OK.
   Also, from Main Menu page → Tracks → Setup Track Log, make sure the box *Wrap When Full* is checked if you want Track Log records over oldest data with new data (otherwise leave the box unchecked).



2. Begin walking and Track Log will start collecting track points (at an interval of every 5 seconds as you walk).

3. Turn Track Log to OFF to stop collecting. From Main Menu page → Tracks. Select *Off* and press OK.

4. Tip: You may stop Track Log when nearing the beginning point of an area (polygon) you've walked. Track Log will automatically close the polygon even if a track is left open ended.

Other Data Collecting Tips

For more detail information on data collecting with Garmin GPS, check out the User's Guide at this link *http://www8.garmin.com/manuals/GPSMAP76CSx_OwnersManual.pdf*

Data Transfer Preparation

Installation of DNR Garmin Software

1. If you already have DNR Garmin 5.4.1 installed on your computer, go to next section "Connect Garmin GPS unit to Computer" below.
2. If a previous version of DNR Garmin exists on your computer, start from Step 3. If there is no previous DNR Garmin software on your computer, start from Step 5.
3. Uninstall any previous versions of DNR Garmin by using the Start → Control Panel → Add/Remove Programs function.
4. When uninstallation is done, perform a search on local drives for all files named "dnrgarmin". If found, delete them. Note: Failure to completely remove any earlier versions can cause problem running the current DNRGarmin version.
5. Install DNRGarmin: If you have access to I&M server, go to M:\Software\GPS_Garmin\DNRGarmin5.4.1, then go to Step 6 to install the software.

If you don't have access to I&M server, you may download the free DNR Garmin 5.4.1 software from the Minnesota Department of Natural Resources at this link http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html and then go to Step 6 to install it.

6. Double click the dnrgarmin54setup.exe file.
7. Press Next at the Welcome Screen, then accept the License Agreement. Press Next to continue.
8. The program will be installed in a default location "c:/program files/dnrgarmin". Press Next to continue.
9. The program will install a desktop shortcut and a DNR Garmin folder will be added to the Start → All Programs menu. Press Finish and view the Readme file if desired, otherwise close Readme file.

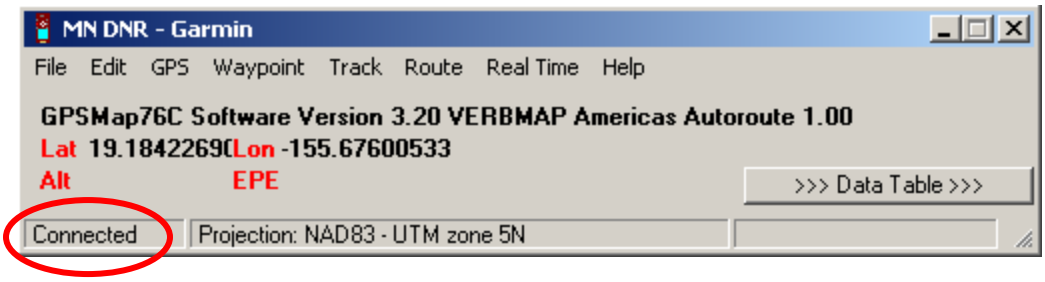
Connect Garmin GPS Unit to Computer

1. Attach the Garmin Cable to either a COM1 serial port or a USB port (depends on what type of cable that comes with your Garmin GPS unit) in the back of your computer.
2. Attach the other end of the Garmin Cable to the back of the Garmin GPS.
3. Turn on the GPS by pressing and holding the red lantern button.
4. Press the Menu button and select the "Use With GPS Off".
5. Press Enter and the Garmin should be in Simulator Mode (GPS unit no longer is searching for satellites).
6. Press the Page button several times until you get to the Main Menu.
7. Make sure the "Serial Data Format" field is set to *Garmin*. From Main Menu page → Setup → Interface.
8. You're now ready to download or upload data between a Garmin GPS unit and your computer.

Download GPS data into ArcGIS

GPS waypoints and tracks collected in the field can be downloaded directly into ArcGIS as shapefiles.

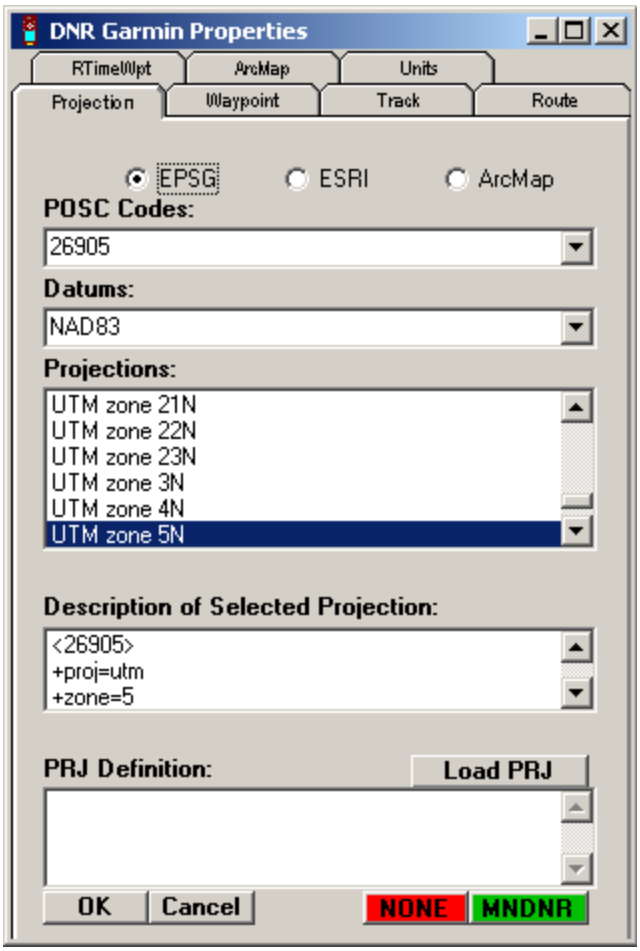
1. Open ArcMap.
2. Launch DNR Garmin from the desktop shortcut or loading from All Programs → DNR Garmin. You should see a screen announcing version 5.4.1 and MN-DNR Garmin window opens with the word "Connected" displayed at the bottom. **If you receive a connection error message or "Not Connected" displayed at the bottom of the DNRGarmin screen, go to section "Connection Troubleshooting Guide" at the end of this document for suggested steps to resolve connection problem**.



3. When DNR Garmin opens for the first time on a computer, you will be asked to accept or change the default projection of UTM -1983, Zone 15. **Select NO to change the default projection**.
4. The DNR Garmin Properties dialog box appears.
5. Set projection based on Table 1 below.

Table 1 Projection settings for islands in PACN

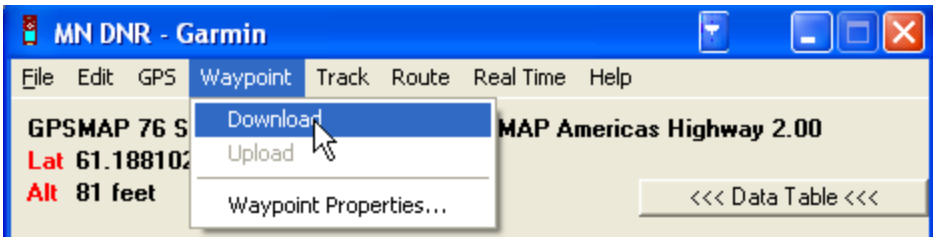
Island	ESRI (or EPSG) POSC code	Datum	Projection
Hawaii Island	26905	NAD83	UTM zone_5N
Maui Island	26904	NAD83	UTM zone_4N
Molokai Island	26904	NAD83	UTM zone_4N
Oahu Island	26904	NAD83	UTM zone_4N
Guam	32602	WGS84	UTM zone_55N
Saipan	32602	WGS84	UTM zone_55N
American Samoa (all islands)	32775	WGS84	UTM zone_2S



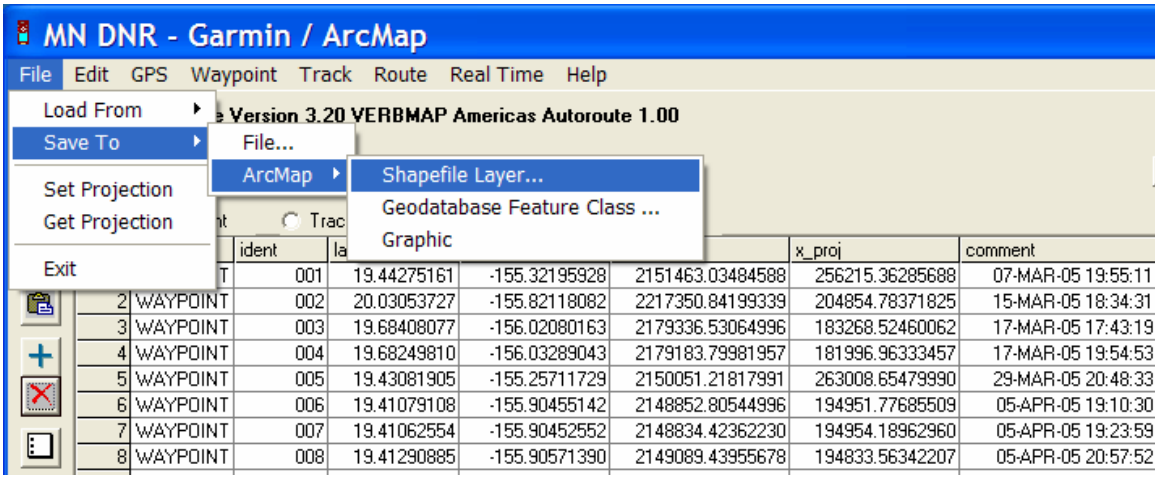
6. When Finished Press OK. **These projection settings MUST be checked EACH time you download GPS data** by selecting File → Set Projection.
7. In ArcMap, ensure that the Data Frame is set to the appropriate projection:

   - Right click on Data Frame name, select Properties.
   - In Data Frame Properties window, select Coordinate System tab. Read the information in Current Coordinate System box. It should have the same Datum and Projection as the GPS data you're about to download.
   - If it is NOT the same or "No projection" is displayed, then go down to Select a Coordinate System box, click on Predefined folder and select the appropriate coordinate system (refer to Table 1 above).
8. Download the waypoints (or tracks) into ArcGIS:

   First, download waypoints into DNRGarmin by selecting Waypoint (or Track) → Download. The waypoints (or tracks) will be tabulated and it might take a while.



Next, you MUST save the waypoints (or tracks) as a GIS layer by selecting File → Save To → ArcMap → Shapefile Layer.

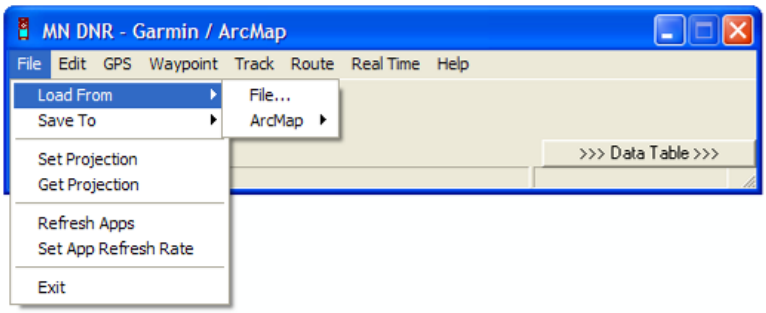


9. Select a location folder and type in a name for the shapefile.
10. Press the Save Button. The new shapefile will be automatically added into ArcMap.

Upload GIS Data Into Garmin GPS

GIS data (point, line, polygon shapefiles) can be uploaded into the Garmin GPS unit to be used as background map features or locations to navigate to.

1. Connect GPS to computer (see section "Connect Garmin GPS unit to Computer" above).
2. Launch DNRGarmin.
3. Go to File → Set Projection to change the coordinate system if needed. It should match the coordinate system of the GIS data you want to upload.
4. Chose either of the 2 methods below to start uploading data.



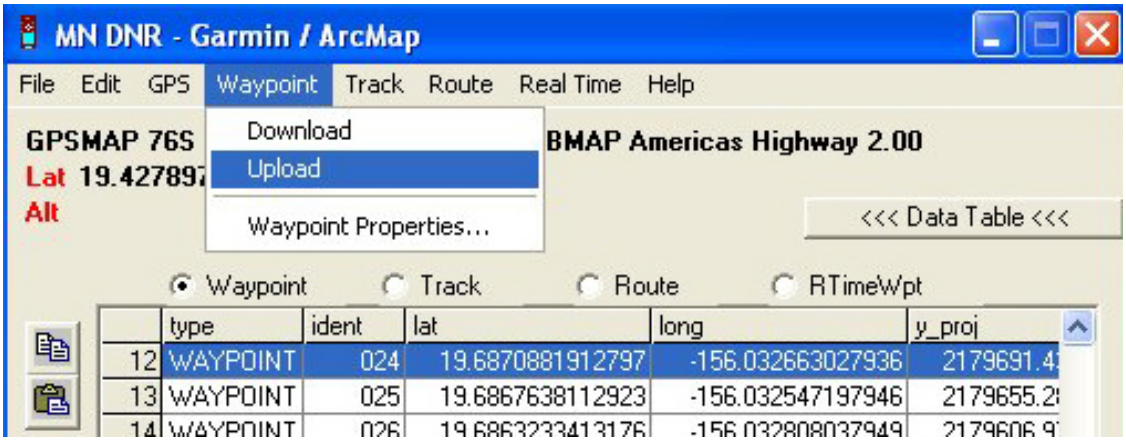
From ArcMap Method

This is an option if you already have an ArcMap project opened and you want to upload a layer from your map project into the Garmin GPS.

1. In ArcMap Table of Content, highlight the layer you want to upload.
2. In DNRGarmin, select File → Load From → ArcMap → Layer. Data will be transferred into DNRGarmin. **Note: The data are NOT uploaded into your GPS yet, must perform step 3.**
3. From the Waypoint (or Track, Route) menu, select Upload and data will be uploaded into the GPS.

From DNRGarmin Method

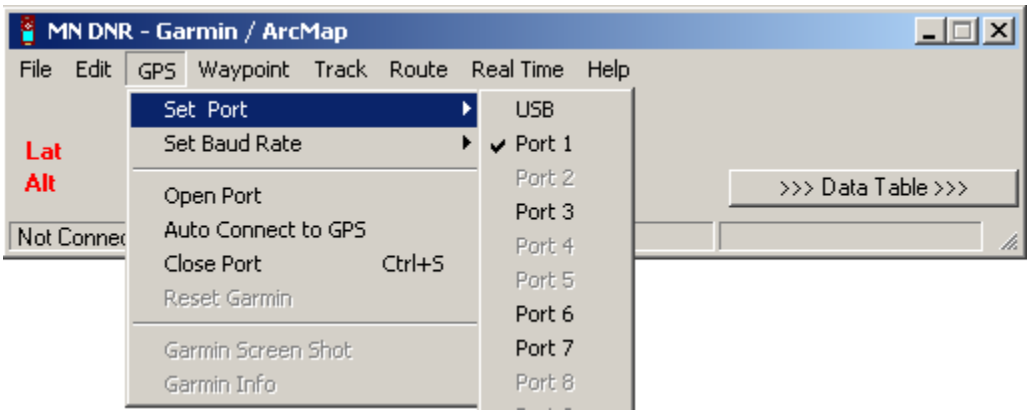
1. Go to File → Load From → File. Select *Shapefile* as Files of Type. Navigate to where the shapefile is located on your computer and select it. Press Open.
2. An Identify Fields dialog may open. Fill in the appropriate fields if necessary. Click OK. Data will be transferred into DNRGarmin. **Note: The data are NOT uploaded into your GPS yet, must perform step 3**.
3. From the (or Track, Route) menu, select Upload and data will be uploaded into the GPS.



Connection Troubleshooting Guide

Here are some steps to follow if you failed to make a connection between the GPS unit and your computer:

1. Ensure the GPS is in Garmin Interface Mode. On your Garmin GPS unit, from Main Menu page → Setup → Interface. Check to make sure the "Serial Data Format" field is set to *Garmin*.
2. Check all cable connections to ensure everything is secured tightly. In DNR Garmin, click GPS → Set Port. Make sure *Port 1* is checked if you attached the cable to COM1 serial port. Otherwise, *USB* should be checked if you attached to a USB port on your computer.
3. If your computer has two or more serial ports, make sure you are attached to COM1. If COM1 port is already taken up by another cable (printer, scanner, etc.), attach the Garmin cable to another available serial port, i.e. COM2, COM3. Then in DNR Garmin, go to GPS → Set Port and select Port2 or Port 3 accordingly.



4. If you are using a serial port cable, make sure it has 4 prongs on one end (where it attached to the back of the Garmin GPS unit) and a parallel port on the other end (attached to a parallel port on your computer).
5. If you are using a USB cable, **you may need to install a USB driver to make this connection work**. The driver is available on I&M server. Follow the steps below to install the USB driver on your computer (you must have administrative privileges to install):
    - Close all running programs.
    - Go to M:\Software\GPS_Garmin\USB Driver. Double click on USBDrivers_221.exe
    - Click Run button to start the installation process.
    - Click Next.
    - Select "I accept the terms in License Agreement", then click Next.
    - Select "No, Not at this time", then click Next.
    - Select "Install the software…(Recommended)", then click Next.
    - Click Finish.
    - Restart your computer when installation is successfully done.
    - Connect USB cable from Garmin GPS to your computer. Turn on GPS unit, check to make sure "Use with GPS off" is set and GPS is in Garmin Interface Mode (refer to section "Connect Garmin GPS unit to Computer" above if needed).
    - Launch DNRGarmin, go to GPS → Set Port and select USB. Connection should be established.
6. If you're using COM1 serial port and DNR Garmin is still not connecting to your GPS after performing step1-5 above, then follow these additional steps (written for Windows XP, may be slightly different for other Windows operating systems):
    - Close DNR Garmin, ArcGIS and turn off GPS unit. You may leave GPS unit connected to the COM1 serial port.

- Click on Start → Control Panel → Performance and Maintenance → Administrative Tools.
- Double-Click Computer Management.
- Double-Click Device Manager.
- Open up Ports and select COM 1.
- Right mouse over COM 1 and select Disable.
- Say yes to really disable this.
- Press OK or Apply all the way out to close all windows.
- Restart your computer.
- When the computer is rebooted, Windows will re-establish the COM1 port. Proceed to step 1 of section "Connect Garmin GPS unit to Computer" of this document.

Other Troubleshooting Tips

1. You must have administrative privileges to install DNRGarmin software in the C:/Program Files directory on your computer. Contact your system administrator if installation was stalled because of installation rights.
2. If you have an earlier version of the DNR Garmin program on your machine you MUST uninstall before installing the new version. Uninstall previous versions by using the Start → Control Panel → Add/Remove Programs tool.
3. ActiveSync software (for use with Trimble GPS) often conflicts with DNR Garmin or other software needing access to a serial port. You may need to exit or disable ActiveSync on your computer first before using DNR Garmin.
4. For other installation errors please refer to Minn. DNR Help page at http://thoreau.dnr.state.mn.us/mis/gis/tools/arcview/Training/WebHelp/Training.htm#DNRExt/DNRGarmin4/GPSIntro.htm

Standard Operating Procedure (SOP) # 3:
National Weather Service Observing Handbook No.2
Cooperative Station Observations

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose

This document provides the link to the procedures for recording and reporting observations, as well as for installation and calibration of equipment National Weather Service (NWS) Cooperative Observer Program climate stations. This handbook can be downloaded from the NWS Cooperative Observer Program web site[34] without alteration.

[34] http://www.nws.noaa.gov/om/coop/training.htm

Standard Operating Procedure (SOP) # 4:
Instructions for National Weather Service Form B-91

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose

This SOP explains the procedures for taking and recording weather observations for National Weather Service (NWS) Cooperative Observer stations that lack an evaporation pan. The content of this SOP was extracted from a NOAA web page[35] without alteration, and is provided here to ensure easy access. Form B-91 is included at the end of this SOP and can also be found at the forms link[36] on the COOP website.

[35] http://www.nws.noaa.gov/om/coop/forms/b91-notes.htm
[36] http://www.weather.gov/om/coop/forms.htm

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. 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," showing only to precipitation, 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. 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 rain gauge 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 rain gauge 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 oil 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.

STATION *(Climatological)(River Station, if different*			MONTH **DEC**	**2000**	WS FORM B-91 (12-93)	U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NATIONAL WEATHER SERVICE
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.*		**RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS**	

DATE	TEMPERATURE F.			PRECIPITATION				WEATHER						Time of observation if different from above	RIVER STAGE			REMARKS (Special observations, etc.,)
	24 HRS ENDING AT OBSERVATION			24-HR AMOUNTS		At ob.	*Type the letter Y through hours precipitation was observed, and a letter P through hours precipitation probably occurred unobserved.)*								CONDITION	GAGE READING AT	TENDENCY	
	MAX	MIN	(52) AT OBSN.	Rain, melted snow, etc., (Ins. and hundredths)	Snow, ice pellets (Ins. And fenths)	Snow, ice pellets hail, ice on ground (Ins.)	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	Fog	Ice pellets	Glaze	Thunder	Hail	Damaging Winds			__A.M.		
1																		
2																		
3																		
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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																		
14																		
15																		
16																		
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.

SOP 4.6

Standard Operating Procedure (SOP) # 5:
Instructions for National Weather Service Form B-92

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose

This SOP explains the procedures for taking and recording weather observations for National Weather Service (NWS) Cooperative Observer stations with an evaporation pan. The content of this SOP was extracted from the NOAA instruction sheet located on the front cover of the B-92 data sheet without alteration, and is provided here to ensure easy access. Form B-91 is included at the end of this SOP and can also be found at the forms link[37] on the COOP website.

[37] http://www.weather.gov/om/coop/forms.htm

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 drybulb 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. II 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."

4e. 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.

4i. 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.

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 ^{N}F**								**PRECIPITATION**							**WIND**		**EVAPORATION** *(Inches & hundredths)*			**WATER TEMP. ^{N}F**		**ADDITIONAL DATA/REMARKS**	
	24 Hours Ending at Observation		At Observation			Supplemental Readings of_____							24 Hour Amounts		At Obsn.						24 Hours Ending at Observation		
	Max.	Min.	Dry-bulb	Wet-bulb	Dew Point	Dry-bulb	Wet-bulb	Dew Point	Time of beginning	Time of ending	Time of beginning	Time of ending	Rain, Melted snow, etc. *(in &hundredths)*	Snow, Ice Pellets, Hail *(in. & tenths)*	Snow, Ice Pellets, Hail, Ice on ground *(in.)*	Ane-mometer dial Reading (miles)	24 Hour Movement	Gage Reading or Amount Added +	Reading When Tank Filled or Amount Removed -	Amount of Evapor-ation	Max.	Min.		
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
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17																								
18																								
19																								
20																								
21																								
22																								
23																								
24																								
25																								
Sum.																								
Avg.											Greatest						Adjusted Total							

WS Form B-92 (5-89) **(PRES. By WSOM B-17)**	**U.S. DEPARTMENT OF COMMERCE** NOAA NATIONAL WEATHER SERVICE	OBSERVER	STATION NUMBER

SOP 5.7

Standard Operating Procedure (SOP) # 6:
Maintenance of Remote Automated Weather Stations (RAWS)

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

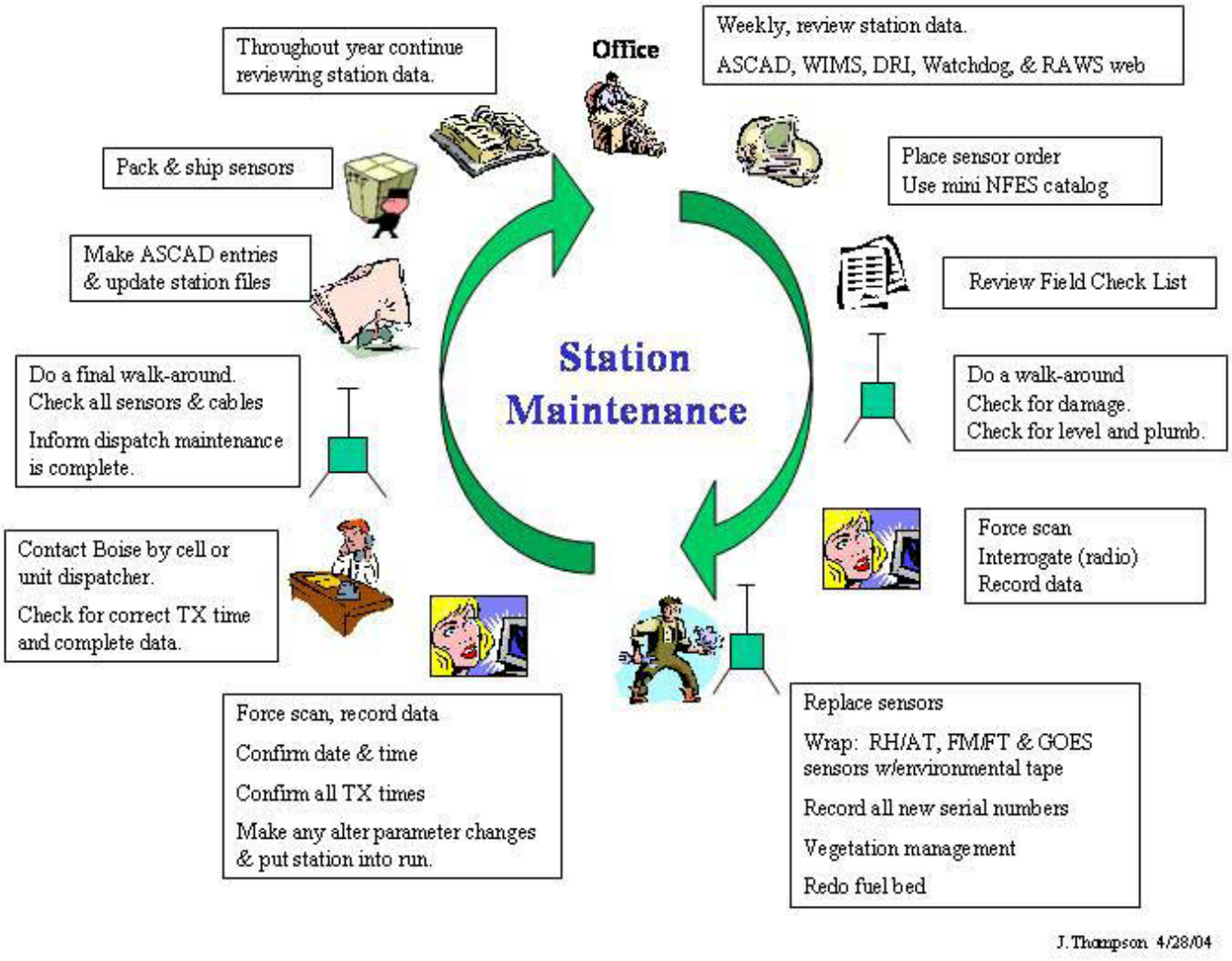
Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This document describes field methods for operating RAWS and provides forms used for station documentation, site visits and field maintenance. It also provides a list of commonly used acronyms for National Interagency Fire Center (NIFC) and RAWS, some of which show up in the forms and instructions. All of this information was downloaded from the RAWS website[38] and is provided here unaltered to ensure easy access. The instructions and forms are not entirely self-explanatory as it is expected that personnel working with RAWS will receive training.

The following documents are included:
Flow Chart for Station Maintenance
RAWS Field Checklist
RAWS Site Visit Form
RAWS Site Documentation Record
RAWS Station Narrative Supplement
NIFC and RAWS Acronyms

[38] http://www.fs.fed.us/raws/

Flow Chart for Station Maintenance



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.

ID:	NAME:	DATE:

CLASS:	TX:	CHAN:	DIST:

SENSORS	NEW S/N	OLD S/N	T/B RESET:(Y / N) CAL: /50 LAST:				
T/B			S/P		VDC		MA
WIND SPD			REG		VDC		MA
WIND DIR			BATT		NO LOAD		LOAD
RH/AT			TRIES: 5M: 10M: 15M:				
FUEL/TEMP	CHANGED	OK	BELT Wx: WET DRY RH				
BATT	CHANGED	OK	FWD Tx:		REV Tx:		
FM/FT			LAT : : LONG : : GPS (Y / N)				
SM/ST			BP LIMITS:				
BP			SM/ST LIMITS:	FULL	ZERO		
			BP LIMITS:	FULL	ZERO		
			WT/G LIMITS:	FULL	ZERO		
DCP S/N			TOWER PN: SSN:				
DCP: FIRMWARE: CHAN:			TALKER: (Y / N) UPDATE INTERVAL :				
SOLAR PANEL			DATA SIZE: MATCH: (Y / N)				
			GUST-CHAN UPDATE : FUTURE: (Y / N)				
ANTENNA			RUN: (Y / N) NXMIT : NSCAN :				
			ID CORRECT: (Y / N)				
WT. GAUGE -		WWV -	XMIT NEXT : : DIFF TIME:				

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:

RAWS Site Documentation Record

Site Documentation Record				
ID:		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				
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)	
Weight		WWV		

Gauge			XMit Next ___:__:__ Diff Time: ___	
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:				

RAWS STATION NARRATIVE SUPPLEMENT

STATION INFORMATION: (station name)

RAWS Type: (Handar 540 or 555 or FTS 12s) N Weather Service Number:

NESS ID: Latitude: Longitude:

Elevation: TRS: Site:

1. Transmit Channel: Transmit Time (GMT):

2. Handar 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. Handar 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 AS POSSIBLE INTO ASCADS. USE THE NARRATIVE AREA AND CHECK PARAMETERS SUCH AS LAT/LONG TO ASSURE THEY ARE CORRECT.

NIFC and RAWS Acronyms

ACWI - Advisory Committee on Water Information
AOP - Annual Operating Plan
ASCADS - Automated Sorting, Conversion, and Distribution System
ASOS - Automatic Surface Observation System
AWS - Automatic Weather Station (Modem Telemetry)
BAER - Burn Area Emergency Rehabilitation
CDF - California Department of Forestry
COOP - Continuation of Operations Planning
CPIC - Capital Planning and Investment Control
CSEPP - Chemical Stockpile Emergency Preparedness Program
DAPS - Data Collection System Automatic Processing System
DCP - Data Collection Platform
DCS - Data Collection System
DOMSAT - Domestic Satellite
DROT - Direct Read Only Terminal
DRGS - Direct Read out Ground Station
DRS - DOMSAT Receive Station
EMIS - Emergency Management Information Systems
ESR - Emergency Stabilization & Recovery
FAM ITIB - Fire & Aviation Information Technology Investment Board
FBAN - Fire Behavior Analyst
FDWT - Fire Danger Working Team
FLERT - Firefighter Law Enforcement Retirement Team
FTS - Forest Technology Systems (vendor)
FWWT - Fire Weather Working Team
EOP - Emergency Operation Center
GACC - Geographical Area Coordination Center
GOES - Geostationary Operational Environmental Satellite
ICBS - Interagency Cache Business System
ITIB - Information Technology Investment Board
IT/IM - Information Technology/Information Management
IRM - Information Resource Management
ISO - International Standardization Organization
IWOS - Incident Weather Observation System
LRGS - Local Readout Ground Station
MAFFS - Mobile Airborne Fire Fighter Systems
MIPR - Military Interfund Purchase Request
MODIS - Moderate Resolution Imaging Spectro Radiometer
NAGFDR - National Advisory Group on Fire Danger Rating
NFDRS - National Fire Danger Rating System
NFES - National Fire Equipment Supply
NFMAS - National Fire Management Analysis System
NESDIS - National Environmental Satellite Data and Information Systems
NICC - National Interagency Coordination Center
NIFMID - National Interagency Fire Management Integrated Database

NLDN - National Lightning Detection Network
NOAA - National Oceanic & Atmospheric Administration
NTIA - National Telecommunication Industry of America
NWCG - National Wildfire Coordination Group
NWS - National Weather Service
NWSA - National Wildfire Suppression Association
OFCM - Office of the Federal Coordinator for Meteorological Services and Supporting Research
PDT - Platform Data Table
RAWS - Remote Automatic Weather Station (satellite telemetry)
REMS - Remote Environmental monitoring Systems
RFI - Ready for Issue
RSFWSU - Remote Sensing/Fire Weather Support Unit
SLA - Service Level Agreement
STIWG - Satellite Telemetry Interagency Work Group
THS - Temperature Humidity Sensor
TWG - Technical Working Group
WFMIS - Wildland Fire Management Information Site
WFO - Weather Forecast Office
WIMS - Weather Information Management System
WRCC - Western Regional Climate Center

Standard Operating Procedure (SOP) # 7:
Annual Maintenance of Vaisala Equipment

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This SOP explains the procedures for annual maintenance of Vaisala equipment on RAWS. These documents were extracted from the Interagency RAWS web page under the Field Guide and Tech Notes Forms link[39] without alteration, and are provided here to ensure accessibility.

The following documents are included:
Field Tool/Supply List
Annual Maintenance Guide for Vaisala Manufactured Equipment
Vaisala Annual Maintenance Checklist

[39] http://raws.fam.nwcg.gov/book/vaisala/

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 screwdriver set
- Slotted screwdriver set
- Combination wrench set (9/16 & 1/2)
- Small sledge hammer
- Six inch level
- Set of nut drivers(9/16 & 1/2 deep well)
- Rachet
- Crescent wrench
- Pliers
- Needle nose pliers
- Set of allen wrenches
- Wire cutters
- Aerosol battery terminal cleaner
- Small mylar space blanket or tarp (for use as sun screen when using laptops)
- Water, water bottle
- 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
- Belt weather kit
- Garbage bags
- Multimeter
- Compass
- Programming set or laptop
- High quality "environmental" style electrician's tape
- Black cable ties (white ones break down in sunlight)
- Spare batteries for your multimeter
- Permanent marker
- Small storage box (good for small parts and fuses)
- Paper towels
- Programming cable
- Battery tester (with load ability)
- A-shaped spring clamps

*available from the depot

Annual Maintenance Guide for Vaisala Manufactured Equipment
Revised 2009

Before you go to the field, get a Most Recent 48 Hours of Observation report from WFMI (WRCC) to check if any sensors are having problems.

Also before you go out, have a reliable time piece set to the correct time in GMT if your station does not have a GPS with auto start program.

Use the Site Documentation Record to make any notes or record data and serial numbers.

General Inspection

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

1. Check general site conditions and make note of any corrections that need to be made, such as fence repair.
2. Check vegetation. Is there anything growing up that needs to be cut back?
3. Inspect all guy wires and footings.
4. Use torpedo levels on towers to check for plumb.
5. Check that cables are tied down neatly and secured.
6. Check for animal damage or vandalism.
7. 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.
8. Hook up your laptop to the DCP. Do a forced scan and record the data from the sensors. You can also retrieve archived data (optional).
9. Click on the View button to verify and record the firmware version in the DCP. This will be helpful to have should you encounter problems with the DCP and will assist the BLM Remote Sensing/Fire Weather Support Unit (depot) folks with assisting your troubleshooting efforts.
10. If you do not have a copy of the program and configuration tables from this station, click on the Archive button to save the program and tables from the DCP to your laptop.
11. Put DCP in stop mode.
12. Record all the serial numbers of the existing sensors, antenna, solar panel, GPS or WWV, and DCP (if needed).
13. Change out the sensors that need replacement. Record the serial numbers of the new sensors before they are installed.

Tipping Bucket

✓ Remove the cover and inspect and clean the tipping bucket and funnels. Check all connections.

✓ 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, REPLACE THE RUBBER BAND ON THE OLD BUCKET TO PREVENT DAMAGE DURING RETURN SHIPPING.**

✔ Reassemble.

✔ Replace sensor every 3 years.

Wind Speed

✔ Check that wind speed cups are tight and properly aligned and all facing in the same direction.

✔ Check for free movement of bearings and cups spin easily and freely.

✔ Verify and record W/S sensor ice skirt size (either 1-3/4" or 2"). If you are using a Vaisala 555 DCP, you must make sure that the ice skirt is 1-3/4". If you have a Handar 540, you must enter the correct size into the programming.

✔ Replace sensor every 2 years.

Wind Direction

✔ Make sure the wind direction vanes are true and tight.

✔ Check for free movement of bearings.

✔ Verify and record cross-arm orientation to assure proper installation of WD sensor.

✔ When installing the wind direction sensor verify the "arrow" points south (180°) and remove the pin only after securing the sensor in its bracket.

✔ Check to see that all 4 quadrants (0, 90, 180, and 270) report correctly with a force scan.

✔ Replace sensor every 2 years

Relative Humidity/Air Temperature

✔ Replace sensor yearly.

Cables

✔ Inspect and clean cable ends as necessary.

✔ Even if not replacing sensor, remove cable connector; inspect, clean if necessary.

✔ Document potential cable problems and note need for replacement as necessary.

✔ In replacing armor cables, note that 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 tie-down straps (white tie-downs break down in sunlight).

✔ Inspect/replace older tie-down straps as necessary.

✔ When attaching sensors to the cable make sure the fitting is snug but not tight.

✔ RH/AT, FM/FT, and GOES antennas need to be wrapped with quality environmental tape at sensor end only. **BE CAREFUL NOT TO COVER DRAIN HOLES ON THE SENSORS WHILE APPLYING TAPE!!**

Fuel Temperature/Fuel Moisture

✔ 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 (conifer needles or hardwood leaves). 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.

✔ Replace fuel moisture/temperature sensor yearly.

✔ Replace fuel temperature only sensor every 3 years.

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.

✔ Replace battery every 3 years.

If you do not have Auto Run Program

You can use the short cut keys or drop down menus to access the information listed below.

On Line Date and time (or use Clock button)
Make sure time is correct on the DCP. Set DCP time using correct time in GMT from your watch.

On Line Telemetry Config GOES (or use satellite button)
Note: you will want to write down this information in case you need to put it back into your DCP (example: if you change out DCP). Verify that this information is correct.

- NESDIS Transmitter ID (example 325EAC8)
- Primary Transmit Channel (example 030)
- Primary Channel Bit Rate (100 bps for low data rate, 300 bps for high data rate)
- First Transmit Time (example 00:29:00 - this is the 1st one of the day, not the next time of transmit)
- Transmit Interval (example 01:00:00 for hourly or 03:00:00 for 3hrly)
- Transmit Window Size (example 00:00:15 for low data rate, 00:00:10 for high data rate or 00:01:00 for 3hrly)
- Secondary Transmit Channel, Secondary Channel Bit Rate and Unit Load Factor are usually not changed.
- If you have a GPS unit or know the latitude/longitude at the station, you can enter it and get the antenna orientation.

On Line Alter Parameters (or use FAV button)
Note: you must be in the STOP mode to change these. You will not see all these parameters. There may be others that can be changed that are not on this list.

- Rain (example .00 if you want to zero out the bucket count or you can put back the amount recorded if you want to continue with rain count and have changed out DCP)
- Clock error (example -10 if clock has drifted by 10 seconds. This field access value is not often used.)
- WWV Lock-ons (example 0 if you want to zero out the WWV tries)
- GPS Acquisitions (0 this out)
- BP Elevation (example 1800 feet)
- Solar Radiation Calibration (example 75.0) - change only if sensor is changed.
- Inst Start Time (example 00-00:27:00, two minutes less than transmit time)
- Avg Start Time (example 00-00:17:00, ten minutes less than instant start time)
- WWV start time (example 16:00:00 GMT) - the time each day that WWV turns on.
- GPS Scan Interval (example 00-06:00:00) - how often the GPS would turn on.

On Line Station ID (or use DCP ID button)
This will set the tones for your radio (if you have installed radio capability in the DCP). Type in 4 characters and a space, then enter. This sequence of numbers (tones), when transmitted by a

radio with DTMF keypad, will cause the RAWS station to transmit current weather data back to the user.

On Line Scan (or use Scan button)
Before you do a forced scan, be sure to disconnect the WWV clock or GPS or else it is included in the forced scan. They both take several minutes to force scan if not disconnected first.

Write down sensor readings. Note: The tipping bucket will show 0 tips until you put it to RUN mode. Force scan each quadrant on the wind direction to make sure it's reading correctly. Force scan a fast and slow wind speed.

On Line Program Control (or use Mode button)
Put DCP in RUN Mode

On Line Scan (or use Scan button)
Compare with the sensor readings you wrote down during the first scan and be sure they match. You can now tip the tipping bucket and the tips will show, but be sure to go back to on line menu and alter parameters to set the tips back to 0.

Hook up WWV clock or GPS.

If you have Auto Run Program

Note: If your DCP has an auto run program and you are setting it up for the first time, you just need to connect the GPS, turn on the DCP, check in 10-15 minutes to make sure it is in the RUN mode. If you are at the site to do annual maintenance, turn off the power and disconnect the GPS unit. After maintenance is done, check Telemetry Configuration, Alter Parameters, check Station ID (for radio), do the force scan. Then turn DCP back on with GPS connected and make sure in 10-15 minutes that it is in the RUN mode. Scan sensors again and check tipping bucket (don't forget to re-set, see above)

Last but MOST Important Item

Do not leave the site until you know that your station has transmitted. Call your home unit on radio or cell or contact RAWS depot helpdesk (208-387-5475) and verify that the station is working.

Refer to the Weather Station Handbook - an Interagency Guide for Wildland Managers (NFES 2140) and NWCG Fire Weather Station Standards (PMS 426-3) for additional weather station information.

Vaisala Annual Maintenance Check List

- ____ Review Vaisala Annual Maintenance Guide
- ____ Review WFMI Station Catalog and Last Data
- ____ Do a walk around and check for:
  - damage to sensors, cables, and tower
  - tower for level and mast plumb
  - GOES antenna azimuth and elevation
- ____ Connect laptop to DCP, go to:
  - (online) telemetry, GOES or Satellite; confirm ID, transmit time, transmit channel
  - (online) alter parameters or FAV; view all information, record instant & average start
  - (online) force scan or Scan; record data on site documentation form
  - (online) station ID or DCP ID; record tone code (when changing tone code, must hit space bar to complete change)
- ____ Interrogate station (if radio present):
  - If it was not successful, check radio frequency, volume, and squelch
- ____ Replace the required sensors:
  - RH/AT, FM/FT; minimum once per year
  - WD, WS; minimum every other year
  - SR, TB; minimum every 3 years
  - Wrap RH/AT and FM/FT; re-wrap GOES antenna cable if necessary
- ____ Test and record:
  - TB and cable; record the test if successful
  - SP voltage and current
  - Regulator voltage and current
  - Battery voltage
- ____ Restart laptop:
  - (online) alter parameters; edit precipitation
  - (online) alter parameters; edit solar radiation constant
  - (online) force scan WD and check quadrants at 90, 180, 270, and 360 degrees
  - (online) force scan WS and check slow and fast wind speed
  - (online) force scan all sensors and record data
  - (date and time) confirm date and confirm time (using GPS)
- ____ Take manual weather with kestrel:
  - record data on site documentation and compare with force scan
- ____ Disconnect laptop
- ____ Replace fuel bed
- ____ Contact RAWS depot helpdesk or local dispatch - confirm transmit time and data are ok

Standard Operating Procedure (SOP) # 8:
Programming of the Vaisala Data Collection Platform

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This SOP explains the procedures for programming the Vaisala/Handar 555 data collection platform. This document was extracted from the Interagency RAWS web page under the Field Guide and Tech Notes Forms link[40] without alteration, and is provided here to ensure accessibility. It is current as of May 2008.

[40] http://raws.fam.nwcg.gov/book/

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 accessible 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

		MODULE: GOES Self-Timed Data Xmit., H2.10
**ID:	GOES Transmitter	
	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.

		MODULE: Radio Speech if DTMF Station ID, H2.01
ID:	Radio Speech	
	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.**

Standard Operating Procedure (SOP) # 9:
Annual Maintenance of Forest Technology Stations (FTS)

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This SOP describes the procedures for annual maintenance of FTS. These documents were extracted from the Interagency RAWS web page under the Field Guide and Tech Notes Forms link[41] without alteration, and are provided here to ensure accessibility.

The following documents are included:
Suggestions for Field Tools and Supply List
Annual Maintenance Guide for FTS Manufactured Stations

[41] http://raws.fam.nwcg.gov/book/

Suggestions for Field Tools and Supply List

Note: You may need additional tools not covered by this list.

- Tape Measure
- Pocket Knife
- Phillips Head Screwdriver
- Standard Screwdriver
- Small 3/32 Standard Screwdriver
- Combination Wrench Set (9/16, 1/2, 7/16)
- Small Sledge Hammer
- Nut Drivers (9/16, 1/2, 7/16, 5/16)
- Ratchet With Deep Well Sockets
- Pliers
- Needle Nose Pliers
- Allen Wrenches
- Side Cutters (wire snips)
- Aerosol Battery Terminal Cleaner
- Aerosol Battery Terminal Protector
- Mylar Space Blanket (use as sun screen when using laptops)
- Water
- Water Bottle
- Small Paintbrush (to clean tipping bucket and general dusting of small parts)
- Belt Weather Kit or Hand-Held Sensor
- Garbage Bags
- Multimeter
- Compass
- Six Inch Level
- Angle Finder
- High Quality "environmental" Style Electricians Tape
- Black Cable Ties (white ones break down in sunlight)
- Spare Battery For Your Multimeter
- Permanent Marker
- Small Storage Box (good for small parts, and fuses)
- Small Crescent Wrench
- Analog Telephone
- Spare Fuses
- 10-32 Stainless Steel Hex Head Cap Screw (RH/AT, Wind Sensors)
- Window Cleaner
- Paper Towels
- Tarp
- Programming Cable
- Battery Tester (with load ability)
- Bungee Cord
- A - Shaped Spring Clamps
- Small Flashlight

Annual Maintenance Guide for FTS Manufactured Stations

Written by: Dean Zeitz
RAWS Technician
Tofte Ranger District
Superior National Forest

General Inspection

During your annual maintenance visit thoroughly inspect the station site visually, physically, and electronically, as well as possible.

1. Check general site conditions and make note of any items that need to be repaired, such as a fence, gate, or station components.
2. Inspect all guy wires and anchor points. Are they secure? Do they need tightening? Are the turnbuckles secured to prevent unwinding due to vibration of the guy wires in high winds?
3. Use a compass to check for correct orientation of wind sensors, and any antennas on the station.
4. If there is a GOES antenna, check antenna and cable for physical serviceability. Are any of the antenna's directional elements (small aluminum rods) bent, loose, or missing? Is the antenna properly aligned? Check with compass and inclinometer. Wrap the GOES antenna cable connector with environmental tape.
5. Use a level to check the tower for plumb.
6. Check that all sensor cables are neatly secured. Do you have drip loops in your cables to shed rain? Have you made a loop in the cables that span any joint on the mast or any sharp edge to prevent cable wear?
7. Check station for animal damage or vandalism.
8. Record all serial numbers of existing sensors, antennas, solar panel, datalogger, all station components if not already recorded.
9. Record model numbers from datalogger, telephone modem (if modem is present), all station sensors, and components. This will be helpful to have should you encounter problems, and will assist with troubleshooting efforts.
10. Change out the sensors that need replacement. Record the serial numbers of all new sensors before they are installed.
11. Tighten any loose nuts, bolts, or clamps.

Pre - Sensor or Component Change Out

Know what times the station collects its data at. Stations collect two sets of data, one set is the FTS formatted data on the top of every hour the other set is the BLM formatted data collected prior to the scheduled GOES transmission. Plan your sensor or component change out around these two collection times to avoid missing transmissions, and loss of data.

All sensors and cables need to be connected to the datalogger, and the station running **twelve minutes** before the scheduled GOES transmit time. This will allow ten minutes for the averaging sensors to collect their data, plus two minutes for the data to be loaded into the G4 transmitter

from the datalogger before transmission. For data that is collected on the top of every hour all sensors and cables need to be connected to the datalogger, and the station running **ten minutes** before the scheduled collection. This will allow ten minutes for the averaging sensors to collect their data. Using an RD05 display unit, Tool Box, or LDS-2 software read sensors and record the current sensor readings.

Sensor and Component Change Out

Cables

✔ Inspect all cables, even if not replacing sensor, remove the cable connector from the sensor inspect, clean if needed, and re-tape connection.

✔ Document potential cable problems and note need for next replacement as necessary.

✔ Cables are identified by color coding, unique connector size, and pinouts. The colored bands on the cable will match the correct port for that sensor or component on the datalogger. Cables with bands of the same color are identified by connectors of different size.

✔ When replacing cables secure with quality black cable-ties (white cable-ties break down in sunlight).

✔ Inspect yearly and replace older cable-ties.

✔ When attaching cables to the sensors 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!!**

✔ Create good rain drip loops when securing cables along support arms, and entering the equipment enclosure. Also create a loop over any joint/union on the mast, and over any sharp edge to prevent cable damage.

✔ Prevent cable ends from contacting the ground to avoid moisture or dirt contact.

Tipping Bucket

✔ First disconnect cable from datalogger before working on the tipping bucket.

✔ Disassemble, inspect, and clean the entire tipping bucket.

✔ If installing a new bucket be sure to remove the rubber band securing the tipping mechanism. **JUST AS IMPORTANTLY, RE-INSTALL THE RUBBER BAND ON THE OLD BUCKET TO PREVENT DAMAGE DURING RETURN SHIPPING.**

✔ Level and tighten tipping bucket platform as needed.

✔ Reassemble.

✔ Verify and record the accumulated precipitation amount. This is necessary if you intend to continue with an ongoing count (Note: FWS 11 and FWS 12 do not allow for change of precipitation number but the FWS 12S does).

✔ If you wish to reset the accumulated precipitation amount back to zero. Disconnect all power to the datalogger, includes disconnecting cables to the battery port, telemetry port, and display port (if station has a TM modem connected to the display port) on the datalogger. Wait a couple minutes then reconnect all cables.

Wind Sensors

Before lowering the mast to work on the wind sensors, make sure all cables have enough slack in them to allow for lowering, if not disconnect from the datalogger. Also disconnect the top guy wire of the **two that point west**, and remove the locking bolt to lower the mast.

Wind Speed

✔ Check that the wind speed cups are tight and properly aligned and all facing in the same direction.

✔ Check that the sensor head easily and freely spins, listen for any grinding noise indicating dust in the bearings.

✔ Check pin connectors for corrosion.

✔ When replacing sensor, set the distance into the holder to be comparable to the wind direction sensor for mechanical balance.

✔ Do not attempt to put any screw into the sensor drain hole. Tighten up the retaining screws. Do not over tighten. There is no locating set-screw required for the wind speed sensor.

✔ Do not cover the sensor drain hole.

✔ Wrap cable connector with environmental tape.

✔ Record wind speed sensor type (ice-rated or non ice-rated).

Wind Direction

✔ Make sure the wind direction vanes are true, tight, and not bent.

✔ Check that the sensor head easily and freely spins, listen for any grinding noise indicating dust in the bearings.

✓ When installing new sensor, align the "north-locating" hole in the shank of the sensor under the empty lower hole in the holder. Insert the north-locating screw into the shank through the holder, and tighten down. Gently tighten down the top retaining screw.

✓ Verify that the "arrow" points south (180°).

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

✓ Do not cover the sensor drain hole.

✓ Wrap cable connector with environmental tape.

✓ Record wind direction sensor type (ice-rated or non ice-rated).

✓ **REMEMBER TO REMOVE THE LOCKING PIN FROM THE SENSOR BEFORE RAISING THE MAST.**

✓ If able to forscan (read sensors) sensor with the mast down, check in all four direction quadrants.

Raise the mast and insert the locking bolt, reattach the top guy wire to its anchor, adjust the turnbuckles to plum the upper half of the mast. Secure turnbuckles to prevent unwinding due to vibration of the guy wire in high winds.

Relative Humidity/Air Temperature (RH/AT)

✓ RH/AT sensor cable is permanently attached to the sensor, disconnect from the datalogger only.

✓ Level support arm.

Solar Radiation Sensor (Pyranometer)

✓ Ensure sensor has unobstructed sunlight throughout the day.

✓ Level sensor support arm.

✓ Clean sensor to maintain accurate readings. Use mild soap and water, dish washing soap is acceptable. Remove hard water deposits from the element with vinegar. Ensure the vertical edges of the white diffuser are cleaned as well.

CAUTION: DO NOT USE ALCOHOL, ORGANIC SOLVENTS, ABRASIVES OR STRONG DETERGENTS TO CLEAN THE SENSOR.

✔ Remember to remove plastic protective cap from top of sensor after installation of a new sensor.

Fuel Temperature/Fuel Moisture

✔ Part of the process for installing the fuel moisture/temperature sensor is to rehabilitate the fuel bed, pull out all green vegetation, and add fresh material if needed. The stick should be facing south, 10-12 inches above the fuel bed. The fuel bed should be 3 feet square and 2 inches deep using needles, leaves, and twigs (one hour fuels) typical of your area. Reference NFES 2140 Weather Station Handbook-an Interagency Guide for Wildland Managers.

✔ When installing sensor do not touch the wood dowel with your hands. Place the fuel stick sensor at the end of the support arm, such that the aluminum shank of the sensor is at the end, but slotted into the U channel, secure with hose clamp.

✔ Level the support arm.

✔ Wrap cable connector with environmental tape.

Solar Panel and Charge Regulator

✔ Inspect for cracks in glass front of the solar panel.

✔ Clean with mild soap and water, or glass cleaner.

✔ If you have the equipment, check output of solar panel with volt ohmmeter (VOM). In the following manner:

1. Remove the positive solar panel connection at the Array + charge regulator terminal. You do not have to disconnect the Array - connection for this test.
2. Use a voltmeter to measure the voltage across the positive and negative connectors at the end of the solar panel cable. The panel can produce as much as 18 volts in direct sunlight. (Note: some regulator checks will be inconclusive if the panel voltage is less than 15 volts). Very low readings (below 12 volts) or zero readings in good daylight conditions indicate a solar panel problem.
3. If there is no problem found, connect the wire back to the Array + terminal.

✔ Check the charge regulator with the VOM. Disconnect the positive battery connection from the Batt + location on the regulator. Measure the voltage at the regulator, across the Batt + and the Batt - connections. The voltage should be close to 14.3 volts. If the voltage is very low (0 to 5 volts) then the regulator may be defective and requires replacement.

✔ Check the temperature sensor wire and probe for damage. If damage is present they must be repaired or replaced. The probe is attached to the side of the 12 volt battery.

The charge regulator begins charging when the battery voltage drops to 13.5 volts, the red LED charging indicator lamp will come on. When the battery voltage reaches 14.3 volts the regulator cuts off charging and the charge indicator LED goes out. This cut-off voltage will vary slightly in accordance with temperature compensation.

Batteries

✓ Replace batteries yearly (in battery pack) with 8 new 'D' cell alkaline batteries, if your station still has the battery pack.

✓ Check the 12 volt rechargeable battery for leakage or corrosion, clean or replace if needed, and test with voltage meter should be over 12.5 volts. Recommended replacement schedule is every three years.

Before You Leave The Station

✓ Ensure all cables are secured with cable-ties.

✓ Trim the excess off from the cable-ties.

✓ Ensure station looks neat and professional.

✓ Check the datalogger for any open ports, where you forgot to reconnect a cable.

✓ Using an RD05 display unit, Tool Box, or LDS-2 software read sensors and record the current sensor reading of the new sensors. Compare against the forscaned readings of the old sensors you took before you started your annual maintenance. They should be close to the same readings.

Steps for Hooking Up the 12 Volt Battery and Solar Panel to the Charge Regulator

The following is not an annual maintenance check, but is listed for your information.

1. The positive battery cable is a clear or white wire with the small red marked ring or fork tongue terminal should be connected to the regulator terminal marked Batt +. The black wire with the small ring or fork tongue terminal should be connected to the regulator terminal marked Batt -.
2. Connect the battery cable to the battery, IN THE FOLLOWING ORDER:
    1. The BLACK wire is connected to the NEGATIVE terminal of the battery.
    2. The red-marked CLEAR or WHITE wire is connected to the POSITIVE terminal of the battery.
3. Attach the solar panel cable to the charge regulator, IN THE FOLLOWING ORDER:
    1. The BLACK wire is connected to the ARRAY NEGATIVE (Array -) terminal of the regulator.
    2. The red-marked CLEAR or WHITE wire is connected to the ARRAY POSITIVE (Array +) terminal of the regulator.

To disconnect: reverse the above order.

Standard Operating Procedure (SOP) # 10:
GOES Instructions

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This SOP provides an overview of GOES function and details the steps for setting up the GOES transmitting system including obtaining an ID and programming the SAT HDR GOES transmitter for the PACN weather stations. The Campbell Scientific, Inc. Instruction Manual for the SAT HDR GOES transmitter[42] outlines in detail the GOES system, transmitter functions, use of the software DCPComm, programming the datalogger, and field installation.

[42] http://www.campbellsci.com/documents/manuals/tx312.pdf

GOES Transmitter Functions

The SAT HDR GOES transmitter supports one-way communication, via satellite, from a Campbell Scientific datalogger to a ground receiving station (Figure 1). The transmitter utilizes non-volatile memory to store configuration information, such as platform ID, transmission baud rate, channel number, scheduled transmission time, offset time, and message window length. The clock is maintained with a GPS receiver.

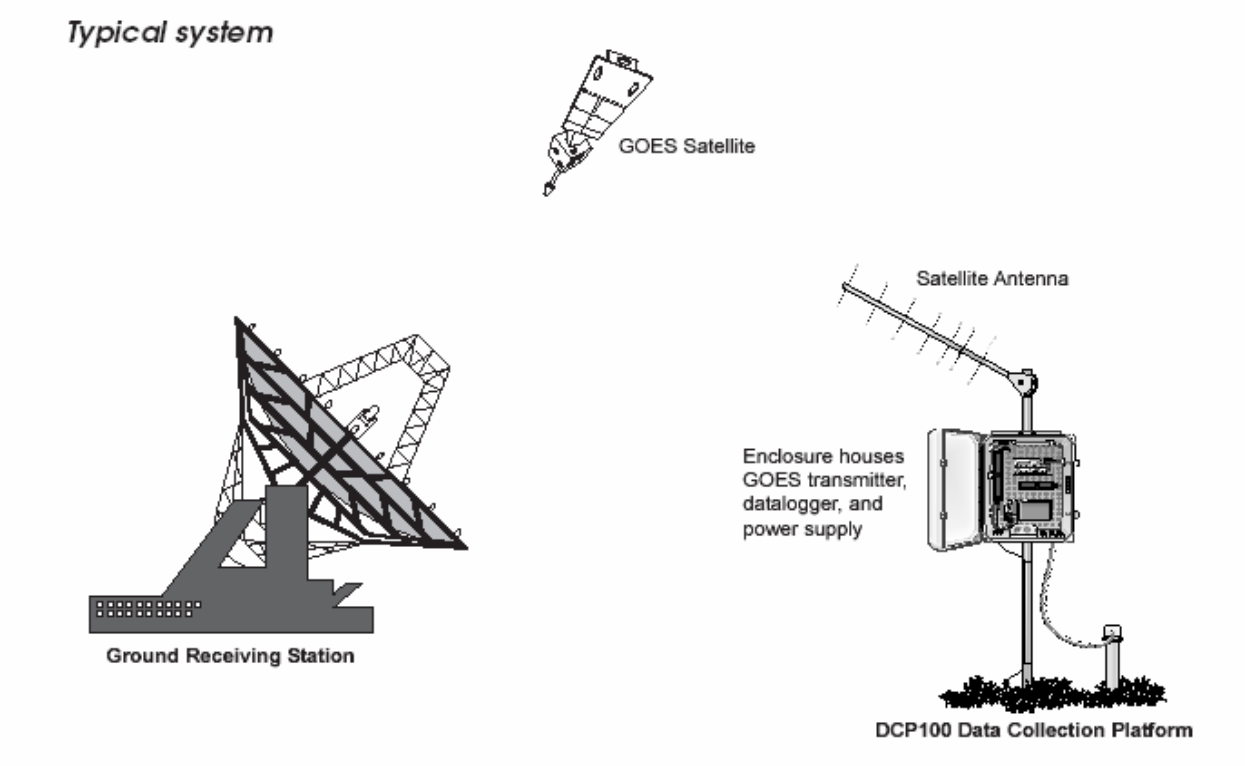


Figure 1. GOES System communication links

The DCP transmitter sends data via Geostationary Operational Environmental Satellites (GOES). GOES satellites have orbits that coincide with the Earth's rotation, allowing each satellite to remain above a specific region. The GOES system is administered by NESDIS which assigns addresses, uplink channels, and self-timed/random transmit time windows. Self-timed windows allow data transmission only during a predetermined time frame. Hawaii is positioned to use the GOES West satellite.

Obtaining a GOES ID

Data cannot be transmitted without first acquiring a GOES ID. Use of the GOES Data Collection System (DCS) is regulated, by law, to the collection of environmental data by U.S. federal, state, and local government agencies, and by international government agencies and research organizations with a U.S. government sponsor. A prospective user must first apply for and be granted a System Use Agreement (SUA) by the National Environmental Satellite, Data, and Information Service (NESDIS) which is typically renewable every 5 years (2 years for manufacturers). Once the SUA has been approved and signed, the user must purchase equipment

that has been certified to be compatible with the GOES DCS. An application form with the policies governing the use of the GOES system can be found at the NOAA GOES Data Collection System[43] (DCS) website.

Programming the GOES transmitter

Programming should be done in the office and tested prior to field installation. A transmitter in the field can be upgraded or reprogrammed by bringing a laptop with the DCPComm software and the proper cable connection.

Certain information is unique to each transmitter including the platform ID, transmission baud rate, channel number, scheduled transmission time, offset time, and message window length. This setup information is entered in the SAT HDR GOES with a computer running DCPComm software. The following steps are taken from the SAT HDR GOES Instruction Manual with additional notes that pertain directly to the setup of the PACN weather stations.

Step 1.
Install DCPComm and verify with Campbell Scientific, Inc. that the latest version of the software is being used.

Step 2.
Load the configuration file. This file contains the information unique to the transmitter (i.e. platform ID). A unique configuration file can be saved for each DCP in service. The default configuration file is GOESTerminalVersion3.0. Only the white fields in the configuration can be changed, the others are preset at the factory.

2.1 Platform ID

Starting from the top of the file select the "value" field for terminal ID Number and enter one of the thirteen assigned IDs for the Central Alaska Network. It is important to keep a log with the IDs used in the network so a platform ID is not duplicated.

2.2 Mode

The mode is the data type. The PACN stations will use ASCII format, so enter a 1 in this field.

2.3 Message Window

The message window is the length of the assigned self-timed transmission window. The value entered for the PACN weather stations is 8 even though the transmission window assigned is 10. This allows a few seconds leeway so the message doesn't overlap the assigned time window. The data stream transmitted for PACN takes approximately 4 seconds to transfer.

2.4 Minimum Voltage Supply

Leave this value as the default 96 (9.6 volts).

[43] http://noaasis.noaa.gov/DCS/index.html

2.5 Timed Configuration
The interval must be set for self timed transmissions. Four values must be entered. Select 0 days, 1 hour, 0 minute, 0 seconds. The offset is the time after midnight of the first transmission of the day. This is the transmission time that is assigned with the platform ID. In the example for Stampede it is 0 hours, 34 minutes, and 10 seconds.

2.6 Timed Channel
The timed channel is also assigned with the platform ID. All of the PACN stations are currently on channel 172.

2.7 Baud rate
The Baud rate must also match your channel assignment. The baud rate assigned to the PACN weather stations is 300.

2.8 Interleaver
The interleaver can be used to provide some error correction to the data transmission however, the number of bytes transmitted will increase, therefore PACN stations have a 0 value entered here to leave the interleaver off.

2.9 Random Configuration
The PACN stations are on self timed transmissions so these values are left at 0.

2.10 GPS Fix Time Out
The default settings work fine for this section.

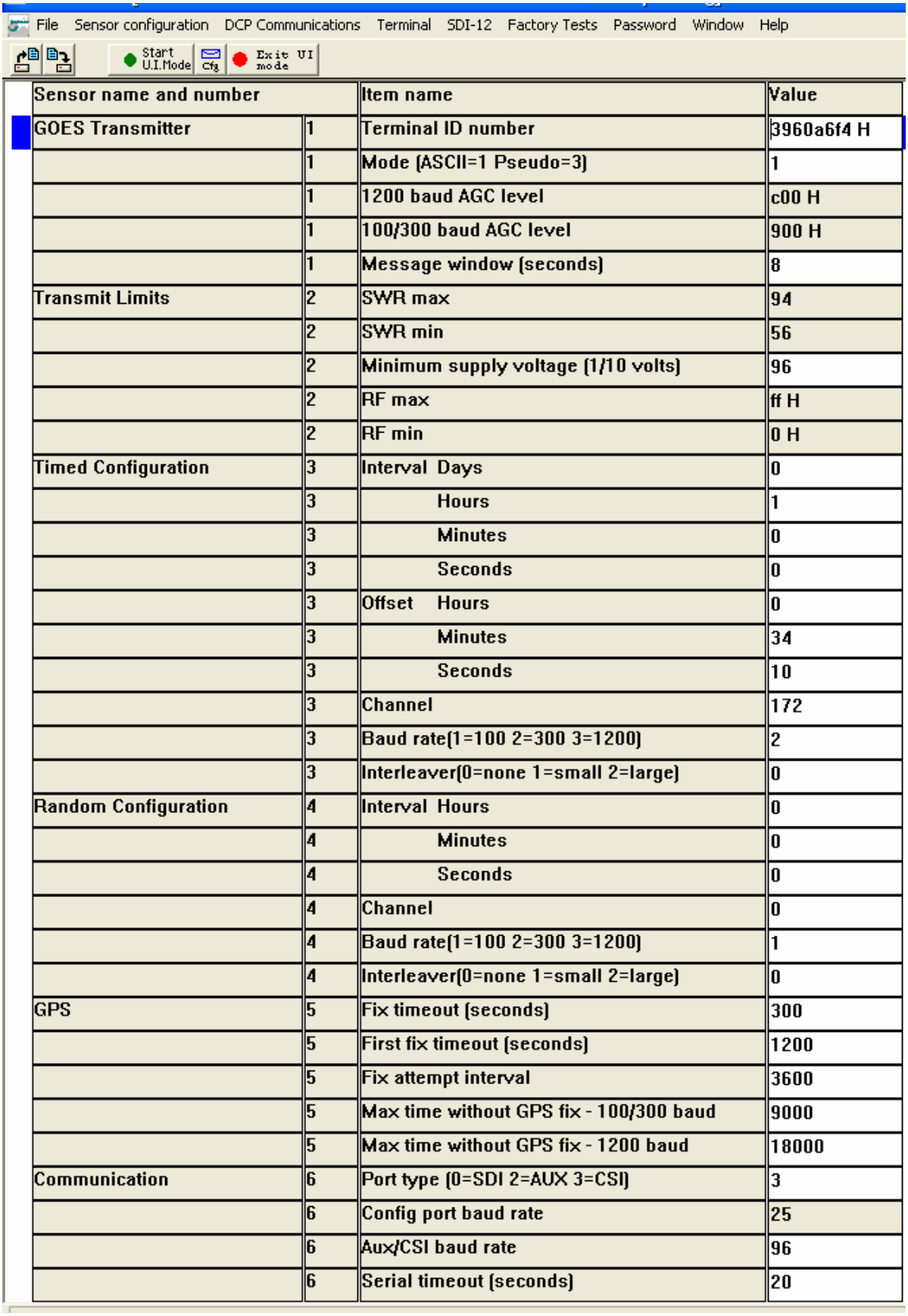
2.11 Communication Port Type
The communication port type sets the active port on the transmitter. The CSI port is used with Campbell Scientific dataloggers. Enter a 3 in this field.

2.12 Serial Time Out
The serial time out is set long enough for all data to be copied from the datalogger to the transmitter before the time out expires. The default setting of 20 for serial time out and 5 for wait before sleep should be entered.

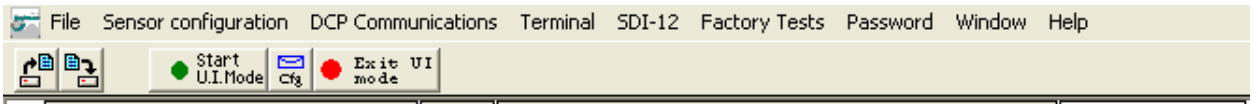
2.13 SDI-12 Settings
These fields are not used for the PACN stations – leave the default values.

2.13 Debug
Leave default settings for debug and Allow test mode.

Below is an example from the Stampede climate station in Denali.



Sensor name and number		Item name	Value
GOES Transmitter	1	Terminal ID number	3960a6f4 H
	1	Mode (ASCII=1 Pseudo=3)	1
	1	1200 baud AGC level	c00 H
	1	100/300 baud AGC level	900 H
	1	Message window (seconds)	8
Transmit Limits	2	SWR max	94
	2	SWR min	56
	2	Minimum supply voltage (1/10 volts)	96
	2	RF max	ff H
	2	RF min	0 H
Timed Configuration	3	Interval Days	0
	3	Hours	1
	3	Minutes	0
	3	Seconds	0
	3	Offset Hours	0
	3	Minutes	34
	3	Seconds	10
	3	Channel	172
	3	Baud rate(1=100 2=300 3=1200)	2
	3	Interleaver(0=none 1=small 2=large)	0
Random Configuration	4	Interval Hours	0
	4	Minutes	0
	4	Seconds	0
	4	Channel	0
	4	Baud rate(1=100 2=300 3=1200)	1
	4	Interleaver(0=none 1=small 2=large)	0
GPS	5	Fix timeout (seconds)	300
	5	First fix timeout (seconds)	1200
	5	Fix attempt interval	3600
	5	Max time without GPS fix - 100/300 baud	9000
	5	Max time without GPS fix - 1200 baud	18000
Communication	6	Port type (0=SDI 2=AUX 3=CSI)	3
	6	Config port baud rate	25
	6	Aux/CSI baud rate	96
	6	Serial timeout (seconds)	20



Communication	6	Port type (0=SDI 2=AUX 3=CSI)	3
	6	Config port baud rate	25
	6	Aux/CSI baud rate	96
	6	Serial timeout (seconds)	20
	6	Wait before sleep (seconds)	5
SDI Sensor 1	7	Sample Interval (seconds)	3600
	7	Offset from midnight (sec)	0
	7	Address	0
	7	Command	NNN
SDI Sensor 2	8	Address	1
	8	Command	NNN
SDI Sensor 3	9	Address	2
	9	Command	NNN
SDI Sensor 4	10	Address	3
	10	Command	NNN
SDI Sensor 5	11	Address	4
	11	Command	NNN
SDI Sensor 6	12	Address	5
	12	Command	NNN
SDI Sensor 7	13	Address	6
	13	Command	NNN
SDI Sensor 8	14	Address	7
	14	Command	NNN
SDI Sensor 9	15	Address	8
	15	Command	NNN
SDI Sensor 10	16	Address	9
	16	Command	NNN
Factory Setups	17	Clear debug entries	E007D00E007
	17	Debug (1=on 0=off)	0
	17	Allow test mode (1=yes 0=no)	0
	17	TCXO Real time clock equipped	0
	17	Set TCXO table to defaults	DDDDDDD
	17	Calculate checksum	WWWWWW

Step 3.
Transferring the configuration information to the SAT HDR GOES The configuration port is an RS232 port utilizing a DB9 female connector. Figure 2 shows the location of the configuration port (and other ports) on the transmitter. The DCPComm software communicates with the transmitter through the configuration port. Use this port to transfer the configuration file from the computer to the transmitter. You must have the proper cable that was included with the purchase of DCPComm. Connect one end to the Com Port on your PC and one end to the Config Port on the transmitter.

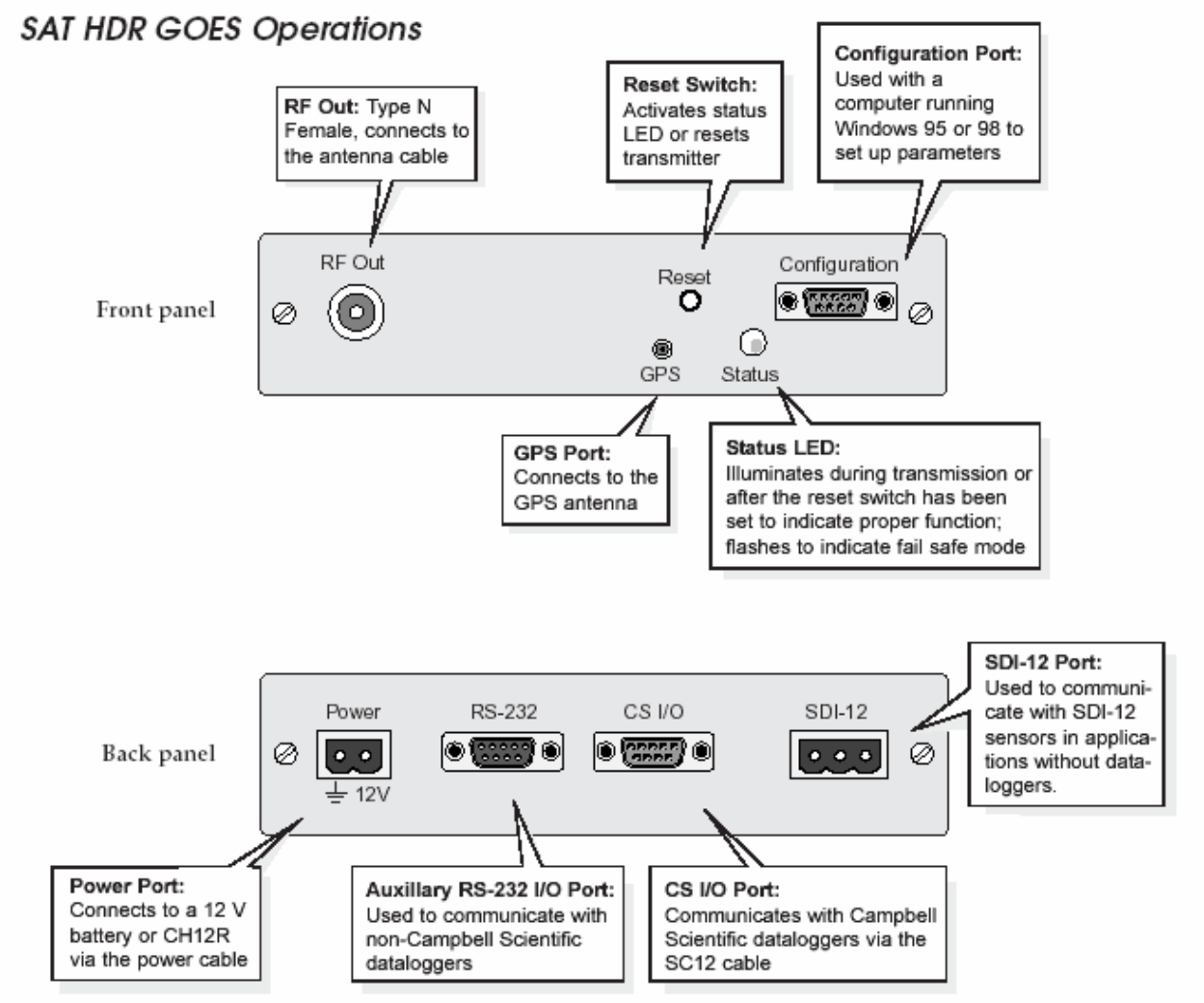


Figure 2 SAT GOES transmitter ports

Edit and save the configuration file under the station name before transferring it to the transmitter. Open DCPComm and then open the configuration file you wish to send. From the main menu select “DCP Communications/Start User Interface”. You will receive a message that the user interface mode started. From the main menu, select “DCP Communications/Send Configuration”. Wait for the message “Configuration Sent”. From the main menu, select “DCP

Communications/Stop User Interface Mode”. After the configuration file is sent it is ready to be installed in the field.

Standard Operating Procedure (SOP) # 11:
LoggerNet Instructions

Version 1.0 (September 2010)

Change History

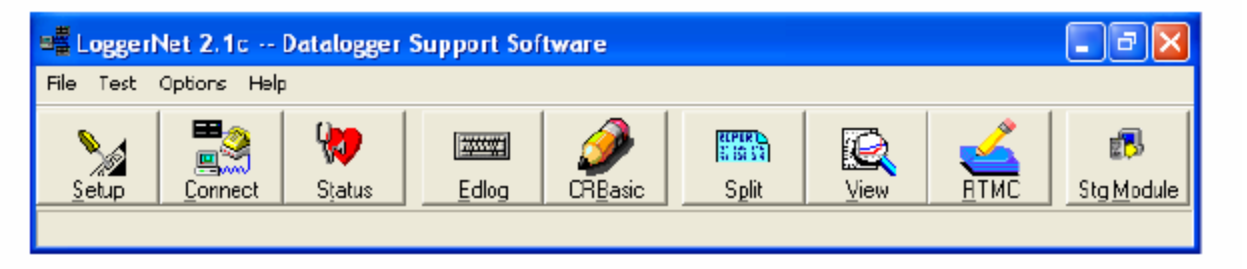
Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This document gives a basic overview of the LoggerNet software and provides instructions for the use of LoggerNet for programming and downloading Campbell Scientific weather stations. This SOP complements the manual[44] for the software.

LoggerNet Overview
LoggerNet is datalogger programming software needed to support a Campbell Scientific, Inc. (CSI) CR1000 datalogger. LoggerNet supports programming, communications, and data retrieval between the CR1000 and a PC. The programming can be done in the office or in the field. The software should be loaded onto all PCs and portable laptop computers that may be used for programming weather stations. It is imperative that the CSI website is checked before any fieldwork for any updates to the current software version. The following instructions outline the basic steps in configuring the datalogger, sending programs to the datalogger, and viewing data collected from the datalogger. There are a number of other tools within the software that will not be described in this SOP, but are available in the manual or online at CSI[45]. Once LoggerNet is loaded onto a PC or laptop the toolbar below is used to navigate through the various functions.

[44] http://www.campbellsci.com/documents/manuals/loggernet.pdf
[45] http://www.campbellsci.com/loggernet



• **Setup**: Describes the configuration of COM ports, modems, dataloggers, and other devices; sets up the data collection protocols and schedules.

• **Connect**: Connects to each automated weather station configured in the "setup" option; synchronizes datalogger clock with the computer's clock; collects data and downloads .DLD files to dataloggers from a PC; views collected data and graphs real-time measurements.

• **Status**: Checks the communication and data collection status of all stations in the network; shows station names, whether or not a specific station is on line, error rates, time and date when the last data collection was attempted, how much data was collected, and the next call schedule.

• **Edlog**: Creates and edits datalogger programs for the CR1000.

• **CR Basic**: Creates and edits programs for the CR5000 and CR9000 dataloggers.

• **Split**: Used to separate mixed array data files into individual files based on the array ID. Split can also be used to create files in custom reports.

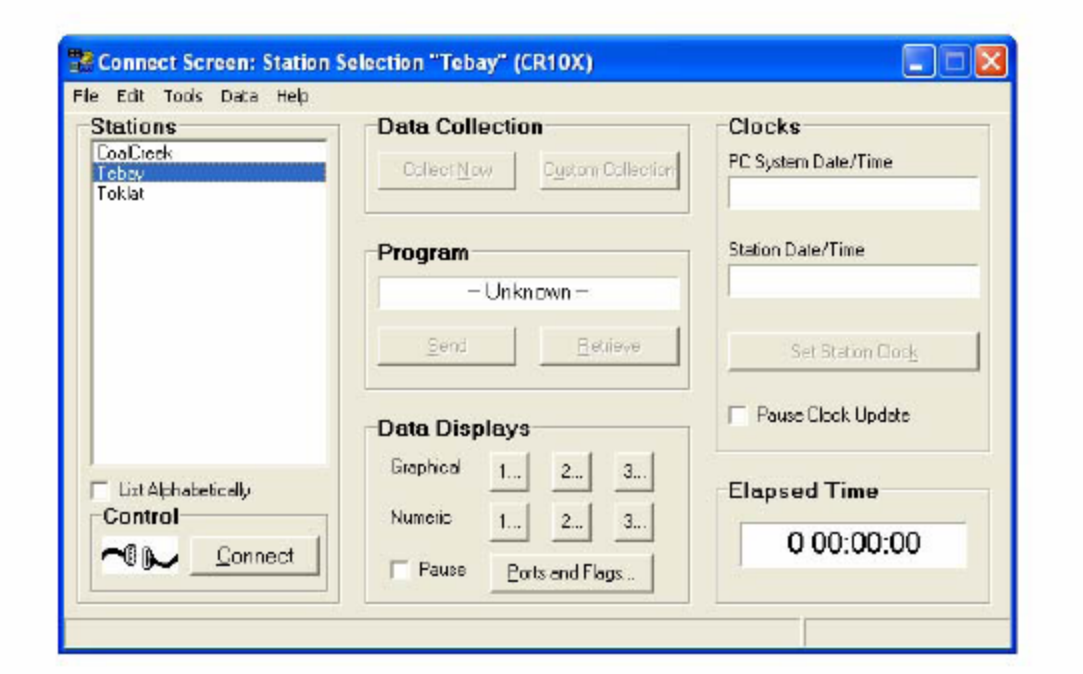
• **View**: Used to look at data files. The data is displayed in either comma separated or tabular format by record or array.

• **RTMC**: Real-Time Monitor and Control creates and displays real-time graphic display screens using the data collected from the dataloggers by LoggerNet.

• **Stg Module**: Retrieves files from storage modules via either a CR1000 and PC Cards or the CSMI/MCRI interface or directly from a PCMCIA slot in the computer with separate tab settings for the categories "setup", "programs", "data", and "erase".

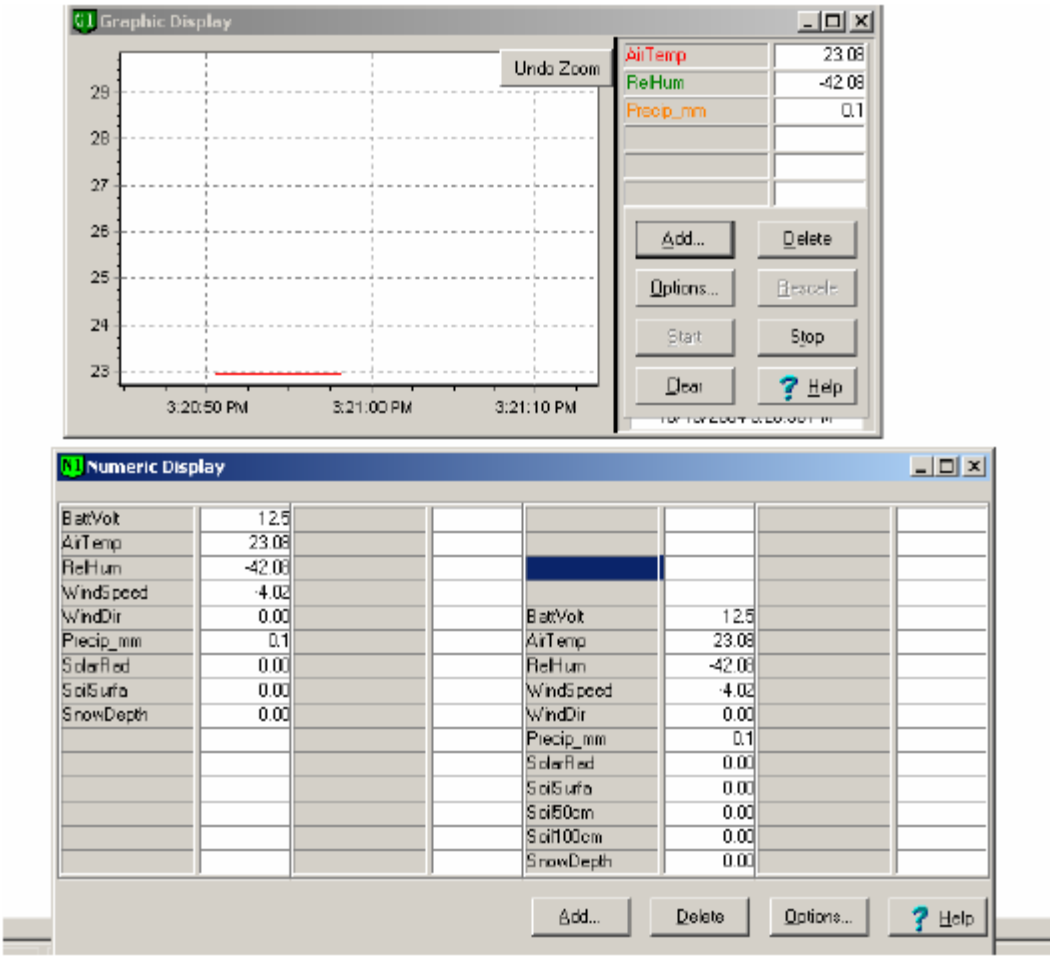
Details for use with the PACN weather stations:

Setup: The Setup button is used to define the communications paths between the computer and the dataloggers. It serves other functions, but this is the one necessary for programming. To connect the datalogger to the PC you need to address the nine-pin communication port (Com Port) that will be used. The default is Com Port1. Add the datalogger to the setup screen by clicking the Add button, this allows you to choose CR1000 from a list of possible datalogger choices. At this point you can choose to name the station; however the sample uses the default name of "CR1000". The datalogger name then appears under the Com Port 1 tab as shown in the screen below. Hit the Apply button to save the edits. In the near future communication ports might be obsolete. The use of USB connections is becoming the standard. The USB connection can be made by adding the datalogger to Com Port XX.



Connect: The Connect button is used to connect the computer to the data logger for the main purpose of transferring a program file and viewing the data. This button can also be used to transfer the data from the datalogger to the computer if a laptop is taken into the field on a site visit. Choose the station name (default on the sample screen is CR1000) and then click on connect. To collect data from a station slick on Collect Now under the Data Collection tab and it will retrieve all of the data from the datalogger and store it under the name of the connection. Use the standard name for the station so that the data files are easily found. To send a program to the datalogger, click on Send under the Program box and it will allow you to browse through your files. Select the program you want to send and click send again. It will send the file and compile the program. A warning message will appear before you send the program alerting you that all data will be lost if you send a new program; make it a standard practice to collect all the data from the datalogger before sending any new programs.

If you use LoggerNet in the field the Data Display tabs can be used to view the current data in either numerical or graphical display as shown below. Click on Data Displays to open the graphs and tables.



Datalogger Programming

The PACN dataloggers are programmed to measure the suite of sensors every 60 seconds, store the values, and output the hourly calculation to the satellite transmitter at 5 minutes after the hour. In order for the data stream to be processed by the National Interagency Fire Center in Boise, ID the output has to follow the RAWS-7 data format outlined in the SAT HDR GOES Transmitter Instruction Manual. RAWS-7 refers to the standard file format that is processed by fire weather managers, the RAWS-7 measurements are; precipitation, wind speed, wind direction, air temperature, fuel temperature, relative humidity, and battery voltage. Data values beyond the RAWS-7 are transmitted individually to the satellite transmitter after the first seven are sent as a package. The file format specifies the number of decimal places for each measurement. The PACN stations also transmit peak wind direction, peak wind speed, solar radiation, minimum air temperature, and maximum air temperature.

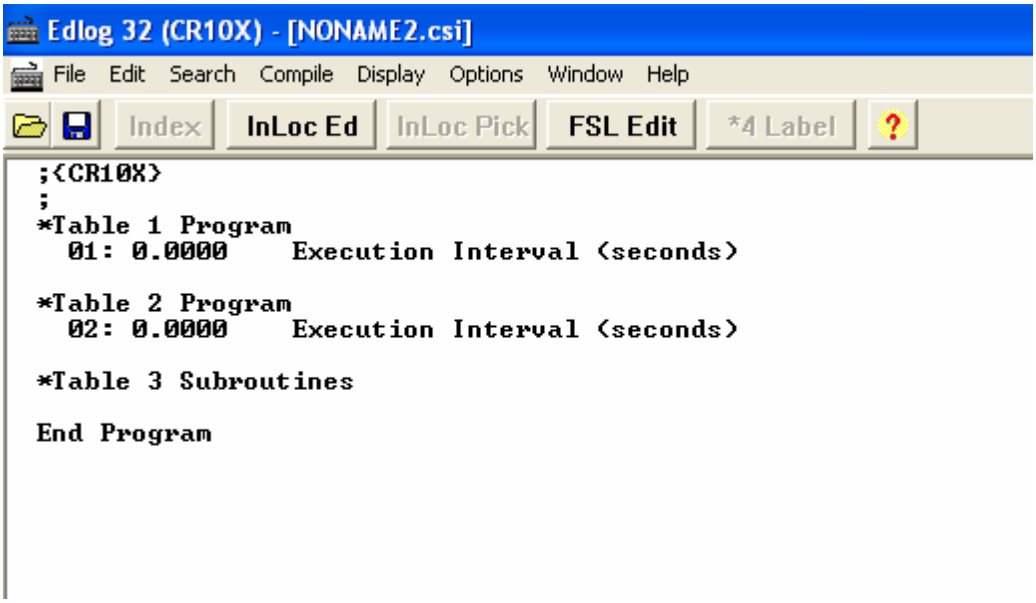
Procedure:

1. To start programming the CR1000 open LoggerNet and click on the Edlog button

2. The software will open the last program you were working with, to create a new program click on File|New. At this point you will be prompted to enter the type of datalogger you will be using.

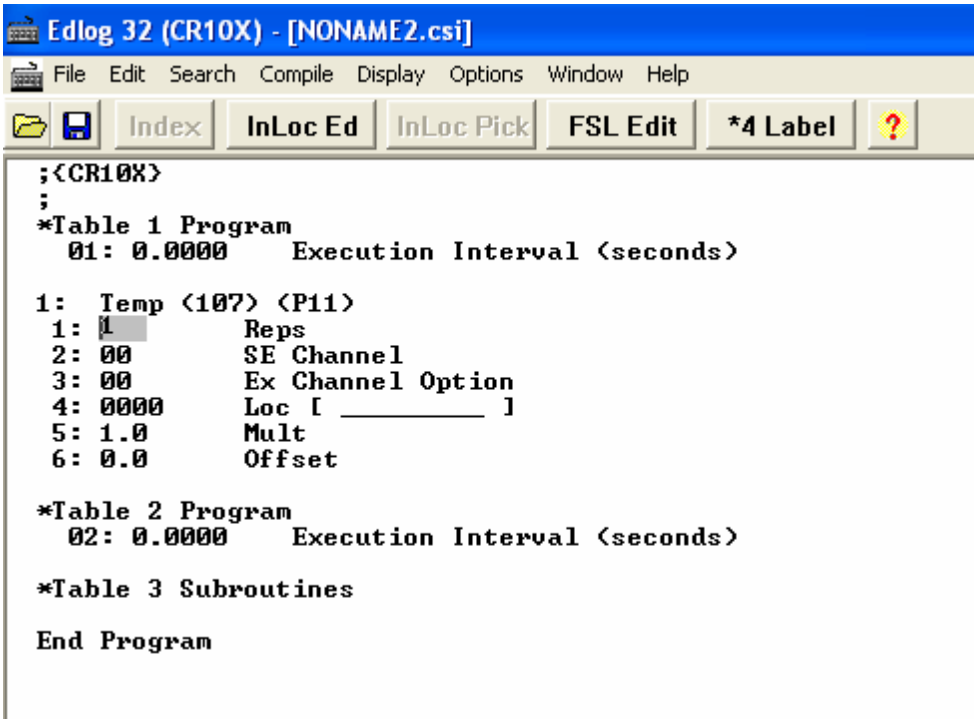
The screen below shows a new file. The file name for the current program for the climate stations is PACN_1. The nomenclature for future programming versions should include a date but the file name cannot exceed 8 characters, an example would be V1_12004 where V1_1 is Version 1.1 created in 2004, subsequent versions would increment to the next number, i.e. V1_22005.

3. The first step is to set the execution interval or how often you want the datalogger to run through the program. The PACN climate station standard is 60 seconds.



4. The next step is to start programming. Instructions can be inserted after the execution interval line in the Table 1 Program. Instructions that cue the datalogger to take a measurement are listed in the CR1000 manual and are also detailed in the instruction manuals for the sensors.

5. Use the Shift +Insert key to pull up a menu of instructions or type in the number of the instruction after consulting either of the manuals. Each instruction will require a number of inputs including repetitions, signal inputs, excitation channels, and location of output, multipliers, and offsets. All of this information is available in the manuals. The screen below shows an example of the instruction used to measure the temperature probe.



6. If you add a sensor to the weather station it will require an instruction within the program to measure and record in order for it to be recorded. Some of the sensors require more than one instruction to complete the measurements, for example the HMP45C measures both air temperature and relative humidity and requires a total of five instructions to complete the measurements. The following screens show the measurement instructions for the PACN_1 program.

Edlog 32 (CR10X) - [C:\CAMPBELLSCI\1PROGRAMS\1PROGRAMS\CAKN_1.CSI]

File Edit Search Compile Display Options Window Help

Index | InLoc Ed | InLoc Pick | FSL Edit | *4 Label | ?

```
;{CR10X}

; RAWS CR10X program for Central Alaska Network Climate Stations
;for DENA, WRST and YUCH
;Program measures Batt. Volt., AT, RH, Precip, WS, WD, Solar Rad,
;| Surface temp, Soil temp at 50cm and 100cm
;and snow depth every 60 seconds.
;  2004

;Set program interval to mesaure sensors every 60 seconds

*Table 1 Program
  01: 60          Execution Interval (seconds)

;Measure battery voltage

1:  Batt Voltage (P10)
 1: 1       -- Loc [ BattVolt  ]

; Measure temp (deg C) and RH (%) (HMP45C)

2:  Do (P86)
 1: 41          Set Port 1 High

3:  Excitation with Delay (P22)
 1: 1           Ex Channel
 2: 0           Delay W/Ex (0.01 sec units)
 3: 15          Delay After Ex (0.01 sec units)
 4: 0           mV Excitation

4:  Volt (SE) (P1)
 1: 1           Reps
 2: 5           2500 mV Slow Range
 3: 1           SE Channel
 4: 2           Loc [ AirTemp   ]
 5: 0.1         Mult
 6: -40         Offset

5:  Volt (SE) (P1)
 1: 1           Reps
 2: 5           2500 mV Slow Range
 3: 2           SE Channel
 4: 3           Loc [ RelHum    ]
 5: 0.1         Mult
 6: 0.0         Offset

6:  Do (P86)
 1: 51          Set Port 1 Low

; Measure Wind Speed (m/s) and Direction (RM Young 05103)

7:  Pulse (P3)
 1: 1           Reps
 2: 1           Pulse Input Channel
 3: 21          Low Level AC, Output Hz
 4: 4           Loc [ WindSpeed ]
 5: 0.0980      Mult
 6: 0.0         Offset

8:  Excite-Delay (SE) (P4)
 1: 1           Reps
 2: 5           2500 mV Slow Range
 3: 3           SE Channel
 4: 2           Excite all reps w/Exchan 2
 5: 2           Delay (units 0.01 sec)
 6: 2500        mV Excitation
 7: 5           Loc [ WindDir   ]
 8: 0.142       Mult
```

```
;Measure precipitation (mm)

9:  Pulse (P3)
 1: 1         Reps
 2: 2         Pulse Channel 2
 3: 2         Switch Closure, All Counts
 4: 6         Loc [ Precip_mm ]
 5: 0.254     Mult
 6: 0         Offset


; Measure Solar Radiation (W/m2) (LI200X)

10:  Volt (Diff) (P2)
 1: 1         Reps
 2: 22        7.5 mV 60 Hz Rejection Range
 3: 3         DIFF Channel
 4: 7         Loc [ SolarRad  ]
 5: 200       Mult
 6: 0         Offset

;Measure soil temps at surface and depth of 50cm and 100cm

11:  Temp (107) (P11)
 1: 3         Reps
 2: 7         SE Channel
 3: 3         Excite all reps w/E3
 4: 8         Loc [ SoilSurfa ]
 5: 1.0       Mult
 6: 0.0       Offset

; Measure/Calculate Snow Depth (m)

12:  If time is (P92)
 1: 0         Minutes (Seconds --) into a
 2: 60        Interval (same units as above)
 3: 30        Then Do

     13:  SDI-12 Recorder (P105)
      1: 0         SDI-12 Address
      2: 1         Start Measurement (aM1!)
      3: 2         Port
      4: 11        Loc [ SnowDepth ]
      5: -1.0      Mult
      6: 0.0       Offset

     14:  Z=X+F (P34)
      1: 2         X Loc [ AirTemp   ]
      2: 273.15    F
      3: 12        Z Loc [ TempK     ]

     15:  Z=F x 10^n (P30)
      1: 273.15    F
      2: 0         n, Exponent of 10
      3: 13        Z Loc [ RefTemp   ]

     16:  Z=X/Y (P38)
      1: 12        X Loc [ TempK     ]
      2: 13        Y Loc [ RefTemp   ]
      3: 14        Z Loc [ SnowMult  ]

     17:  Z=SQRT(X) (P39)
      1: 14        X Loc [ SnowMult  ]
      2: 14        Z Loc [ SnowMult  ]
```

```
     18:  Z=X*Y (P36)
      1: 11        X Loc [ SnowDepth ]
      2: 14        Y Loc [ SnowMult  ]
      3: 11        Z Loc [ SnowDepth ]

; Height of sensor above bare-ground level

     19:  Z=X+F (P34)
      1: 11        X Loc [ SnowDepth ]
      2: 1.95      F
      3: 11        Z Loc [ SnowDepth ]

; Set snow depth values less than 1cm to zero

     20:  If (X<=>F) (P89)
      1: 11        X Loc [ SnowDepth ]
      2: 4         <
      3: 0.01      F
      4: 30        Then Do

          21:  Z=F x 10^n (P30)
           1: 0         F
           2: 0         n, Exponent of 10
           3: 11        Z Loc [ SnowDepth ]

     22:  End (P95)

23:  End (P95)
```

7. The next step involves some preliminary processing and calculations. It is common to eliminate negative solar radiation values and relative humidity values above 100%. This can be accomplished by using processing instructions. It is also necessary to store values of measurements beyond the RAWS-7 data points such as peak wind speed and direction at peak and minimum and maximum air temperatures in an intermediate storage location, the following screens show the calculations and processing for this next step.

```
;************************************************
; Calculations/processing sent to input locations


; Set negative solar radiation values to zero

24:  If (X<=>F) (P89)
 1: 7         X Loc [ SolarRad  ]
 2: 4         <
 3: 0         F
 4: 30        Then Do

     25:  Z=F (P30)
      1: 0         F
      2: 0         Exponent of 10
      3: 7         Z Loc [ SolarRad  ]

26:  End (P95)

; Eliminate RH values greater than 100

27:  If (X<=>F) (P89)
 1: 3         X Loc [ RelHum    ]
 2: 3         >=
 3: 100       F
 4: 30        Then Do

     28:  Z=F (P30)
      1: 100       F
      2: 0         Exponent of 10
      3: 3         Z Loc [ RelHum    ]

29:  End (P95)
```

```
30:  If time is (P92)
 1: 0         Minutes (Seconds --) into a
 2: 60        Interval (same units as above)
 3: 10        Set Output Flag High (Flag 0)


31:  Set Active Storage Area (P80)
 1: 3         Input Storage Area
 2: 42        Loc [ MaxWindSp ]


32:  Maximum (P73)
 1: 1         Reps
 2: 00        Time Option
 3: 4         Loc [ WindSpeed ]


33:  Sample on Max or Min (P79)
 1: 1         Reps
 2: 5         Loc [ WindDir   ]


34:  Minimum (P74)
 1: 1         Reps
 2: 00        Time Option
 3: 2         Loc [ AirTemp   ]


35:  Maximum (P73)
 1: 1         Reps
 2: 00        Time Option
 3: 2         Loc [ AirTemp   ]


36:  Time (P18)
 1: 3         Store Year,Day,Hr,Min,Sec in 5 consecutive locations
 2: 0         Mod/By
 3: 46        Loc [ Year      ]
```

8. Sending the hourly values to the transmitter is the next step. The PACN weather stations are set up to calculate hourly averages for air temperature, relative humidity, wind speed, mean vector wind direction, solar radiation, soil temperatures, and snow depth. This program also records hourly precipitation totals and the maximum and minimum air temperatures and peak wind speeds and direction. See the following screens for the programming involved in the data transmission process. This section of the programming is bulky because each measurement needs to be sent individually to the transmitter.

```
;*****************************************************

;Write hourly RAWS-7 data to final storage area 1
;and then send to transmitter
;Order is important, First in-First out.
;Precip (Hourly total)
;Wind Speed
;Wind Direction
;Air temperature (Hourly average)
;Fuel temperature (Hourly average)
;Relative Humidity (Hourly average)
;Battery Voltage (Hourly minimum )
;After RAWS-7 is sent to transmitter append other measurements
;Deg dir max gust, w/s max gust, Solar Rad, snow depth
;Min Air temp, Max Air Temp,
;Temp 50 cm, temp 100cm


37:  If time is (P92)
 1: 0        Minutes (Seconds --) into a
 2: 60       Interval (same units as above)
 3: 10       Set Output Flag High (Flag 0)
```

9. The last part of the programming is for diagnostics regarding the satellite transmissions. The datalogger registers the number of times it attempts to send the data to the transmitter and sends an error code if something is wrong. This step helps in the diagnostic phase if the transmissions are interrupted.

10. After the programming is complete, the entire file is compiled and checked for errors and then saved in multiple file formats; clicking on the save button automatically initiates these functions. The file is then ready for transfer to the data logger.

The programming will be changed over time as technology advances. Documentation of program changes should be included with the metadata for the program. Version numbers will help clarify what was changed and when it was changed. It is important to run new program versions prior to field deployment to ensure the programming is correct.

Data Collection using LoggerNet

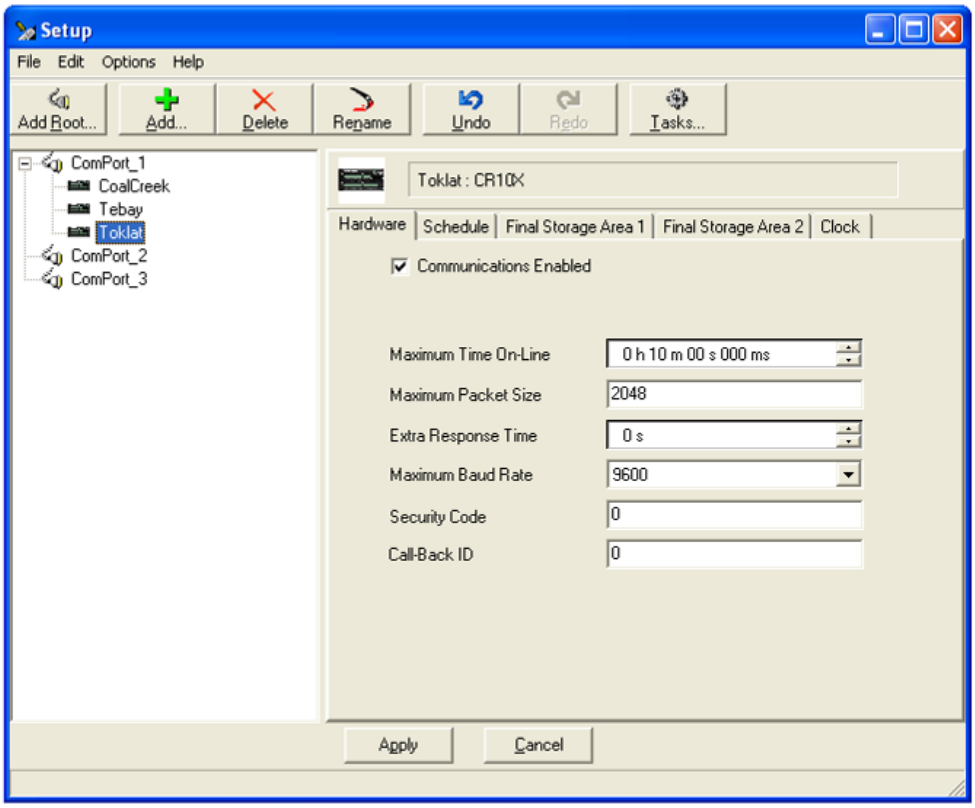
This section describes the procedure to download data from a CR1000 datalogger in the field. This can be accomplished in two ways, with a laptop or with a Palm PDA. The following is a summary of the procedures involved in collecting data via a laptop with Campbell Scientific, Inc. LoggerNet software installed. Laptops and PDAs do not work well at temperatures below 0°C, if possible schedule downloads in warmer seasons.

Procedures

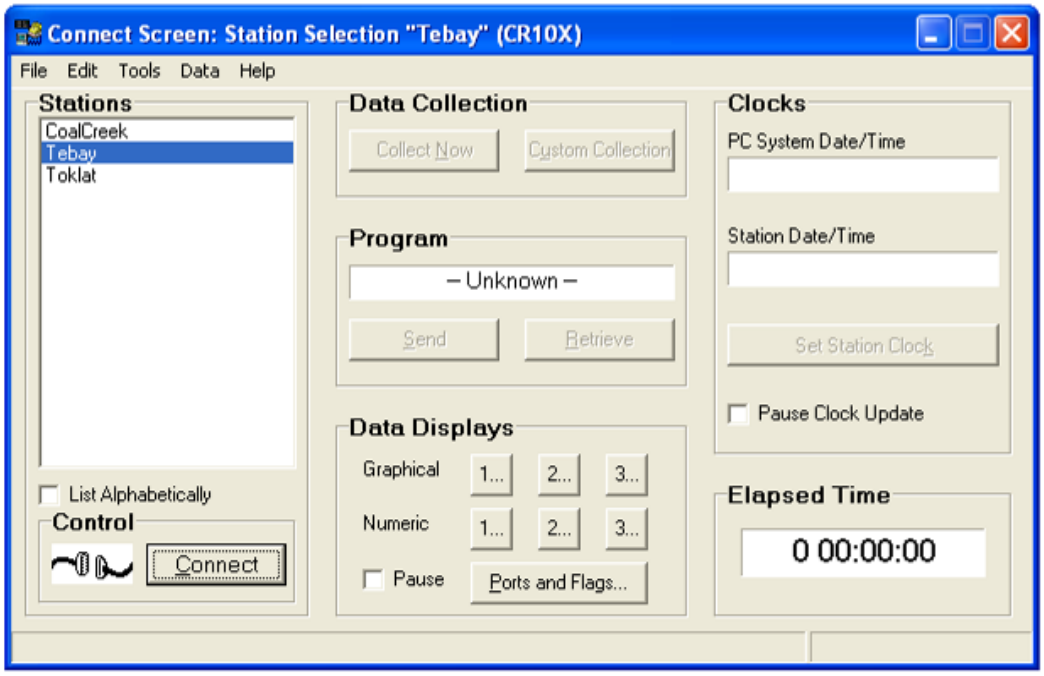
Collecting data in the field

1. Connect the datalogger to the laptop using the 9-pin CSI serial cable for battery powered laptops.
2. In LoggerNet hit the **Setup** button and add the name of the station you are visiting under ComPort_1. The default will say CR1000. Click the **Rename** button up top and then **Apply**. It is important to name the station at this point.

3. Click **Connect** on the LoggerNet toolbar. The station name should appear in the box on the left. If it doesn't go back to **Setup** and add the station. Click on the station and then click **Connect** at the bottom of the screen.



4. The icon at the lower left should show that you are connected and the elapsed time indicator will start.
5. Click on **Collect Now** under **Data Collection.** The data from the datalogger will be collected and stored in a file named *stationname*.dat in the LoggerNet file under the Campbell_sci folder**.**



CRBasic Editor

This help file contains example program code for all instructions in the datalogger. Look for the Example link at the top of each instruction topic.

The CRBasic Editor is a programming tool for the CR200(X), CR5000, CR1000, CR3000, CR800, and CR9000(X) dataloggers. It is intended for use by the experienced datalogger programmer who needs more flexibility than what is found in Short Cut for Windows. This programming language is similar in syntax, program flow, and logic to the BASIC programming language. Many functions found in BASIC languages are also found in CRBasic.

The CRBasic Editor's main window is divided into two parts: the program entry window and the Instruction Panel. The Instruction Panel is a list that comprises the instructions in the CRBasic language. Instructions can be selected from this list or typed directly into the program entry window. By default a list of all instructions is displayed, but this list can be filtered by instruction types using the list box above the panel. When a program is compiled, a third section of the screen displays compiler messages.

Also see:

Programming Tips
The Parameter dialog box
Compiling Programs
Customizing the "Look and Feel" of the Editor

Standard Operating Procedure (SOP) # 12:
Instructions and Forms for Site Visits

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This SOP provides instructions and forms for site visits to weather stations by PACN staff. These visits may be to PACN weather stations or stations belonging to RAWS, COOP, GPMN, HaleNet, or ALERT stations.

General Field Form Handling Procedures
Field data forms are part of the permanent record for project data and should be handled in a way that preserves their future interpretability and information content. If changes to data on the forms need to be made either during or after field data acquisition, the original values should not be erased or otherwise rendered illegible. Instead, changes should be made as follows:

- Draw a horizontal line through the original value, and write the new value adjacent to the original value with the date and initials of the person making the change.
- All corrections should be accompanied by a written explanation in the appropriate notes section on the field form. These notes should also be dated and initialed.
- If possible, edits and revisions should be made in a different color ink to make it easier for subsequent viewers to be able to retrace the edit history.
- Edits should be made on the original field forms and on any photocopied forms.

These procedures should be followed throughout data entry and data revision. On a yearly basis, data sheets are to be scanned as PDF documents and archived. The PDF files may then serve as a convenient digital reference of the original if needed.

Station Visits

It is the goal of the PACN climate data management effort to use digital versions of datasheets whenever possible to reduce possible transcription errors. If the datasheet is filled in manually, data should be transcribed immediately after the field visit and the datasheet should be scanned.

New Stations

Site conditions for new PACN weather stations need to be documented using the PACN Weather Station Documentation form (appended below). If the station is not a PACN station reporting requirements for the climate network to which the station belongs need to be followed. For the PACN data management effort, it will be useful if PACN staff fills in the PACN Weather Station Documentation form for all stations regardless to which climate monitoring program they belong. For PACN stations only: if data collection for new stations is initiated at the same time that the station is set up, the PACN Weather station Field Datasheet should also be used to record the results of current readings.

Maintenance Visits

Annual maintenance is required for all PACN stations. The following maintenance procedures need to be conducted at that time:

1. Download data from datalogger (SOP 11)
2. Replace the RH/temperature probe.
3. Calibrate the rain gauge in the field (see sensor manual).
4. Replace desiccant in enclosure
5. Tighten guy wires

Additional required procedures dependent on length of station operation:

6. Replace the LI 200X pyranometer (every other year)
7. Replace the Sonic Wind Sensor (every 3 years)
8. Replace the CR1000 datalogger (every 3 years)
9. Replace battery (every 5 years)
10. Replace GOES transmitter (every 5-10 years)

Note: calibration of pyranometers, wind sensors, dataloggers, and GOES transmitters is expensive; stagger the rotation so that only 2-3 are being calibrated per year. Follow manufacturer specifications for return/calibration of sensors; ensure that sensors are sent off in a timely manner to have spares on hand for scheduled or emergency replacements.

Even if data are transmitted remotely, regular station visits are necessary to ensure that data collection is not compromised due to physical problems of the sensors, the support structure, or the environment. The PACN weather stations are visited every other month to every 12 months depending on how remote the site is to check on the condition of the station. Sensor replacements or calibrations and notes on the general conditions of the weather station must be recorded on the PACN Weather Station Field Datasheet at each visit. An equipment checklist for station visits is appended below.

Maintenance for station belonging to other climate monitoring programs is outlined in Chapter 3 of the PACN weather/ climate monitoring protocol with links to the appropriate 1s.

Station Documentation

Detailed field site documentation including photo documentation (SOP 13) should be conducted at least every other year. Documentation will include all weather stations in the PACN located inside the national parks if access is feasible without incurring excessive cost (helicopter access or extended hikes to reach the site). If time and resources permit, stations included in PACN climate monitoring but located outside the national park boundaries will also be included. The goal is to assess if environmental factors have changed that could affect the validity of the collected data. For these station visits PACN Station Documentation checklist (appended below) needs to be filled out. In preparation for these visits the original station documentation for the given station needs to be retrieved and brought into the field to allow comparisons. This maybe a PACN station documentation or documentation by another climate monitoring program. In addition the PACN Weather station Field Datasheet should be filled out to record the condition of the station.

PACN Weather Station Field Datasheet		
Date (dd month year):	**Time:**	
Station Name/Number:	**Observer:**	
Is this a general maintenance visit or annual maintenance?	**Station documentation conducted today?**	
Data downloaded today?	**Using PDA or laptop?**	
Station Physical Inspection Checklist	**Yes or No**	**Comments Note any adjustments/cleaning/repairs made to sensors or station hardware.**
Any sign of vandalism or animal damage?		
Guy wires & footings appear tight and in good condition?		
Tripod and mast appear straight and in good condition?		
Grounding rod and cables in good condition and properly connected?		
Cables are tied down and secured and in good condition?		
Battery housing looks in good condition?		
Solar panel clean?		
Wind speed cups spin freely and easily?		
RH/Temps sensor housing appears clean and in good condition?		
Solar radiation sensor clean?		
Tipping bucket clean and clear?		
Current readings		
Wind speed		
Wind direction		
RH		
Temperature		
Rainfall		

Radiation		
Battery voltage		
Sensor calibration/replacement	**C or R**	**Comments (note serial# of old and new sensors)**
Anemometer		
RH/temperature		
Pyranometer		
Rain gauge		
Battery		
GOES transmitter		
Other replacements		
Other Notes: **For instance, signs of human or animal activity, disturbance by severe weather. If extensive land use changes are evident fill out a PACN Station Documentation Checklist.**		

PACN Weather Station Documentation	
Date (dd month year):	**Time:**
Station Name/Number:	**Observer:**
Data recording initiated today?	
Site Physical Description	**Detailed Notes** **If this is a repeat visit describe changes compared to last station documentation**
Location general description (area and road names, etc)	
Topographic features	
Elevation (determined how?)	
GPS Coordinates (record lat, long, GPS model, waypoint names)	
GPS track from nearest road taken? (GPS model, track names)	
Local weather patterns	
Vegetative cover type	
Free of tall weeds and grass?	
Fenced against people and animals?	
Shadow free (0700-1700)?	
Sources of dust (e.g., roads, parking areas, etc)	

Sources of surface moisture (e.g., irrigated lawns, pastures, gardens, lakes and rivers	
Large reflective surfaces (e.g., buildings, lakes, ponds, rivers)	
Large buildings, trees and dense vegetation	
Distinct changes in topography - gullies, peaks, ridges, steep slopes & narrow valleys	
Extensively paved or blacktopped areas	
Photo documentation done?	
Other Notes:	

Equipment Checklist for Deployment/Maintenance

Tools

Adjustable Wrench
Drill
Electrical tape
Enclosure putty
Extra nuts/bolts/washers/screws
GPS
Hacksaw
Hex wrench set
Level
Loppers
Needle Nose Pliers
Nut drivers 3/8", 5/16"
Open Ended Wrenches: 3/3", 7/16", ½", 9/16"
Philips Head Screwdriver
Pipe wrench 12"
Pliers
Pocket Knife
Rock bar
Shovel
Silicone spray (to loosen bolts if necessary)
Small sledgehammer
Socket Wrench and 7/16" deep well, 9/16" and ½" sockets
Straight Bit Screwdriver
Tape measure
Teflon tape/Pipe Dope
Tie-wraps
Voltmeter
Wire cutters and strippers

Other

Binoculars
Calculator
Camera and extra batteries
Compass w/known magnetic declination of area
CR1000 program
CR1000 prompt sheet
CR1000 wiring diagrams
Data sheets
Desiccant packs
GOES program
Inclinometer
Laptop computer and connection cables and Palm PDA w//PC Connect and cables
Paper towels
Radio and/or cell phone
Sharpie/Pencil
Step ladder (4' or 6')
Thermometer (°C)

Standard Operating Procedure (SOP) # 13:
Photographic Documentation of Weather/Climate stations

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This Standard Operating Procedure (SOP) explains the procedures for proper photographic documentation of a weather station and its surroundings. This SOP also provides a diagram illustrating photograph locations and the directions in which to take each photograph. This diagram is intended to assist the user in the photographic documentation process. A list of necessary tools and equipment is provided, along with a list of example photographs from selected weather stations in the western United States.

This SOP is based directly on the SOP created for the NPS Inventory and Monitoring Program by Greg McCurdy in 2006 (Version 1.00, 10/1/06).

I. Introduction

Photographic documentation of a weather station and its surroundings allow users of the station data to more accurately interpret readings. In addition, repeat station photography documents evidence of physical changes occurring over time at the site that may affect station data. For example, vegetation growth over time or changes such as buildings or parking lots may alter temperature or wind patterns. Photographs also show station placement in relation to surrounding features that maps cannot illustrate.

The procedures outlined below provide a method for consistently capturing the exposures and overall physical setting of a station.

II. Digital Camera Settings

Specific camera settings will vary between camera manufacturers, models and change with different circumstances and exposures. The following guidelines will require referring to the camera manual for determining specific settings.

1. Photo size setting may be any size, but the ideal settings are 1280x960 or 1600x1200 with normal resolution or compression. This will create an image that is about 200-400 Kb. This provides a good quality image and allows for timely network transport.
2. Methodology instructions are for a camera with a 35mm lens. Many digital cameras are capable of a zoom setting. Do not zoom in. Set lens at widest angle possible for the standard photo positions. This will provide a consistent lens setting for each standard position photo. Additional photos that highlight a feature or setting not captured from the standard photo positions are encouraged. Specialty lens (such as fish-eye lens) may also be used for additions photos, if desired. Notes of camera settings and location for non-standard position photos will be useful at future dates.
3. Auto focus and auto shutter may be used. Set auto shutter to expose the terrain, not necessarily the sky. Most digital cameras allow this by pointing at an object at the same distance as the weather station (probably down at the base of the station), gently pressing the button to the first depression, then re-center the photo (re-leveling) and pressing the button the remainder of the way to take the picture. It will be noticed that the first depression will fix the shutter and the focus.
4. Unlike photographic film, digital memory is cheap and can be reused. Taking multiple pictures from each position is suggested.
5. Ideal conditions are a clear day, with the sun high in the sky, (2 hrs. after sunrise to 2 hrs. before sunset).

III. Method

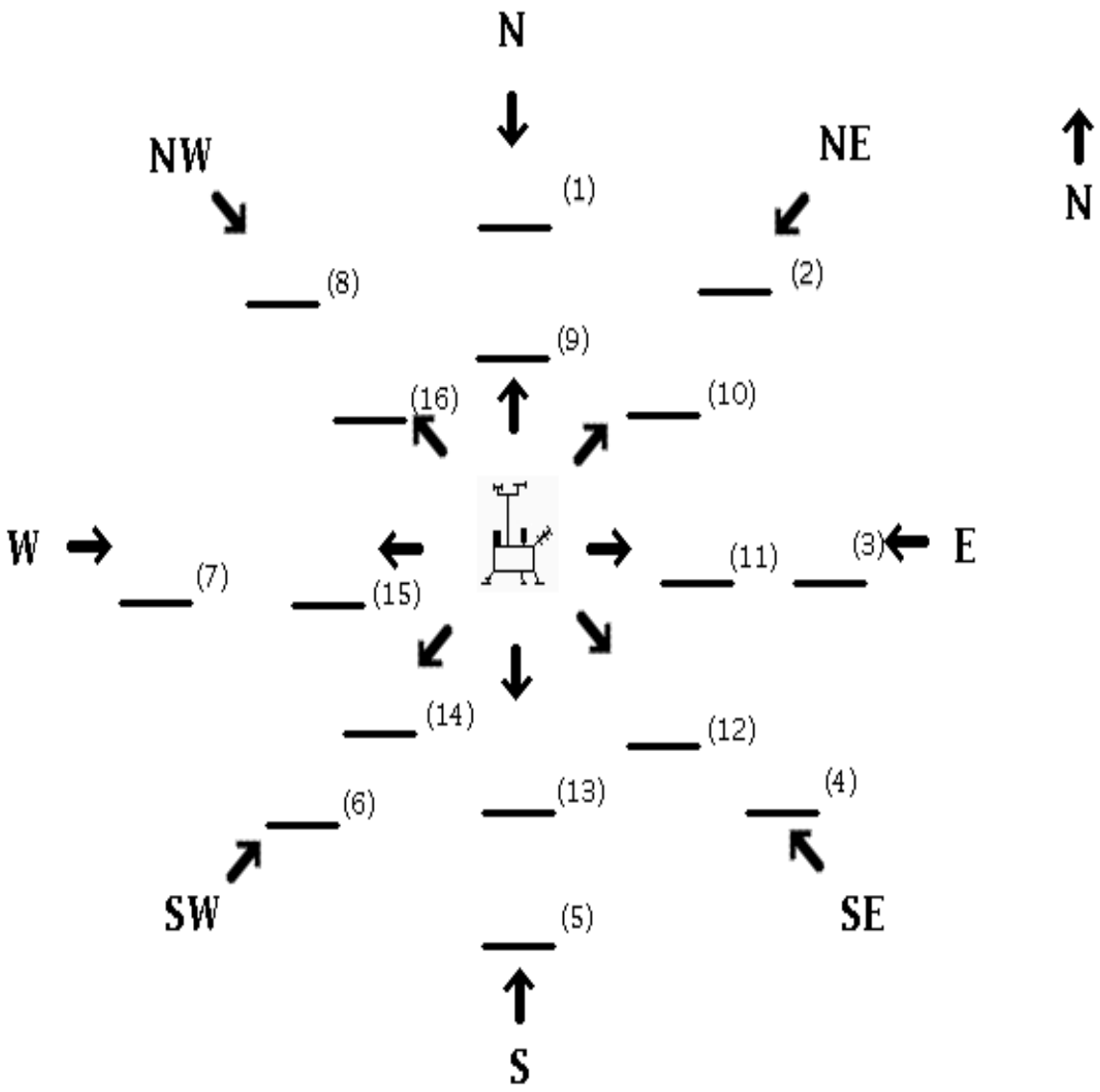
1. Using a compass or GPS, identify positions that are between 50-100 feet from the station in each of the cardinal directions (N, S, E, W) and secondary directions (NE, SE, SW, NW).
2. Begin at north cardinal direction, labeled as N (1) on accompanying station map (Figure 1).
    a. Check your distance and orientation. Again, the position should typically be at a distance of 50 to 100 feet from the station. If a cliff or other unnavigable obstruction does not allow the ideal distance, the photo should be taken at the best reasonable distance (cliff edge or cliff wall). Some directions may not have the station obviously visible in the photo.
    b. Take picture in landscape orientation (not portrait).
    c. The weather station structure should occupy 50-70% of the vertical frame.
    d. Try to take photograph as level (both vertically and horizontally) as possible, even if the station is positioned above or below the photograph center position. Take 2-5 photos varying exposure as noted in camera settings #3.
    e. Note your location relative to the station (the attached sheet should be used for this purpose). Items that should be noted here include the photo sequence and number of photos.
3. Go to the next position (labeled NE (2) on Figure 1), checking your distance and orientation, and repeat step 2.
4. Repeat steps 2-3 until station photographs have been taken at all 8 positions.

5. Return to the same cardinal compass point (labeled N (2) on Figure 1) as you started at in step 2, but now orient yourself so that the weather station is 5 to 10 feet behind you and aim away from the station.
    a. Take picture in landscape orientation.
    b. Photo should be level to horizon, even if there is a tree, cliff, wall, other obstacle, or open horizon.
    c. Double-check where the camera is being aimed. Without a subject (weather station) it can be easy to point at another subject and not toward the compass direction desired.
    d. Note your location relative to station and record same information as in step 2e.
6. Repeat step 5 for each of the 8 positions. It is best to go around these positions in the same order as in steps 2,3.

Take photos from all positions unless absolutely, physically impossible (i.e. 2000' cliff, 10 feet from station), even if small variations of above protocol is required. For example, if a wall or tree is physically in the position where a photo would be taken, move slightly to obtain the photo. Keep in mind that the photo is to tell the story of the setting of the station and measuring equipment.

Additional photographs: Additional photographs may be taken that show any element of interest that might not have been captured in the sequence. These may include photos from a greater distance that illustrate the station exposure. Make every effort to ensure that the weather station is visible in the station photos (or at least identifiable) and not hidden.

Movie clips: Many new digital cameras are capable of taking short streaming video or .avi format video clips. A short (45-70 sec. duration) video clip can be taken to give a 360 degree (panoramic) sweep of the station setting. To do this, select a location in proximity to the station (usually 100 to 200 feet away). Typically this location would be at an elevated vantage point relative to the station. Begin by aiming due north, start the .avi exposure and slowly rotate in a clockwise direction until again aiming north, pause briefly (~1 sec.) then stop the exposure. To avoid 'video blur', the speed of rotation will require about 60 seconds completing the 360 degree sweep. If the station is in a heavily forested area, try to select a location with optimum exposure where the station is still visible. For tall tower sites, this might actually be on the weather station tower.



Fill blank with photo number or photo sequence.

Station:_____
Date:_____
Photographer:_____
Photographer Contact Info:_____
Other Remarks: _____
_____

Figure 1. Photodocumentation key map

IV. Required Tools and Materials

1. Camera
2. Extra Batteries for camera or means to recharge
3. Computer to download pictures from camera
4. Sunshade (Hat with brim) to view camera LCD.
5. Compass or GPS receiver with compass capability
6. Blank copies of photo documentation key map.

V. Examples:

http://www.wrcc.dri.edu/cgi-bin/wea_info.pl?caclab	Los Banos, California
http://www.wrcc.dri.edu/cgi-bin/wea_info.pl?cacleo	Leo Carillo, California
http://www.wrcc.dri.edu/cgi-bin/wea_info.pl?nvndea	Dead Camel Mountain, Nevada
http://www.wrcc.dri.edu/cgi-bin/wea_info.pl?nvnrer	Red Rock, Nevada
http://www.wrcc.dri.edu/cgi-bin/wea_info.pl?nvihsb	Horse Butte, Idaho
http://www.wrcc.dri.edu/cgi-bin/wea_info.pl?cacsqu	Squaw Lake, California
http://www.wrcc.dri.edu/cgi-bin/wea_info.pl?azatwe	Tweeds Point, Arizona
http://www.wrcc.dri.edu/cgi-bin/wea_info.pl?nvnced	Cedar Pass, Nevada

Standard Operating Procedure (SOP) # 14:
Workspace Setup and Project Records Management

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This document describes how to set up the computer project workspace and describes the PACN Digital Library which is used for archiving of weather/climate monitoring products.

Set Up Project Workspace
A section of the networked PACN file server is reserved for this project, and access permissions are established so that weather project staff members have access to needed files within this workspace. Prior to each calendar year, the project manager should make sure that network accounts are established for each new weather project staff member, and that the data manager is notified to ensure access to the project workspace and databases. If network connections are too slow for efficient data entry and processing, individual weather project staff members may set up a workspace on their own workstation, with periodic data transfer to the PACN server. Daily backups of the workstation to an external hard drive will ensure that no data is lost.

The recommended file structure within this workspace is shown in Figure 1. Certain folders – especially those for GPS data and images – should be retained in separate folders for each calendar year as shown in Figure 1.This will make it easier to identify and move these files to the project archives at the end of each calendar year (see Chapter 4: Season Close-out).

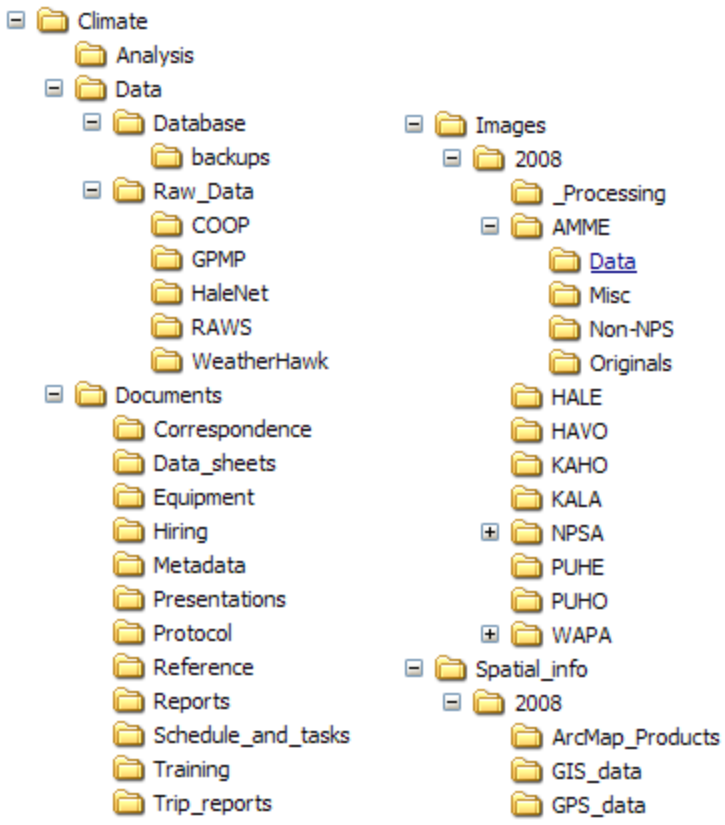


Figure 1. Recommended file structure for project workspace.

Each major subfolder is described as follows:

- Analysis – Contains working files associated with data analysis.

- Data – Contains the working database file for the calendar year and raw, unedited climate data. The master database for the project is stored in the PACN Digital Library.

- Documents – Contains subfolders to categorize documents as needed for various stages of project implementation.

- Images – For storing images associated with the project (refer to **S**OP 15). Note that this folder contains subfolders to arrange files by year.

- Spatial info – Contains files related to visualizing and interacting with GIS data.
    - ArcMap Products – Map composition files (.mxd).
    - GIS data – New working shapefiles and geodatabases specific to the project.
    - GPS data – Contains GPS data dictionaries and raw and processed GPS data files. Note that this folder contains subfolders to arrange files by year.

Naming Conventions

Folder Naming Standards

In all cases, folder names should follow these guidelines:

- No spaces or special characters in the folder name.
- Use the underbar ("_") character to separate words in folder names.
- Try to limit folder names to 20 characters or fewer.
- Dates should be formatted as YYYYMMDD.

File Naming Standards

In all cases, file names should follow these guidelines:

- No spaces or special characters in the file name.
- Use the underbar ("_") character to separate file name components.
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters.
- Dates should be formatted as YYYYMMDD.
- Correspondence files should be named as YYYYMMDD_AuthorName_subject.ext.

Archiving and Records Management

All project files should be reviewed, cleaned up and organized by the project manager on a regular basis (e.g., annually in January). Decisions on what to retain and what to destroy should be made following guidelines stipulated in NPS Director's Order 19[46], which provides a schedule indicating the amount of time that the various kinds of records should be retained. Although many of the files for this project may be scheduled for permanent retention, it is important to isolate and protect these important files and not lose them in the midst of a large, disordered array of miscellaneous project files. Because this is a long-term monitoring project, good records management practices are critical for ensuring the continuity of project information. Files will be more useful to others if they are well organized, well named, and stored in a common format.

To help ensure safe and organized electronic file management, PACN has implemented a system called the PACN Digital Library, which is a hierarchical digital filing system stored on the PACN file servers. The typical arrangement is by project, then by year to facilitate easy access. Network users have read-only access to these files, except where information sensitivity may preclude general access. Submission of certified products occurs in the PACN Digital Library by uploading the certified products in the "Submissions" folder and notifying the data manager.

As digital products are delivered for long-term storage according to the schedule in SOP 19 they will be catalogued in the PACN project tracking database and filed within the PACN Digital Library by the data manager. The master versions of all digital files relating to the climate protocol are stored within the PACN Digital Library, with regular file backups accomplished automatically. This includes all raw, unedited data downloaded from WRCC in their original file format. Presently, the master protocol files include the protocol narrative including appendices, the SOPs, and the climate database files. Analog (non-digital) materials are to be handled according to current practices of the individual park collections.

[46] http://www.nps.gov/refdesk/DOrders/DOrder19.html

Archived Data Maintenance

Any editing of archived data is accomplished jointly by the project manager and the PACN data manager. Prior to any major changes of a dataset, a copy is stored with the appropriate version number to allow for tracking of changes over time. Likewise, any time a revision of the protocol requires a revision to the database, a complete copy of the database will be made and stored in an archive directory. In addition to this copy in its native database format, all tables will be archived in a comma-delimited ASCII format that is platform-independent by using the Access_to_ascii.mdb utility developed by Northern Colorado Plateau Network.

New versions of the archived datasets are renamed by adding a three digit number to the file name, with the first version numbered 001 (e.g., climate_be_2008_validated_v001, for the first version of a back-end data file validated by the project manager and data manager at the end of the 2008 calendar year). The two text files generated by the Access_to_ascii.mdb utility, FieldDef.txt and TableDef.txt, will be stored in a similarly named folder (e.g., climate_be_2008_validated_v001_text). Each additional version is assigned a sequentially higher number. Frequent users of the data are notified of the updates, and provided with a copy of the most recently archived version.

Every change must be documented in the edit log and accompanied by an explanation that includes pre- and post-edit data descriptions. All data collected using this protocol is subject to the following three caveats:

- Only make changes that improve or update the data while maintaining data integrity.
- Once archived, document any changes made to the dataset through an edit log. At end of each fiscal year, the database manager will update the central database and will post read-only versions.
- Mistakes can be made during editing so updates must be compared with the original data form prior to validating the data.

Standard Operating Procedure (SOP) # 15:
Managing Photographic Images

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose

This document describes how to process photographic images collected by project staff or volunteers during the course of conducting project-related activities. Images that are acquired by other means – e.g., downloaded from a website or those taken by a cooperating researcher – are not project records and should be handled separately.

Data Photos

Care should be taken to distinguish data photos from incidental or opportunistic photos taken by project staff. Data photos are those taken for at least one of the following reasons:

- to document the condition and set up of a weather station
- to capture site habitat characteristics and to indicate gross structural changes over time
- to document a particular feature or perspective for the purpose of site relocation

Data photos are linked to specific records within the database, and are stored in a manner that permits the preservation of those database links. Other photos (e.g., of field crew members at work) may also be retained but are not necessarily linked with database records.

Effectively managing hundreds of photographic images requires a consistent method for downloading, naming, editing and documenting. The general process for managing data photos proceeds as follows:

A. File Structure Setup – Set up the file organization for images prior to acquisition
B. Image Acquisition
C. Download and Process

- Download the files from the camera
- Rename the image files according to convention
- Copy and store the original, unedited versions
- Review and edit or delete the photos
- Move into appropriate folders for storage

D. Establish Database Links
E. Deliver Image Files for Final Storage

File Structure Setup

Prior to data collection for any given year, project staff will need to set up a new folder under the Images folder in the project workspace as follows:

[Year]	The appropriate year – 2010, 2011, etc.
_Processing	Processing workspace
_Ricoh_memos	Memos to be loaded onto the Ricoh GPS camera
[Park code]	Arrange files by park – HAVO, NPSA, etc.
[Park code]	Arrange files by park – HAVO, NPSA, etc.
Data	Data images
[Site_code]	Arranged by sampling locations, or
[Date]	by date, for images not taken at sampling locations
Miscellaneous	Non-data images taken by project staff
[Site_code]	Arranged by sampling locations, or
[Date]	by date, for images not taken at sampling locations
Originals	Renamed but otherwise unedited image file copies
[Site_code]	Arranged by sampling locations, or
[Date]	by date, for images not taken at sampling locations
Non-NPS	Images acquired from other sources
Ricoh_Camera	Arranged by sampling locations and date

This folder structure permits data images to be stored and managed separately from non-record and miscellaneous images collected during the course of the project. It also provides separate space for image processing and storage of originals. Note: For additional information about the the project workspace, refer to SOP 14.

Folder Naming Standards

In all cases, folder names should follow these guidelines:

- No spaces or special characters in the folder name
- Use the underscore ("_") character to separate words in folder names
- Try to limit folder names to 20 characters or fewer
- Dates within folder names should be formatted as YYYYMMDD (for better sorting)

Image Acquisition

Capture images at an appropriate resolution that balances space limitations with the intended use of the images. Although photographs taken to facilitate future navigation to the site do not need to be stored at the same resolution as those that may be used to indicate gross environmental change at the site, it may be more efficient to capture all images at the same

resolution initially. A recommended minimum raw resolution is 1600 x 1200 pixels (approximately 2 megapixels).

Download and Processing Procedures

1. Download the raw, unedited images from the camera into the appropriate "_Processing" folder.
2. Rename the images according to convention (refer to the image file naming standards section below). If image file names were noted on the field data forms, be sure to update these to reflect the new image file name prior to data entry.
3. Process the images in the _Processing folder. At a minimum, the following processing steps should be performed on all image files:
    - Copy the images to the 'Originals' folder and set the contents as read-only by right clicking in Windows Explorer and checking the appropriate box. These originals are the image backup to be referred to in case of unintended file alteration or deletion.
    - Delete any poor quality photos, repeats, blurred or otherwise unnecessary photos. Low quality photos might be retained if the subject is highly unique, or the photo is an irreplaceable data photo.
    - Rotate the image to make the horizon level.
    - Photos of people should have 'red eye' glare removed.
    - Photos should be cropped to remove edge areas that grossly distract from the subject.
4. When finished, move the image files that are to be retained and possibly linked in the database to the appropriate folder – data images under the Data folder, other images under the Miscellaneous folder. Photos of interest to a greater audience should be copied to the the PACN Digital Library\Photo Archive folder. Metadata associated with the image should be entered into the ThumbsPlus application. To minimize the chance for accidental deletion or overwriting of needed files, no stray files should remain in the processing folder between downloads.
5. Depending on the size of the files and storage limitations, contents of the Originals folder may be deleted if all desired files are accounted for after processing.

Large groups of photos acquired under sub-optimal exposure or lighting can be batch processed to enhance contrast or brightness. Batch processing can also be used to resize groups of photos for use on the web. Batch processing may be done in ThumbsPlus, Extensis Portfolio or a similar image software package.

Image File Naming Standards

In all cases, image names should follow these guidelines:

- No spaces or special characters in the file name
- Use the underscore ("_") character to separate file name components
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters
- Park code and year should either be included in the file name or conclusive by the directory structure

The image file name should consist of the following parts:

- The date of data capture (formatted as YYYYMMDD)
- The sampling location (if recorded at a sampling location)
- Optional: a brief descriptive word or phrase
- Optional: a sequential number if multiple images were captured
- Optional: time (formatted as HHMM)

Example:
- 20070621_Waihanau_habitat_001.jpg: The habitat at Waihanau Valley taken on June 21, 2007

In cases where there are small quantities of photos it is practical to individually rename these files. However, for larger numbers it may be useful to rename files in batches. This may be done in ThumbsPlus, Extensis Portfolio or a similar image software package. A somewhat less sophisticated alternative is to batch rename files in Windows Explorer, by first selecting the files to be renamed and then selecting File > Rename. The edits made to one file will be made to all others, although with the unpleasant side effect of often adding spaces and special characters (e.g., parentheses) which will then need to be removed manually.

Renaming photos may be most efficient as a two part event – one step performed as a batch process which inserts the date and transect number at the beginning of the photo name, and a second step in which a descriptive component is manually added to each file name.

Establish Database Links

During data entry and processing, the database application will provide the functionality required to establish a link between each database record and the appropriate image file(s). To establish the link, the database prompts the user to indicate the root project workspace directory path, the specific image folder within the project workspace, and the specific file name. This way, the entire workspace may be later moved to a different directory (i.e., the PACN Digital Library) and the links will still be valid after changing only the root path. Refer to SOP 16 for additional details on establishing these links.

Note: It is important that the files keep the same name and relative organization once these database links have been established. Users should not rename or reorganize the directory structure for linked image files without first consulting with the data manager.

Deliver Image Files for Final Storage

Note: For detailed product delivery specifications refer to SOP 19.

At the end of the season, and once the year's data are certified, data images for the year may be delivered along with the working copy of the database to the data manager on a CD or DVD. To do this, simply copy the folder for the appropriate year(s) and all associated subfolders and images onto the disk. These files will be loaded into the project section of the PACN Digital Library, and the database links to data images will be updated accordingly.

Prior to delivery, make sure that all processing folders are empty. Upon delivery, the delivered folders should be made read-only to prevent unintended changes.

Standard Operating Procedure (SOP) # 16:
Data Entry and Verification

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose

This document describes the general procedures for entry, importation, and verification of weather data in the working project database. Refer to protocol sections Overview of Database Design and Data Entry and Processing for related guidance and a clarification of the distinction between the working database and the master database.

The following are general guidelines to keep in mind:

1. Data entry and importation will be conducted by the project manager at their duty station.
2. The working database application will be found in the project workspace on the networked server. For enhanced performance, it is recommended that users copy the front-end database onto their workstation hard drives and open it there. This front-end copy may be considered "disposable" because it does not contain any data, but rather acts as an interface with data residing in the back-end working database. The database may be in a project workspace on the user's computer if the connection to the networked server is too slow (see SOP 14), with periodic uploads to the network server.
3. Each data entry form is patterned after the layout of the field form, and has built-in quality assurance components such as pick lists and validation rules to test for missing data or illogical combinations. Although the database permits users to view the raw data tables and other database objects, users are strongly encouraged only to use the pre-built forms as a way of ensuring the maximum level of quality assurance.
4. As data are being imported, the person importing the data should visually review each data file being imported to make sure that the data is logical and falls within quality constraints. This should be done for each record prior to importing the next data file.

5. At regular intervals and at the end of the calendar year the project manager should inspect the data that have been entered and imported to check for completeness and perhaps catch avoidable errors.
6. After each data entry or importation session, the project manager should upload the working copy of the database onto the networked server if the database has been stored on another computer.

Database Instructions

Getting Started

The first action to be taken is to make sure the database workspace is set up properly either on a networked drive or the user's computer if networked server connections are too slow for efficient data entry. If you are unclear about where the data entry workspace should be, contact the data manager (see SOP 14).

- Store the back-end database file in the database folder in the project workspace. The back-end file has "_be_" as part of its name.
- The user's copy of the front-end database should also be stored in the same folder.
- If it doesn't already exist, also create a folder in the same network folder named "backups" for storing daily backups of the back-end database file.
- Open the front-end database. The first thing it will do is to ask to update the links to the back-end database file. This will only need to be done once for each new issue of the front-end database.

Important Reminders for Daily Database Use

- A copy of the front-end will need to be copied to your workstation if the project workspace is set up on the networked server. Do not open up and use the front-end on the network as this 'bloats' the database file and makes it run more slowly.
- The front-end application will automatically prompt you to make a backup upon initially opening the application. Backups can also be made on demand by hitting the "Back up data" button on the main menu.
- To save drive space and network resources, backup files should be compacted by right-clicking on the backup file in Windows Explorer and selecting the option: "Add to Zip file". Older files may be deleted at the discretion of the project manager.
- New issues of the front-end application may be released as needed through the course of the calendar year. If this happens, there should be no need to move or alter the back-end file. Instead, the front-end file may be deleted and replaced with the new version, which will be named in a manner reflecting the update (e.g., weather_2008_v2.mdb).
- If the front-end database gets bigger and slower, compact it periodically by selecting Tools > Database Utilities > Compact and Repair Database.

Working Database Functions

The working front-end application has the following functional components, which are accessed from the main application switchboard form that opens automatically when the application starts:

Data Entry and Review:

1. Station Information–a form will open to enter station information and to link images of the stations.

2. Import Climate Data – opens a form that will allow the user to import weather station data for a station.

3. Observation Frequency – opens a form that allows the user to import and/or view observation frequency data for a station.

4. View COOP/RAWS Data – opens a form that allows the user to view imported data for a COOP or RAWS station.

Other Functions:

4. Lookup tables – opens a tool for managing the lookup values for the project data set (e.g., , list of project personnel, etc.)

5. View navigation pane – allows the user to view the database objects (tables, queries and forms)

6. Back up data – creates a date-stamped copy of the back-end database file

7. Connect back-end database – Verifies the connection to the back-end working database file, and provides the option to redirect or update that connection

8. Set system defaults – user name, declination, current park, coordinate datum

9. View release history – opens a form describing known bugs and changes made to the front-end database since its first release

General Use Instructions

To view detailed instructions for entering, importing, and editing data see the Weather Database User's Guide, Appendix E.

Standard Operating Procedure (SOP) # 17:
Data Quality Review and Certification

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This document describes the procedures for validation and certification of data in the working project database. Refer also to protocol sections Overview of Database Design, Quality Review, and Data Certification and Delivery for related guidance and a clarification of the distinction between the working database and the master database.

Data Quality Review
At the end of each calendar year, the project manager and the PACN data management staff are collectively responsible for finalizing a validated dataset for that calendar year. Data validation is the process of checking data for completeness, structural integrity, and logical consistency. The project manager will complete all data validation. Data received from WRCC have already undergone a quality review and verification process. HaleNet data and data from GPMN too, are received after preliminary quality control; however further validation of these data may be conducted by PACN staff to ensure that the data to be analyzed does not include outliers, missing values, or illogical data. Some validation (ensuring that the data make sense) methods have been incorporated into the weather database. Other, more specific validation routines will be worked out with the protocol project manager and/or project staff and incorporated into the database as appropriate. These modifications will be described in the edit log and the functionality of the validation routines will be explained in detail in the water quality database user manual. The raw, unedited weather data files will be archived in the PACN Digital Library (See SOP 14).

Once the data have undergone the validation process and metadata have been developed for them, they are to be certified by completing the PACN Project Data Certification Form[47], available on the PACN website. The completed form, certified data, and updated metadata may then be delivered to the data manager according to the timeline in table 6.1.

Completing Data Certification

Data certification is a benchmark in the project information management process that indicates that: 1) the data are complete for the period of record; 2) they have undergone and passed the quality assurance checks; and 3) that they are appropriately documented and in a condition for archiving, posting, and distribution as appropriate. Certification is not intended to imply that the data are completely free of errors or inconsistencies which may or may not have been detected during quality assurance reviews.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. The project manager is primarily responsible for completing a PACN Project Data Certification Form, available on the PACN website. This brief form and the certified data should be submitted according to the timeline in Table 6.1. For delivery instructions refer to SOP 19.

[47] http://www1.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Project_Data_Certification_Form.doc

Standard Operating Procedure (SOP) # 18:
Metadata Development

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose

Metadata consist of information that characterizes data; thus, provide documentation for data products. This document describes the PACN guidelines for the creation of metadata.

Metadata Documentation

Data documentation is a critical step toward ensuring that data sets are usable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, condition and other characteristics of a given data set. Additionally, metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata for all PACN monitoring data will conform to Federal Geographic Data Committee (FGDC) guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed and synthesized.

Updated metadata is a required deliverable that should accompany each calendar year's certified data. For long-term projects such as this one, metadata creation is most time consuming the first time it is developed – after which most information remains static from one year to the next. Metadata records in subsequent years then only need to be updated to reflect changes in contact information, to include recent publications, to update data disposition and quality descriptions, and to describe any changes in collection methods, analysis approaches or quality assurance for the project.

Specific procedures for creating, parsing, and posting the metadata record are found in PACN Metadata Development Guidelines[48]. The general flow is as follows:

1. After the annual data quality review has been performed and the data are ready for certification, the project manager updates the PACN Metadata Interview Form[49].
    a. The metadata interview form greatly facilitates metadata creation by structuring the required information into a logical arrangement of 15 main questions, many with additional sub-questions.
    b. The first year, a new copy of the metadata interview form should be downloaded. Otherwise the form from the previous year can be used as a starting point, in which case the Track Changes tool in MS Word should be activated in order to make edits obvious to the person who will be updating the XML record.
    c. Complete the metadata interview form and maintain it in the project workspace. Much of the interview form can be filled out by cutting and pasting material from other documents (e.g., reports, protocol narrative sections, and SOPs).
    d. The data manager can help answer questions about the metadata interview form.
2. Deliver the completed interview form to the data manager according to the product delivery specifications (SOP 19).
3. The data manager (or GIS Specialist for spatial data) will then extract the information from the interview form and use it to create and update an FGDC- and NPS-compliant metadata record in XML format. Specific guidance for creating the XML record is contained in PACN Metadata Development Guidelines[1].
4. The data manager will post the record and the certified data to the Natural Resource Information Portal, and maintain a local copy of the XML file for subsequent updates.
5. The project manager should update the metadata interview content as changes to the protocol are made, and each year as additional data are accumulated.

[48] http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Metadata_Guidelines.pdf
[49] http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Metadata_Interview_Form.doc

Standard Operating Procedure (SOP) # 19:
Product Delivery Specifications

Version 1.0 (September 2010)

Change History

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Purpose
This document provides details on the process of submitting completed data sets, reports and other project deliverables. Prior to submitting digital products, files should be named according to the naming conventions appropriate to each product type (see below for general naming conventions).

All digital file submissions that are sent by email should be accompanied by a Product Submission Form, which briefly captures the following information about the products:

- Submission date
- Name of the person submitting the product(s)
- Name and file format of each product

This form can be obtained from the data manager or from the PACN website[50]. Upon notification and/or receipt of the completed products, the data manager and/or GIS specialist will check them into the PACN project tracking application.

[50] http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Product_Submissions_Form.doc

Product Delivery Schedule and Specifications

Deliverable Product	Primary Responsibility	Target Date	Instructions
Field season report	Project manager	September 15 of the same year	Upload digital file in MS Word format to the PACN Digital Library [1] submissions folder.
Raw GPS data files	Field crew lead	September 15 of the same year	Zip and send all digital files to the GIS Specialist who will post it to the PACN Digital Library[1].
Processed GPS data files	GIS specialist	September 15 of the same year	Zip and upload files to the PACN Digital Library[1].
Digital photographs	Project manager	November 30 of the same year	Organize, name and maintain photographic images in the project workspace according to SOP 14.
Certified working database	Project manager	November 30 of the same year	Refer to the following section on delivering certified data and related materials. Data will be uploaded to the Natural Resource Information Portal[2], and stored in the PACN Digital Library[1].
Certified geospatial data	Project manager with GIS specialist		
Data certification report	Project manager		
Metadata interview form	Project manager and project lead		
Full metadata (parsed XML)	Data manager and GIS specialist	March 15 of the following year	Upload the parsed XML record to the the Natural Resource Information Portal[2], and store in the PACN Digital Library[1].
Annual I&M report	Project manager and project lead	April 30 of the following year	Refer to the following section on reports and publications. Final reports will be entered in the Natural Resource Information Portal[2], and stored in the PACN Digital Library[1].
5-year analysis report	Project manager, data analyst, project lead	Every 5 years by April 30	
Other publications	Project manager, data analyst, project manager	as completed	
Field data forms	Project lead and Project manager	Every 5 years by April 30	Scan original, marked-up field forms as PDF files and upload these to the PACN Digital Library [1] submissions folder. Originals go to the park curator for archiving.
Other records	Project lead and Project manager	review for retention every January	Organize and send analog files to park curator for archival. Digital files that are slated for permanent retention should be uploaded to the PACN Digital Library. Retain or dispose of records following NPS Director's Order #19 [3].

[1] The PACN Digital Library is a hierarchical digital filing system stored on the PACN file servers. Network users have read-only access to these files, except where information sensitivity may preclude general access.
[2] The Natural Resource Information Portal is a clearinghouse for natural resource data, metadata, bibliographic records, and park species information (http://nrinfo/Home.mvc/showWelcomePage). Only non-sensitive information is posted to the Natural Resource Information Portal. Refer to the protocol section on sensitive information for details.
[3] NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: http://data2.itc.nps.gov/npspolicy/DOrders.cfm

Specific Instructions for Delivering Certified Data and Related Materials

Data certification is a benchmark in the project information management process that indicates that: 1) the data are complete for the period of record; 2) they have undergone and passed the quality assurance checks; and 3) that they are appropriately documented and in a condition for archiving, posting and distribution as appropriate. To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. For more information about data quality review and certification refer to SOP 17.

The following deliverables should be delivered as a package:

- *Certified working database* – Database in MS Access format containing data for the current calendar year that has been through the quality assurance checks documented in SOP 17.
- *Certified geospatial data* – GIS themes in ESRI coverage or shapefile format.
- *Data certification form* – A brief questionnaire in MS Word that describes the certified data product(s) being submitted. A template form is available on the PACN website[51].
- *Metadata interview form* – The metadata interview form is an MS Word questionnaire that greatly facilitates metadata creation. It is available on the PACN website[52]. For more details on metadata development refer to SOP 18.

After the quality review is completed, the project manager should package the certification materials for delivery as follows:

1. Open the certified back-end database file and compact it (in Microsoft Access, Tools > Database Utilities > Compact and Repair Database). This will make the file size much smaller. Back-end files are typically indicated with the letters "_be" in the name (e.g., weather_be_2008.mdb).
2. Rename the certified back-end file with the project name ("weather"), the year or span of years for the data being certified, and the word "certified". For example: weather_2008_certified.mdb.
3. Create a compressed file (using WinZip® or similar software) and add the back-end database file to that file. Note: The front-end application does not contain project data and as such should not be included in the delivery file.

[51] http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Project_Data_Certification_Form.doc
[52] http://science.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Metadata_Interview_Form.doc

4. Add the completed metadata interview and data certification forms to the compressed file. Both files should be named in a manner consistent with the naming conventions described elsewhere in this document.
5. Add any geospatial data files that aren't already in the possession of the GIS specialist. Geospatial data files should be developed and named according to PACN GIS naming conventions.
6. Upload the compressed file containing all certification materials to the submissions folder of the PACN Digital Library. If the project manager does not have access to the PACN Digital Library, then certification materials should be delivered as follows:
    a. If the compressed file is under 5 mb in size, it may be delivered directly to the data manager/project lead by email.
    b. If the compressed file is larger than 5 mb, it should be copied to a CD or DVD and delivered in this manner.
7. Notify the data manager/project lead by email that the certification materials have been uploaded or otherwise sent.

Upon receiving the certification materials, the data manager will:

1. Review them for completeness and work with the project manager if there are any questions.
2. Notify the GIS Specialist if any geospatial data are submitted. The GIS specialist will then review the data, and update any project GIS data sets and metadata accordingly.
3. Check in the delivered products using the PACN project tracking application.
4. Store the certified products together in the PACN Digital Library.
5. Upload the certified data to the master project database.
6. Notify the project manager that the year's data have been uploaded and processed successfully. The project manager may then proceed with data summarization, analysis and reporting.
7. Develop, parse and post the XML metadata record to the Natural Resource Information Portal.
8. After a holding period of 2 years, the data manager will upload the certified data to the Natural Resource Information Portal. This holding period is to protect professional authorship priority and to provide sufficient time to catch any undetected quality assurance problems. For more details on product posting and distribution see SOP 20.

Specific Instructions for Reports and Publications

Annual reports and trend analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Annual reports will use the Natural Resource Report[53] template, and trend analysis and other peer-reviewed technical reports will use the Natural Resource Technical Report[54] template. Instructions for acquiring a series number and other information about NPS publication standards can be found at the NPS Natural Resources Publications website[55]. In general, the procedures for reports and publications are as follows:

[53] http://www.nature.nps.gov/publications/NRPM/NRR.dot
[54] http://www.nature.nps.gov/publications/NRPM/NRTR.dot
[55] http://www.nature.nps.gov/publications/NRPM/index.cfm

1. The document should be formatted using the NPS Natural Resource Publications template. Formatting according to NPS standards is easiest when using the template from the very beginning, as opposed to reformatting an existing document.
2. The document should be peer reviewed at the appropriate level. For example, I&M Annual Reports should be reviewed by other members of the appropriate project work group. The program manager will also review all annual reports for completeness and compliance with I&M standards and expectations.
3. Upon completing the peer review, acquire a publication series number from the NPS Key Official (currently the Regional I&M Coordinator).
4. Upload the file in PDF and MS Word formats to the PACN Digital Library submissions folder.
5. Send a digital copy to each park curator.
6. The data manager or a designee will create a bibliographic record and upload the PDF document to Natural Resource Information Portal.

File naming conventions

In all cases, digital file names should follow these guidelines:

- No spaces or special characters in the file name
- Use the underscore ("_") character to separate file name components
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters
- As appropriate, include the project name (e.g., "weather"), network code ("PACN") or park code, and year in the file name.

Examples:

- PACN_weather_2008_Annual_report.pdf
- PACN_weather_2008_Field_season_report.doc

Standard Operating Procedure (SOP) #20:
Product Posting and Distribution

Version 1.0 (September 2010)

Change History

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Purpose
This document provides details on the process of posting and otherwise distributing finalized data, reports, and other project deliverables. For a complete list of project deliverables, refer to SOP 18.

Product posting and distribution
Once digital products have been delivered and processed, the Data Manager will post the products to the Natural Resource Information Portal[56]. The Natural Resource Information Portal is the NPS clearinghouse for natural resource products that are available to the public. The following sets of products are available in the Natural Resource Information Portal:

1. Full metadata records and datasets will be posted to the References service within the Natural Resource Information Portal and made available to the public.
2. A record for reports and other publications will be created in the Reference service. The digital report file in PDF format will then be uploaded and linked to the reference record.
3. Species observations will be extracted from the database and entered into the Biology service which is the NPS database and application for maintaining park-specific species lists and observation data.

The Natural Resource Information Portal serves as the primary mechanism for sharing reports, data, and other project deliverables with other agencies, organizations, and the general public.

[56] http://nrinfo/Home.mvc/showWelcomePage

However, because of restrictions on climate data acquired from the Western Regional Climate Center and the Haleakala Climate Network, raw data acquired from these programs will not be posted to the Natural Resource Information Portal.

Upon delivery products will be posted to NPS websites and clearinghouses (e.g., Natural Resource Information Portal) as appropriate.

Responding to Data Requests

Occasionally, a park or project staff member may be contacted directly regarding a specific data request from another agency, organization, scientist, or from a member of the general public. The following points should be considered when responding to data requests:

- The originators and stewards of the data, should be acknowledged in any professional publication using the data. For the PACN climate data this may include acknowledging several or all of the climate monitoring programs which provide data such as NWS-COOP, RAWS, WRCC, HaleNet, as well as the PACN.
- NPS and/or the originators of the data retain distribution rights; copies of the data should not be redistributed by anyone but NPS or the original data stewards.
- The data that project staff members and cooperators collect using public funds are public records and as such cannot be considered personal or professional intellectual property.
- No sensitive information (e.g., information about the specific nature or location of protected resources) may be posted to the Natural Resource Information Portal or another publicly-accessible website, or otherwise shared or distributed outside NPS without a confidentiality agreement between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared.
- For quality assurance, only the certified, finalized versions of data sets should be shared with others.

The project manager will handle all data requests as follows:

1. Notify the data manager of the request if s/he is needed to facilitate fulfilling the request in some manner.
2. Respond to the request in an official email or memo.
3. In the response, refer the person who is requesting data to the Natural Resource Information Portal, so they may download the necessary data and/or metadata. If the request cannot be fulfilled in that manner – i.e. the data products have not been posted yet – work with the data manager to discuss options for fulfilling the request directly (e.g., burning data to CD or DVD). Ordinarily, only certified data sets should be shared outside NPS.
4. If the request is for a document, it is recommended that documents be converted to PDF format prior to distributing it.
5. After responding, provide the following information to the data manager, who will maintain a log of all requests in the PACN Project Tracking database:
    a. Name and affiliation of person requesting data
    b. Request date
    c. Nature of request

d. Responder
e. Response date
f. Nature of response
g. List of specific data sets and products sent (if any)

Standard Operating Procedure (SOP) # 21:
Acquiring Climate Data

Version 1.0 (September 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose
This document describes how to download, store, and process climate data from each of the climate monitoring station types before importing the data into the PACN weather/climate database.

COOP, RAWS and PACN Data
COOP, RAWS and PACN weather data will be downloaded from the Western Region Climate Center (WRCC).

RAWS Data
To download RAWS data, go the WRCC website (http://www.raws.dri.edu/wraws/hiF.html).

1. Select the RAWS station.
    a. Choose from the list of stations on the left of the web page, or click on a location on the map (Figure 1).

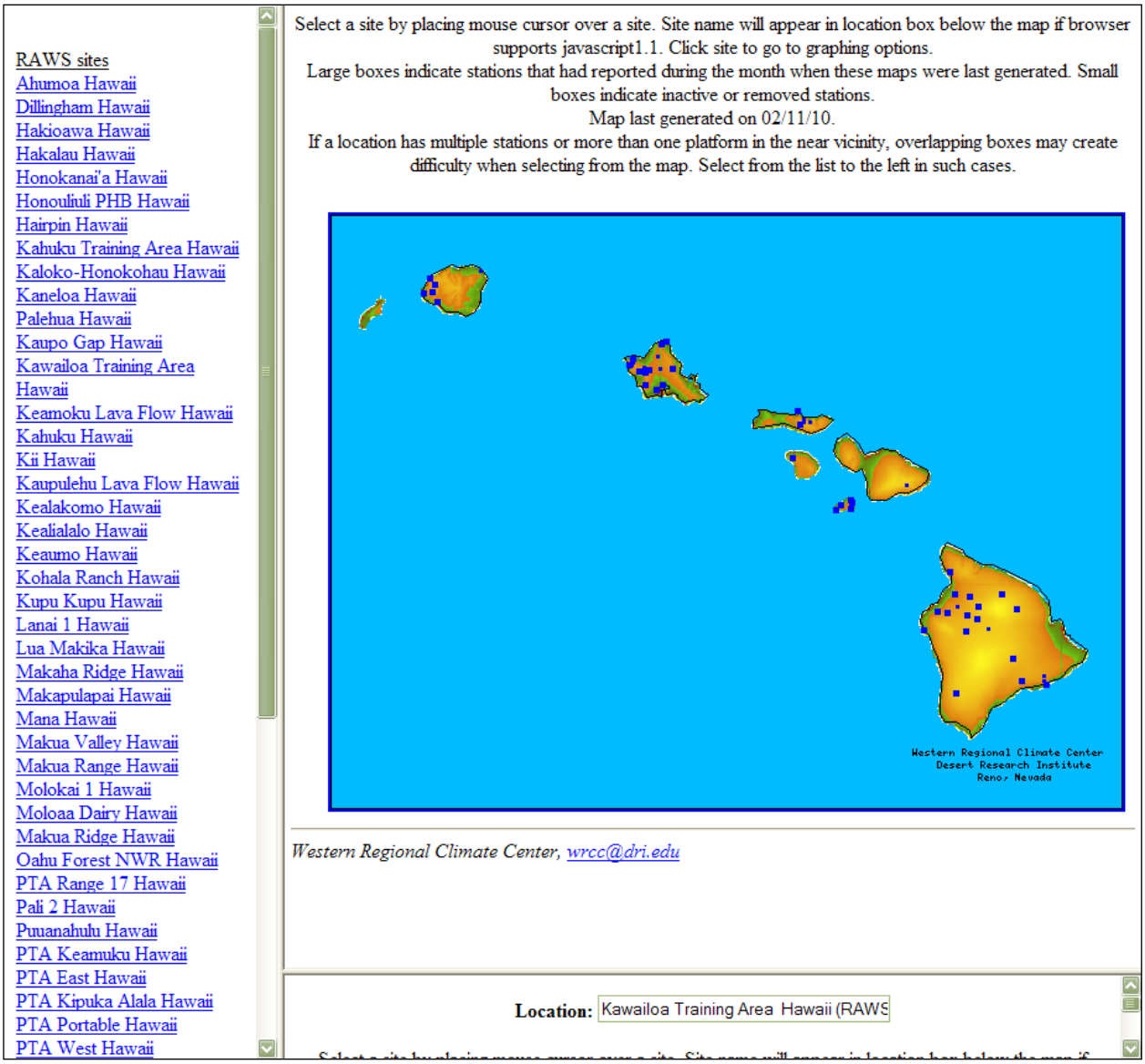


Figure 1. WRCC RAWS sites data download webpage.

2. Select ‘Daily Summary Time Series’ from the list on the left side of the page (Figure 2).



Figure 2. RAWS station web page.

a. Choose a starting and ending date (Figure 3).

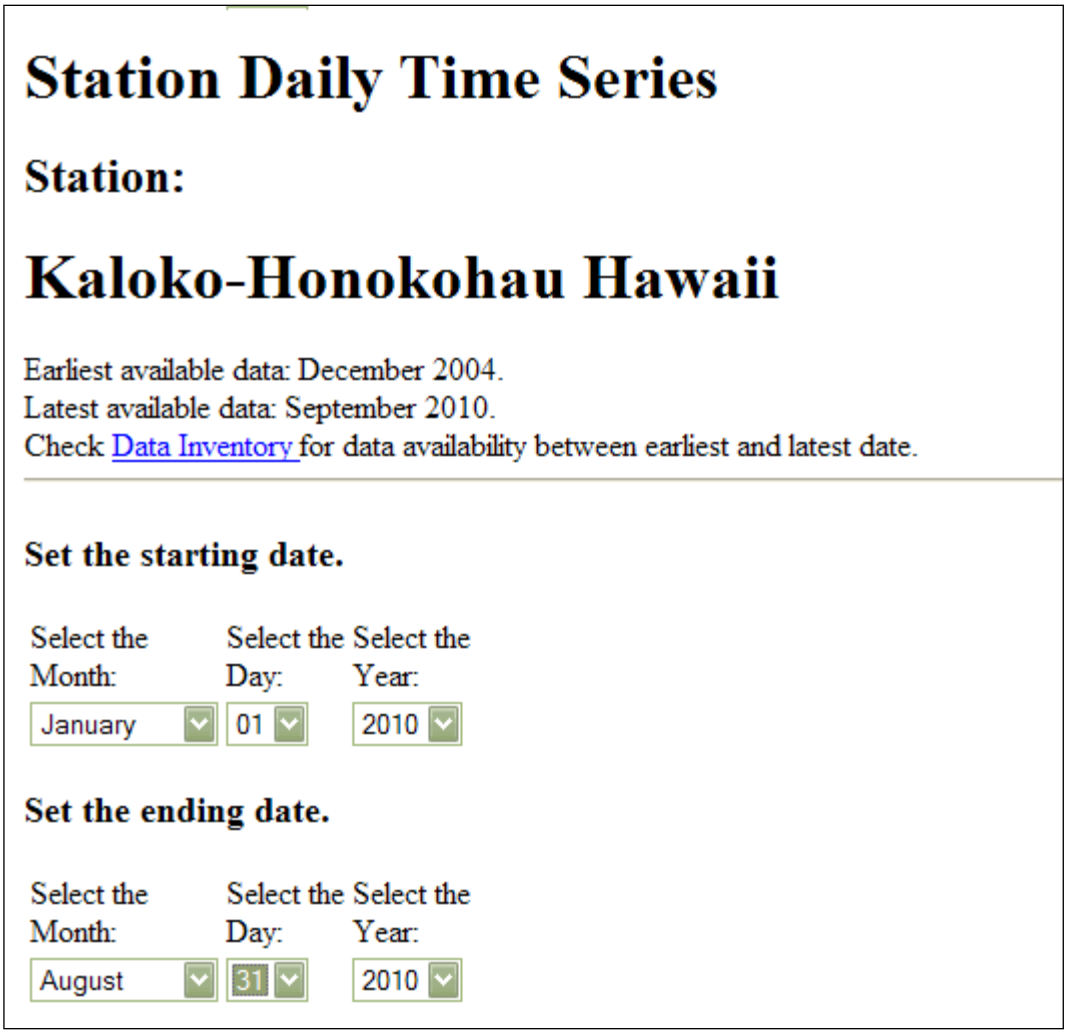


Figure 3. RAWS station daily time series data retrieval web page.

3. Select the following options (Figure 4):
    a. Select Elements to list: check Elements marked with *
    b. Select the output units: English
    c. Select the output format: Downloadable Ascii
    d. Select the data summarization requirements: only complete data
    e. Apply physical limits QC to data: yes
    f. Represent missing data as : -999
    g. Include # of valid observations for each element: no
    h. Sub interval windows: same as starting and ending date
4. Click “Submit Info”.

Options.

Select Elements to list

- [x] Elements marked with *
- [ ] Solar Radiation *
- [ ] Wind Speed and Direction *
- [ ] Air Temperature *
- [ ] Soil Temperature
- [ ] Fuel Temperature
- [ ] Relative Humidity *
- [ ] Barometric Pressure
- [ ] Precipitation *
- [ ] Penman Et Calculation info
- [ ] ASCE Standardized Ref. Et Calculation info
- [ ] Heating Degree Day
- [ ] Cooling Degree Day
- [ ] Growing Degree Day - Base 40
- [ ] Growing Degree Day - Base 50

Select the Output Units

(•) English ( ) Metric

Select the Output format

( ) html (+graphics) (•) Downloadable Ascii

Select the Data Summarization requirements

( ) Any data (•) Only Complete data

'Any data' allows summarization from any available data.

'Only Complete data' requires all observations for the day or the element is considered missing.

Apply physical limits QC to data:

(•) Yes ( ) No "

'Details of QC checks.

Represent Missing data as:

-999

Include # of valid observations for each element.

NOTE: This Option is available only when html output format is selected.

( ) Yes (•) No

Sub interval windows:

Examples of Sub interval windows use.

Select the Starting Date:

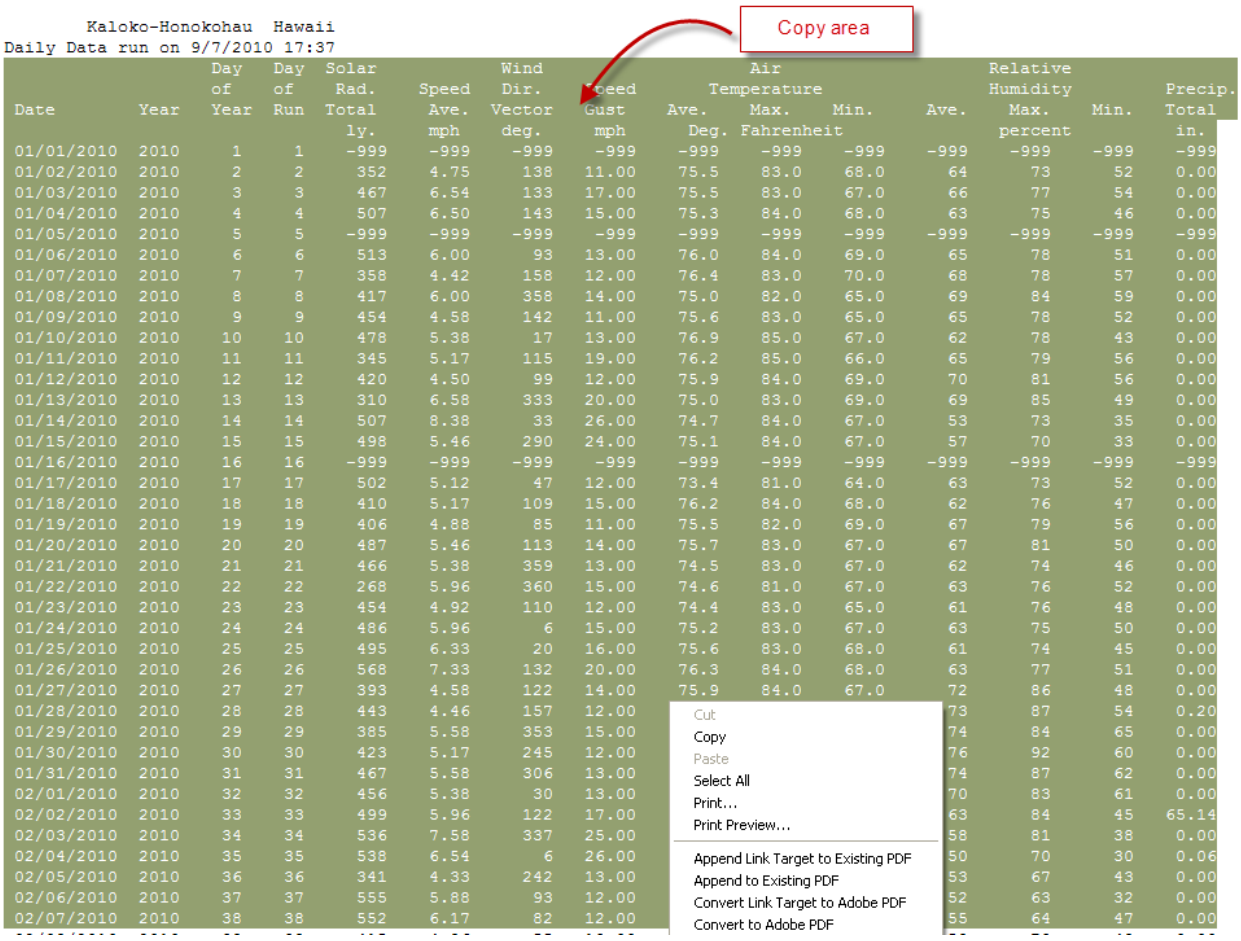
Month: January Day: 01

Select the Ending Date:

Month: August Day: 31 (inclusive)

Figure 4. Options for RAWS data download.

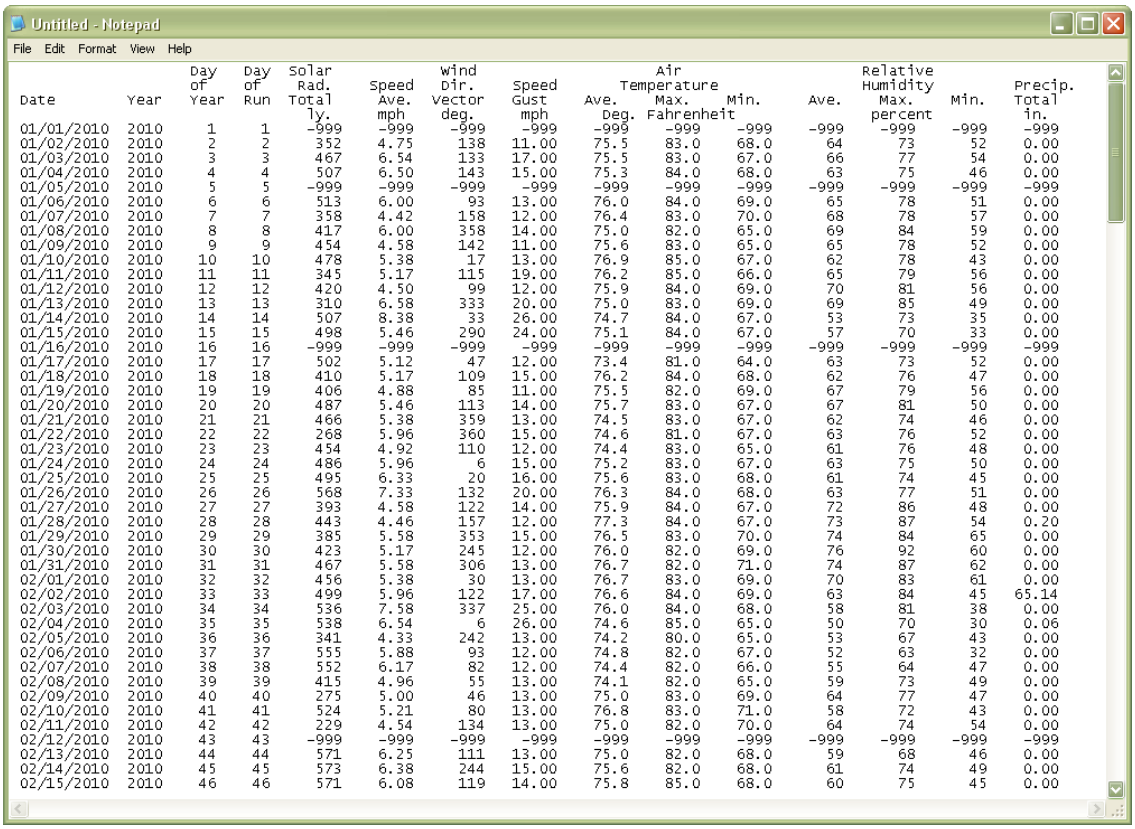
1. Copy the data from the screen and paste it into Notepad.
    a. Select the data under Daily Data Run, right click, and choose Copy (Figure 5).



Date	Year	Day of Year	Day of Run	Solar Rad. Total ly.	Wind Speed Ave. mph	Wind Dir. Vector deg.	Wind Speed Gust mph	Air Temperature Ave. Deg. Fahrenheit	Air Temperature Max. Fahrenheit	Air Temperature Min. Fahrenheit	Relative Humidity Ave.	Relative Humidity Max. percent	Relative Humidity Min.	Precip. Total in.
01/01/2010	2010	1	1	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
01/02/2010	2010	2	2	352	4.75	138	11.00	75.5	83.0	68.0	64	73	52	0.00
01/03/2010	2010	3	3	467	6.54	133	17.00	75.5	83.0	67.0	66	77	54	0.00
01/04/2010	2010	4	4	507	6.50	143	15.00	75.3	84.0	68.0	63	75	46	0.00
01/05/2010	2010	5	5	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
01/06/2010	2010	6	6	513	6.00	93	13.00	76.0	84.0	69.0	65	78	51	0.00
01/07/2010	2010	7	7	358	4.42	158	12.00	76.4	83.0	70.0	68	78	57	0.00
01/08/2010	2010	8	8	417	6.00	358	14.00	75.0	82.0	65.0	69	84	59	0.00
01/09/2010	2010	9	9	454	4.58	142	11.00	75.6	83.0	65.0	65	78	52	0.00
01/10/2010	2010	10	10	478	5.38	17	13.00	76.9	85.0	67.0	62	78	43	0.00
01/11/2010	2010	11	11	345	5.17	115	19.00	76.2	85.0	66.0	65	79	56	0.00
01/12/2010	2010	12	12	420	4.50	99	12.00	75.9	84.0	69.0	70	81	56	0.00
01/13/2010	2010	13	13	310	6.58	333	20.00	75.0	83.0	69.0	69	85	49	0.00
01/14/2010	2010	14	14	507	8.38	33	26.00	74.7	84.0	67.0	53	73	35	0.00
01/15/2010	2010	15	15	498	5.46	290	24.00	75.1	84.0	67.0	57	70	33	0.00
01/16/2010	2010	16	16	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
01/17/2010	2010	17	17	502	5.12	47	12.00	73.4	81.0	64.0	63	73	52	0.00
01/18/2010	2010	18	18	410	5.17	109	15.00	76.2	84.0	68.0	62	76	47	0.00
01/19/2010	2010	19	19	406	4.88	85	11.00	75.5	82.0	69.0	67	79	56	0.00
01/20/2010	2010	20	20	487	5.46	113	14.00	75.7	83.0	67.0	67	81	50	0.00
01/21/2010	2010	21	21	466	5.38	359	13.00	74.5	83.0	67.0	62	74	46	0.00
01/22/2010	2010	22	22	268	5.96	360	15.00	74.6	81.0	67.0	63	76	52	0.00
01/23/2010	2010	23	23	454	4.92	110	12.00	74.4	83.0	65.0	61	76	48	0.00
01/24/2010	2010	24	24	486	5.96	6	15.00	75.2	83.0	67.0	63	75	50	0.00
01/25/2010	2010	25	25	495	6.33	20	16.00	75.6	83.0	68.0	61	74	45	0.00
01/26/2010	2010	26	26	568	7.33	132	20.00	76.3	84.0	68.0	63	77	51	0.00
01/27/2010	2010	27	27	393	4.58	122	14.00	75.9	84.0	67.0	72	86	48	0.00
01/28/2010	2010	28	28	443	4.46	157	12.00				73	87	54	0.20
01/29/2010	2010	29	29	385	5.58	353	15.00				74	84	65	0.00
01/30/2010	2010	30	30	423	5.17	245	12.00				76	92	60	0.00
01/31/2010	2010	31	31	467	5.58	306	13.00				74	87	62	0.00
02/01/2010	2010	32	32	456	5.38	30	13.00				70	83	61	0.00
02/02/2010	2010	33	33	499	5.96	122	17.00				63	84	45	65.14
02/03/2010	2010	34	34	536	7.58	337	25.00				58	81	38	0.00
02/04/2010	2010	35	35	538	6.54	6	26.00				50	70	30	0.06
02/05/2010	2010	36	36	341	4.33	242	13.00				53	67	43	0.00
02/06/2010	2010	37	37	555	5.88	93	12.00				52	63	32	0.00
02/07/2010	2010	38	38	552	6.17	82	12.00				55	64	47	0.00

Figure 5. Copy data under the Daily Data run.

5. Open the program Notepad and paste the data (right click, choose Paste; Figure 6).



Date	Year	Day of Year	Day of Run	Solar Rad. Total ly.	Wind Speed Ave. mph	Wind Dir. Vector deg.	Wind Speed Gust mph	Air Temperature Ave. Deg. Fahrenheit	Air Temperature Max. Fahrenheit	Air Temperature Min.	Relative Humidity Ave. percent	Relative Humidity Max.	Relative Humidity Min.	Precip. Total in.
01/01/2010	2010	1	1	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
01/02/2010	2010	2	2	352	4.75	138	11.00	75.5	83.0	68.0	64	73	52	0.00
01/03/2010	2010	3	3	467	6.54	133	17.00	75.5	83.0	67.0	66	77	54	0.00
01/04/2010	2010	4	4	507	6.50	143	15.00	75.3	84.0	68.0	63	75	46	0.00
01/05/2010	2010	5	5	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
01/06/2010	2010	6	6	513	6.00	93	13.00	76.0	84.0	69.0	65	78	51	0.00
01/07/2010	2010	7	7	358	4.42	158	12.00	76.4	83.0	70.0	68	78	57	0.00
01/08/2010	2010	8	8	417	6.00	358	14.00	75.0	82.0	65.0	69	84	59	0.00
01/09/2010	2010	9	9	454	4.58	142	11.00	75.6	83.0	65.0	65	78	52	0.00
01/10/2010	2010	10	10	478	5.38	17	13.00	76.9	85.0	67.0	62	78	43	0.00
01/11/2010	2010	11	11	345	5.17	115	19.00	76.2	85.0	66.0	65	79	56	0.00
01/12/2010	2010	12	12	420	4.50	99	12.00	75.9	84.0	69.0	70	81	56	0.00
01/13/2010	2010	13	13	310	6.58	333	20.00	75.0	83.0	69.0	69	85	49	0.00
01/14/2010	2010	14	14	507	8.38	33	26.00	74.7	84.0	67.0	53	73	35	0.00
01/15/2010	2010	15	15	498	5.46	290	24.00	75.1	84.0	67.0	57	70	33	0.00
01/16/2010	2010	16	16	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
01/17/2010	2010	17	17	502	5.12	47	12.00	73.4	81.0	64.0	63	73	52	0.00
01/18/2010	2010	18	18	410	5.17	109	15.00	76.2	84.0	68.0	62	76	47	0.00
01/19/2010	2010	19	19	406	4.88	85	11.00	75.5	82.0	69.0	67	79	56	0.00
01/20/2010	2010	20	20	487	5.46	113	14.00	75.7	83.0	67.0	67	81	50	0.00
01/21/2010	2010	21	21	466	5.38	359	13.00	74.5	83.0	67.0	62	74	46	0.00
01/22/2010	2010	22	22	268	5.96	360	15.00	74.6	81.0	67.0	63	76	52	0.00
01/23/2010	2010	23	23	454	4.92	110	12.00	74.4	83.0	65.0	61	76	48	0.00
01/24/2010	2010	24	24	486	5.96	6	15.00	75.2	83.0	67.0	63	75	50	0.00
01/25/2010	2010	25	25	495	6.33	20	16.00	75.6	83.0	68.0	61	74	45	0.00
01/26/2010	2010	26	26	568	7.33	132	20.00	76.3	84.0	68.0	63	77	51	0.00
01/27/2010	2010	27	27	393	4.58	122	14.00	75.9	84.0	67.0	72	86	48	0.00
01/28/2010	2010	28	28	443	4.46	157	12.00	77.3	84.0	67.0	73	87	54	0.20
01/29/2010	2010	29	29	385	5.58	353	15.00	76.5	83.0	70.0	74	84	65	0.00
01/30/2010	2010	30	30	423	5.17	245	12.00	76.0	82.0	69.0	76	92	60	0.00
01/31/2010	2010	31	31	467	5.58	306	13.00	76.7	82.0	71.0	74	87	62	0.00
02/01/2010	2010	32	32	456	5.38	30	13.00	76.7	83.0	69.0	70	83	61	0.00
02/02/2010	2010	33	33	499	5.96	122	17.00	76.6	84.0	69.0	63	84	45	65.14
02/03/2010	2010	34	34	536	7.58	337	25.00	76.0	84.0	68.0	58	81	38	0.00
02/04/2010	2010	35	35	538	6.54	6	26.00	74.6	85.0	65.0	50	70	30	0.06
02/05/2010	2010	36	36	341	4.33	242	13.00	74.2	80.0	65.0	53	67	43	0.00
02/06/2010	2010	37	37	555	5.88	93	12.00	74.8	82.0	67.0	52	63	32	0.00
02/07/2010	2010	38	38	552	6.17	82	12.00	74.4	82.0	66.0	55	64	47	0.00
02/08/2010	2010	39	39	415	4.96	55	13.00	74.1	82.0	65.0	59	73	49	0.00
02/09/2010	2010	40	40	275	5.00	46	13.00	75.0	83.0	69.0	64	77	47	0.00
02/10/2010	2010	41	41	524	5.21	80	13.00	76.8	83.0	71.0	58	72	43	0.00
02/11/2010	2010	42	42	229	4.54	134	13.00	75.0	82.0	70.0	64	74	54	0.00
02/12/2010	2010	43	43	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
02/13/2010	2010	44	44	571	6.25	111	13.00	75.0	82.0	68.0	59	68	46	0.00
02/14/2010	2010	45	45	573	6.38	244	15.00	75.6	82.0	68.0	61	74	49	0.00
02/15/2010	2010	46	46	571	6.08	119	14.00	75.8	85.0	68.0	60	75	45	0.00

Figure 6. Pasting the data into Notepad.

6. Save the file.
    a. Go to File -> Save As (Figure 7).
    b. In the dialog box, save the file in the protocol workspace folder for raw RAWS data (Figure 8). Name the file in the following format: RAWS_xxxx_ $YYYYMM_S$_$YYYYMM_E$.xls where:
        i. xxxx is the station name (no spaces, underscores if necessary).
        ii. $YYYYMM_S$ is the beginning month and year for the data record.
        iii. $YYYYMM_e$ is the ending month and year for the data record.

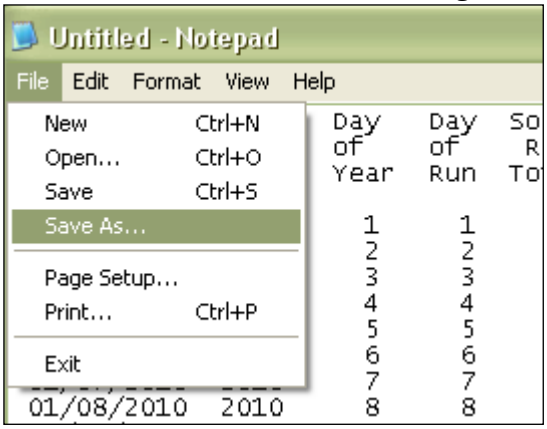


Figure 7. Save As.

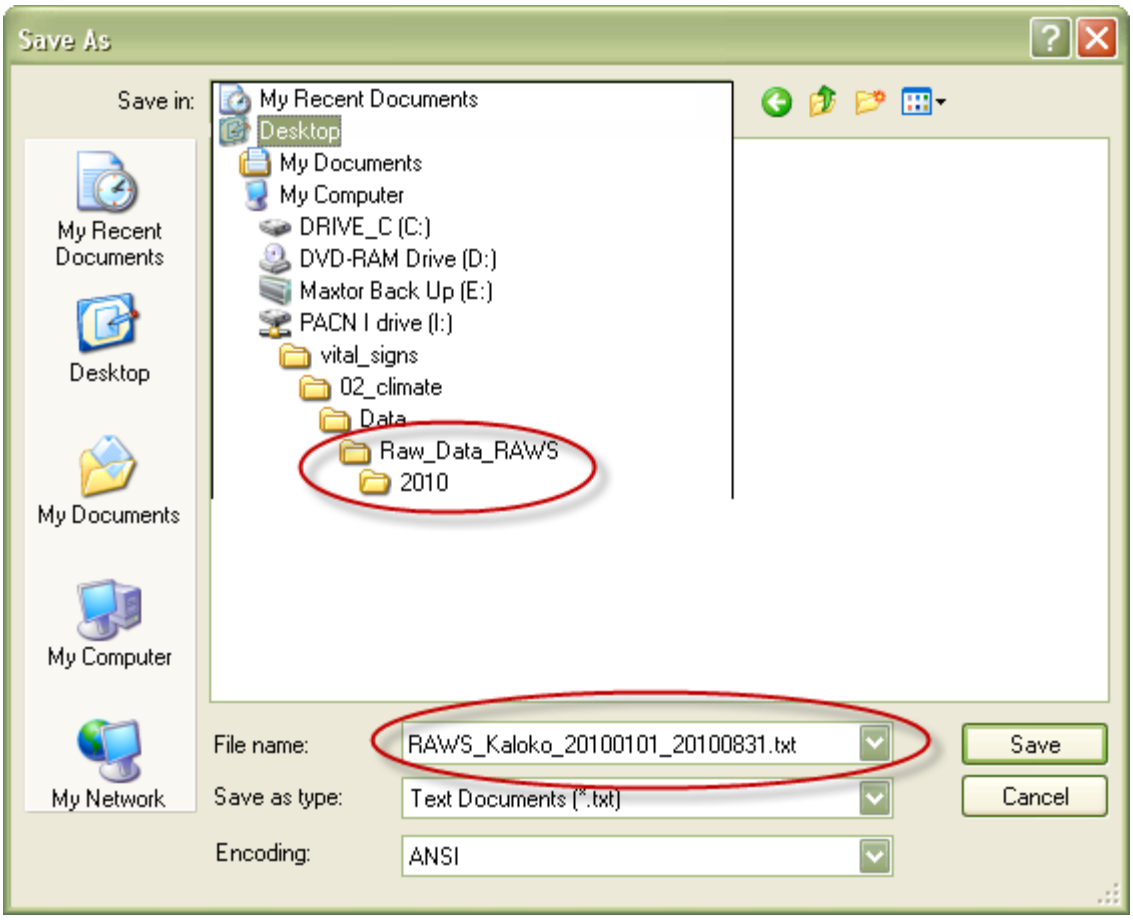


Figure 8. Dialog box.

7. Navigate back to the RAWS stations page to download data for another station and repeat the above steps to acquire data.

COOP Data

To download COOP data, go the WRCC websites for Hawaii (http://www.wrcc.dri.edu/cgi-bin/sod_graph.pl?51) and the Pacific Islands (http://www.wrcc.dri.edu/cgi-bin/sod_graph.pl?91).

2. Select the criteria for displaying data (Figure 9).
    a. Select the COOP station from the drop down menu.
    b. Select a Start Date and End Date.
    c. Select Image Size: Medium (650x370)
    d. Select Elements to Plot – leave the defaults checked.
    e. Scroll down to the Scaling section – leave the defaults
    f. In the Data section, enter the password.
        i. Hawaii data password: wrcc51
        ii. Pacific Island data password: wrcc91
    g. Check “Display Data Table”.

h. Click the ‘Create Graph’ button.

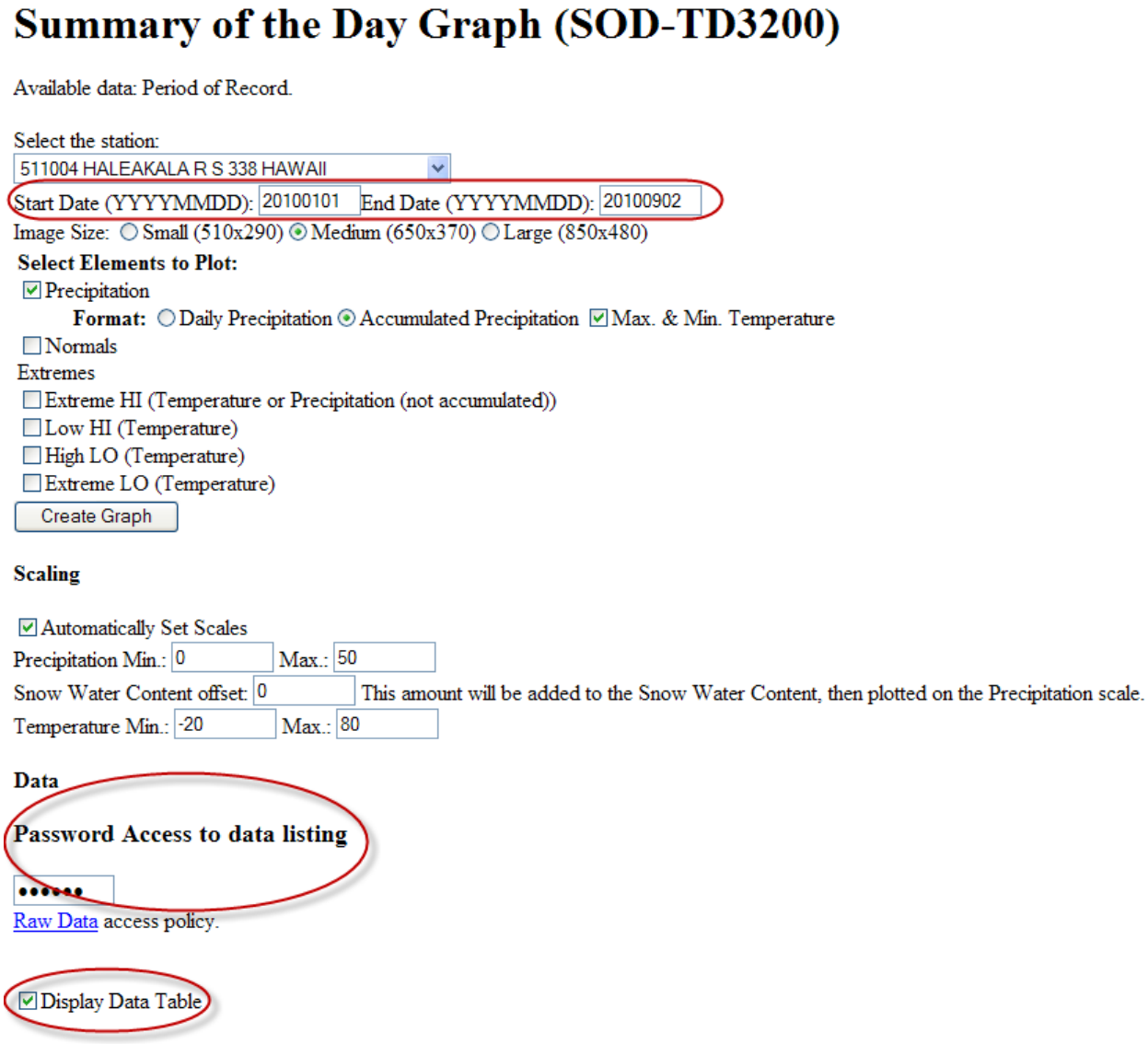
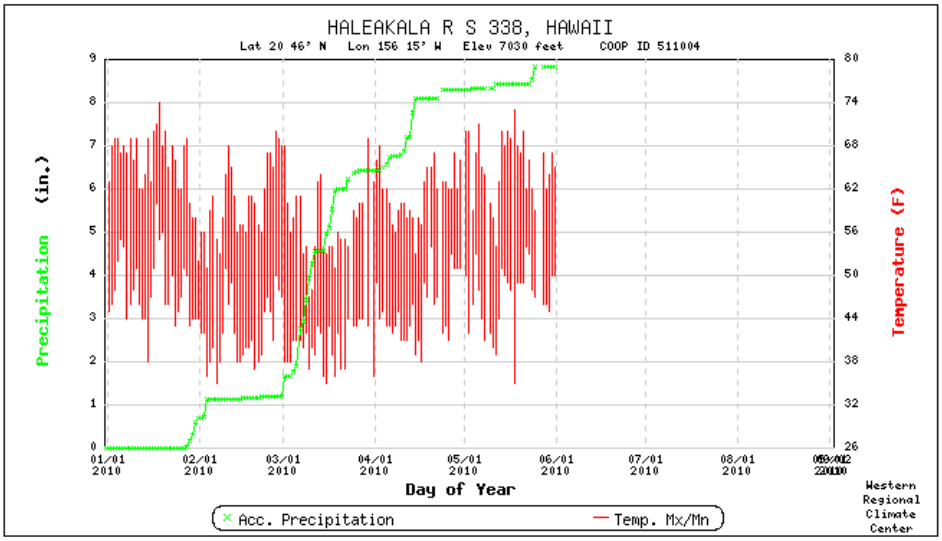


Figure 9. Selection criteria for COOP data.

3. The data will displayed as a graph and as a table (Figure 10).

Summary-Of-the-Day Graph

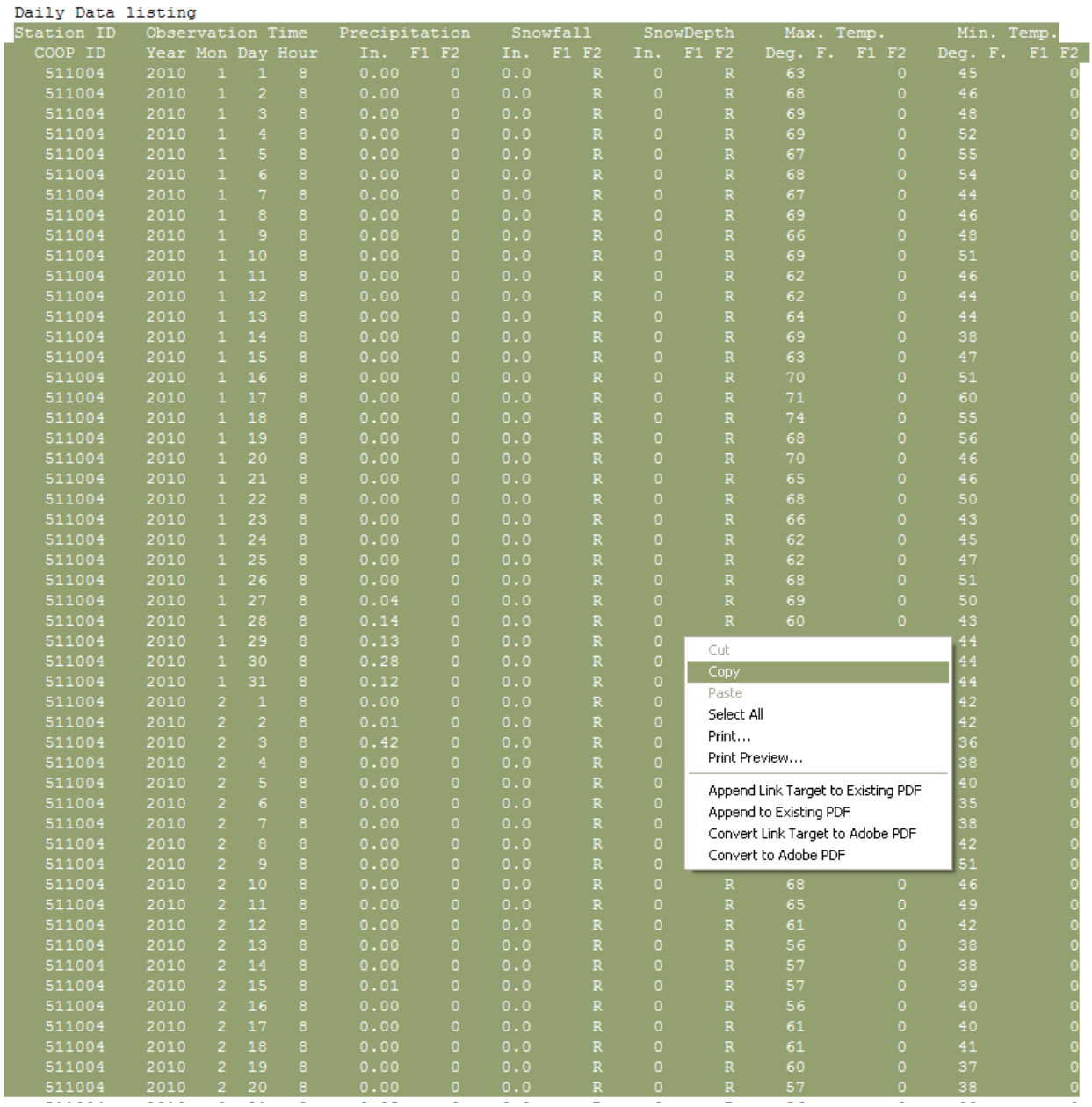


Daily Data listing

Station ID	Observation Time				Precipitation			Snowfall			SnowDepth			Max. Temp.			Min. Temp.		
COOP ID	Year	Mon	Day	Hour	In.	F1	F2	In.	F1	F2	In.	F1	F2	Deg. F.	F1	F2	Deg. F.	F1	F2
511004	2010	1	1	8	0.00		0	0.0		R	0		R	63		0	45		0
511004	2010	1	2	8	0.00		0	0.0		R	0		R	68		0	46		0
511004	2010	1	3	8	0.00		0	0.0		R	0		R	69		0	48		0
511004	2010	1	4	8	0.00		0	0.0		R	0		R	69		0	52		0
511004	2010	1	5	8	0.00		0	0.0		R	0		R	67		0	55		0
511004	2010	1	6	8	0.00		0	0.0		R	0		R	68		0	54		0
511004	2010	1	7	8	0.00		0	0.0		R	0		R	67		0	44		0
511004	2010	1	8	8	0.00		0	0.0		R	0		R	69		0	46		0
511004	2010	1	9	8	0.00		0	0.0		R	0		R	66		0	48		0
511004	2010	1	10	8	0.00		0	0.0		R	0		R	69		0	51		0
511004	2010	1	11	8	0.00		0	0.0		R	0		R	62		0	46		0
511004	2010	1	12	8	0.00		0	0.0		R	0		R	62		0	44		0
511004	2010	1	13	8	0.00		0	0.0		R	0		R	64		0	44		0
511004	2010	1	14	8	0.00		0	0.0		R	0		R	69		0	38		0
511004	2010	1	15	8	0.00		0	0.0		R	0		R	63		0	47		0
511004	2010	1	16	8	0.00		0	0.0		R	0		R	70		0	51		0
511004	2010	1	17	8	0.00		0	0.0		R	0		R	71		0	60		0
511004	2010	1	18	8	0.00		0	0.0		R	0		R	74		0	55		0
511004	2010	1	19	8	0.00		0	0.0		R	0		R	68		0	56		0
511004	2010	1	20	8	0.00		0	0.0		R	0		R	70		0	46		0
511004	2010	1	21	8	0.00		0	0.0		R	0		R	65		0	46		0
511004	2010	1	22	8	0.00		0	0.0		R	0		R	68		0	50		0
511004	2010	1	23	8	0.00		0	0.0		R	0		R	66		0	43		0

Figure 10. Displayed COOP data.

4. Copy the data from the screen and paste it into Notepad.
    a. Select the data under Daily Data Listing, right click, and choose Copy (Figure 11).

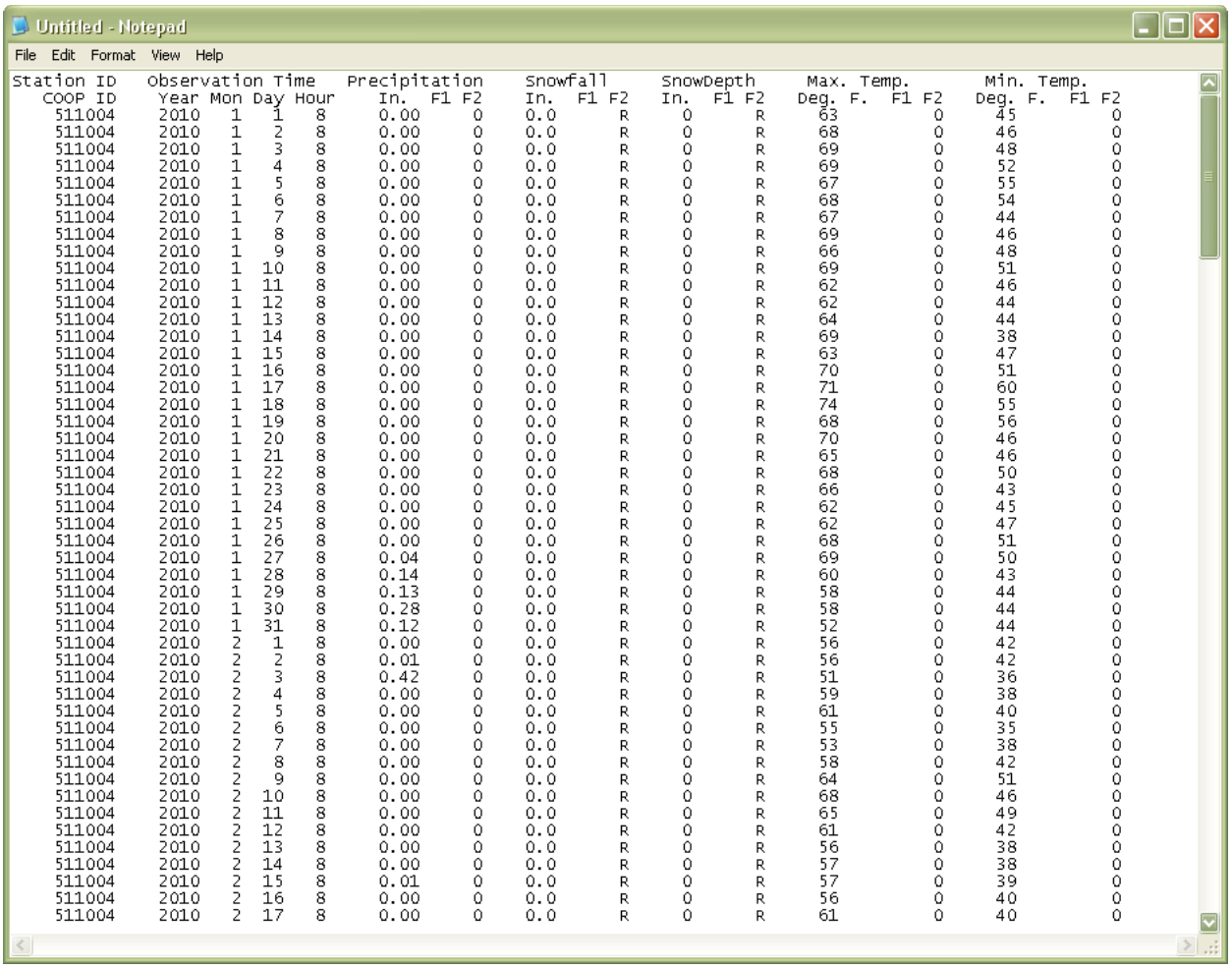


Daily Data listing

Station ID	Observation Time				Precipitation			Snowfall			SnowDepth			Max. Temp.			Min. Temp.		
COOP ID	Year	Mon	Day	Hour	In.	F1	F2	In.	F1	F2	In.	F1	F2	Deg. F.	F1	F2	Deg. F.	F1	F2
511004	2010	1	1	8	0.00		0	0.0		R	0		R	63		0	45		0
511004	2010	1	2	8	0.00		0	0.0		R	0		R	68		0	46		0
511004	2010	1	3	8	0.00		0	0.0		R	0		R	69		0	48		0
511004	2010	1	4	8	0.00		0	0.0		R	0		R	69		0	52		0
511004	2010	1	5	8	0.00		0	0.0		R	0		R	67		0	55		0
511004	2010	1	6	8	0.00		0	0.0		R	0		R	68		0	54		0
511004	2010	1	7	8	0.00		0	0.0		R	0		R	67		0	44		0
511004	2010	1	8	8	0.00		0	0.0		R	0		R	69		0	46		0
511004	2010	1	9	8	0.00		0	0.0		R	0		R	66		0	48		0
511004	2010	1	10	8	0.00		0	0.0		R	0		R	69		0	51		0
511004	2010	1	11	8	0.00		0	0.0		R	0		R	62		0	46		0
511004	2010	1	12	8	0.00		0	0.0		R	0		R	62		0	44		0
511004	2010	1	13	8	0.00		0	0.0		R	0		R	64		0	44		0
511004	2010	1	14	8	0.00		0	0.0		R	0		R	69		0	38		0
511004	2010	1	15	8	0.00		0	0.0		R	0		R	63		0	47		0
511004	2010	1	16	8	0.00		0	0.0		R	0		R	70		0	51		0
511004	2010	1	17	8	0.00		0	0.0		R	0		R	71		0	60		0
511004	2010	1	18	8	0.00		0	0.0		R	0		R	74		0	55		0
511004	2010	1	19	8	0.00		0	0.0		R	0		R	68		0	56		0
511004	2010	1	20	8	0.00		0	0.0		R	0		R	70		0	46		0
511004	2010	1	21	8	0.00		0	0.0		R	0		R	65		0	46		0
511004	2010	1	22	8	0.00		0	0.0		R	0		R	68		0	50		0
511004	2010	1	23	8	0.00		0	0.0		R	0		R	66		0	43		0
511004	2010	1	24	8	0.00		0	0.0		R	0		R	62		0	45		0
511004	2010	1	25	8	0.00		0	0.0		R	0		R	62		0	47		0
511004	2010	1	26	8	0.00		0	0.0		R	0		R	68		0	51		0
511004	2010	1	27	8	0.04		0	0.0		R	0		R	69		0	50		0
511004	2010	1	28	8	0.14		0	0.0		R	0		R	60		0	43		0
511004	2010	1	29	8	0.13		0	0.0		R	0						44		0
511004	2010	1	30	8	0.28		0	0.0		R	0						44		0
511004	2010	1	31	8	0.12		0	0.0		R	0						44		0
511004	2010	2	1	8	0.00		0	0.0		R	0						42		0
511004	2010	2	2	8	0.01		0	0.0		R	0						42		0
511004	2010	2	3	8	0.42		0	0.0		R	0						36		0
511004	2010	2	4	8	0.00		0	0.0		R	0						38		0
511004	2010	2	5	8	0.00		0	0.0		R	0						40		0
511004	2010	2	6	8	0.00		0	0.0		R	0						35		0
511004	2010	2	7	8	0.00		0	0.0		R	0						38		0
511004	2010	2	8	8	0.00		0	0.0		R	0						42		0
511004	2010	2	9	8	0.00		0	0.0		R	0						51		0
511004	2010	2	10	8	0.00		0	0.0		R	0		R	68		0	46		0
511004	2010	2	11	8	0.00		0	0.0		R	0		R	65		0	49		0
511004	2010	2	12	8	0.00		0	0.0		R	0		R	61		0	42		0
511004	2010	2	13	8	0.00		0	0.0		R	0		R	56		0	38		0
511004	2010	2	14	8	0.00		0	0.0		R	0		R	57		0	38		0
511004	2010	2	15	8	0.01		0	0.0		R	0		R	57		0	39		0
511004	2010	2	16	8	0.00		0	0.0		R	0		R	56		0	40		0
511004	2010	2	17	8	0.00		0	0.0		R	0		R	61		0	40		0
511004	2010	2	18	8	0.00		0	0.0		R	0		R	61		0	41		0
511004	2010	2	19	8	0.00		0	0.0		R	0		R	60		0	37		0
511004	2010	2	20	8	0.00		0	0.0		R	0		R	57		0	38		0

Figure 11. Copy the data.

5. Open the program Notepad and paste the data (right click, choose Paste; Figure 12).



Untitled - Notepad

File Edit Format View Help

Station ID	Observation Time				Precipitation			Snowfall			SnowDepth			Max. Temp.			Min. Temp.		
COOP ID	Year	Mon	Day	Hour	In.	F1	F2	In.	F1	F2	In.	F1	F2	Deg. F.	F1	F2	Deg. F.	F1	F2
511004	2010	1	1	8	0.00		0	0.0		R	0		R	63		0	45		0
511004	2010	1	2	8	0.00		0	0.0		R	0		R	68		0	46		0
511004	2010	1	3	8	0.00		0	0.0		R	0		R	69		0	48		0
511004	2010	1	4	8	0.00		0	0.0		R	0		R	69		0	52		0
511004	2010	1	5	8	0.00		0	0.0		R	0		R	67		0	55		0
511004	2010	1	6	8	0.00		0	0.0		R	0		R	68		0	54		0
511004	2010	1	7	8	0.00		0	0.0		R	0		R	67		0	44		0
511004	2010	1	8	8	0.00		0	0.0		R	0		R	69		0	46		0
511004	2010	1	9	8	0.00		0	0.0		R	0		R	66		0	48		0
511004	2010	1	10	8	0.00		0	0.0		R	0		R	69		0	51		0
511004	2010	1	11	8	0.00		0	0.0		R	0		R	62		0	46		0
511004	2010	1	12	8	0.00		0	0.0		R	0		R	62		0	44		0
511004	2010	1	13	8	0.00		0	0.0		R	0		R	64		0	44		0
511004	2010	1	14	8	0.00		0	0.0		R	0		R	69		0	38		0
511004	2010	1	15	8	0.00		0	0.0		R	0		R	63		0	47		0
511004	2010	1	16	8	0.00		0	0.0		R	0		R	70		0	51		0
511004	2010	1	17	8	0.00		0	0.0		R	0		R	71		0	60		0
511004	2010	1	18	8	0.00		0	0.0		R	0		R	74		0	55		0
511004	2010	1	19	8	0.00		0	0.0		R	0		R	68		0	56		0
511004	2010	1	20	8	0.00		0	0.0		R	0		R	70		0	46		0
511004	2010	1	21	8	0.00		0	0.0		R	0		R	65		0	46		0
511004	2010	1	22	8	0.00		0	0.0		R	0		R	68		0	50		0
511004	2010	1	23	8	0.00		0	0.0		R	0		R	66		0	43		0
511004	2010	1	24	8	0.00		0	0.0		R	0		R	62		0	45		0
511004	2010	1	25	8	0.00		0	0.0		R	0		R	62		0	47		0
511004	2010	1	26	8	0.00		0	0.0		R	0		R	68		0	51		0
511004	2010	1	27	8	0.04		0	0.0		R	0		R	69		0	50		0
511004	2010	1	28	8	0.14		0	0.0		R	0		R	60		0	43		0
511004	2010	1	29	8	0.13		0	0.0		R	0		R	58		0	44		0
511004	2010	1	30	8	0.28		0	0.0		R	0		R	58		0	44		0
511004	2010	1	31	8	0.12		0	0.0		R	0		R	52		0	44		0
511004	2010	2	1	8	0.00		0	0.0		R	0		R	56		0	42		0
511004	2010	2	2	8	0.01		0	0.0		R	0		R	56		0	42		0
511004	2010	2	3	8	0.42		0	0.0		R	0		R	51		0	36		0
511004	2010	2	4	8	0.00		0	0.0		R	0		R	59		0	38		0
511004	2010	2	5	8	0.00		0	0.0		R	0		R	61		0	40		0
511004	2010	2	6	8	0.00		0	0.0		R	0		R	55		0	35		0
511004	2010	2	7	8	0.00		0	0.0		R	0		R	53		0	38		0
511004	2010	2	8	8	0.00		0	0.0		R	0		R	58		0	42		0
511004	2010	2	9	8	0.00		0	0.0		R	0		R	64		0	51		0
511004	2010	2	10	8	0.00		0	0.0		R	0		R	68		0	46		0
511004	2010	2	11	8	0.00		0	0.0		R	0		R	65		0	49		0
511004	2010	2	12	8	0.00		0	0.0		R	0		R	61		0	42		0
511004	2010	2	13	8	0.00		0	0.0		R	0		R	56		0	38		0
511004	2010	2	14	8	0.00		0	0.0		R	0		R	57		0	38		0
511004	2010	2	15	8	0.01		0	0.0		R	0		R	57		0	39		0
511004	2010	2	16	8	0.00		0	0.0		R	0		R	56		0	40		0
511004	2010	2	17	8	0.00		0	0.0		R	0		R	61		0	40		0

Figure 12. COOP data pasted into Notepad.

6. Save the file in the protocol workspace folder for raw COOP data (Figure 13). Name the file using the following convention: COOP_id_YYYYMM$_S$_YYYYMM$_E$.txt where:
    a. id is the 6-character station code.
    b. YYYYMM$_S$ is the beginning month and year for the data record.
    c. YYYYMM$_e$ is the ending month and year for the data record.

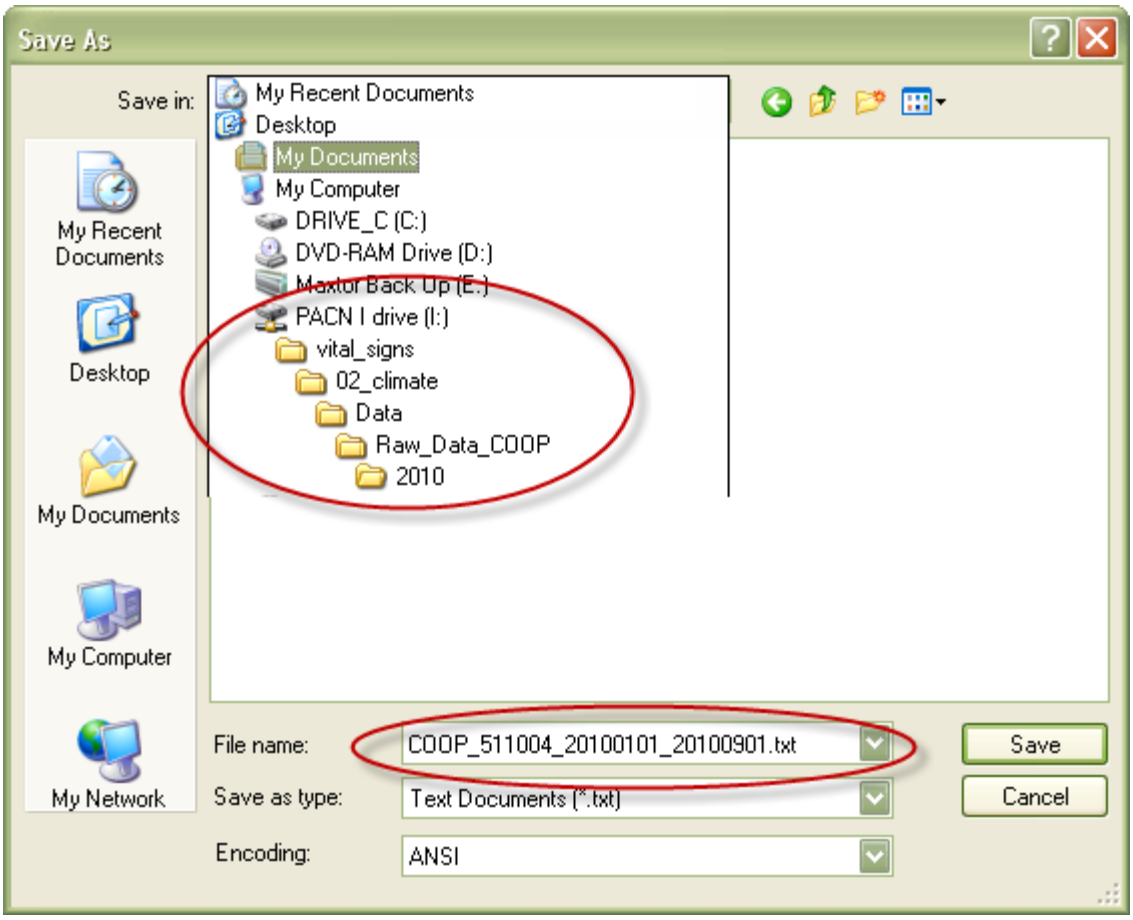


Figure 13. Saving the COOP data text file.

7. Navigate back to the selection criteria page to choose another COOP station for data download.

Processing Raw Data Files

The raw data files will have to be manipulated somewhat to get them into a format compatible with importing into the PACN climate database. Follow the steps below to format COOP and RAWS raw data.

Processing RAWS Data

1. Open the RAWS raw data folder and find the .txt file for the station and data to be imported into the PACN climate database.
2. Right click on the file, click “Open with”, and choose Excel to open the file (Figure 14).

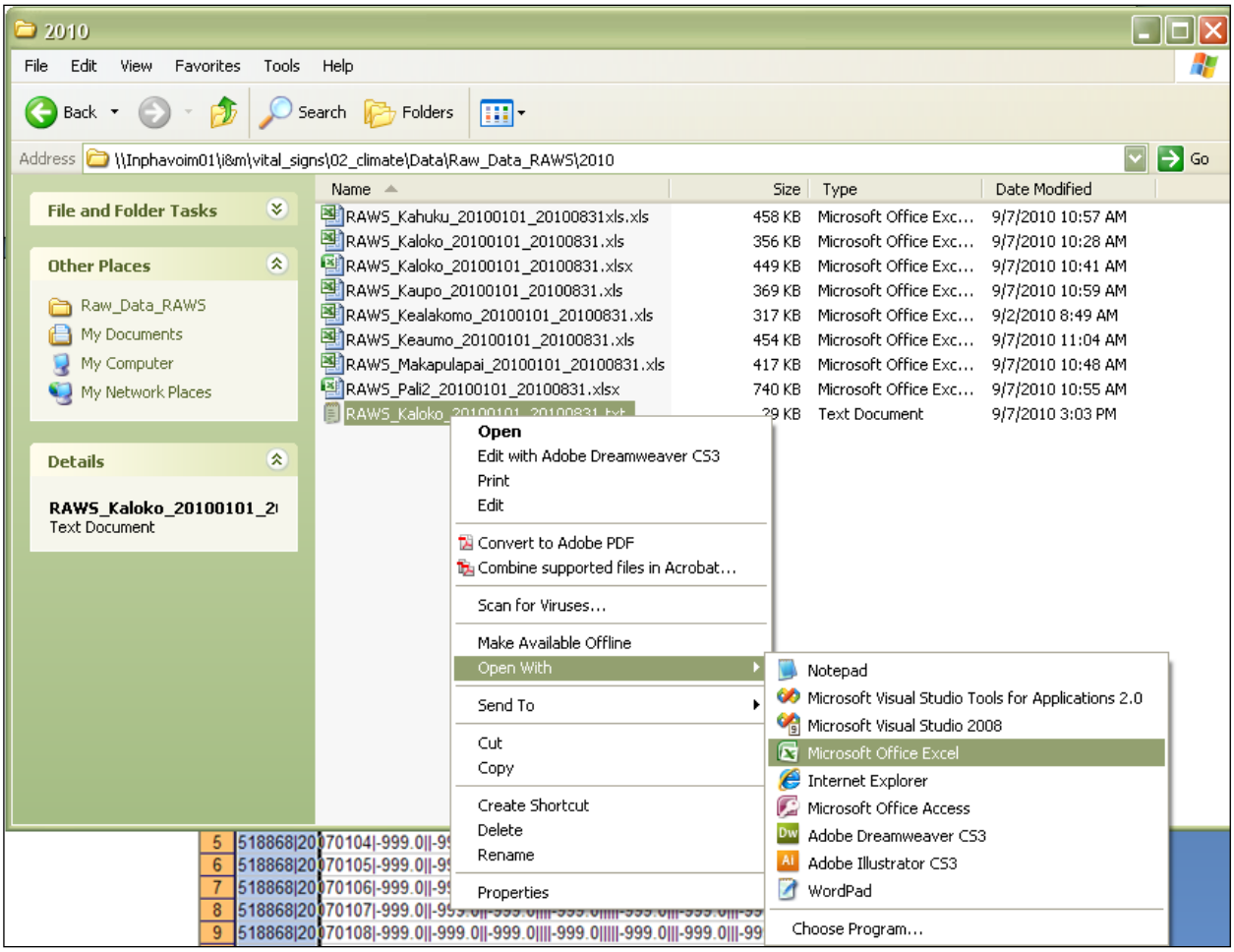


Figure 14. Open RAWS text file using Excel.

3. The data are compressed into the first column, and needs to be formatted before it can be imported. To do this, use the “Text to Columns” data tool.
    a. Click on Column A (Figure 15)

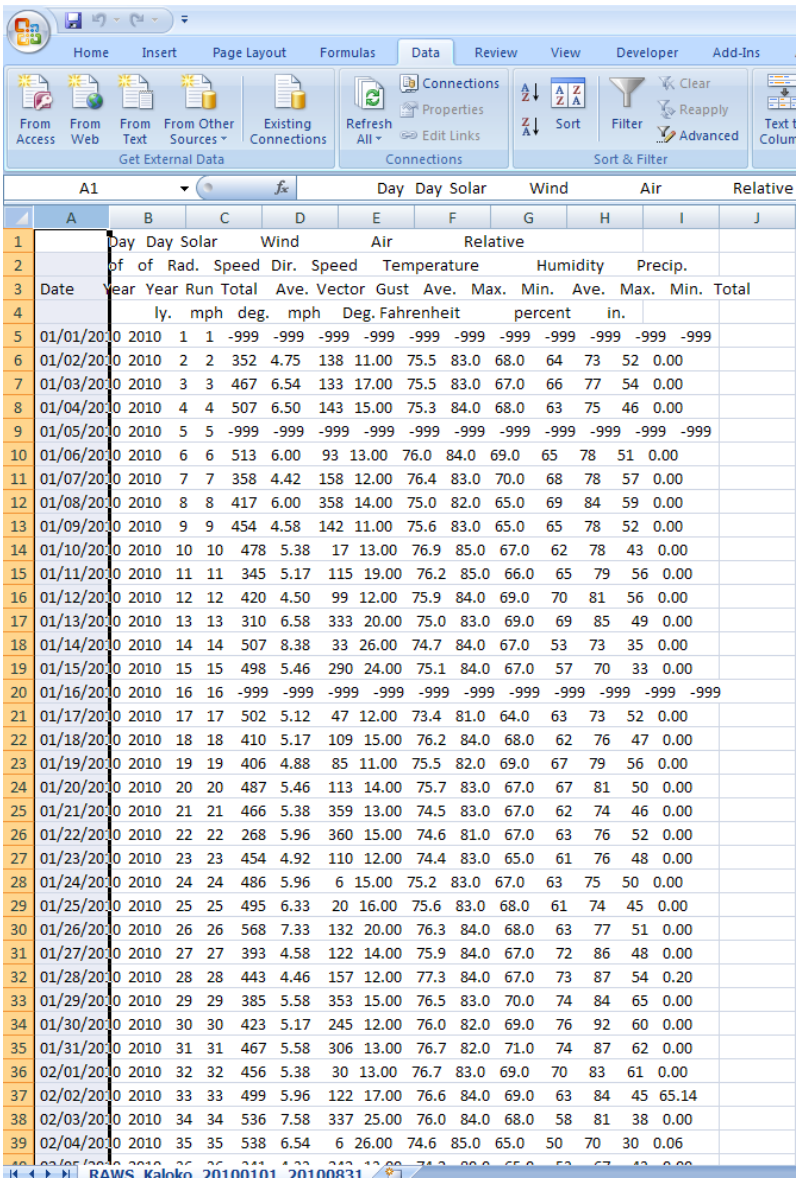


Figure 15. RAWS text file opened in Excel.

a. Click on the Data tab at the top of the spreadsheet and choose “Text to Columns” (Figure 16).

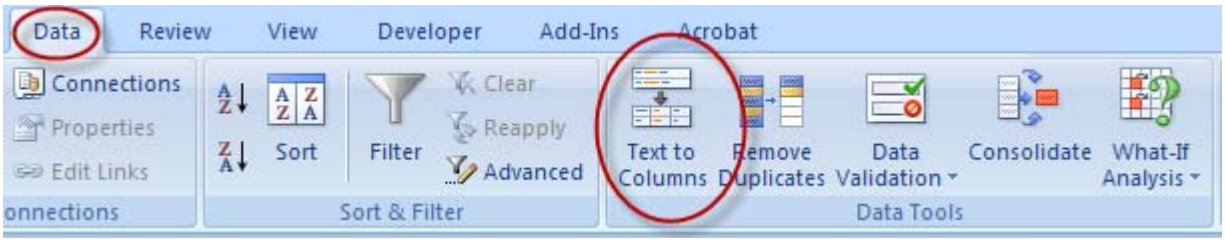


Figure 16. Text to columns.

b. Keep Step 1 of the Wizard as it is (Figure 17). Click “Next”.

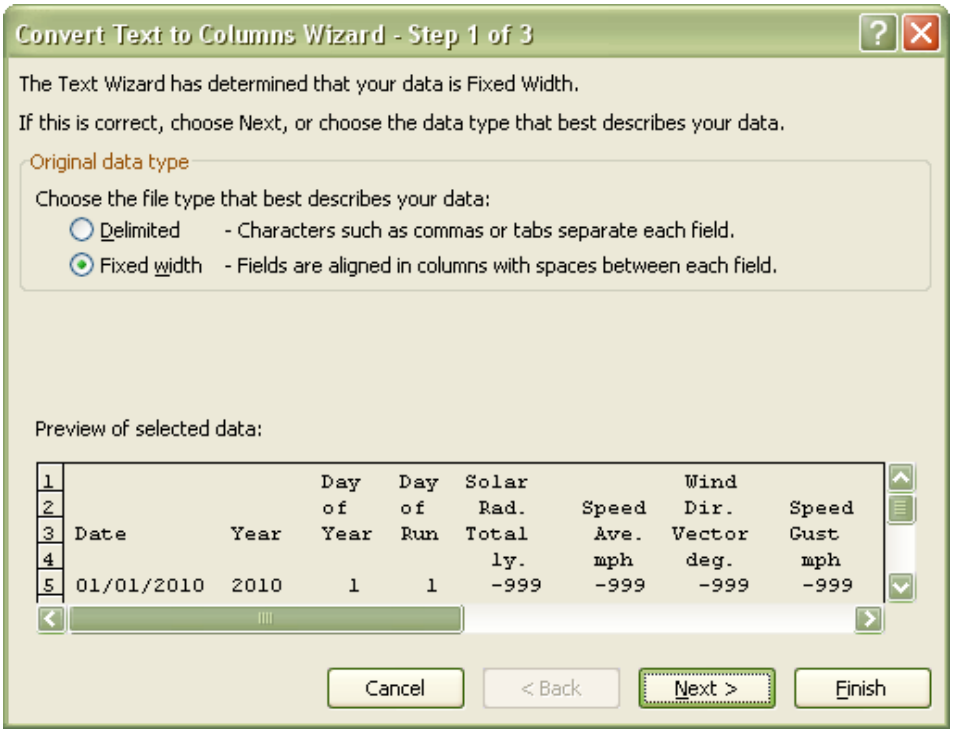


Figure 17. Text to columns wizard, step 1.

c. In step 2, check to make sure the fixed width falls between the data parameters (Figure 18). Click “Next”.

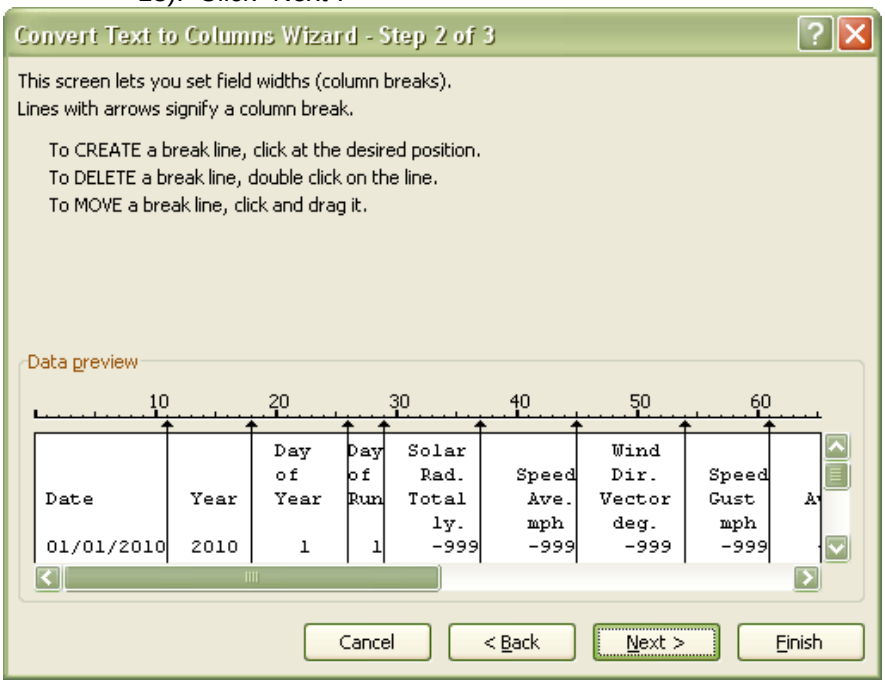


Figure 18. Text to columns wizard, step 2.

d. In step 3, click “Finish” (Figure 19).

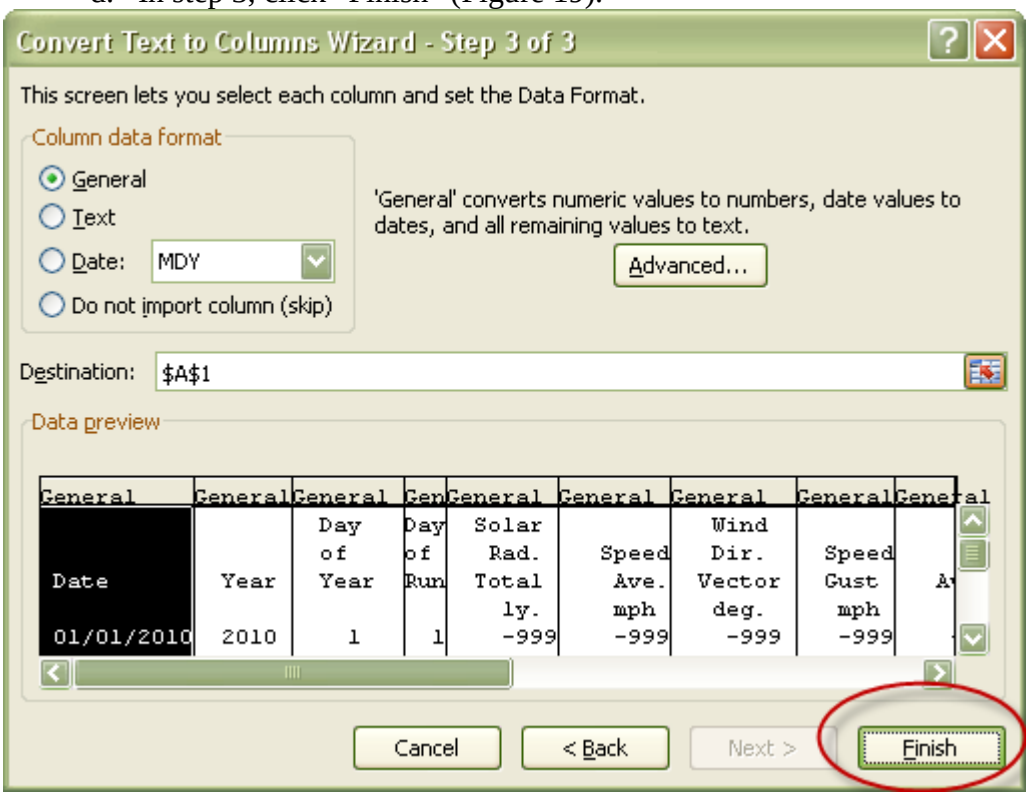


Figure 19. Text to columns wizard, step 3.

4. The headings will have to be fixed in the Excel spreadsheet before it can be imported into the database (Figure 20).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Keau	mo Ha	waii												
2	Daily Data	run on	9/24/2002	010 1	2:10										
3			Day	Day	Solar		Wind			Air			Relative		
4			of	of	Rad.	Speed	Dir.	Speed	Te	mperature			Humidity		Precip.
5	Date	Year	Year	Run	Total	Ave.	Vector	Gust	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
6					ly.	mph	deg.	mph	Deg.	Fahrenhe	it		percent		in.
7	1/1/2009	2009	1	1	237	2.58	241	11	54.3	66	46	96	100	72	-999
8	1/2/2009	2009	2	2	354	3.75	0	13	55.1	69	50	94	100	65	0.43

Figure 20. Headings in Excel need to be changed.

5. Delete the columns for Year (column B), Day of Year (column C), Day of Run (column D), and Speed Ave. mph (column F). Change the headings for the following columns so they match the headings in Figure 21. Delete any extraneous header rows.

	A	B	C	D	E	F	G	H	I	J	K
1	Date	srad	pkwd	pkws	tavg	tmax	tmin	avrh	mxrh	mnrh	prcp
2	1/1/2009	237	241	11	54.3	66	46	96	100	72	-999
3	1/2/2009	354	0	13	55.1	69	50	94	100	65	0.43

Figure 21. New headings in Excel.

6. Save the file in Excel.
    a. Click on the Office button and click Save As. Choose Excel Workbook (Figure 22).

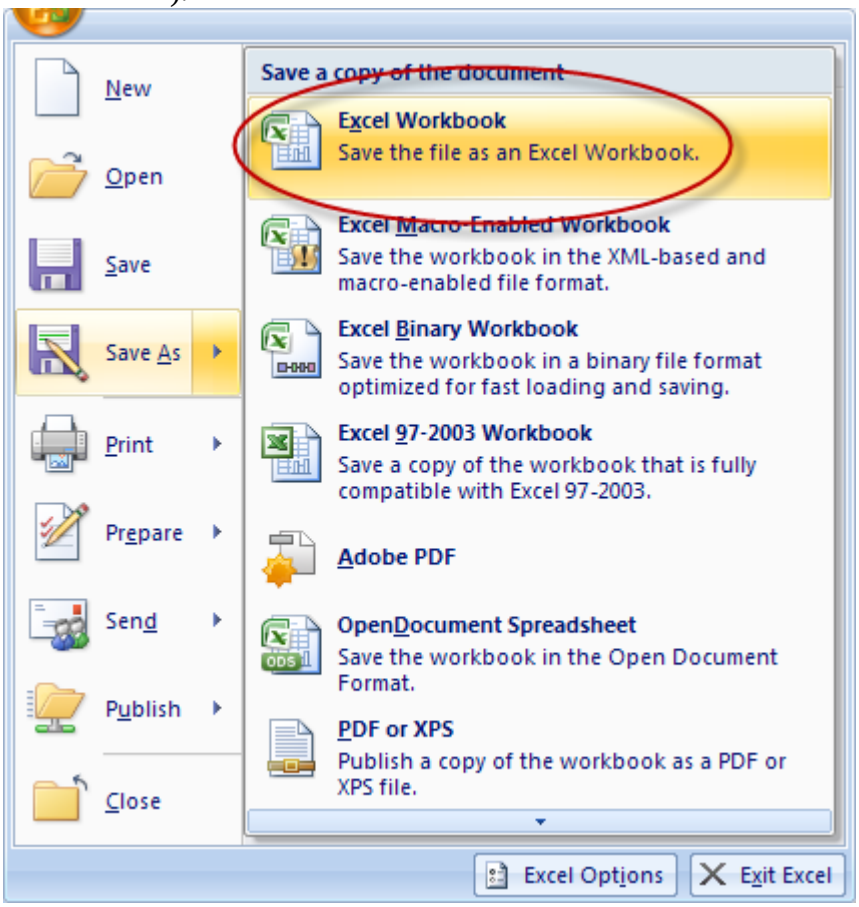


Figure 22. Save as Excel file.

    b. The name of the Excel file will be the same as the text file. Save the file in the same folder as the text file (Figure 23).

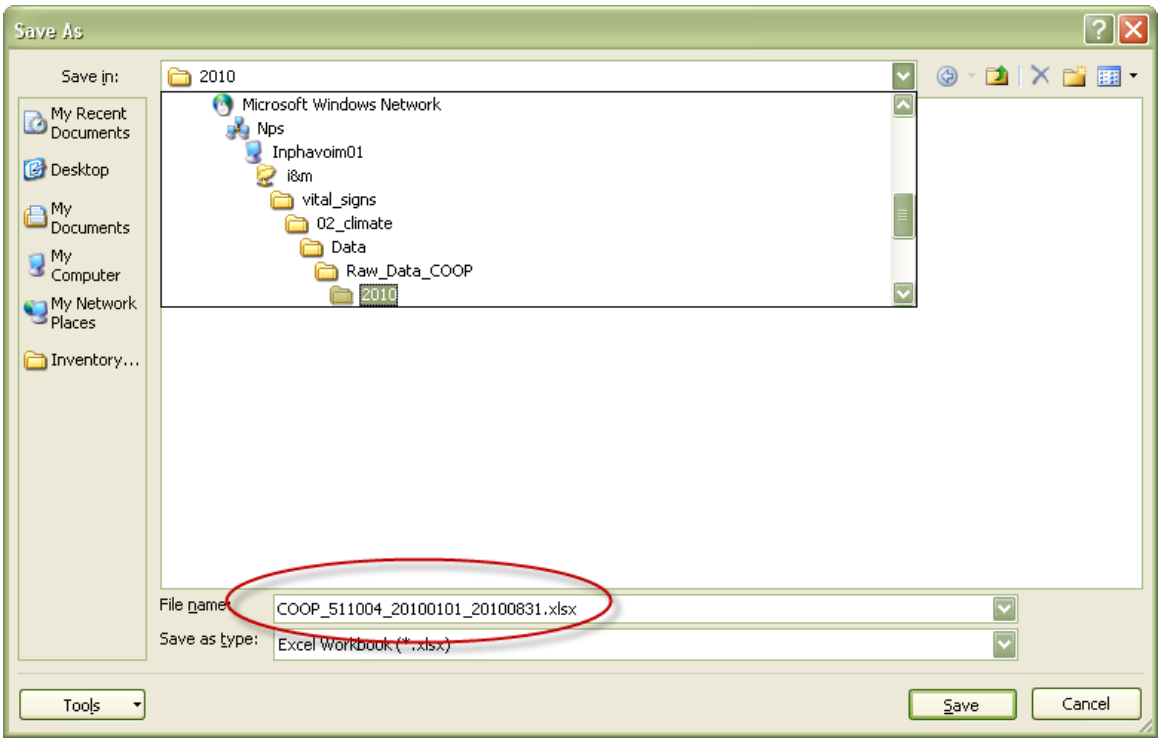


Figure 23. Save as Excel file.

c. The file is now ready to be imported into the PACN climate database (see the PACN Climate Database User's Guide for instructions on how to import files).

Processing COOP Data

1. Open the COOP raw data folder and find the TXT file for the station and data to be imported into the PACN climate database using Excel.
   a. Right click on the file name, click Open With, then choose Excel (Figure 24).

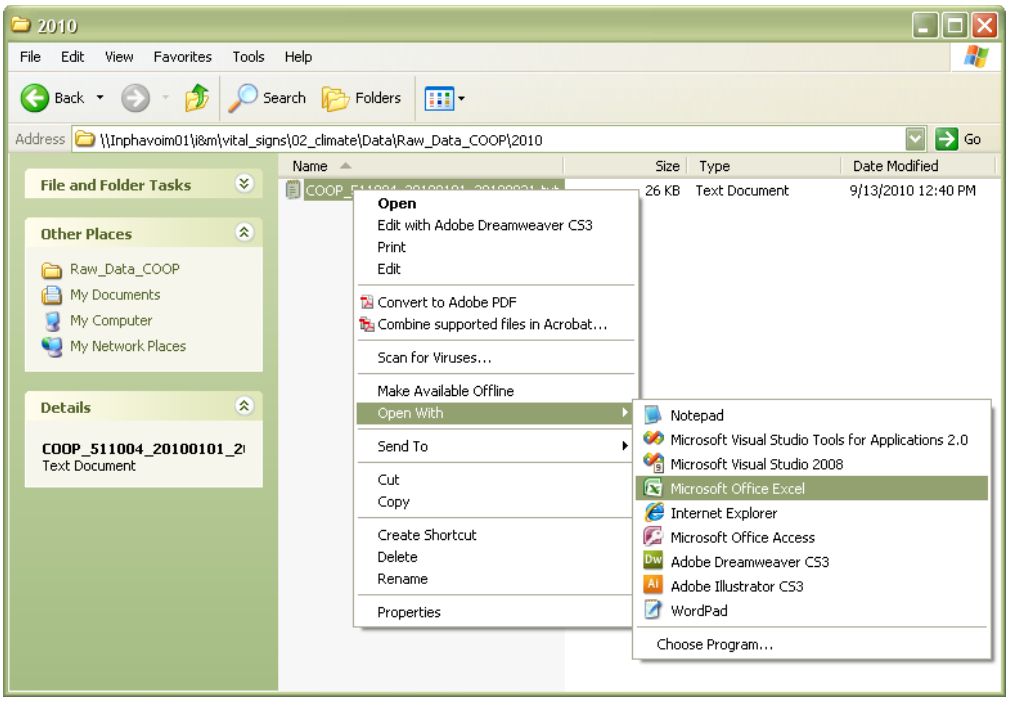


Figure 24. Opening the text file with Excel.

2. The data are compressed into the first column, and needs to be formatted before it can be imported. To do this, use the "Text to Columns" data tool.
    a. Click on Column A

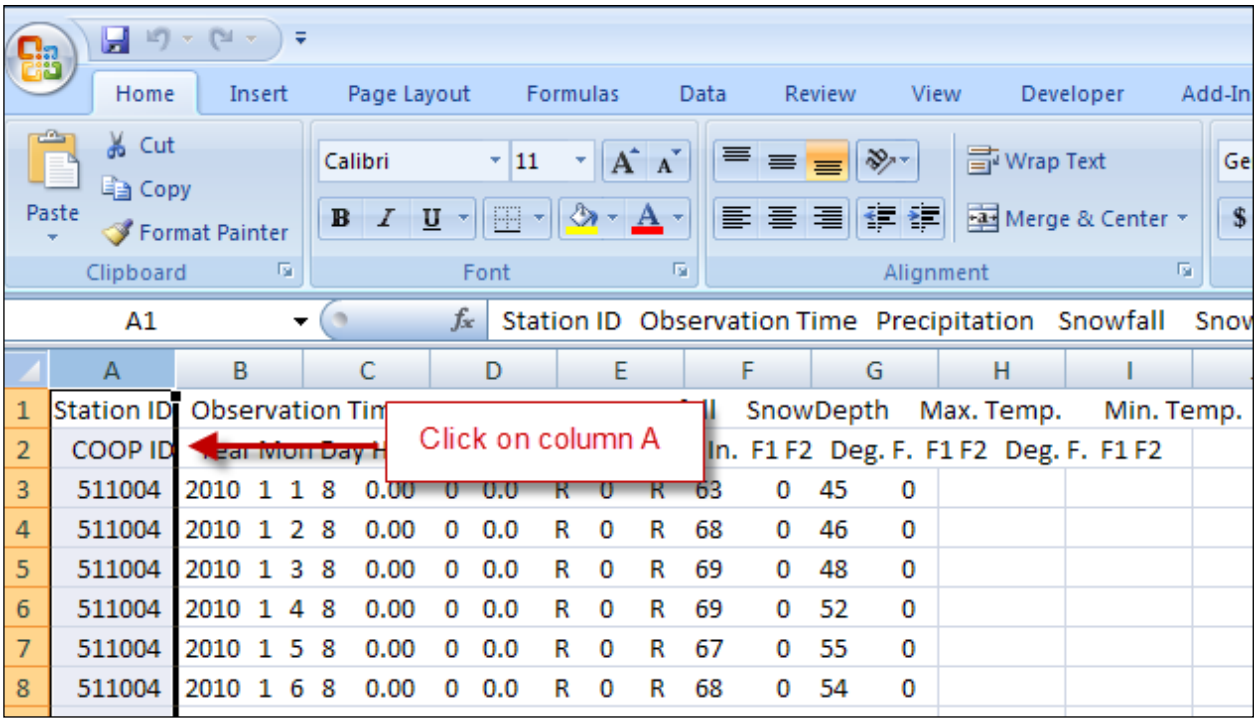


Figure 25. Click on Column A.

b. Click on the Data tab at the top of the spreadsheet and choose “Text to Columns” (Figure 26).

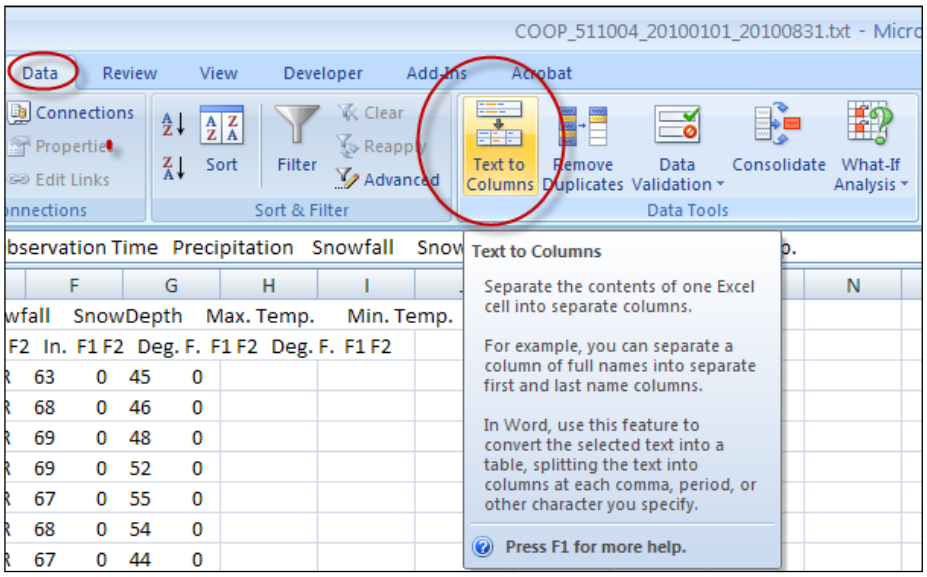


Figure 26. Text to Columns button.

c. Keep Step 1 of the Wizard as it is (Figure 27). Fixed width will be used for this data. Click Next.

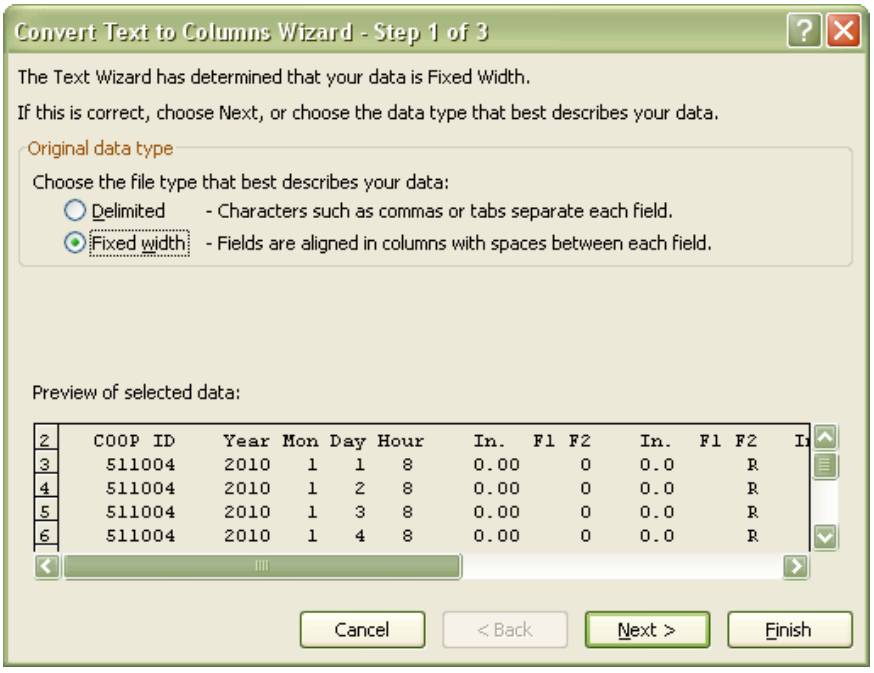


Figure 27. Text to Column Wizard, Step 1.

d. In Step 2, confirm that the arrowed line is between sets of data, and that it doesn't overlap with the data (Figure 28). This is how the data will be broken up into columns. Click Next.

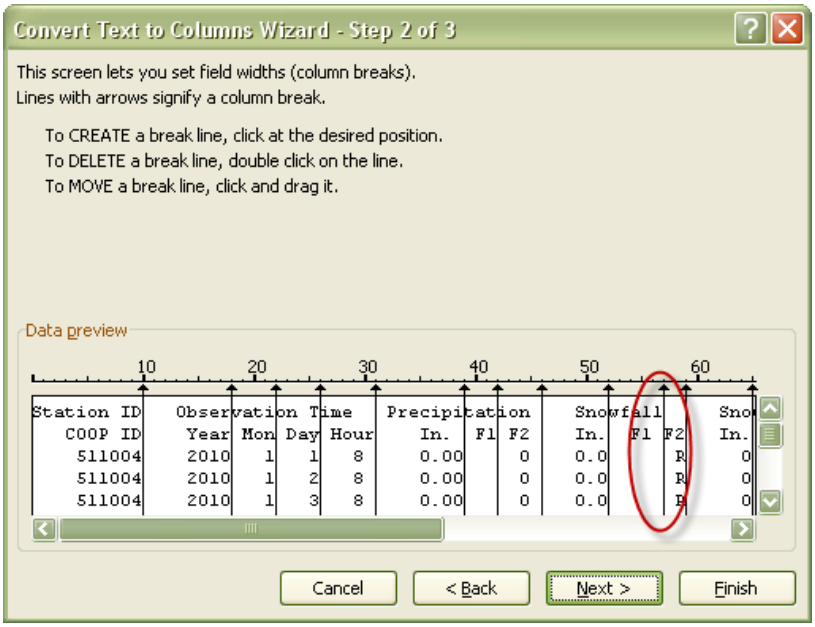


Figure 28. Text to Column Wizard, Step 2.

e. In Step 3, leave the defaults and click Finish (Figure 29).

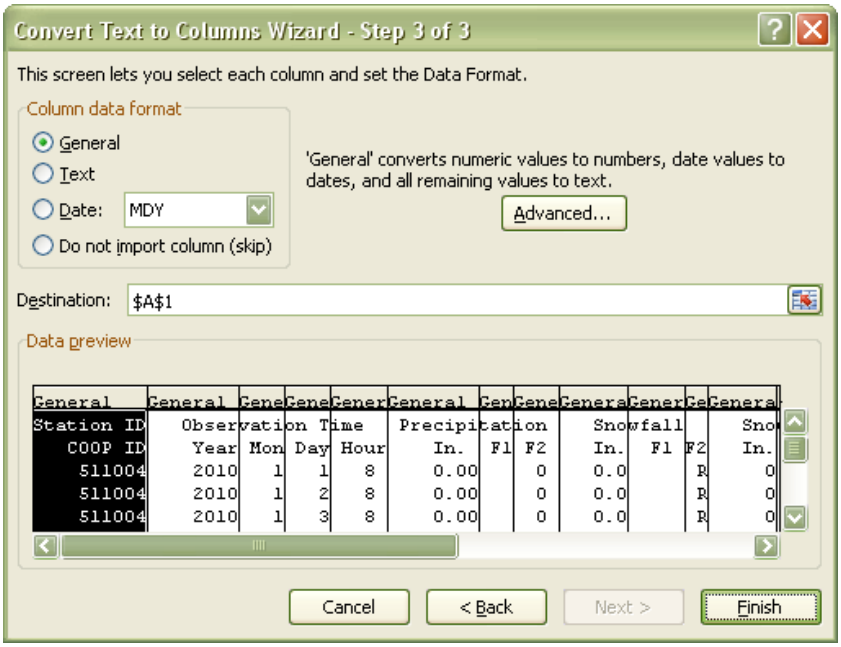


Figure 29. Text to Column Wizard, Step 3.

f. The data will be separated out into the correct columns. The first of the two header rows has been broken up by the Text to Column function (Figure 30). To fix this, the second header row will have to be manipulated.

A	B	C	D	E	F	G	H	I	J
Station ID	Obser	vati	on T	ime	Precipi	tat	ion	Sno	wfall
COOP ID	Year	Mon	Day	Hour	In.	F1	F2	In.	F1
511004	2010	1	1	8	0		0	0	
511004	2010	1	2	8	0		0	0	
511004	2010	1	3	8	0		0	0	
511004	2010	1	4	8	0		0	0	

Figure 30. First header row.

g. First delete the columns for Snow and Snow Depth (Figure 31). Click on the column letter over the first snow column and scroll over to include all snow columns. Right click and choose Delete.

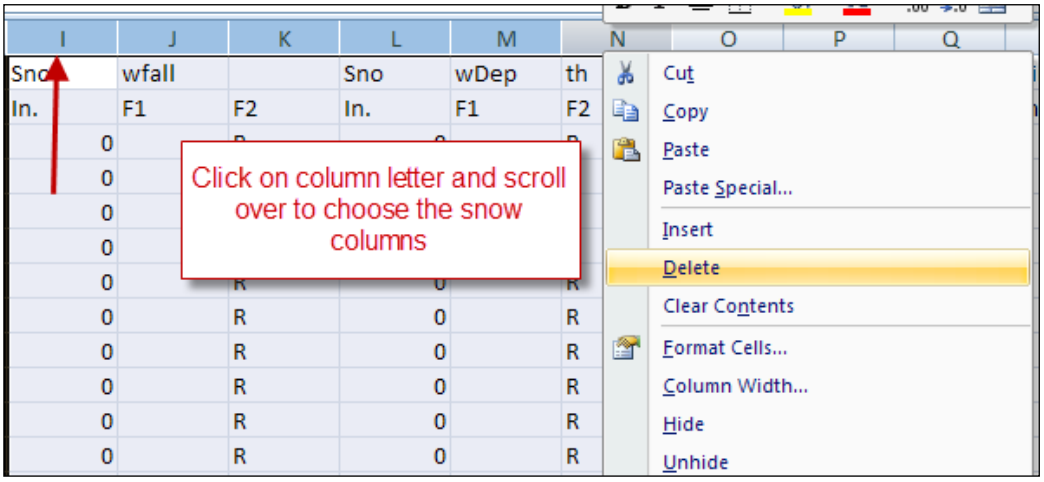


Figure 31. Delete snowfall and snow depth columns.

h. Next, delete the columns for F2, these won't be used. Click on the column for each F2 and delete column. Repeat for all F2 columns (Figure 32).

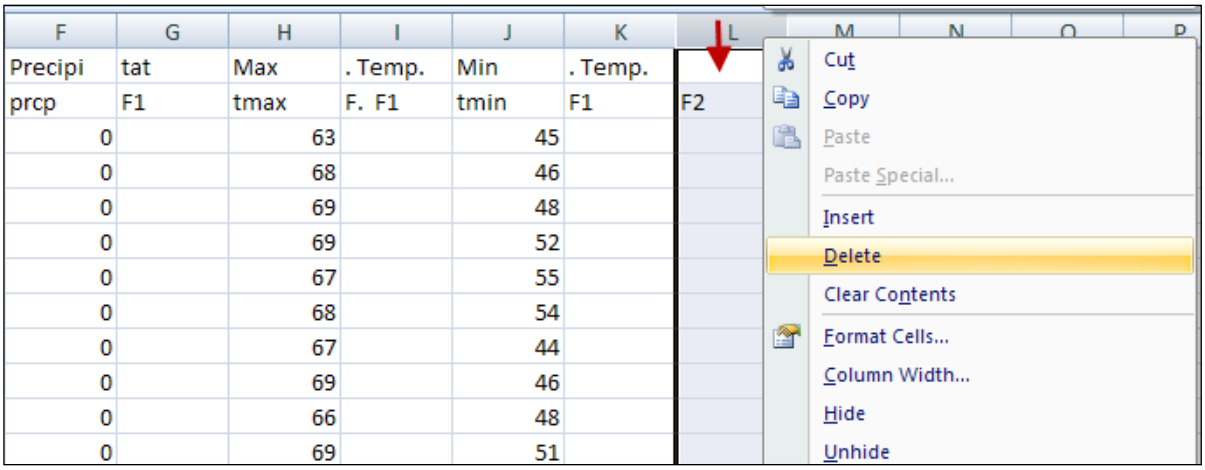


Figure 32. Delete F2 columns.

i. Next, in the column with Precipi in the top row, type prcp in the second row, overwriting the units. This can be repeated for the following rows (Figure 33).
    i. Max – Deg replaced with tmax
    ii. Min – Deg replaced with tmin

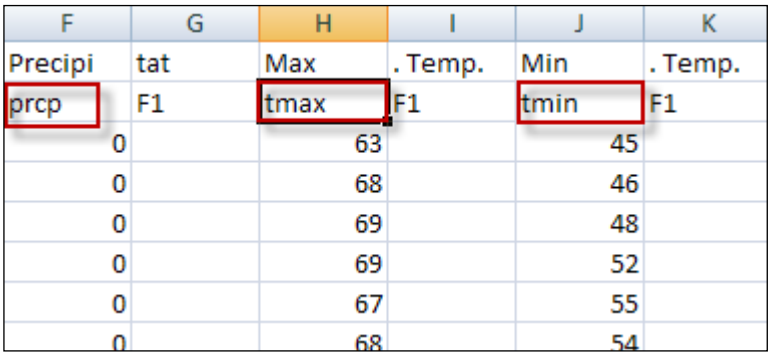


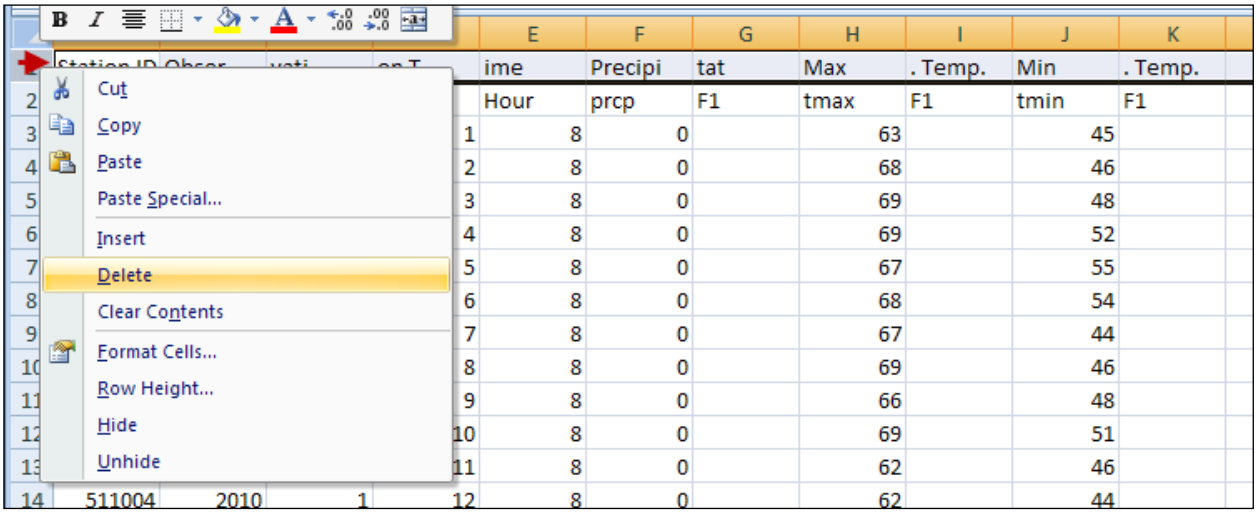
Figure 33. Replace headers.

j. Rename the F1 columns to the correct flag.
    i. F1 after the column prcp should be renamed: prcp_flag
    ii. F1 after the column tmax should be renamed: tmax_flag
    iii. F1 after the column tmin should be renamed: tmin_flag
k. Insert a column between the columns Hour and prcp. Name the column Date
l. Concatenate the columns Mon, Day, and Year in the new column Date
    i. type in the first row: =CONCATENATE(C3, "/", D3, "/", B3)
    ii. C3 should be the column labeled Mon, D3 should be the column labeled Day, and B3 should be the column labeled Year. If they are not, type in the correct column letter.
    iii. Copy the field that was just populated with the concatenate formula
    iv. Paste it in the remaining empty fields for the column Date
    v. Copy the entire column Date, and Paste Special right back over the column

1. choose “Values” in the Paste Special list

m. Delete the rows for Year, Mon, Day, and Hour

n. Lastly, delete the first header row. Right click on the first row and click Delete (Figure 34).



	E	F	G	H	I	J	K
2	Hour	prcp	F1	tmax	F1	tmin	F1
3	8	0		63		45	
4	8	0		68		46	
5	8	0		69		48	
6	8	0		69		52	
7	8	0		67		55	
8	8	0		68		54	
9	8	0		67		44	
10	8	0		69		46	
11	8	0		66		48	
12	8	0		69		51	
13	8	0		62		46	
14	8	0		62		44	

Figure 34. Delete first header.

o. The final header will look like Figure 35.

	A	B	C	D	E	F	G	H
1	COOP ID	date	prcp	prcp_flag	tmax	F1	tmin	F1
2	511004	1/1/2010	0		63		45	
3	511004	1/2/2010	0		68		46	

Figure 35. Final header row.

3. Save the file in Excel.

a. Click on the Office button and click Save As. Choose Excel Workbook (Figure 36).

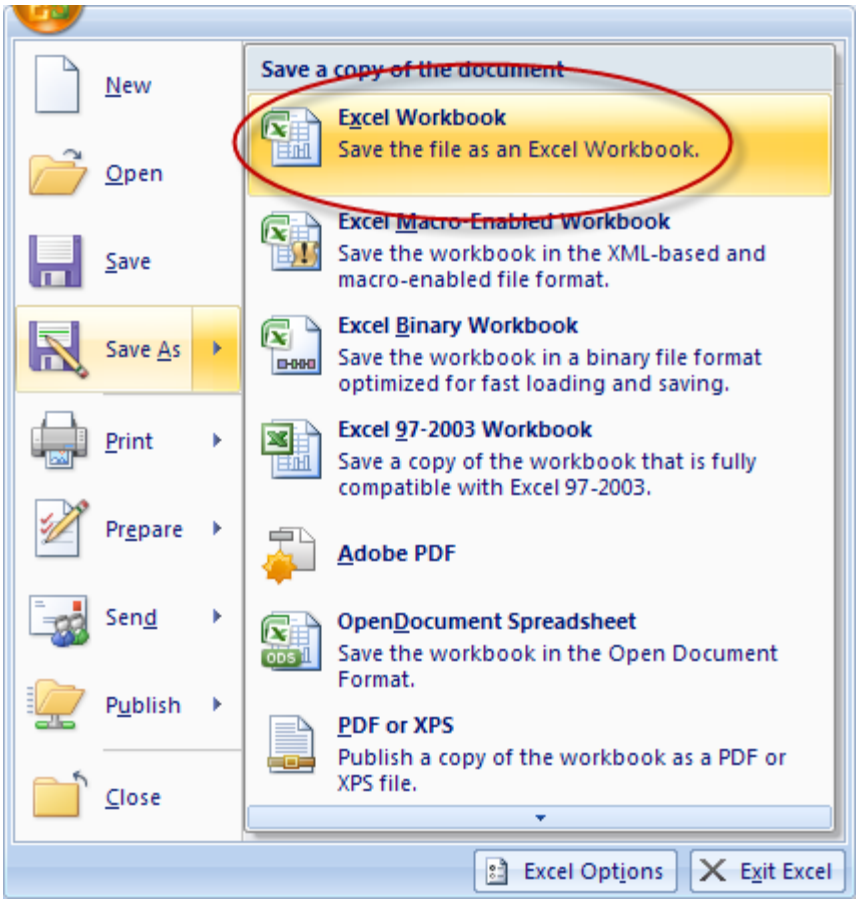


Figure 36. Save as Excel file.

4. The name of the Excel file will be the same as the text file. Save the file in the same folder as the text file (Figure 37).

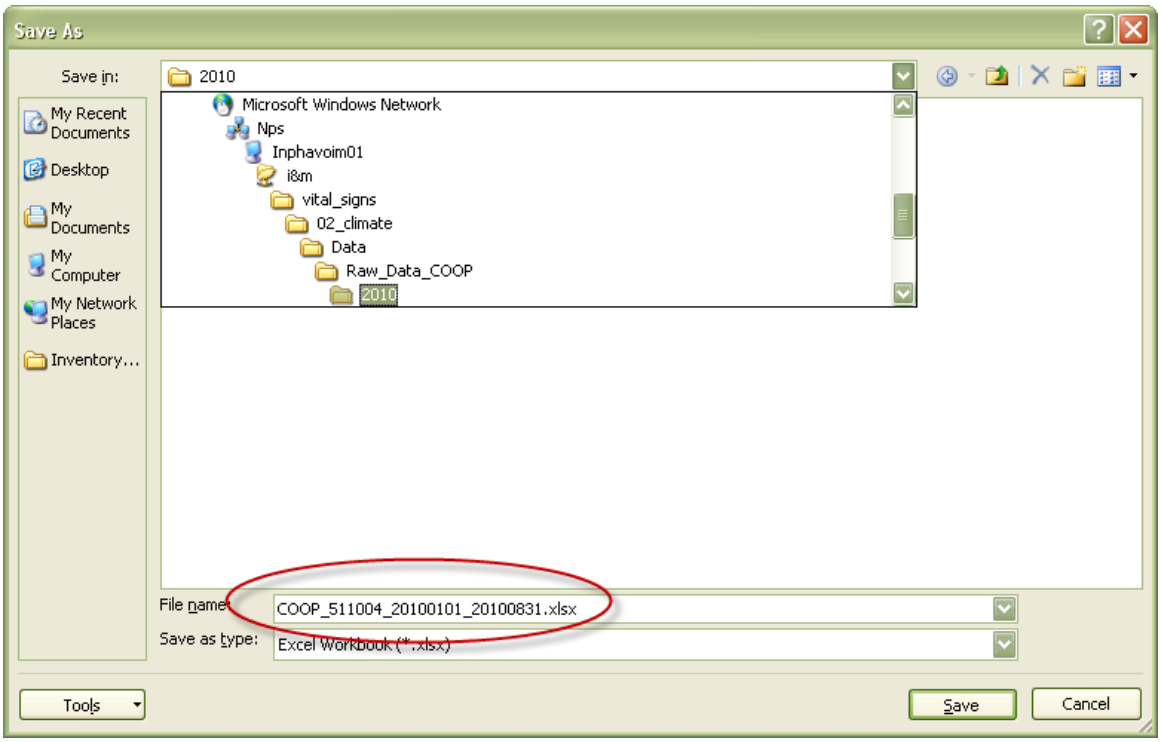


Figure 37. Save as Excel file.

5. The file is now ready to be imported into the PACN climate database (see the PACN Climate Database User's Guide for instructions on how to import files).

GPMN Data

Data from the Gaseous Pollutant Monitoring Network will be downloaded from the data access website[57] established by Air Resource Specialists, Inc. Click on the "Data Export " link on the left hand side of the page. Leave the default Output Format (Comma Delimited Text File (CSV) and enter a start and end date. Click "Continue". Next select a site and then click the Continue button. Choose a Parameter Interval and Parameters and click "Export" to download the generated data file. Save the file in the GPMN raw data folder. Rename the file using the station name and a date range.

Processing Raw Data Files

1. Once the data file has been saved, make a copy of the file and add "_import" to the file name. These files will be modified for importing into the climate database.
2. Open the file by right clicking on the file. Click "Open with", and choose Excel to open the file.
3. The first 9 lines of the spreadsheet are metadata for the data file and do not need to be imported into the database. Delete the first 9 rows, leaving the column heading row. Make sure to delete the actual rows, not just the data in the rows (Figure 38).

[57] http://12.45.109.6/

	A	B	C	D	E	F	G	H	I	J
1	Users of this data file should acknowledge the National Park Service Air Resources Division									
2	NOTE: There are two parts to this file. Part I contains information on the sites selected.									
3	Part II contains the actual data and begins on line 9.									
4										
5	Part I - Site Information									
6	ABBR	AIRS_SITE_CODE	SITE_NAME							
7	HAVO-OB	15-001-0007	Hawaii Volcanoes National Park - Observatory							
8										
9	Part II - Data									
10	ABBR	DATE_TIME	SWS_M_S	VWS_M_S	VWD_DEG	SDWD_DE	TMP_DEG	RH_PERCE	RNF_MM_	BAR_MB
11	HAVO-OB	6/29/2010 0:00	5.5	5.3	355	13	13.6	89	0	880
12	HAVO-OB	6/29/2010 1:00	5.5	5.4	357	14	13.3	86	0	880
13	HAVO-OB	6/29/2010 2:00	5.3	5.2	359	13	13	83	0	879
14	HAVO-OB	6/29/2010 3:00	5.5	5.3	356	15	13.1	83	0	879
15	HAVO-OB	6/29/2010 4:00	4.6	4.4	359	13	13.2	89	0	879

Figure 38. Delete header rows.

4. Save the file as an Excel Spreadsheet, using the same file name (Figure 39).

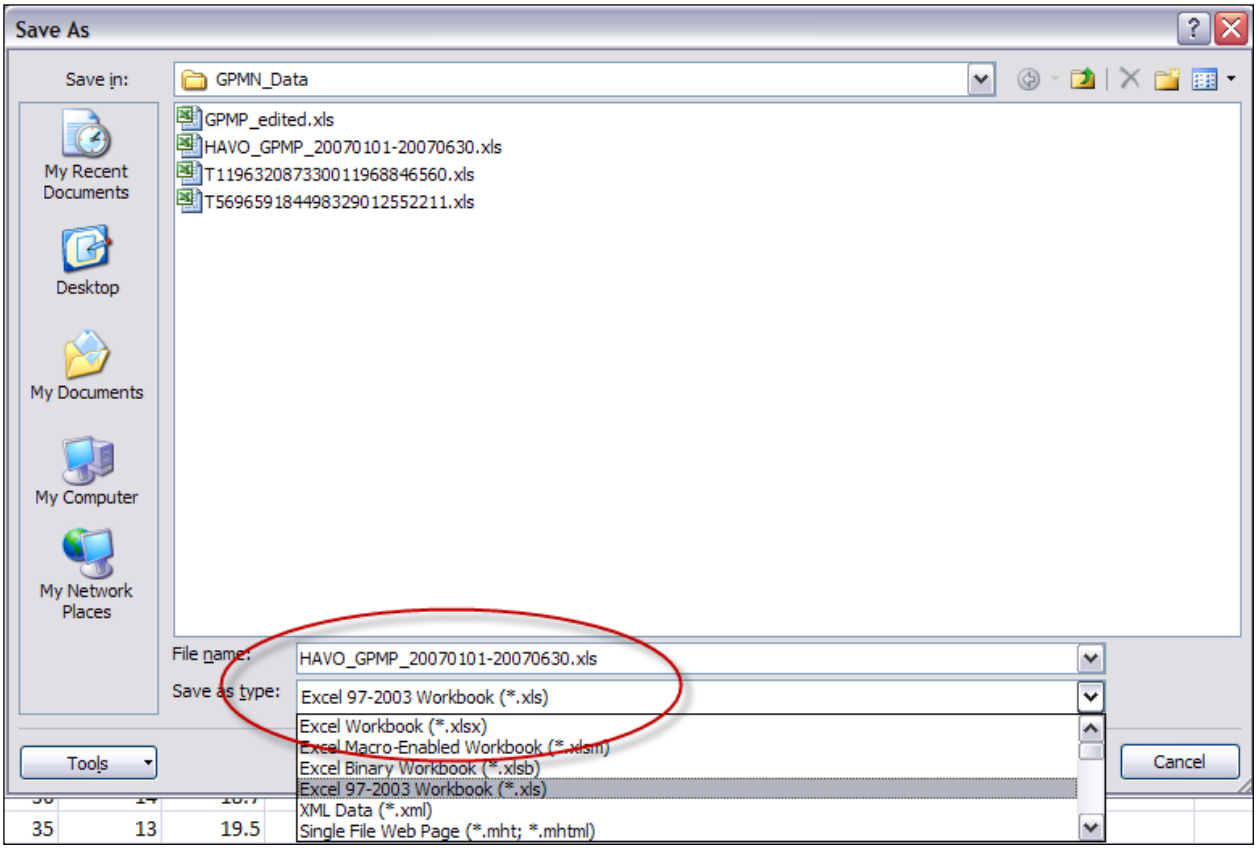


Figure 39. Save as Excel file.

5. The file is now ready to be imported into the PACN climate database (see the PACN Climate Database User's Guide for instructions on how to import files).

HaleNet Data

HaleNet data will be acquired annually from Tom Giambelluca at the University of Hawaii at Manoa's Geography Department in a compressed zip file format. Individual files within the compressed folder will contain daily mean data for a station. To import an individual file into the PACN climate database, follow the steps below.

6. Unzip the compressed file and store the raw data folder in the project workspace (see SOP 14: Workspace Setup and Project Records Management for folder structure details).
7. Make a copy of the unzipped folder and add "_import" to the folder name. These files will be modified for importing into the climate database.
8. Open the folder and open the first file. Right click on the file, click "Open with", and choose Excel to open the file.
9. The first seven rows of the spreadsheet contain metadata information and needs to be deleted. Delete all rows before the row that contains the column headings. Make sure to delete the actual rows, not just the data in the rows (Figure 40).

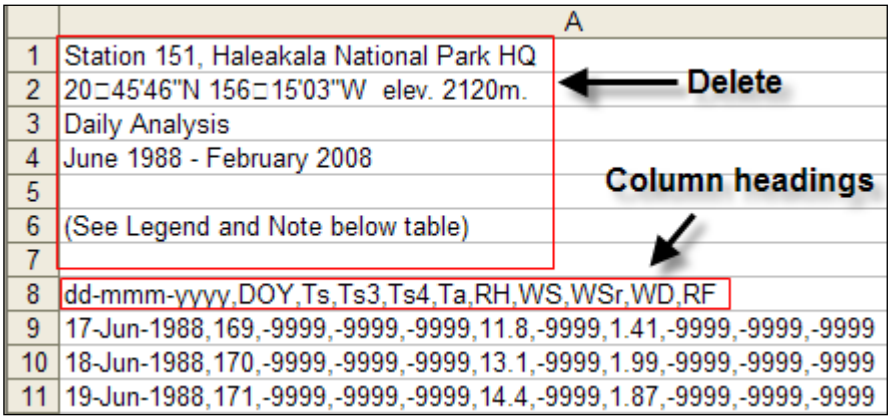


Figure 40. Delete header rows.

10. Scroll to the bottom of the data set. The last several rows contain the legend and the notes about the data. Delete these rows as well (Figure 41).

7199	Legend	
7200	-9999	missing data
7201	Ts	Soil Temperature, avg 2 and 6 cm (□C)
7202	Ts3	Soil Temperature, 2.5 cm (□C)
7203	Ts4	Soil Temperature, 5 cm (□C)
7204	Ta	Air Temperature (□C)
7205	RH	Relative Humidity (%)
7206	WS	Wind Speed (m/s)
7207	WSr	Resultant Wind Speed (m/s)
7208	WD	Wind Direction (degrees)
7209	RF	Rainfall (mm)
7210		
7211	Note: If some observations are missing during the period, the total or average of daily	
7212	values may not equal the monthly value. See statistical methods description:	
7213	http://webdata.soc.hawaii.edu/climate/HaleNet/Data_procedures	

Figure 41. Delete bottom rows.

11. After these deletions, the first column in the Excel spreadsheet will need to be formatted using "Text to Columns" (Figure 42. Follow steps (see COOP and RAWS Data: Processing Raw Data Files above.

    a. Click on Column A

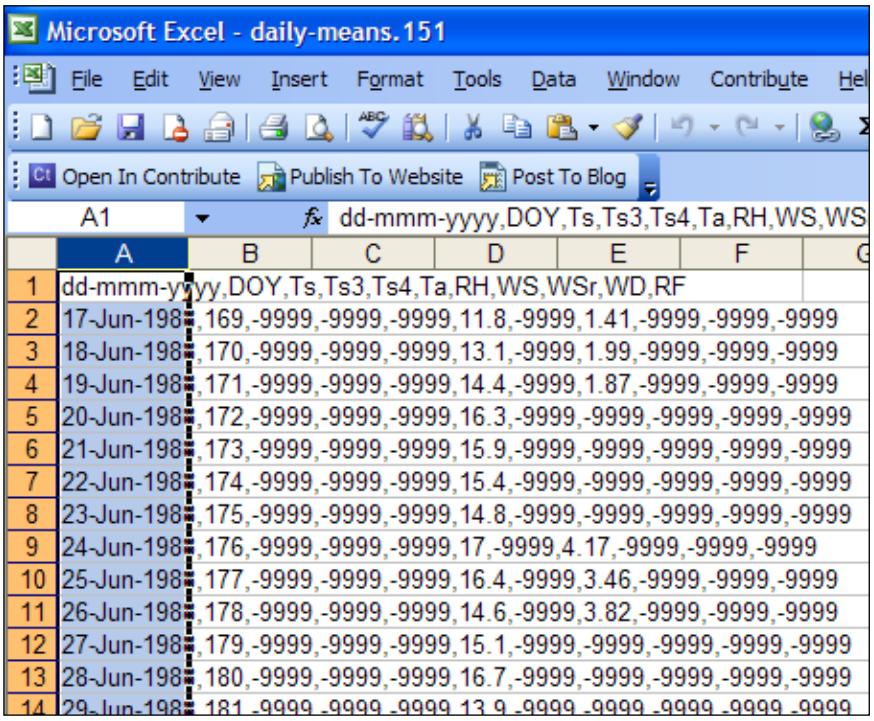


Figure 42. Text to Columns.

    b. Click on the Data tab at the top of the spreadsheet and choose "Text to Columns" (Figure 43).

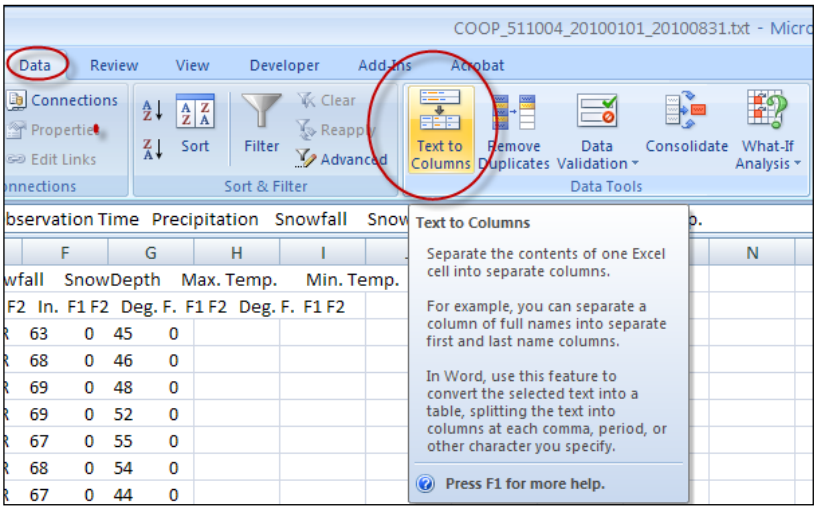


Figure 43. Text to Columns button.

c. Keep Step 1 of the Wizard as it is (Figure 44). Click Next.

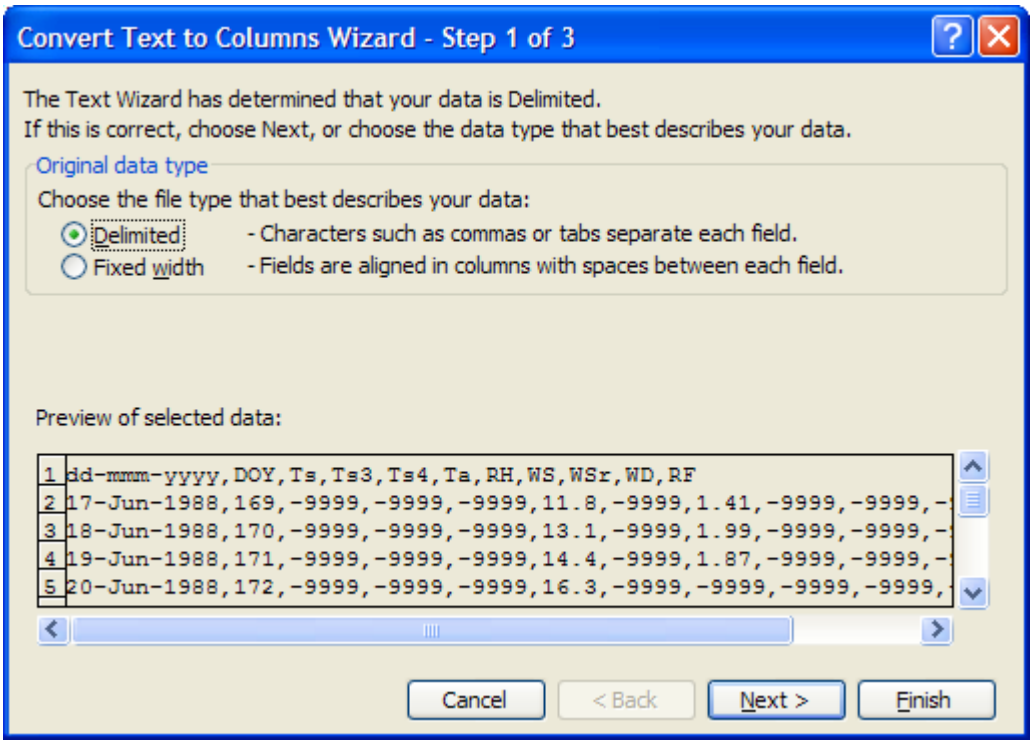


Figure 44. Text to Columns Step 1.

d. In Step 2, click the “Comma” box (Figure 45). Click Next.

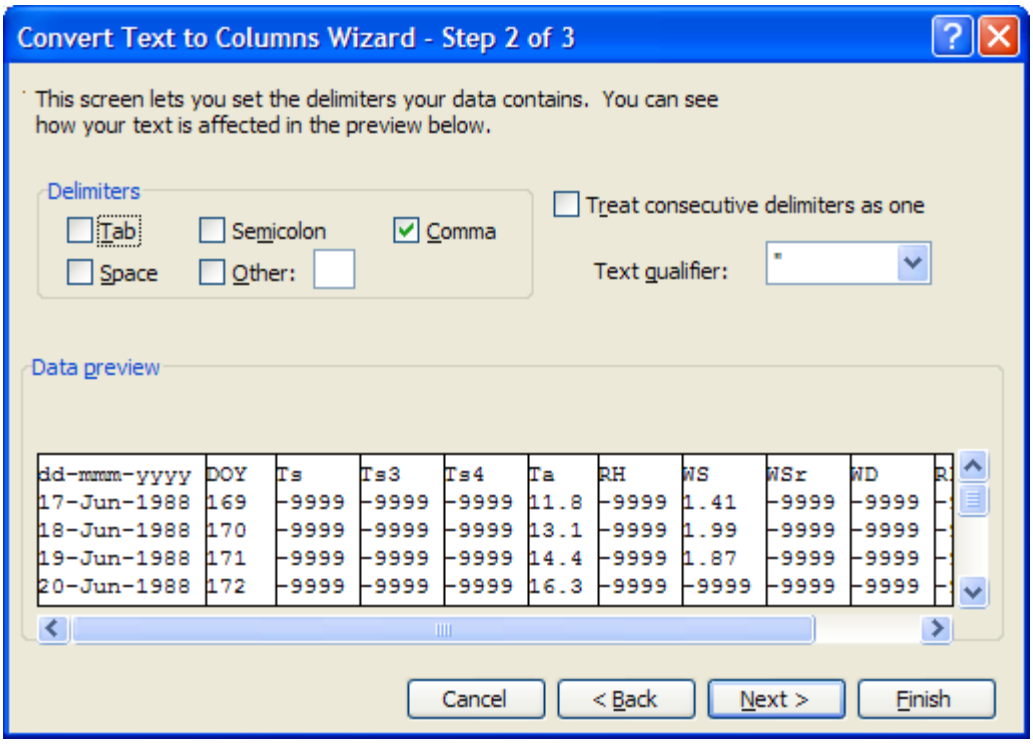


Figure 45. Text to Columns Step 2.

e. Click the first column and change the column data format to Date. Choose the format "DMY" from the pull down list (Figure 46). Click Finish.

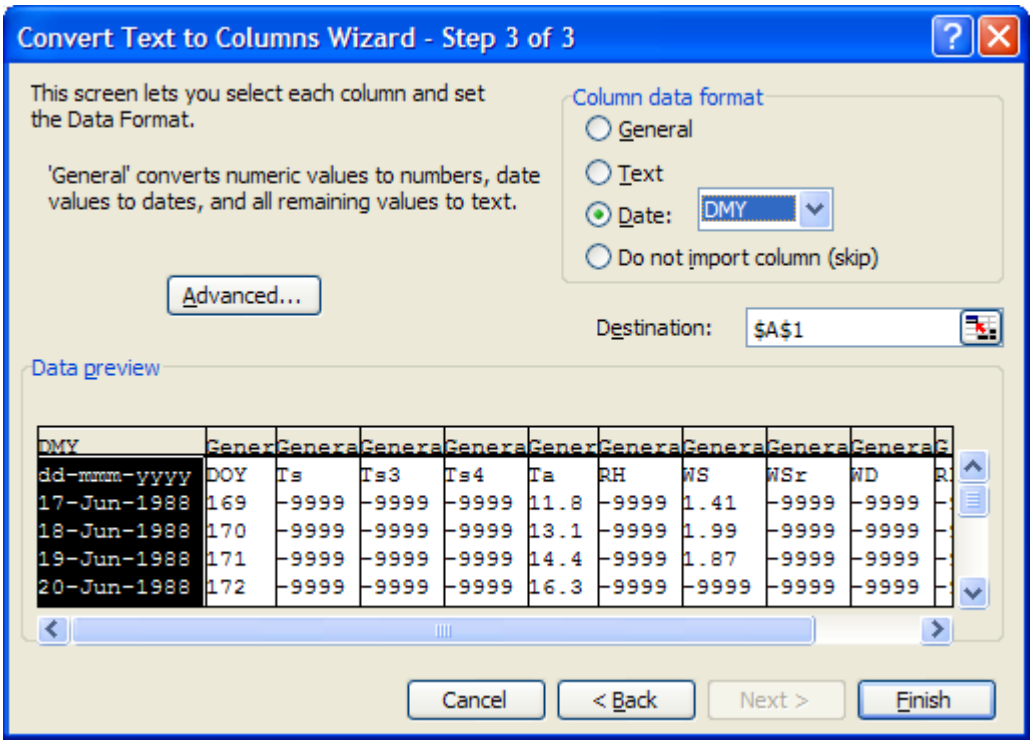


Figure 46. Text to Columns Step 3.

f. Save the file as an Excel Spreadsheet, using the same file name (Figure 47).

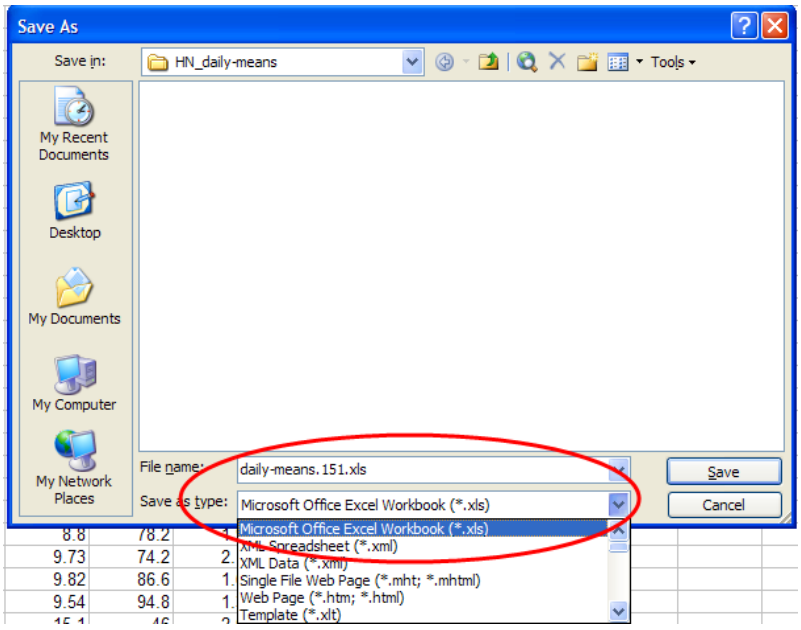


Figure 47. Save as Excel file.

12. The file is now ready to be imported into the PACN climate database (see the PACN Climate Database User's Guide for instructions on how to import files). Repeat these steps for the other files in the folder.

Standard Operating Procedure (SOP) #22
Safety Protocol

Version 1.0 (January 8, 2010)

Change History

Version #	Date	Revised by	Changes	Justification

Only changes in this specific SOP will be logged here. Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

Purpose

This SOP explains safety procedures that all field crew members should follow to ensure optimum safety when working in the field to monitor Pacific Island Network (PACN) weather stations. Part of this SOP covers material found in Pacific Cooperative Studies Unit (PCSU) field operation SOPs (2010), while other parts cover material from a Wilderness Hiking and Backpacking Training workshop for PACN Inventory and Monitoring employees held in January 2007.

PCSU Procedures

The PCSU is part of the national network of Cooperative Ecosystem Studies Units established to provide technical assistance and research to environmental and resource managers at organizations such as the NPS. Field personnel should examine the following procedures before working in the field to ensure all safety procedures are understood and followed. These field safety rules and regulations are meant to ensure the safety and well-being of all field workers.

Field Personnel Rules and Regulations

1. Only staff and approved field crew are allowed to assist with field work. Friends, pets and children are prohibited from accompanying field teams. Employees of state and federal agencies on official business connected with the project may accompany people working in the field. The project lead should always be consulted if there are uncertainties regarding someone's eligibility to accompany the field crew.

2. Field work will be planned ahead of departure and discussed with a supervisor. On a daily basis, park personnel will be notified of the itinerary and destination (including plot location where appropriate) of the field crew and the estimated return time. A contact person should be chosen at the park that will be responsible for notifying a Safety Officer if a field person is injured.
3. Field crew members must avoid working alone and should never traverse difficult terrain without another crew member. If travel by vehicle alone during working hours is needed, the crew member will notify a park contact person or supervisor. Whatever the case, the individual must ensure that someone knows of their location and expected return time. A radio or cellular phone is required when working off the road or in a remote area.
4. When working in the sun, members of the field crew should wear a hat and a pair of sunglasses to protect themselves from harmful ultraviolet rays. Sunscreen should be applied to exposed skin.
5. Be aware of weather forecasts and changes in the weather, and be prepared to alter field work and clothing accordingly.
6. Learn how to lift heavy objects properly. Ask for help when lifting heavy objects.
7. In areas concerning safety of field personnel, the on-site supervisor's decision is final. However, an individual still may refuse to engage in what they believe is an unsafe operation.
8. It is the employee's responsibility to notify the supervisor regarding any health problems that might put the employee at additional risk of injury in the field. Such problems include fever, aches, fatigue, colds or other ill health, as well as allergies and other long-term and chronic health concerns.
9. Any injury incurred on the job will be reported to the supervisor IMMEDIATELY. Failure to report injury may result in the denial of workers compensation claims and/or disciplinary action.
10. Vehicles must be operated safely and in a manner consistent with Standard Operating Procedures for Vehicles for the agency whose vehicle is being utilized. A supervisor should be asked for a briefing on the procedures before any field crew members operate the vehicle for the first time.
11. Know the Emergency Action Plan.

Emergency Action Plan

1. The contact person is responsible for making sure that an emergency alert and/or process is initiated if field personnel do not return when scheduled or no radio or cell phone contact is received from the field at the expected call-in time.
2. Thirty minutes after call-in time, an alert is issued. The contact person or another person should stay near the phone in case field personnel call.
3. One hour from call-in time, search procedures should begin. Note: Prior to going into the field, the field leader and park contact person should agree on a time when search procedures should begin, as it may be more appropriate to set an alternate time to begin search procedures.
4. One person should remain near the phone, and one person familiar with the field area should begin tracking the scheduled route.

5. Tracking person should have a radio and/or cell phone and call back to the office every 20 minutes to see if field personnel have made contact.
6. Tracking continues until the person is found or word is received that the field personnel are safe.

Emergency Response Plan

If an emergency arises and a call must be placed to 911, be sure to give the following information: name, location of emergency, type of emergency and type of help required. Notify any supervisory personnel and provide them with the same information. Notify the local park manager for the relevant national park.

Safety Clothing and Equipment

1. Field personnel shall wear sturdy boots that provide ankle support and traction. Sturdy sneakers may be allowed if terrain is not very rugged. Bare feet, other shoes, and slippers are not allowed.
2. Rain gear and outerwear (i.e., sweater or jacket) shall be carried in the field at all times in wet forests or other locations. Rain gear includes rain pants and rain jacket. The combination of clothing must be adequate to keep the worker warm and reasonably dry until returning from the field or reaching field shelters, or for surviving an unplanned overnight stay in the field.
3. Each field person shall carry water with them in canteens or other suitable containers. Sufficient water shall be carried for unplanned, extended emergency stays overnight in the field.
4. Each field person shall carry a First Aid Kit while in the field. Additionally, each vehicle should carry a fully stocked first aid kit and a survival kit.
5. There shall be at least one individual per field crew with current Standard First Aid and CPR certificates.
6. Each person working in the field should have a box of waterproof matches (kept in a sealable plastic bag or waterproof container), a space blanket, a whistle and a flashlight or headlamp in their pack.

Portable Radios

The most important thing that field crew members should know about the Bendix King R-31 (14 channel) portable radio is that it is a communication tool that helps to ensure the safety of staff in the field. Portable radios allow other staff in the park to know the location and status of crew members in the field. Because crew members often work off-trail in the park backcountry, and hike over uneven ground, slopes, and near cliff edges, the radios are especially important as a means of communication in the event that injuries are incurred. The radios also provide an invaluable tool for communicating scientific observations if field crew members are some distance apart. Field crew members should have a working knowledge of the protocols for communicating with the radios, and a basic understanding of how to use them. Procedures for using radios effectively and appropriately are listed below. Note that some of the procedures below relate specifically to HAVO, and may require some modifications when working in other parks. Thus before entering the field in other parks, be sure to discuss current radio SOPs with park personnel.

1. Read and review the user guide, if available. Also review the radio call numbers and radio channels. Field crew members should photocopy the list of radio call numbers and take it with them into the field as a reference.
2. Whenever the portable radio is not in use (i.e., when crew members are back at the office or base yard), make sure that the unit is turned off (with the on/off volume control dial turned as far counterclockwise as possible) and charging in a battery charger. Chargers are available in the I&M office, and should be assigned to field crew members at the beginning of the season.
3. Before going into the field, take an extra battery from a charging unit.
4. Before traveling into the field, park dispatch must be notified. The field leader will inform Dispatch of the field plans and the estimated time of arrival (ETA) back at the departure point. For example within HAVO, you might contact the **Pacific Area Communications Center (808-985-6170)**, tell them you are working at HAVO on Mauna Loa and provide your ETA as 1700 hr at HAVO Visitor's Center. This is important because it provides the dispatch station with your general location in the event of an emergency. Follow the procedures listed below for HAVO:
    - Turn on the radio by turning the on/off volume control dial clockwise, until it is facing about 11 o'clock. The LED indicator should show a green light, indicating that the battery is charged and the unit is on.
    - There are four channels used on the HAVO radio system:
        - **Channel 1** – This is a direct channel, used for short, line of sight distances. It is used for talking to another field crew member close by. Employees in other areas of the park do not hear their conversations using Channel 1.
        - **Channel 2** – The repeater for Channel 2 is located at the Summit of Mauna Loa. This channel is used to reach all areas of HAVO except for some areas located at the Kahuku Ranch portion of the park. Channel 2 is the channel to use most of the time you are using the radio,
        - **Channel 3** – The repeater for Channel 3 is located at the South Point on the Big Island. This channel is used for the Kahuku Ranch area, as well as along the coastal areas of HAVO.
        - **Channel 4** – The repeater for this channel is located on Kulani Cone. This channel is used by field personnel working in remote forests of HAVO.
    - Press and firmly hold down the push-to-talk (PTT) button, and speak into the microphone. The LED indicator will show a red light, indicating that the speaker's communications are being broadcast through the radio.
    - Inform the dispatcher of travel plans and ETA back at departure point.
5. While in the field, keep the radio on with the volume loud enough to hear and respond to any communications directed at the designated radio call number (TBD).
6. In most situations, it will not be necessary to communicate with anyone while monitoring plant communities. If arrival off-trail will be later than the previously stated ETA, inform dispatch of the revised ETA as soon as possible.
7. If work requires that two paired field crew members to be separated by physical distance, the channel selector dial should be turned to Channel 1 so crew members can freely

communicate with one another, while leaving the regular airwaves of Channels 2, 3 and 4 open for park-wide use. Return to Channel 2 when crew members are together.

8. When returning from the field, contact dispatch again to let them know the field crew is safe: for example, “Dispatch, off trail at 2100 hours.”
9. After signing off with dispatch, return the radio to the charger unit, and make sure the radio is turned off while charging. Return the extra battery to the battery charger.
10. Follow the protocols listed below as general guidelines for appropriate use of the radio:
    - Each division within HAVO has a series of Call Numbers. Each employee is assigned a Call Number from the series of the Division they are working in. Example: Maintenance employees call numbers all start with 200, 201, 202, etc.
    - When communicating with the radio, always begin by stating the call number of the person you are trying to reach, followed by your own. For example, state: “505, 301”, or “Volcano Dispatch, 301.” Then the dispatcher will come on the radio and say “301, this is dispatch.” Then let the dispatcher know the reason for the radio transmission.
    - After keying the radio, wait a second before speaking into the radio. This prevents the start of the radio communication from being cut off.
    - Be brief and concise when communicating with the radio. This keeps the airwaves clear and saves battery power.
    - Speak clearly into the radio’s microphone, and press the PTT button firmly while speaking.
    - Think about what needs to be relayed before calling on the radio.
    - If your transmission is longer than 30 seconds, you must take a “break”, which means you must say “break”, take a breath, listen for any other traffic and then resume your transmission to dispatch if there is no other traffic. The “break” allows for someone else to interrupt the transmission is there is an emergency.
    - Securing the Radio Channel: During park emergencies or certain incidents, the dispatch office will “SECURE THE RADIO FREQUENCY.” When this happens, the only traffic on the radio should relate to the ongoing incident. If there is an emergency that happens during an ongoing incident, then use the radio for that. Otherwise, there should be no radio traffic until the original incident is done and then the dispatchers will “RELEASE THE FREQUENCY TO NORMAL TRAFFIC.” If you have not been listening to the radio, you might not know there is a situation going on in the park. So, when turning on the radio, give a minute of time to listen for any ongoing radio traffic.
11. Be careful about carrying your radio in your back pack or wearing it while using the seatbelt in a vehicle. The radio key could be activated by the pressure of your seat belt or something in your back pack that will not allow anyone else to use the radio. Also, everyone in the park with a radio on can hear what you might be talking about or other noises related to what you are doing. Having the radio key activated will keep the system out of use for other traffic, including emergencies.
12. Protect radios from moisture, dust and hard impacts.

Travel on Foot

1. Wear proper clothing and footwear.

2. Always carry a first aid kit, radio and water.
3. Be sure that equipment and supplies are carried in a manner consistent with safe travel over rough terrain. Backpacks should be in good repair and fit properly. DO NOT OVERESTIMATE YOUR LOAD CAPACITY.
4. Always be aware of what's around you (on ground and overhead).
5. Be conscious of surroundings – when disoriented, familiar objects can set you on track. Even if you have a GPS, carry a compass, and an area (field) map showing locations of pertinent transects, plots, roads, trails, and other landmarks. These items may prove invaluable especially in fog, rain or darkness.
6. Always be sure someone at the park knows where you are and when you are expected to return.
7. Never overextend your capabilities.
8. Be sure permission is GRANTED before entering private property.
9. Report accidents immediately to your supervisor.
10. Use common sense.
11. If you do get lost or become disoriented STAY WHERE YOU ARE. You may be overcome by panic. Sit down and quietly organize your thoughts on where you are. A few moments of recollection may clarify your situation. If not, find a comfortable place to rest. Use your whistle or other means to attract the attention of anyone around you. Do not try to leave the area if there are no signs of where to go. Do not follow a stream downhill, as it will almost certainly go over a waterfall at some time. Do not travel at night.

Hiking and Backpacking Techniques

Worker injuries, in addition to causing physical harm, directly impact projects by reducing personnel and funds available for project research. Although most workers possess a reasonable degree of wilderness hiking knowledge and experience, the hazards of wilderness hiking or backpacking should not be taken for granted. A large number of injuries result from slips, trips, and falls while hiking. Just like any other work activity, hazards must be identified, safe procedures and techniques must be developed, and workers must be trained to perform tasks safely.

The general training material below (taken from the January 2007 training course on Wilderness Hiking and Backpacking) is designed to insure that workers are aware of the hazards, and knowledgeable of the procedures and techniques for safely hiking and backpacking in wilderness areas.

Section 1: Individual levels of physical conditioning, knowledge, and experience for wilderness hiking and backpacking

- Years of experience
- Types of terrain and elevation changes
- Climate and environmental conditions
- Length and duration of hikes
- Types of gear and/or work equipment utilized

- Amount of weight carried
- Types of physical conditioning
- Types of wilderness activities
- Participation in hiking/climbing organizations
- Training and/or certifications from hiking/climbing organizations and/or employers
- Involvement in wilderness work activities requiring hiking (i.e. Resource Management, Hunting, Surveying)

Section 2: Hazards involved in hiking and backpacking activities

- Lack of physical conditioning
- Improper footwear
- Carrying backpacks
- Carrying hand tools and equipment
- Improper protective eyewear
- Slips, trips and falls due to uneven terrain
- Ascending, descending, or traversing hillsides
- Abrupt ledges and cliffs
- Grass or brush-concealed rocks, holes, roots, forest debris, drop-offs
- Brush and other low-growing vegetation
- Lava tubes and tree molds (Hawai'i)
- Broken, jagged lava flows (Hawai'i)
- Logs
- Slippery mud
- Loose rocks
- Footing conditions while hiking alongside or crossing streams
- Flash flood hazards while hiking alongside or crossing streams
- Falling limbs and trees in windy conditions
- Extreme weather to include: Lightening, Heavy Rain, Windstorm, Misty /Foggy Conditions
- Fatigue and heat stress
- Dehydration
- Disorientation
- Hypothermia
- Over-confidence
- Lack of communication and a daily check-in procedure
- Poor time management resulting in a rushed schedule or return in darkness
- Being unprepared as far as needed gear, and mental readiness for the daily challenges and unplanned circumstances

Section 3: Procedures and techniques to mitigate hiking and backpacking hazards

- Physical conditioning is the key critical element in performing hiking tasks, especially when additional weight, such as backpacks, tools, or equipment is to be carried, and the terrain is steep. Lack of conditioning may lead to fatigue and poor judgment in executing safe hiking procedures.
- "Buddy System" – Always work in the field with a buddy.
- Always be prepared for the day's tasks, mentally, physically, and with the proper equipment. At a minimum, all staff should have first aid kits, field maps, cell phone, pager, radio, raingear, lunch, and water.
- Always conduct a hiking hazard safety briefing with crews prior to starting the hike.
- High-visibility bright colored clothing is required for all field operations to more readily locate workers in the wilderness. Long and short-sleeved shirts may be provided for all workers by their project unit.
- Good footwear is essential for hiking safely. Proper footwear will provide good traction, firm ankle and arch support, protection from sharp tools, and general comfort. For hiking in steep, muddy, wet, or loose terrain, lace-up boots that are a minimum 8" (20 cm) high with lug soles are required. It is important that footwear fit properly, be worn with appropriate socks, and be "broken in" to prevent blisters. Footwear must be maintained in good condition, and periodically inspected, especially the soles, to maintain skid resistance.
- Backpack fit and comfort improve hiking safety. An ill-fitting pack can result in short and long term back pain and injury. For a good fit follow these tips:
    - Use a pack with wide, padded shoulder straps.
    - Make sure the straps are long enough.
    - Ensure that the pack properly fits your torso and stays contoured correctly along your back.
    - Never put more weight in a pack than you can comfortably carry. (Never exceed one third of your body weight.)
    - Position your pack low on your back. Wearing your pack too high can increase shoulder and neck pain.
    - Adjust the hip-belt correctly. Your pack should rest right above your hip bones. For smaller packs, the hip-belt serves to reduce bouncing. It helps keep the pack comfortably in place. For larger packs, the hip-belt also helps distribute the weight load more evenly.
    - Use both straps to carry your pack.
    - Typically, if you are able to stand up straight and comfortably when using your pack, you have a good fit.
    - Use a sternum strap to position shoulder straps in the correct position.
- Knowing how to pack your backpack can also improve comfort and safety.

  Follow these packing tips:
    - Distribute the weight throughout your pack.
    - Most heavy items do best toward the middle of your pack, closest to your back, or toward the bottom for a lower center of gravity.

    - With too many heavy objects toward the top or outside of your pack, your posture will shift to accommodate the added burden.
    - Pad bulky items (i.e., tools and equipment) well so they do not stick out and irritate your back.
    - Secure the hip-belt to help distribute weight more evenly.
- Always carry tools and equipment on the downhill side of the body. Tools should be sheathed while walking, unless they are needed for clearing vegetation (e.g., pruning saw). Never carry loads that require use of both hands; instead have two persons carry them or use a backpack or pack frame. Long pieces of equipment, are best carried by two persons.
- Wear tempered sunglasses, safety glasses, or goggles whenever there is a chance of eye injury. The project provides safety glasses for eye protection which is required in areas with thick vegetation and in dusty environments.
- Maintain safe walking and working distance between people (10-foot minimum) to avoid being struck by branches and tools. Stagger spacing when on slopes such that people are not directly below other personnel higher on the slope. Be sure other workers in the vicinity know where you are. If something comes loose from a slope, warn others by yelling "ROCK!!!"
- The majority of injuries involve slips, trips and falls. When negotiating the hazards of uneven terrain and hidden ground surface hazards, either on or off designated trails, watching where you step is most critical as this can prevent 99% of slip, trip and fall incidents. If work tasks require observation of items or areas other than the path you are walking, make periodic stops to conduct your observations, and then resume your travel with a focus on the path in front of you. Never look at the forest canopy while walking.
- Always examine the ground ahead of where you are walking, and test and use secure footing. Plan ahead, select safe routes, and be alert to changes in ground surface, slick spots, or unusual hazards. Select each stepping spot carefully, and do not shift body weight until you are sure the spot is solid.
- In heavy undergrowth, lift your knees high to clear obstacles. Slow down and exaggerate steps in the area of exposed roots to keep from catching your toes.
- Watch for and avoid lava tubes, earth cracks, and tree molds when walking through forest, shrubland, and grassland. Walk slowly and test footing. Uluhe, a native fern, is very effective at concealing holes and cracks, so be especially careful when walking in areas covered by uluhe.
- Avoid walking on logs because they can be deceptively slippery. Step over small logs. If you must cross a large log, sit on it and swing your legs over one at a time. If stepping on a log is unavoidable, test the footing first before shifting your full weight to the log. Walk slowly.
- When contouring a steep slope, do not lean into the hill. This tends to loosen footing. Erect posture, or slightly leaning out, gives more secure footing.
- When moving uphill or in sandy soils, lean slightly forward, turn feet outward, shorten stride, and use as much of the inside of the foot as possible. Another technique is to toe into the slope by kicking your toe in and creating a step

- On slippery, loose ground, or going downhill, keep most of your weight on your heels. Shorten your stride, keep knees bent, and lean slightly backward. Make sure of secure footing and safe working positions. Walk - never run down slopes.
- Rocky slopes, especially loose rock and steep country, are treacherous. Have one hand free, preferably on the uphill side, for protection against falls or obstructions. Always carry tools on your downhill side.
- When slipping, lean into the slope and grasp for things to help arrest your descent. Do not lean out away from the slope, as this may result in a head over heels tumble.
- If you feel yourself slipping, pick a landing spot. Even before this, as you traverse a steep area, survey the area and look for good landing spots.
- Know how to fall to avoid hard impacts. Keep flexible with knees slightly bent. This helps your legs act as a shock absorber. Sit down if you begin to slide, or roll with the fall.
- Carry webbing for use when hiking or working in steep environments. Be conservative when deciding to use webbing. Remember, it is always easier to go up, than down.
- Do not stick your arms out to break a fall from a log or on level ground. Keep your arms slightly bent in front of your head. Protect you head and back.
- “Curse your fall.” This means shout out an exclamation as you fall. This ensures you exhale as you land, which in turn releases air from your lungs. This can help minimize damage to your internal organs.
- When crossing streams, scout the area to determine a safe spot to ford the stream. Avoid crossing where the water is knee high or higher. Do not cross on logs that span the stream. Do not attempt crossing during heavy rainfall or if upslope thunder has been noted. Walk slowly and deliberately to allow for proper evaluation of upcoming terrain in order to avoid any potentially dangerous obstacles. Place your feet carefully in firm footholds. Avoid loose rocks, high water flow, slippery rocks, and overly steep or muddy terrain. When climbing rocks or crossing rocky areas attempt to have three points of contact at all times and keep your center of gravity low. A wading pole is required to aid in balance and exploring for drop offs. Appropriate footwear with traction (tabies, or shoes with a felt or nylon sole, lace-on oversoles, or bonded carpeting sole) should be used for stream work. If wearing a non-quick release backpack, slip off the upstream shoulder strap so the pack can be discarded in an emergency situation.
- Reliable weather reports should be obtained for the areas that influence the streams or river beds in areas where work will be conducted, prior to leaving for the field. Avoid working in flooded areas or where water is moving swiftly. Cancel work activities during or following storm events that would compromise the safety of such activities. Be aware of quick weather changes, especially upslope of stream sites (excessive rain, although it may be sunny at the site). Be alert and listen for signs of a flash flood. Any sudden increase of debris, muddy water, or a low roar of thunder are indicators of a possible flash flood. Leave yourself with exit routes in the event of flash flooding.
- Always be on guard against injury from falling trees, snags, limbs, rolling logs or rocks. Never run blindly if a rolling rock, log, or tree is heard. Try to determine the direction of fall, and then move out of the path.

- Do not enter the forest during a lightning storm. If a lightning storm is heard approaching, leave the forest and get into the vehicle. If a lightning storm is occurring while you are still in the forest do the following:
  - Put down all tools.
  - Do not use the cell phone or radio.
  - Do not lean against a tree.
  - Get off of ridges and hilltops, and avoid open spaces, ledges, outcrops of rock, and other exposed locations.
  - If you feel your hair standing on end or your skin tingling, lightning may be about to strike you. Squat down immediately, keeping the soles of your feet flat on the ground and curl into the smallest ball possible.
- Avoid fatigue and heat-stress. Plan long-distance foot travel for the cooler hours of the day. Stop for frequent rest periods of at least 15 minutes to cool down and drink water, especially if carrying heavy loads. Keep hydrated and include in meals and snacks potassium-rich foods, such as bananas and citrus fruits. Avoid high-protein foods (meats) which increase metabolic heat production and water loss. Wear lightweight, light-colored, loose clothing. During periods of continued extreme temperatures, monitor each other and watch for signs of heat-stress disorders.
- Prevent dehydration. Carry 2-4 liters of water for the day – more if the day is going to be hot. Take drinks regularly so that normal urination patterns are maintained. Keep a reserve quart in the vehicle for use on the return to base. Do not drink stream or ponded water without first filtering and treating to eliminate harmful organisms, including *Giardia lamblia* and *Leptospira interrogans*.
- Avoid disorientation. Always remain within verbal hailing distance of another crewmember. Always carry and know how to use a compass and a site map that shows true and magnetic north relative to the study area and the location of the parked vehicle. Orient yourself at the parking area and at intervals as you walk through and work in the forest. Trust your compass. Turn on, carry, and periodically test operability of field radios among crewmembers. Check in with Base at lunch, and at the end of the day. Carry charged replacement batteries. Stay put if lost, and protect yourself from hypothermia by keeping warm and dry. Wear high visibility clothing.
- Prevent hypothermia. Hypothermia results in a subnormal core body temperature and is a medical emergency. Carry in your pack a long-sleeve shirt or jacket. If you feel chilled, put it on. Always carry a full set of rain gear and put it on when rain starts falling. Each crewmember must carry the supplied emergency space blankets. Crewmembers must know the symptoms and treatment of hypothermia.
- Know Your Limits! When you start as a new worker in the field, you may not be sure of your limits, and should explore and expand them slowly, at your own pace. When working with an experienced staff member whose limits are beyond yours, do not feel obligated to push yourself to follow them onto a ledge or across a steep slope unless you feel comfortable doing so. Forcing yourself to go beyond your limits may increase the chance of an accident.

Travel in Vehicles

Follow the guidelines below for vehicle use:

1. You must have a valid driver's license before driving any vehicle whether on the road or off-road.
2. Persons not experienced in 4-wheel driving may require training in off-road driving.
3. Always carry emergency equipment (i.e., first aid and basic survival kit and car jack).
4. Always be sure someone in the park knows where you are going and when you are expected to return.
5. On private land the owners and their workers have the right of way. Drive slowly so as not to kick up dust.
6. Any vehicle being used to reach sampling sites should be inspected prior to use.
7. Report any vehicle problem immediately to the supervisor and maintenance.
8. Report accidents to your supervisor immediately.
9. Use common sense.
10. Obey the rules of the road even when driving off-road.
11. Driving safety policies are listed in NPS Reference Manual 50B, Section 6.0 Motor Vehicles

Travel in Helicopters and on Commercial Flights

If you will be flying in helicopters for work related activities, you are required to take the Basic Aviation Safety Training. See your supervisor for details about participating in the Aviation Safety Program. If you will be flying on commercial airlines, you are not permitted to take any fuel for cook stoves or have it packed in your luggage. All fuel must be purchased at your destination. It is also prohibited to fly commercially with any fuel containers (even if they are empty) or stoves using fuel containers that have previously contained fuel. You can be fined and/or arrested for attempting to bring these items on commercial airlines. For a listing of what is not allowed on commercial airlines, visit the Federal Aviation Administration (FAA 2010) or the Transportation Security Administration (TSA 2010) websites.

Health Concerns

An open cut may become infected easily under field conditions; therefore all scratches and cuts should be given appropriate attention, such as disinfecting and bandaging, and any injury should be monitored. Antibacterial cream, such as Neosporin, may be applied to reduce the chances of infection. Persons with serious injuries should seek professional medical attention as soon as possible.

Leptospirosis

There is a known risk of contracting leptospirosis in Hawai'i and American Samoa. This is a disease caused by bacteria (*Leptospira interrogans*) that are transmitted from animals to humans. The bacteria can survive long periods of time in fresh water and mud and can enter the body through the eyes, nose, mouth and broken skin. It is inadvisable to drink or swim in potentially contaminated water (i.e., streams and ponds). The last outbreak in American Samoa was reported in 2004, which appeared to be related to contamination of streams from pig farms (Goldberg 2010). Avoid entering freshwater if you have breaks in the skin.

If 2 to 20 days after working in or around a stream, you experience flu-like symptoms that persist for more than two days, consult a physician and inform him/her that you may have been exposed to *L. interrogans* bacteria. If you come down with any severe fever or disease, ask your doctor to consider whether there are any unusual diagnoses that should be considered because of your fieldwork.

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The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

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