

# **Improvement of the Surface Weather Observation Network in the Arizona Portion of the NAME Tier 1 Region**

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## **Introduction**

This document describes the data, instrumentation, and quality control post processing from the above titled project that was part of the NAME 2004 Field Program. The goal of the project was to provide surface weather observations to help resolve circulation and moisture advection patterns within a particularly data sparse region of southern Arizona which lies fairly close the northern end of the Gulf of California but is not subject to the daily sea-land breeze cycle. Three automated surface weather stations were installed at fixed locations: one in Yuma county, well east of the city of Yuma, and the other two in western Pima county. The principal investigator contracted with the Arizona Department of Water Resources in order to procure, deploy, and maintain the equipment.

## **Station Locations**

- Digital pictures of the stations will be located in the same directory that this document is located.

- Ajo, AZ

- Latitude: 32° 23' 11" North (32.39N)

- Longitude: 112° 52' 22" West (112.87W)

- Elevation: 1560 ft.

- Aspect: flat

- Surroundings: Sonoran desert vegetation with a one-story building and a road nearby. The building is the field office for the Cabeza Prieta National Wildlife Refuge.

- Organ Pipe Cactus National Monument, AZ

- Latitude: 31° 57' 19" North (31.96N)

- Longitude: 112° 48' 4" West (112.80W)

- Elevation: 1680 ft.

- Aspect: flat

- Surroundings: Sonoran desert vegetation with a one-story building and a road nearby. The building is the Visitor's Center for the Monument.

- Wellton, Arizona
  - Latitude: 32° 39' 10" North (32.65N)
  - Longitude: 114° 7' 0" West (114.12W)
  - Elevation: 304 ft.
  - Aspect: flat
  - Surroundings: very little vegetation with a few scrub bushes nearby on sandy soil. Land was a citrus orchard years ago but has long since been cleared and left fallow.

### **Equipment Description**

- The stations are designed to operate self-sufficiently in remote locations and report in real time using VHF radio transmitters and repeater links employing the ALERT format (Automated Local Evaluation in Real Time). In the case of the Ajo and Organ Pipe stations, the locations are too remote to reach established ALERT repeaters and no viable sites were available to install new repeaters. So, these stations transmit their data to a nearby building wherein a local base station computer receives and decodes each transmission and then sends the data via Internet to the National Weather Service office in Phoenix.

- ALERT weather stations are sold as packages by commercial vendors. In our case, the vendor was High Sierra Electronics. Each sensor that is part of an ALERT weather station is assigned its own sensor identification number. The system comes setup so that each sensor reports independently of the others based on an "event" such as a tip of the tipping bucket or, an amount of change from the previous value. A modification can be made to settings on the system logic board such that some the sensors report in synch at fixed intervals. Temperature, relative humidity, barometric pressure, and peak wind speed for the past 15 minutes can be set this way. In our case, this was done on July 31<sup>st</sup> with a reporting interval of 15 minutes. Sustained wind speed and direction, as well as precipitation, cannot be set to report in fixed intervals because they report "events." In the case of the sustained wind, it is actually 1 km of wind run which triggers a report.

- Below are links with specifications and diagrams of the weather station equipment. It should be noted that the heights of the sensors are different than other automated observing systems such as ASOS and AWOS. For instance, the anemometer is positioned approximately 13-14 feet above the ground instead of 10 meters (~33 feet). The temperature and relative humidity sensor sits approximately 11-12 feet above the ground and the tipping bucket is about 10 feet above the ground.

Weather station package:

[www.highsierraelectronics.com/spec\\_sheets\\_PDF/Model\\_3451.pdf](http://www.highsierraelectronics.com/spec_sheets_PDF/Model_3451.pdf)

Wind sensor:

[www.highsierraelectronics.com/spec\\_sheets\\_PDF/Model\\_5712.pdf](http://www.highsierraelectronics.com/spec_sheets_PDF/Model_5712.pdf)

Rain gage tipping bucket:

[www.highsierraelectronics.com/spec\\_sheets\\_PDF/Model\\_2400.pdf](http://www.highsierraelectronics.com/spec_sheets_PDF/Model_2400.pdf)

Temperature and relative humidity sensor plus protective housing/sun shield:

[www.highsierraelectronics.com/spec\\_sheets\\_PDF/Model\\_5722.pdf](http://www.highsierraelectronics.com/spec_sheets_PDF/Model_5722.pdf)

[www.highsierraelectronics.com/spec\\_sheets\\_PDF/Model\\_5728.pdf](http://www.highsierraelectronics.com/spec_sheets_PDF/Model_5728.pdf)

Barometric pressure sensor:

## **Data**

- Within the UCAR/JOSS directory that this “read me” document resides, there is one Excel spreadsheet file (.xls) for each station. The file names correspond to the station location.
- The data span much of the 2004 summer starting before and ending after the Enhanced Observation Period. Each station recorded precipitation (inches), sustained wind speed (mph) and direction (degrees), peak wind speed during the previous 15 minutes (mph), air temperature (deg. F), relative humidity (%), and station barometric pressure (inches and mb).
- The exact start and end dates of the data vary for each station. For Wellton, the data run from June 10th through September 24th of 2004. For Organ Pipe Cactus National Monument, the data span June 3<sup>rd</sup> through September 30<sup>th</sup> of 2004. The Ajo station dataset has a shorter span than the other two sites and is missing the peak wind speed parameter. The Ajo wind speed and direction data runs from June 21<sup>st</sup> through August 31<sup>st</sup> of 2004. The other available parameters run from June 21<sup>st</sup> through September 30<sup>th</sup>.

## Format

- The layout of each spreadsheet is such that there are a group of columns and many rows for each parameter (e.g. wind, temperature, relative humidity, etc.). The columns correspond to fields and rows correspond to records. Each parameter has individual columns for the ALERT id number, month, day, year, hour, minute, second, sensor reading/value, and quality control flag. In the case of sustained wind, there are separate columns for speed and direction along with separate quality control flag columns. A blank column separates each parameter from the others.
- Since the sensors did not all report in synch with one another, there are independent time fields for each parameter. So, for a given row number on the spreadsheet, there will be a different time stamp for each parameter. For instance, the time stamp found on row #500 for “Wind” will be different than that found for “Temperature” even though it is on the same row in the spreadsheet.
- On July 31<sup>st</sup>, temperature, relative humidity, and barometric pressure were set to report in synch with each other at fixed intervals. With temperature and rh in synch, this enabled dew point to be calculated and inserted as the last column of the relative humidity group.

## Quality Control Procedures

- The data were obtained from each station’s datalogger except at Ajo where it was taken from a database on the computer that is first in line to receive the data.
- The primary checks performed on the data were for gross values and discontinuity. Automated routines were run to flag values which were unrealistic (gross value) and/or abrupt transient changes (discontinuity). All quality control was performed by the principal investigator and every value of each parameter was inspected “manually” after automated routines were run. Some of the automated flags were removed and other flags assigned as part of this process where a human eye examined all of the data.
- The flags that were used were, “Bad,” “Questionable,” and “Okay.” Most values were not flagged one way or another and the Q/C column was left blank. This indicated they were fine. Trends within each parameter were closely observed from one reading to the next. If it differed from an anticipated trend (accounting for diurnal cycles) then it was

evaluated within a larger context of the other parameters in order to identify causative mechanisms such as wind shifts, precipitation, etc.

- A very small number of values were erroneous and were labeled as “Bad.” The values were then assigned “-99.” These occurred during the initial equipment installation and at the mid-summer maintenance visit.

- If a value initially looked suspicious at first glance but corresponded to a wind shift and/or precipitation, and had continuity, it was flagged as “Okay.” If a value/s were abruptly different from values before and/or after, but it was not meteorologically unreasonable, then it was flagged as “Questionable.”

- A conservative approach was taken to try to differentiate possible sensor noise from actual meteorological signal. Thus, relatively small changes could trigger a “Questionable” flag. Some values that were used as thresholds for possible flagging are as follow:

- Wind Speed: if the speed was double or more than that of the preceding and succeeding values.
- Wind Direction: if the speed was  $\geq 5$  mph and the direction changed by more than 90 degrees from the preceding value.
- Relative Humidity: changes  $> 2\%$ ; changes  $> 1-2\%$  if RH value is  $< 10\%$  or if the trend deviates from an anticipated diurnal pattern.
- Dew Point: for the months where temperature and RH were reporting in synch and a dew point could be calculated, a change  $\geq 3$  deg would raise scrutiny.
- Temperature: if the temperature value differed 2 or more degrees from an anticipated diurnal trend.

- In addition to checking for discontinuities between individual readings, broader trends were also examined. For instance, if temperatures climbed significantly before sunrise and/or fell significantly before sunrise and there were no apparent wind shifts (indicative of convection) or precipitation then the values would be flagged as “Questionable.”

- Overall, the data look rather reliable. Many of the values flagged as “Questionable” are quite possibly due to microscale processes which can lead to curious fluctuations.

Site Photographs

**Ajo Station**



**North**



**West**



**East**



**South**

# Organ Pipe Station



North



West



East



South

# Wellton Station



**Northwest View**



**North-Northeast View**



**Northeast View**



**West View**



**East Southeast View**



**Southwest View**



**South Southwest View**



**Southeast View**