



Mediterranean Coast Network Climate of 2013 Annual Report

Channel Islands National Park

Natural Resource Data Series NPS/MEDN/NRDS—2014/732



ON THE COVER

East-facing beach on Santa Rosa Island, Channel Islands National Park
Photo by Stacey Ostermann-Kelm

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

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Contents

Figures.....	iv
Tables.....	iv
Executive Summary	v
Glossary	vii
Approach and Methods.....	4
Selection of Datasets.....	4
Quality Control of Ranger-Managed (Manual) Weather Stations.....	5
Quality Control of RAWs Data.....	5
Analysis of Wind Data.....	6
Results.....	7
Temperature, Precipitation, and Drought Status During Calendar Year 2013	7
Broader Picture – The region became drier during the course of 2013.....	7
The Reconnaissance Drought Index	8
El Nino – La Nina Status	9
Precipitation During 2013.....	9
Temperature During 2013.....	9
Wind Speed and Direction.....	9
Accumulated Growing Degree Days: an Index of Growing Season Length.....	13
Conclusions.....	23
Literature Cited	24
Appendix 1.....	26
Appendix 2.....	27

Figures

	Page
Figure 1. Map showing key climate stations used in this report.....	4
Figure 2. U.S. Drought Monitor maps for Channel Island National Park during calendar years 2013 - 2014	7
Figure 3. The Reconnaissance Drought Index (RDI) calculated for the Santa Rosa Island (top) and UCLA (bottom) weather stations	8
Figure 4a. Monthly precipitation and temperature data collected by RAWS in Channel Islands National Park.....	14
Figure 4b. Monthly precipitation and temperature data collected by manual ranger managed weather stations in Channel Islands National Park.	16
Figure 5. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2013 monthly precipitation as a percentage of 1981 – 2010 averages	18
Figure 6. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2013 monthly average daily maximum temperature (Tmax) departure from 1981 – 2010 averages in degrees Fahrenheit	19
Figure 7. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2013 monthly average daily minimum temperature (Tmin) departure from 1981 – 2010 averages in degrees Fahrenheit	20
Figure 8. Wind roses for data from RAWS in Channel Islands National Park, contrasting calendar years 2012 and 2013 to the averages for 2005 – 2010	21

Tables

	Page
Table 1. Monthly total precipitation in inches during 2013 in Channel Islands National Park.....	10
Table 2. Monthly average daily maximum temperatures (Tmax) during 2013 in degrees Fahrenheit.	11
Table 2 continued. Monthly average daily minimum temperatures (Tmin) during 2013 in degrees Fahrenheit.....	12
Table 3. Accumulated Growing Degree Days (AGDD) and days above or below critical temperature thresholds during 2013.....	13

Executive Summary

This report details the climate (temperature, precipitation, drought, and wind conditions) of Channel Island National Park (NP) during 2013. Gridded maps are used to present broad-brush conditions across the region for each month. This regional presentation is compared to detailed data from Remote Automated Weather Stations (RAWS) and manual, ranger-managed weather stations. Prior to analysis, the authors performed a set of data quality control checks in accordance with a National Park Service protocol (Rocky Mountain Climate Working Group 2010).

Key points summarizing calendar year 2013 are presented as bullets in the Conclusion section at the end of the report. There was significant spatial and month to month variability in the data that provided exceptions to these generalizations, so an examination of the regional maps is key to understanding the climatic patterns for 2013. Readers can download the data used in this report and make custom climate graphs and tables of their own by visiting www.ClimateAnalyzer.org.

Acknowledgments

The National Park Service Mediterranean Coast Network Inventory and Monitoring Program provided funding for this report. Format editing was provided by A. Durham.

Glossary

AGDD: Accumulated Growing Degree Days

B-91 Forms: Paper data sheets that are used to record climate data at weather stations.

Climate: Complete and entire ensemble of statistical descriptors of temporal and spatial properties comprising the behavior of the atmosphere. These descriptors include means, variances, frequency distributions, autocorrelations, spatial correlations and other patterns of association, temporal lags, and element-to-element relationships. The descriptors have a physical basis in flows and reservoirs of energy and mass. Climate and weather phenomena shade gradually into each other and are ultimately inseparable (Davey et al. 2006).

Climate Normal, 30-year Average or “Normals”: A long-term average value of a meteorological parameter (i.e., temperature) measured at a specific station. For example, “temperatures are normal for this time of year” means that temperatures are at or near the average climatological value for a given period. Climate normals are usually taken from data averaged over a 30-year period (e.g., 1971-2000). Official 30-year averages for each weather station are issued every 10 years by NOAA. Prior to 2011, the official reference period was 1971-2000.

Cooperative Observer (COOP) Stations: A station where measurements are typically recorded by human observers on paper data sheets that are submitted to NWS for aggregation and error checking. COOP stations can also be automated to collect data at regularly scheduled times.

CSUN: California State University, Northridge

ENSO: El Nino-Southern Oscillation

F: Fahrenheit

FAO: Food and Agriculture Organization

GHCN: Global Historical Climatology Network

Met: Automated meteorological weather station

NIFC: National Interagency Fire Center

NOAA: National Oceanic and Atmospheric Administration

NP: National Park

NRA: National Recreation Area

NWS: National Weather Service

P: Precipitation

PET: Potential Evapotranspiration

PRISM: Parameter-elevation Regression on Independent Slopes Model. See <http://www.prism.oregonstate.edu/>

Qa/Qc: [The combination of quality assurance \(the set of processes used to measure and assure the quality of a product, and quality control \(the process of meeting products and services to user expectations\).](#)

RAWS – Remote Automated Weather Station

RDI: Reconnaissance Drought Index

Tmax / Tmin: Mean daily maximum and minimum temperatures.

UCLA: University of California, Los Angeles

US Drought Monitor: A broad brush assessment of drought conditions. See <http://drought.unl.edu/dm/monitor.html>

Water Year: The Water Year (or Hydrologic Year) is most often defined as the period from October 1 to September 30 of the following year. It is called by the calendar year in which it ends. Thus, Water Year 2011 is the 12-month period beginning October 1, 2010 and ending September 30, 2011. The period is chosen so as to encompass a full cycle of precipitation accumulation.

Weather: Instantaneous state of the atmosphere at any given time, mainly with respect to its effects on biological activities. Distinguished from climate, weather consists of the short-term (minutes to days) variations in the atmosphere.

WRCC: Western Regional Climate Center

Introduction

Climate is a dominant driver of physical and ecologic processes in the Mediterranean Coast Network (MEDN) parks (Davey et al. 2006). Trends in precipitation, wind, and temperature influence how an ecosystem and its organisms function. Through direct and indirect means, climate affects the behavior and reproduction of terrestrial and aquatic animal species (Crozier et al. 2008). Given the importance of climate, it has been identified as a primary vital sign by all 32 Inventory and Monitoring (I&M) networks within the National Park Service (NPS) (Gray 2008). The MEDN monitors climate in order to track variations from other park resources being monitored, compare current and historic data to understand long-term trends, and provide data for modeling the impacts on park facilities and resources in the future. The climate data developed by the MEDN climate monitoring program plays an important role in understanding and interpreting the other physical and ecological vital signs monitored within network parks.

Channel Islands National Park (CHIS) comprises five offshore islands 20 to 61 kilometers from mainland Southern California, including San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara. Remote, rugged and geographically diverse, each island experiences unique weather and climate conditions, in part, because the park islands span a major transition in climate that begins at the California coastline where the cool waters of the northern Humboldt Current mix with the warmer California Current from the south (Redmond and McCurdy 2005).

This report summarizes all the climate data for CHIS that were complete enough to support monthly and annual summaries for calendar year 2013 at the time of writing. Only a subset of the weather stations located in CHIS were used because instrumental failure and incomplete data entry led to a large number of missing values in the time series from some of the weather stations. This made them unavailable for analysis. Climatic events in this report are presented both from a local perspective, with data from individual weather stations, and from a regional perspective, with maps that depict broad-scale conditions across southern California during each month of the year.

Channel Islands National Park began monitoring weather in the mid-1980s, although weather records extend back into the early 1900's for some islands. The program consists of four Remote Automated Weather Stations (RAWS), one on each island except San Miguel, supplemented by daily observations made at six sites by island staff when stationed on the islands (Ranger Station data). The RAWS data are downloaded via satellite and archived by the Western Regional Climate Center (WRCC) at the Desert Research Institute in Reno, Nevada. WRCC also archives the Ranger Station data for the Park. The weather data used in this report are available from the WRCC or from the NPS sponsored web interface located at www.ClimateAnalyzer.org. RAWS parameters measured include precipitation, air temperature, relative humidity, wind speed and direction, solar radiation, fuel moisture, fuel temperature, and barometric pressure.

Redmond and McCurdy (2005) discuss an approach to weather and climate monitoring among the Channel Islands in the context of broader climate monitoring and modeling nationwide. Their rationale and specific design considerations form the basis for the CHIS weather and climate monitoring program, including the choices of parameters to measure, RAWS and manual weather station siting, considerations for data handling and display, and operating procedures for site maintenance.

Each island except San Miguel has one park owned and maintained RAWS, supplemented by weather instruments manually operated by island staff. Collectively, the stations provide data on weather from both the marine layer and terrestrial climate regimes of the islands (McEachern, et al. 2008). In addition to the Park, a number of agencies and organizations including the National Interagency Fire Center (NIFC), the U.S. Navy, the County of Santa Barbara, California State University, Northridge (CSUN), the University of California, Santa Barbara, and the Santa Barbara Amateur Radio Club have invested in island weather stations. Collectively, these stations address the needs of Park resource management, Park operations, fire planning and management, Navy operations, mariner safety and specific research needs.

Those interested in additional climate-related information for CHIS and the surrounding areas should seek:

The ClimateAnalyzer: www.ClimateAnalyzer.org. This web site allows you to create custom graphs and tables from both “official,” unedited data and from the corrected datasets used in this report. You can also download all the data from the weather stations in the area as spreadsheets.

Western Regional Climate Center (<http://www.wrcc.dri.edu/>)

Drought Monitor (<http://drought.unl.edu/dm/monitor.html>)

National Oceanic Atmospheric Administration (NOAA) National Weather Service
(<http://www.cpc.ncep.noaa.gov/>)

U.S. Geological Survey (USGS) Water National Information System
(<http://waterdata.usgs.gov/nwis>)

Approach and Methods

Selection of Datasets

In order to place CHIS within a regional context, grid-based estimates of precipitation and temperature were used to provide a broad overview of climatic conditions in the area. These estimates were generated with a statistical modeling technique that interpolates precipitation and temperature values between actual climate stations while also accounting for the effects of aspect and elevation. Known as the Parameter-elevation Regression on Independent Slopes Model (PRISM; <http://www.prism.oregonstate.edu/>), this approach has a long history of use in the western United States, and it has been shown to provide robust products in a wide variety of studies (Daly et al. 2008).

Ranger-managed, manual weather stations, often referred to as “ranger” stations, were included because they have long, established records that can be meaningfully compared to the RAWS stations. Both RAWS and “Ranger weather stations” are owned and maintained by CHIS. Data from the “Ranger stations” are archived by the National Oceanic and Atmospheric Administration (NOAA) and are available from the Western Regional Climate Center or from the NPS sponsored web interface located at www.ClimateAnalyzer.org. The locations of weather stations cited in this report are shown in Figure 1. Metadata for these stations can be accessed from the internet links provided in Appendix 1.

As a way of presenting the integrated effects of temperature and precipitation, maps from the US Drought Monitor (<http://drought.unl.edu/dm/monitor.html>) were used to depict broad-brush conditions across the region. Drought status was also assessed with the Reconnaissance Drought Index (RDI), which is the ratio of precipitation (P) to potential evapotranspiration (PET) divided by the average of this ratio for the time period selected minus one, or $((P/PET)/(\text{avg-P}/\text{avg-PET}) - 1)$ (Tsakiris and Vangelis 2005). Evapotranspiration, in turn, is calculated using the Penman-Montieth equation, with methods described by the Food and Agriculture Organization (FAO) (Allen et al. 1988). Negative values of the index indicate drier than average conditions, while positive values are wetter than average.

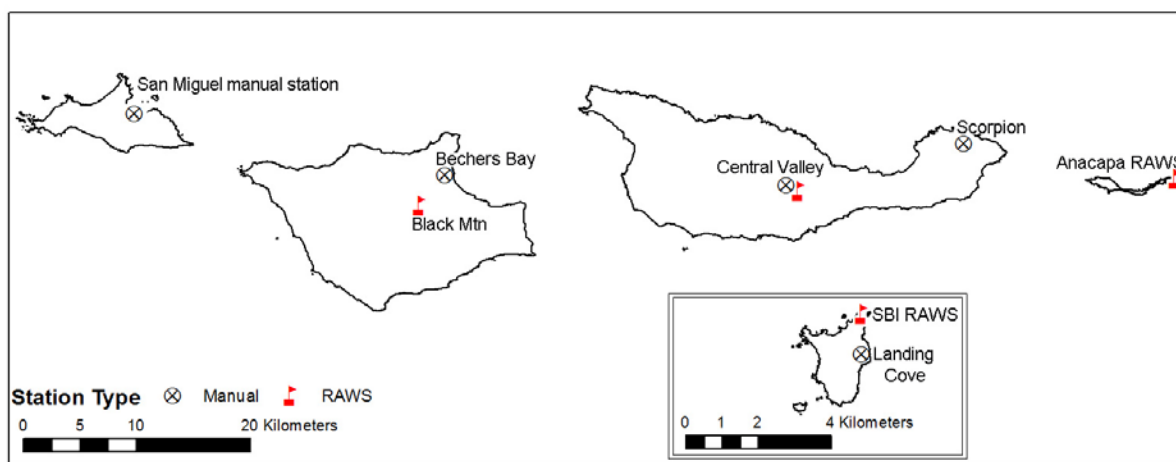


Figure 1. Map showing key climate stations used in this report. There are additional weather stations in Channel Islands NP, but data from those stations was not complete enough for 2013 to merit inclusion.

Quality Control of Ranger-Managed (Manual) Weather Stations

All of the “Ranger stations” used in this report are operated and maintained by CHIS. These stations are sometimes referred to as “Cooperative Observer” stations because in most cases human observers record their measurements on paper data sheets (NOAA Form B-91 and NOAA form 72-5A). Data are recorded when islands are staffed, which may be only two weeks in a month on the more remote islands. The data are entered into the Western Regional Climate Center website, where the data is then aggregated and error checked by NOAA.

Data from these weather stations undergo quality control and error-checking by NOAA, and as part of this process many of the observations in the data files are assigned “flags” (letter or number codes) that indicate potential problems or other factors that should be taken into consideration when interpreting the data. Consequently, the authors of this report have created software tools that assist in the interpretation of the data flags and diagnostic plotting of the data. (This software, the Climate Data Summarizer, can be downloaded from www.YellowstoneEcology.com). Following guidelines from Kittel (2008), Kittel et al. (2009), and Rocky Mountain Climate Working Group (2010), the QA/QC employed by these software tools involved graphing and visual inspection of each time series, evaluation of the data quality flags that accompany each observation, comparison with historical observations and observations from surrounding sites, and logical consistency tests (e.g., confirming that minimum daily temperatures were lower than the daily maximum temperatures). Point observations provided by the Ranger (manual) weather stations were also compared to corresponding estimates from the PRISM datasets and to the original datasheets used by weather station staff. When possible, data missing in the electronic records were recovered from the original datasheets and hand entered by the authors of this report. If more than 3 days of precipitation data were missing for a particular month, a monthly total was not calculated, and the entire month was considered missing. Similarly, if more than 5 days of mean daily maximum temperature (Tmax) or mean daily minimum temperature (Tmin) were missing, monthly average temperatures were not calculated. The data handling was conservative. For example, no data points were changed unless it was very clear that an erroneous value was found and verified, such as a precipitation measurement with a missing decimal point that could be verified on the original station records.

Quality Control of RAWS Data

All of the RAWS stations used in this report are maintained by CHIS. The park swaps RAWS sensors annually as part of the National Interagency Fire Center Weather Program. The Program maintains a parts depot in Boise, Idaho, which exchanges clean, recalibrated sensors with sensors from the field. A record of station maintenance is found in Appendix 2. Occasionally sensors fail during the year resulting in a data gap for that parameter. When this occurs, a replacement sensor is ordered from the parts depot in Boise, and the faulty sensor is replaced as quickly as possible.

Because RAWS data are collected hourly, daily Tmax, Tmin, and precipitation values must be derived from the automated data stream. Furthermore, precipitation is recorded as a running total that must be translated into daily measurements. If any particular day in a record was missing more than 6 hours of measurements, the entire day was considered missing. In addition, if the temperature during any day varied by less than 2 degrees Fahrenheit, data for the entire day was considered invalid due to instrument error and replaced with missing values. Once daily statistics had been calculated, diagnostic plots were used to screen for physically impossible

measurements, which were ascribed to instrument error and considered missing; and the missing data criteria just described for Ranger stations were used to calculate monthly statistics.

All the data used in the preparation of this report (including original and quality checked files) are available electronically from www.ClimateAnalyzer.org. These data files may be read and re-analyzed by the same software that was used to produce this report, available for download at www.YellowstoneEcology.com. Readers can download the data used in this report and make custom climate graphs and tables of their own by visiting www.ClimateAnalyzer.org

Analysis of Wind Data

Wind roses were used to present average conditions during 2013 and to contrast them with the period from 2005 – 2010. This period was chosen because it was common to all the RAWS stations in the park.

Results

Temperature, Precipitation, and Drought Status During Calendar Year 2013

The patterns described in this section are often stated as broad generalizations. In most cases there was significant variability across the region and exceptions to the patterns described here were common. In order to appreciate this variability, it is important to examine the PRISM maps (Figures 7 – 9) and compare them to the weather station data presented in Figures 4 – 6 and Tables 1 – 2.

Broader Picture – The region became drier during the course of 2013

The region entered into drought conditions in April 2012 (Tercek 2013) and became progressively drier throughout 2013. By March 2014, the US Drought Monitor classified the area in and near Channel Islands NP as “Exceptional Drought” (Figure 2).

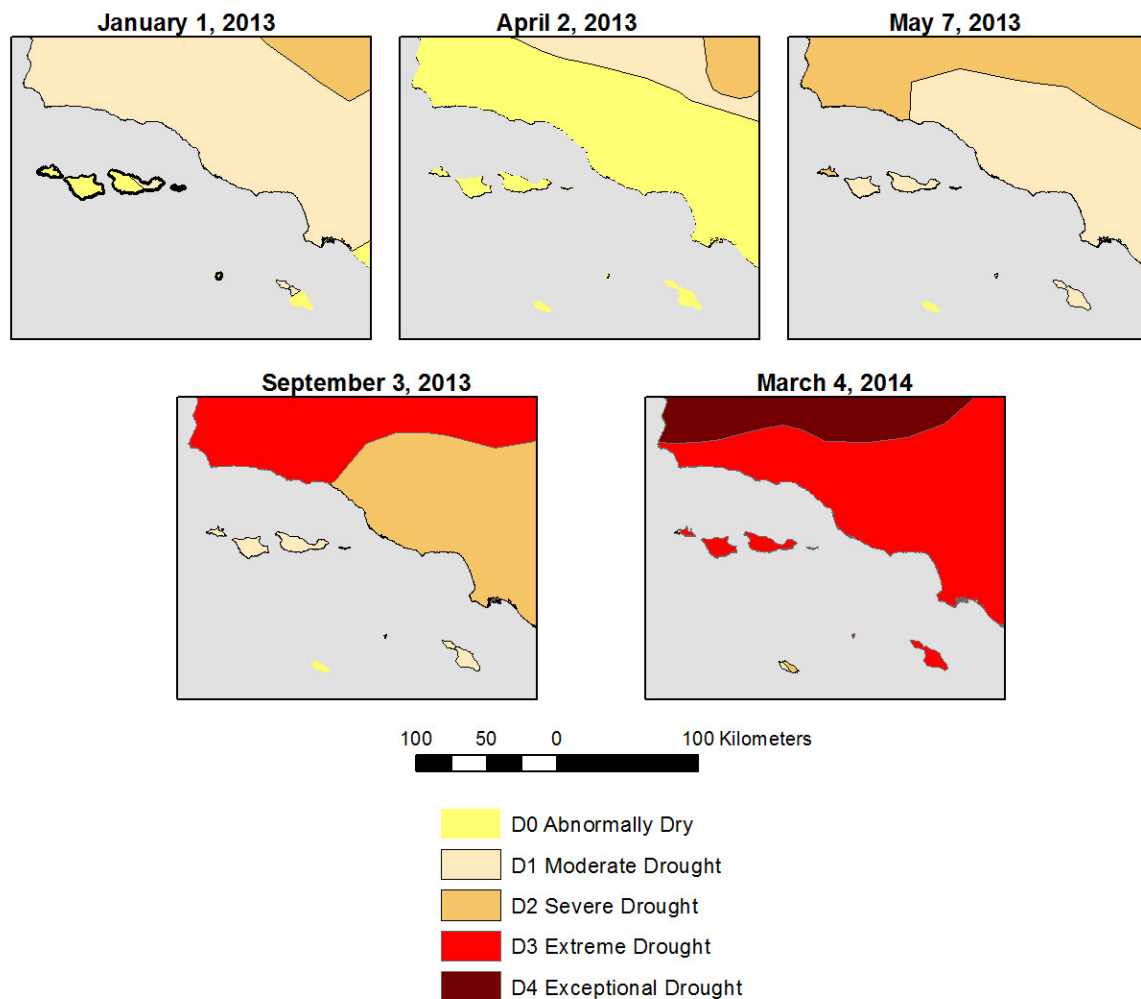


Figure 2. U.S. Drought Monitor maps for Channel Island National Park during calendar years 2013 - 2014. Drought classifications range from “abnormally dry” (D0) to “exceptional drought” (D4). Gray areas = Pacific Ocean. White areas = no drought. For more information visit: www.drought.unl.edu/dm/monitor.html

The Reconnaissance Drought Index

When viewed from a longer-term perspective, the 2012 – 2013 water year, which runs from October 2012 – September 2013 (see methods), showed a deepening of the drought that began in 2012 (last two bars in Figure 3). It was not as dry as the period between the water years 2005 – 2006 to 2008 – 2009, likely because the region still benefited from the wetter than average conditions during 2010 – 2011 (Figure 3). The drought experienced by the region became extreme after the 2013 water year ended and continued into the beginning of 2014. (Figure 2).

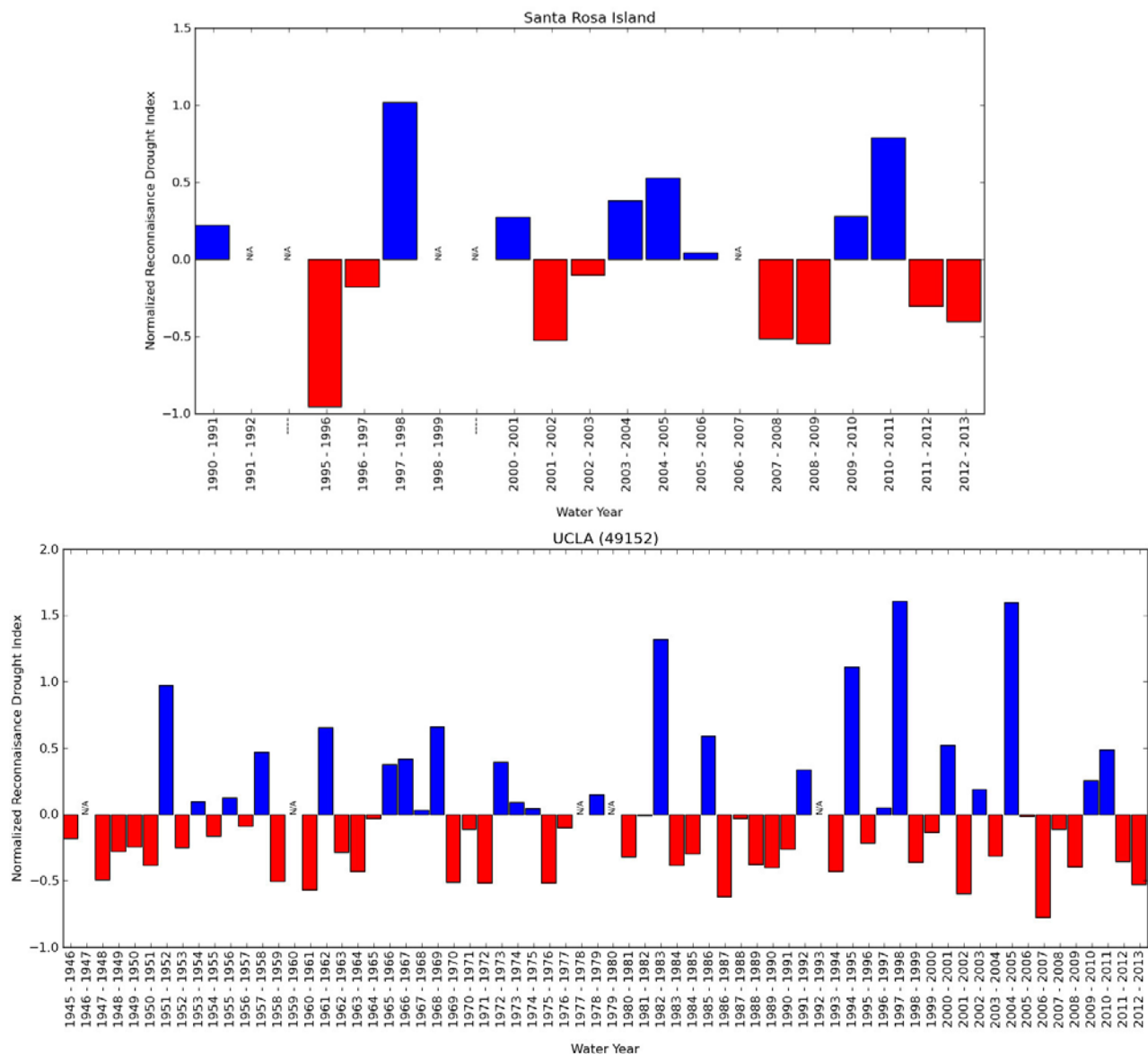


Figure 3. The Reconnaissance Drought Index (RDI) calculated for the Santa Rosa Island (top) and UCLA (bottom) weather stations. Negative index values indicate water years that were drier than the long-term. Positive values indicate wetter than average water years. Water years run from October – September of the following year. The mainland station is included because it has similar patterns to the islands and provides a longer-term perspective.

El Nino – La Nina Status

The El Nino – Southern Oscillation (ENSO) is an oscillation of the ocean – atmosphere climate system centered over the tropical Pacific Ocean that follows a rough cycle of approximately 2 – 7 years. When ENSO is in its “El Nino phase,” sea surface temperatures in the central and eastern tropical Pacific are warmer than average. This generally produces warmer, drier conditions in the northern continental United States and cooler, wetter conditions in the southern United States, particularly the southwest. In contrast, the opposite conditions prevail when ENSO is in its “La Nina phase.” More information on ENSO can be found on the NOAA web site located here: <http://www.pmel.noaa.gov/tao/elnino/el-nino-story.html>

ENSO entered the neutral state between La Nina and El Nino during 2012 and remained neutral throughout 2013. Normally, La Nina conditions produce drier conditions in southern California and El Nino produces wetter conditions. Given its transitional state, predicting the effects of ENSO on regional climate is difficult. For long-term El Nino patterns, consult NOAA here: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

Precipitation During 2013

The PRISM maps (Figure 5) show that all of the non-summer months had precipitation totals that were well below the 1981 – 2010 averages. Precipitation totals for the islands are summarized in Figures 4a, Figure 4b, and Table 1. Many non-summer months had 25% or less normal precipitation (Figure 5). Note that precipitation during May – August is very low. It is therefore easy to misinterpret calculations of “percent normal” for these months, as only a few hundredths of an inch of rain can mean the difference between below vs. above average precipitation.

Temperature During 2013

There are no weather stations with established 30-year averages within Channel Islands National Park. We rely instead on PRISM maps (Figures 6 – 7) when comparing 2013 to the past. (See the Introduction for more information on how 30-year averages are calculated by NOAA). Temperature data from the park’s weather stations are summarized in Table 2 and Figures 4a and 4b. According to PRISM, January, February, August and October had average daily minimum temperatures (night time temperatures - Tmin) that were near or below average, while the other months in 2013 had above average Tmin (Figure 6). In general, average daily maximum temperatures (daytime highs – Tmax) were above average during April – June and near or below average during the other months (Figure 7). The severe drought that the region currently experiences is thus due more to low precipitation than to high temperatures.

Wind Speed and Direction

Winds during 2013 were very similar to 2012 and to previous years. None of the differences among 2005 – 2010 vs. 2012 and 2013 appear significant (Figure 8).

Table 1. Monthly total precipitation in inches during 2013 in Channel Islands National Park.

	Anacapa Island RAWS	Santa Rosa Island RAWS	Santa Barbara Island RAWS	Santa Cruz Island RAWS	Santa Rosa Island Manual	Santa Cruz Island Manual	Santa Barbara Island Manual	San Miguel Island Manual
Month	2013 Precip. (in)	2013 Precip. (in)	2013 Precip. (in)	2013 Precip. (in)	2013 Precip. (in)	2013 Precip. (in)	2013 Precip. (in)	2013 Precip. (in)
January	0.85	0.83	0.64	1.34	0.98	1.46	0.88	3.11
February	0.28	0.39	0.04	0.36	0.27	(-)	0.34	(-)
March	1.02	1.08	0.48	1.18	1.28	0.85	0.65	1.54
April	0	0.24	0.01	0.03	0.02	0.7	0.28	0.11
May	0.1	0.17	0.12	0.06	0.05	(-)	(-)	0.18
June	0.01	0.17	0.1	0.05	0	0.03	0.07	0.14
July	0	0.18	0.02	0	(-)	0.02	0.03	0.04
August	0	0.24	0	0	0	0	0.06	0.11
September	0	0.08	0	0	0	(-)	0.06	0.03
October	0	0.27	0.03	0.08	0.2	(-)	0.23	0.21
November	0.65	0.7	0.12	0.99	(-)	(-)	0.17	(-)
December	0.02	0.17	0.02	0.11	(-)	(-)	0.13	(-)
YR	2.93	4.52	1.58	4.2	(-)	(-)	(-)	(-)

(-) = insufficient data for an accurate calculation

Table 2. Monthly average daily maximum temperatures (Tmax) during 2013 in degrees Fahrenheit.

	Anacapa Island RAWS	Santa Rosa Island RAWS	Santa Barbara Island RAWS	Santa Cruz Island RAWS	Santa Rosa Island Manual	Santa Cruz Island Manual	Santa Barbara Island Manual	San Miguel Island Manual
Month	2013 Tmax (F)	2013 Tmax (F)	2013 Tmax (F)	2013 Tmax (F)	2013 Tmax (F)	2013 Tmax (F)	2013 Tmax (F)	2013 Tmax (F)
January	nan	58.7	64.6	65.0	61.1	64.6	62.3	60.2
February	61.8	56.4	77.1	65.0	60.6	(-)	63.5	58.5
March	64.6	61.5	(-)	70.7	62.9	66.8	66.5	60.2
April	67.8	61.2	(-)	71.1	64.7	69.5	68.8	62.1
May	68.9	63.5	(-)	77.4	66.7	72.7	73.0	63.8
June	70.4	66.1	(-)	77.2	68.9	72.4	73.6	65.4
July	69.1	67.3	66.9	79.0	71.2	72.0	73.7	65.4
August	70.4	66.0	66.5	80.6	67.9	71.6	72.8	64.9
September	72.7	69.9	69.1	82.9	71.5	77.1	79.1	68.5
October	70.6	66.2	67.5	74.3	70.0	(-)	74.2	67.2
November	69.2	65.8	66.1	71.4	69.1	(-)	71.4	66.3
December	66.9	64.6	63.8	68.5	66.3	(-)	67.9	(-)
YR	68.4	64.4	(-)	74.4	67.3	(-)	71.3	(-)

Table 2 continued. Monthly average daily minimum temperatures (Tmin) during 2013 in degrees Fahrenheit.

	Anacapa Island RAWS	Santa Rosa Island RAWS	Santa Barbara Island RAWS	Santa Cruz Island RAWS	Santa Rosa Island Manual	Santa Cruz Island Manual	Santa Barbara Island Manual	San Miguel Island Manual
Month	2013 Tmin (F)	2013 Tmin (F)	2013 Tmin (F)	2013 Tmin (F)	2013 Tmin (F)	2013 Tmin (F)	2013 Tmin (F)	2013 Tmin (F)
January	nan	47.1	57.2	42.3	47.6	60.6	52.5	46.3
February	51.2	44.8	70.9	41.4	47.4	(-)	50.6	45.8
March	53.5	47.2	(-)	46.4	47.7	46.6	51.6	47.4
April	56.8	47.7	(-)	49.3	47.9	50.8	54.4	47.9
May	57.9	50.3	(-)	52.0	50.4	53.7	57.0	50.0
June	59.5	52.5	(-)	53.6	52.2	55.8	58.8	52.3
July	60.9	53.4	59.2	55.9	53.5	57.4	59.8	54.2
August	61.8	53.4	58.7	54.4	52.7	56.9	59.1	53.8
September	62.9	55.3	61.4	56.3	55.2	58.0	61.0	56.0
October	60.1	53.8	59.2	49.8	54.2	(-)	57.6	53.5
November	58.6	52.9	57.8	47.5	52.9	(-)	57.1	52.5
December	55.9	52.0	55.0	43.1	50.1	(-)	54.7	(-)
YR	(-)	50.9	(-)	49.3	51.0	(-)	56.2	(-)

Accumulated Growing Degree Days: an Index of Growing Season Length

Accumulated Growing Degree Days (AGDD) are often used as an index of growing season length. They are calculated as the sum of the differences between the average temperature for each day of the year and a base temperature. The base temperature is often chosen as the threshold below which plants are thought to be metabolically inactive. In the case of AGDD 40, the base temperature is 40 degrees Fahrenheit. Consequently, 40 (F) is subtracted from the mean temperature for each day, and these differences are added up for the entire year, giving a single number. Similarly, AGDD 50 is calculated with a base temperature of 50 (F).

The Channel Islands RAWS have not been in operation long enough to calculate a “normal” growing season length, and during 2013 only the Santa Rosa and Santa Cruz Island RAWS had enough data to calculate AGDD statistics (Table 3). The AGDD values reported in Table 3 are near (105 – 120%) the calculated values for 2010 - 2012 (Tercek 2011, 2012).

Table 3. Accumulated Growing Degree Days (AGDD) and days above or below critical temperature thresholds during 2013.

Station Name	Station ID	AGDD40	AGDD50	# days >= 80 F	# days >= 90 F	# days <= 32F
Anacapa Island	RAWS	(-)	(-)	(-)	(-)	(-)
Santa Rosa Island	RAWS	6302	2900	22	3	0
Santa Barbara Island	RAWS	(-)	(-)	(-)	(-)	(-)
Santa Cruz Island	RAWS	7750	4214	96	15	2

(-) = insufficient data for an accurate calculation

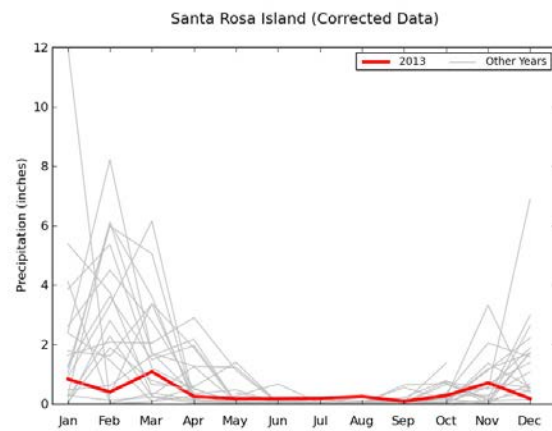
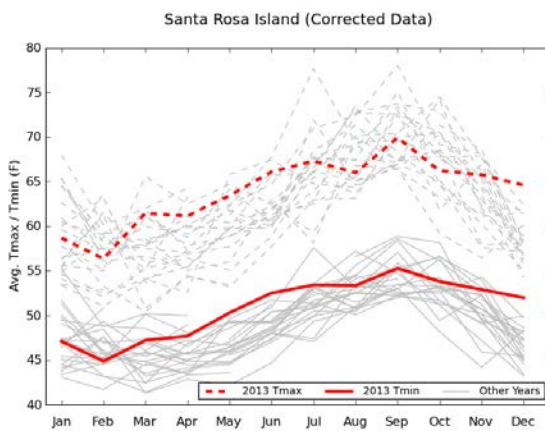
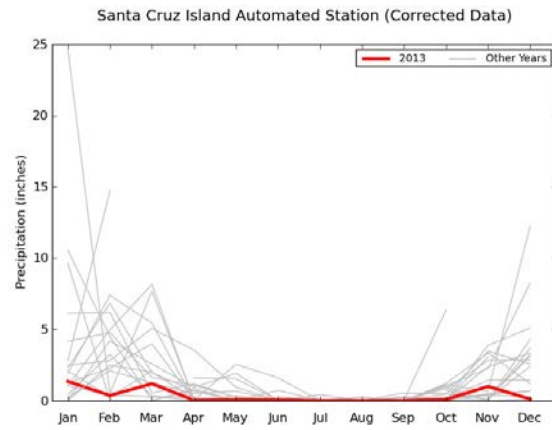
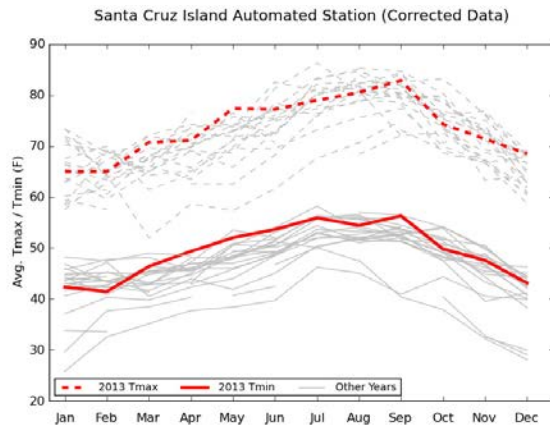


Figure 4a. Monthly precipitation and temperature data collected by RAWS in Channel Islands National Park. Red = 2013 measurements. Gray = other years.

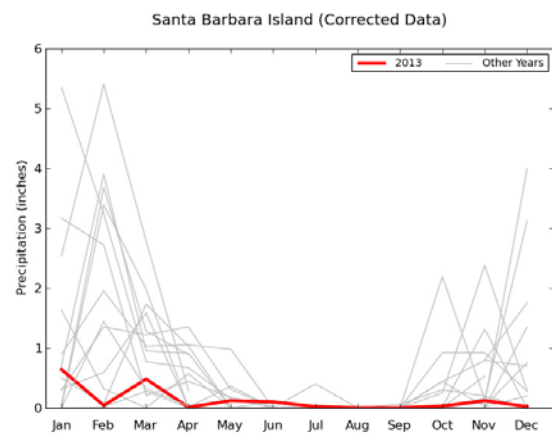
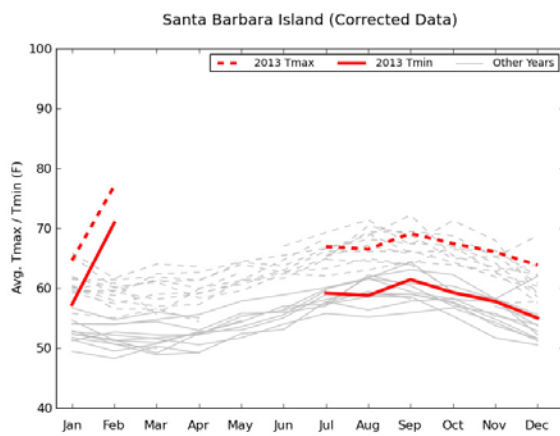
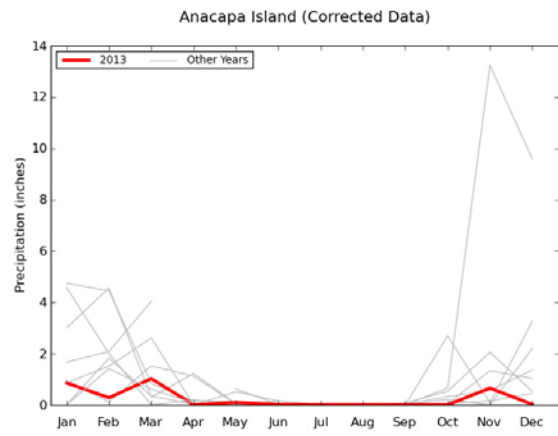
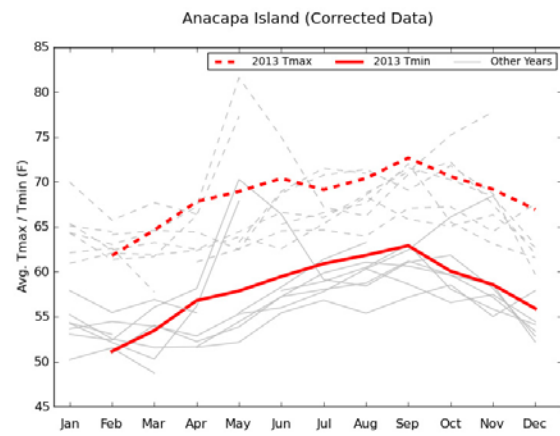


Figure 4a. Continued

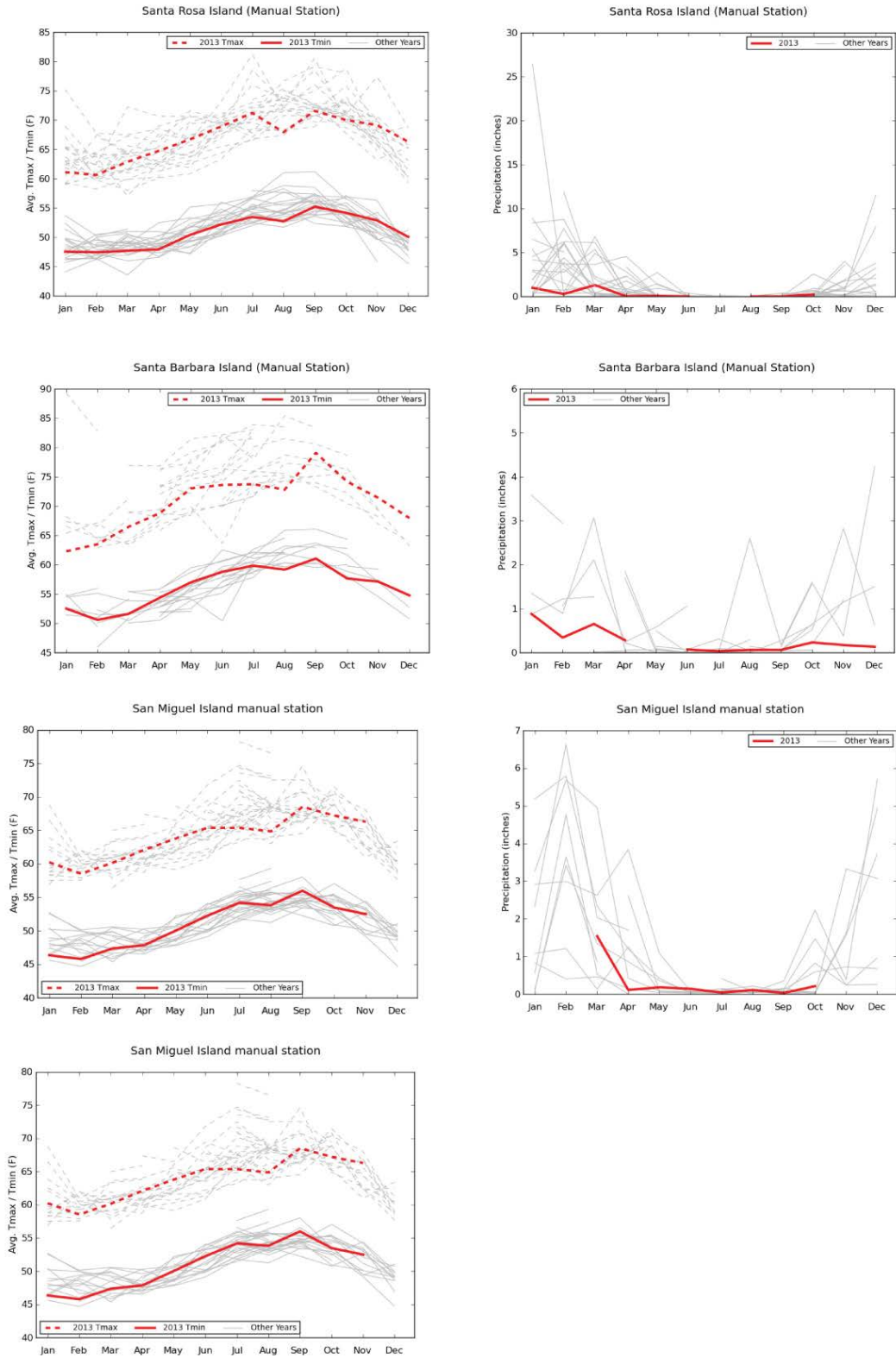


Figure 4b. Monthly precipitation and temperature data collected by manual ranger managed weather stations in Channel Islands National Park. Red = 2013 measurements. Gray = other years.

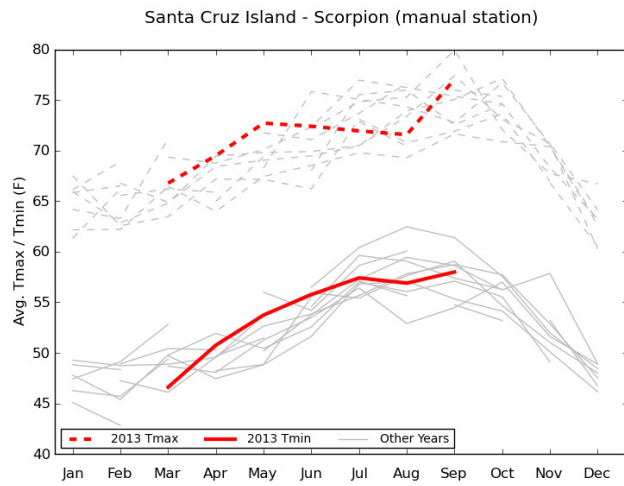


Figure 4b Continued. There was not enough precipitation data from the Santa Cruz Island manual ranger managed weather station to generate a graph for 2013.

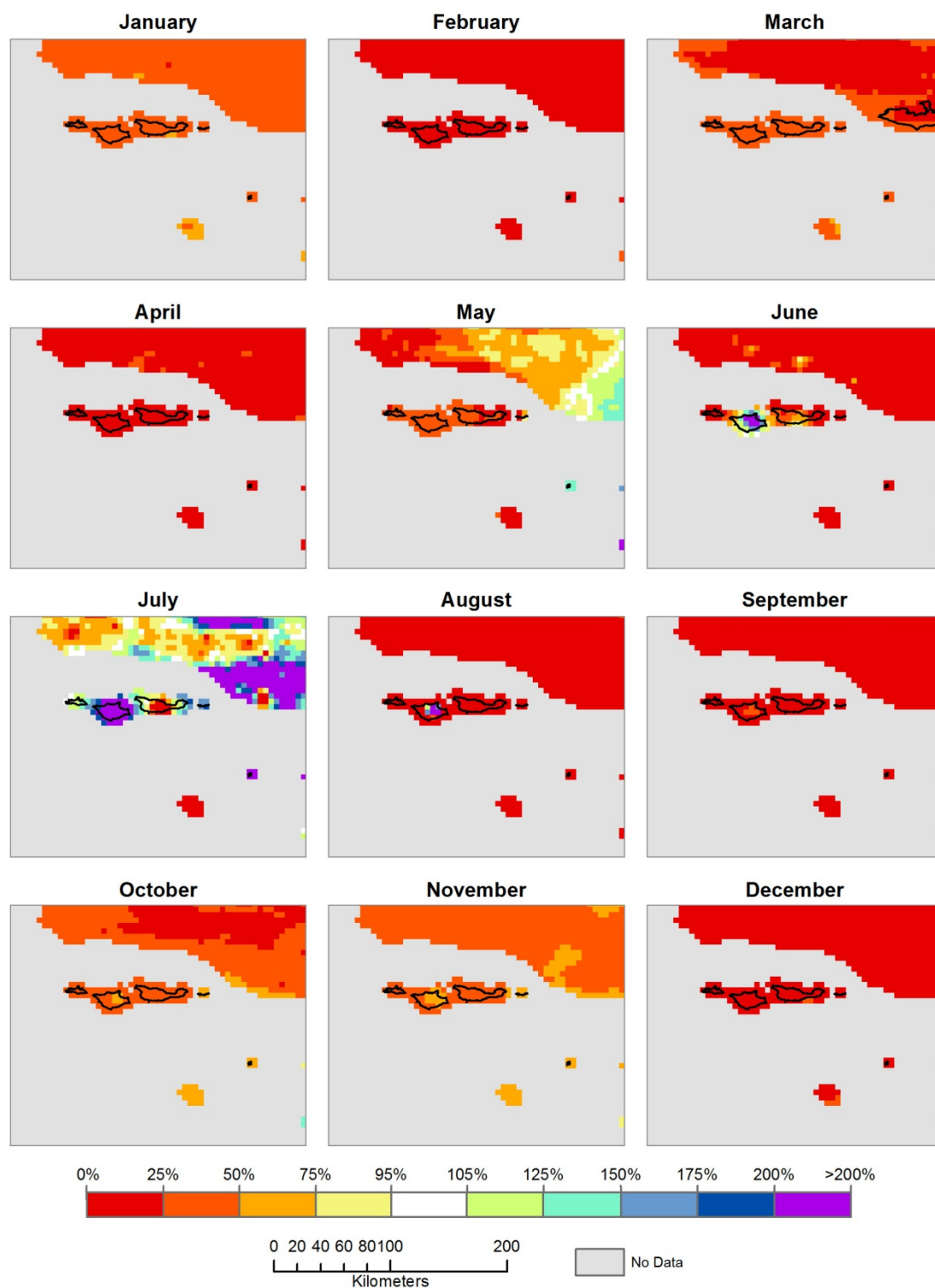


Figure 5. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2013 monthly precipitation as a percentage of 1981 – 2010 averages. Gray areas = Pacific Ocean. For more information, see <http://www.prism.oregonstate.edu/>.

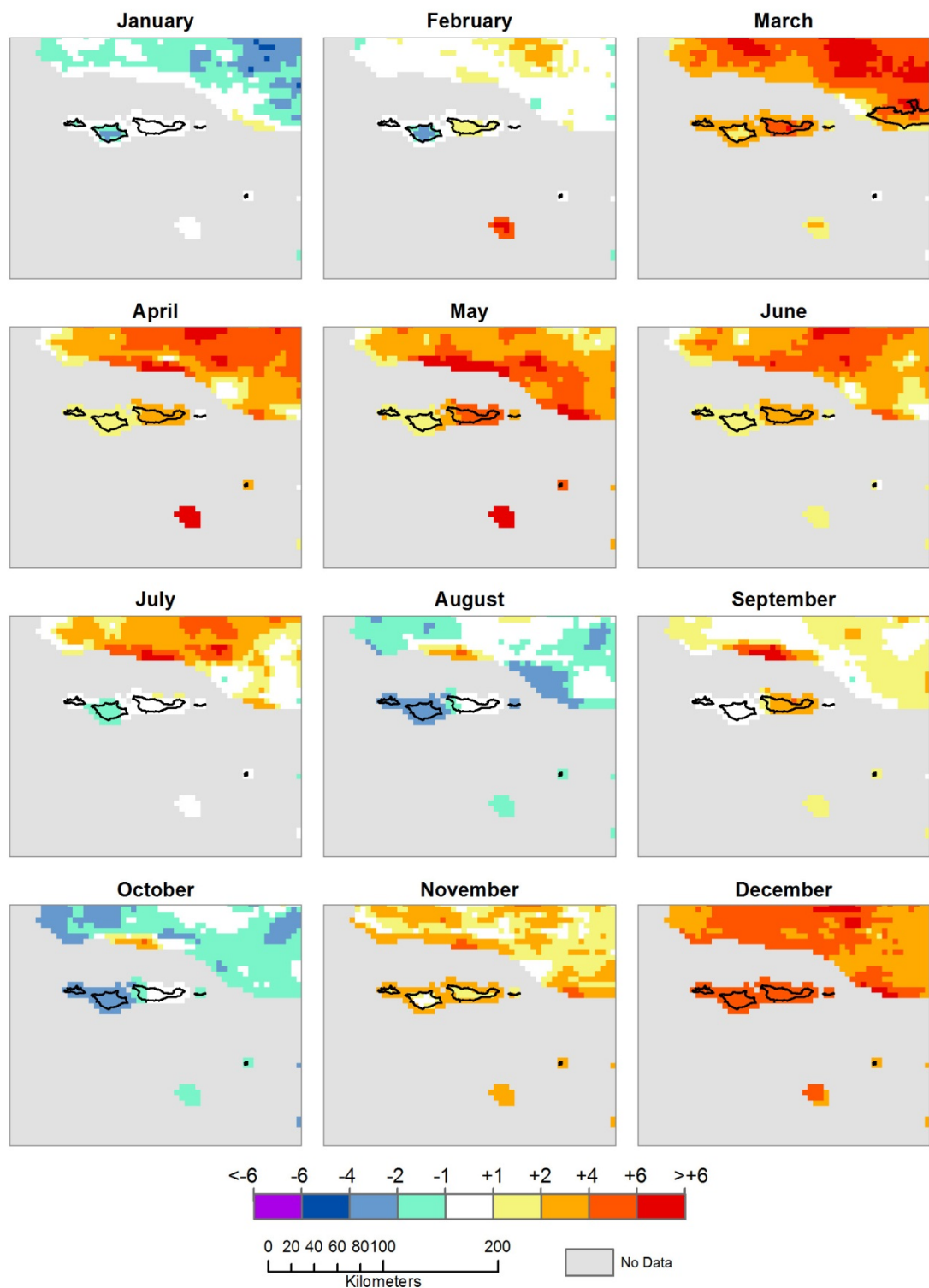


Figure 6. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2013 monthly average daily maximum temperature (Tmax) departure from 1981 – 2010 averages in degrees Fahrenheit. Gray areas = Pacific Ocean. For more information, see <http://www.prism.oregonstate.edu/>.

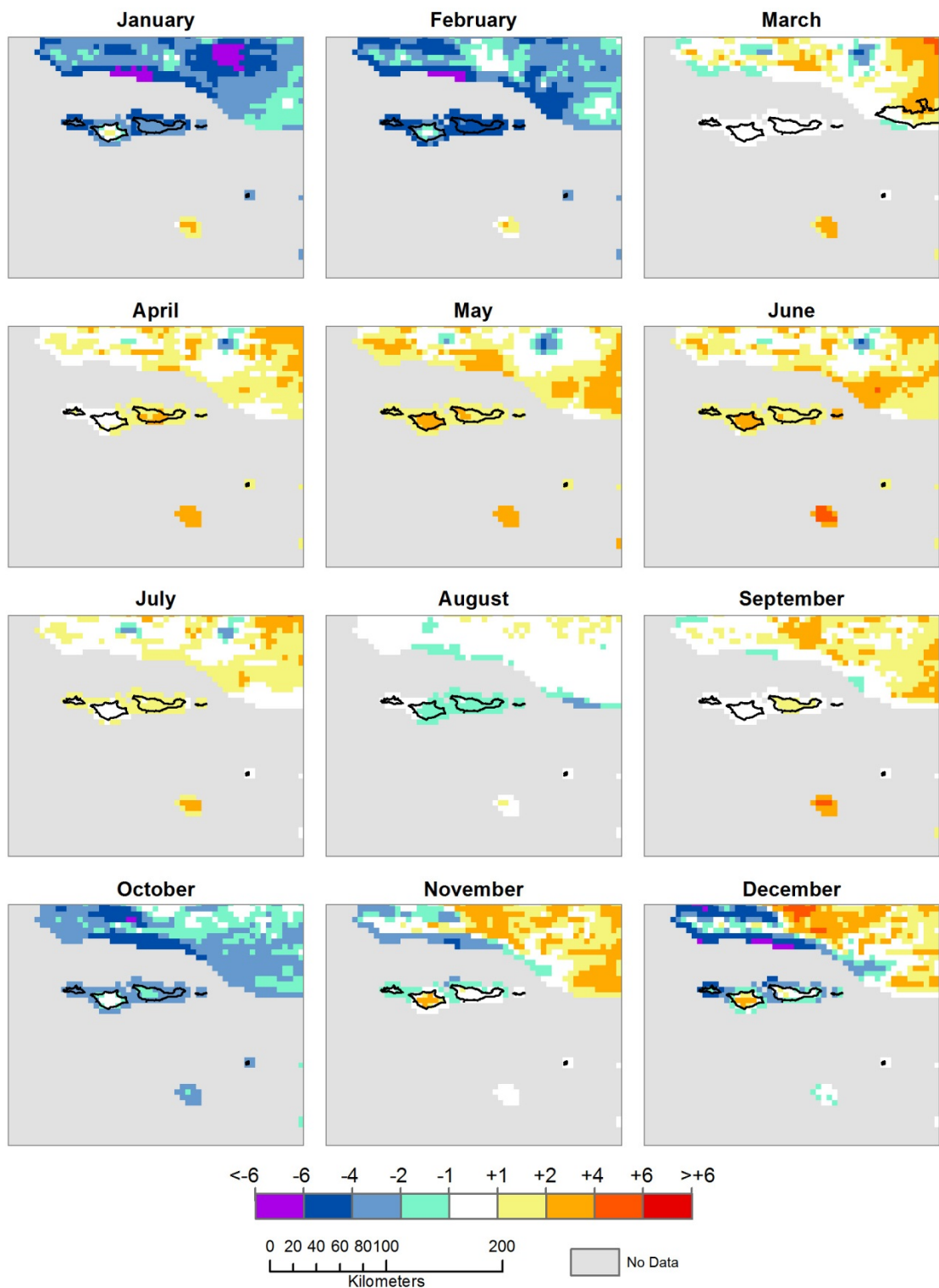
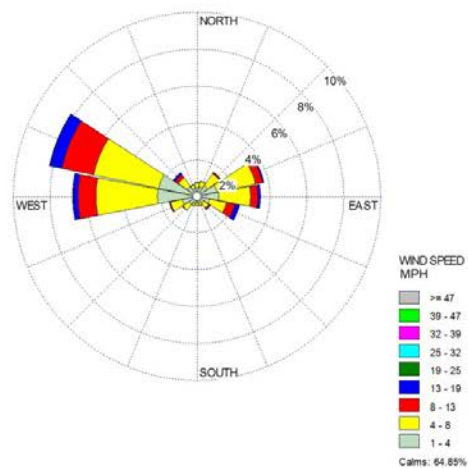
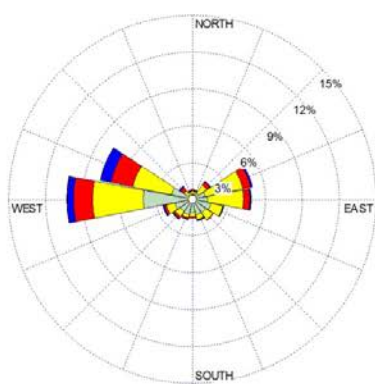


Figure 7. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2013 monthly average daily minimum temperature (Tmin) departure from 1981 – 2010 averages in degrees Fahrenheit. Gray areas = Pacific Ocean. For more information, see <http://www.prism.oregonstate.edu/>.

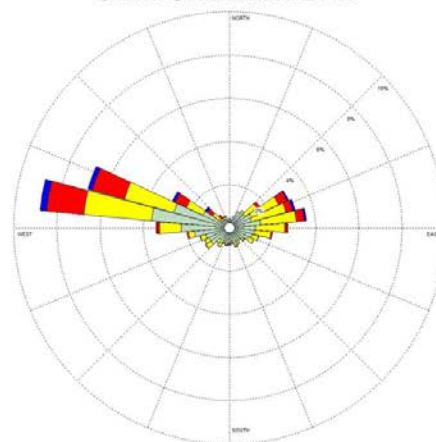
Santa Cruz Island 2005 - 2010



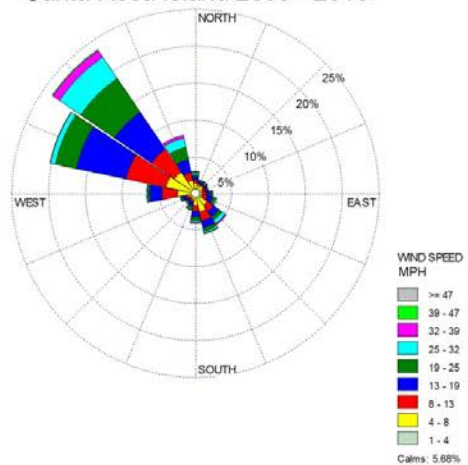
Santa Cruz Island 2012



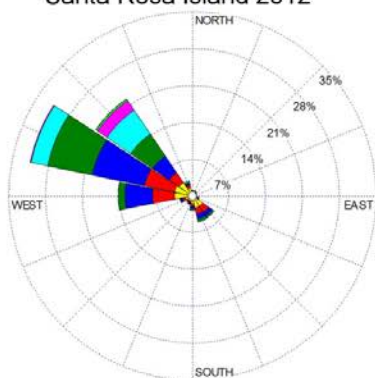
Santa Cruz Island 2013



Santa Rosa Island 2005 - 2010



Santa Rosa Island 2012



Santa Rosa Island 2013

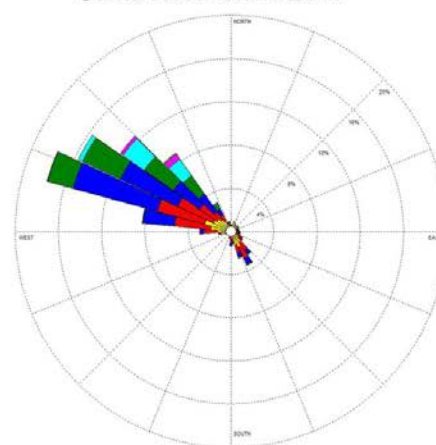
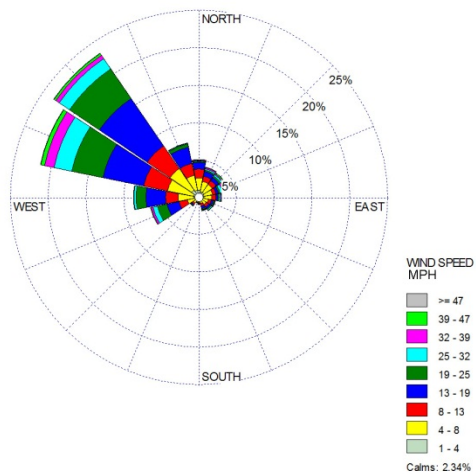
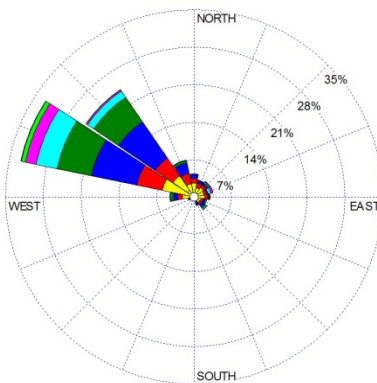


Figure 8. Wind roses for data from RAWs in Channel Islands National Park, contrasting calendar years 2012 and 2013 to the averages for 2005 – 2010. The orientation of a spoke indicates wind direction (compass heading, degrees from which the wind originated), and the length of a spoke indicates the amount of time (%) that wind from a given direction occurred. Colors within the spokes express the amount of time (%) that wind from each direction had the indicated velocity. Speeds are miles per hour.

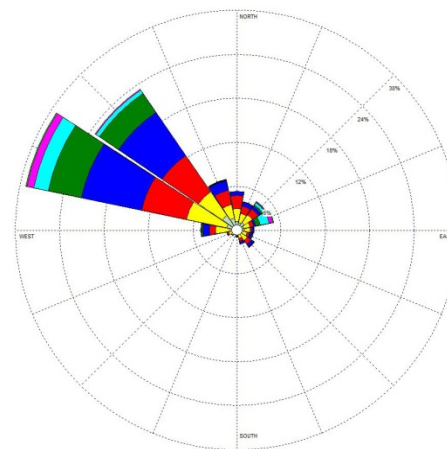
Anacapa Island 2005 - 2010



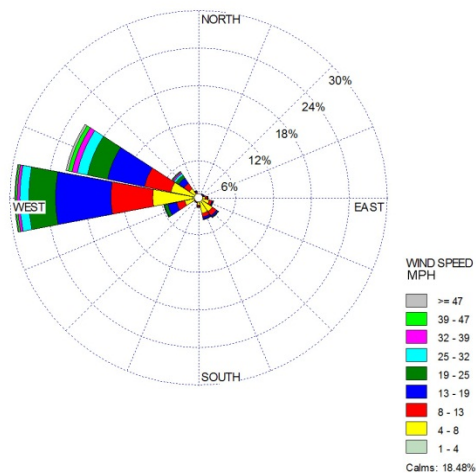
Anacapa Island 2012



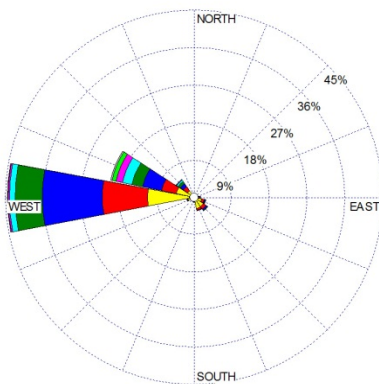
Anacapa Island 2013



Santa Barbara Island 2005 - 2010



Santa Barbara Island 2012



Santa Barbara Island 2013

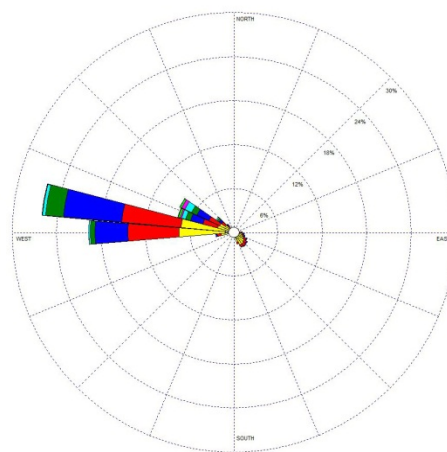


Figure 8. Continued

Conclusions

- The region entered into drought conditions in April 2012 (Tercek 2013) and became progressively drier throughout 2013. By March 2014, the US Drought Monitor classified the area in and near Channel Islands NP as “Exceptional Drought” (Figure 2).
- The PRISM maps (Figure 5) show that all of the non-summer months had precipitation totals that were well below the 1981 – 2010 averages. Many non-summer months had 25% or less than the 1981 - 2010 precipitation average (Figure 5).
- Note that precipitation during May – August is very low, and it is therefore easy to misinterpret calculations of “percent normal” for these months, when only a few hundredths of an inch of rain can mean the difference between below and above average precipitation.
- According to PRISM, January, February, August, and October had average daily minimum temperatures (night time temperatures - Tmin) that were near or below average, while the other months in 2013 had above average Tmin (Figure 6). In general, average daily maximum temperatures (daytime highs – Tmax) were above average during April – June and near or below average during the other months (Figure 7). The temperature data from the park’s weather stations shows that, with some exceptions, temperatures during most months were within the mid-range of previous years (Figures 4a, 4b). The severe drought that the region currently experiences is thus due to more low precipitation than to high temperatures.

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Appendix 1

Table of climate stations used in this report. Detailed histories, period of record, and 30-year averages can be accessed from the links provided below.

Name	Stn type	Metadata
Santa Cruz Island (NPS)	RAWS	http://www.wrcc.dri.edu/cgi-bin/rawMAIN.pl?caCSCI
Anacapa Island (NPS)	RAWS	http://www.wrcc.dri.edu/cgi-bin/rawMAIN.pl?caCANA
Santa Barbara Island (NPS)	RAWS	http://www.wrcc.dri.edu/cgi-bin/rawMAIN.pl?caCSBB
Santa Rosa Island (NPS)	RAWS	http://www.wrcc.dri.edu/cgi-bin/rawMAIN.pl?caCSRI
Santa Cruz Island - Scorpion	Manual	http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7802+sca
Santa Rosa Island	Manual	http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7804+sca
Santa Barbara Island	Manual	http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7801+sca
San Miguel Island	Manual	http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7803+sca

Appendix 2

SBI

A new RH/AT sensor was installed on April 2nd, 2013.

ANI

A new RH/AT sensor was installed on January 9, 2013.

SCI

On March 4, 2013, the existing Handar 555 was upgraded and replaced with a weather station manufactured by Forestry Technology Systems (FTS). The Handar 555 data collection platform (DCP) was replaced with a Forestry Technology System DCP along with all the sensors and cables. Active sensors include precipitation, wind speed, wind direction, air temperature, relative humidity, and solar radiation. A Fuel temperature sensor was added under the new system.

SRI

On March 27-March 29, 2013 the existing Handar 555 data collection platform (DCP) was replaced with a Forestry Technology System DCP along with all the sensors and cables.

Precipitation, wind speed, wind direction, air temperature, relative humidity, fuel temperature sensor, and solar radiation.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 159/127139, November 2014

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