



Climate Monitoring In the Mediterranean Coast Network 2015

Channel Islands National Park

Natural Resource Report NPS/MEDN/NRR—2016/1313



ON THE COVER

Photograph of Anacapa Island marine layer at sunset
Photograph courtesy of the National Park Service

Climate Monitoring In the Mediterranean Coast Network 2015

Channel Islands National Park

Natural Resource Report NPS/MEDN/NRR—2016/1313

Michael T. Tercek¹, Rocky Rudolph² and Stacey Ostermann-Kelm³

¹Walking Shadow Ecology

PO Box 1085

Gardiner, MT 59030

²Channel Islands National Park

1901 Spinnaker Dr.

Ventura, CA 93001

³NPS Inventory and Monitoring Program, Mediterranean Coast Network

401 West Hillcrest Dr.

Thousand Oaks, CA 91360

September 2016

U.S. Department of the Interior

National Park Service

Natural Resource Stewardship and Science

Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

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. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the Mediterranean Coast Network website (<http://science.nature.nps.gov/im/units/medn/>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

Please cite this publication as:

Tercek, M. T., R. Rudolph, and S. Ostermann-Kelm. 2016. Climate monitoring in the Mediterranean Coast Network 2015: Channel Islands National Park. Natural Resource Report NPS/MEDN/NRR—2016/1313. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	iv
Tables.....	iv
Executive Summary	v
Acknowledgments.....	vi
Glossary	vi
Introduction.....	1
Methods.....	3
Selection of Datasets	3
Quality Control of Ranger-Managed (Manual) Weather Stations.....	3
Quality Control of RAWs Data	4
State of the California Current	5
Results.....	6
Temperature, Precipitation, and Drought Status During Calendar Year 2015.....	6
Broader Picture – The Ongoing Drought Became More Severe	14
El Niño – La Niña Status.....	14
Precipitation During 2015	14
Temperature During 2015	15
Accumulated Growing Degree Days, an Index of Growing Season Length.....	15
State of the California Current	16
Conclusions.....	18
Literature Cited	19
Appendix 1.....	21
Appendix 2.....	22

Figures

	Page
Figure 1. Map showing key climate stations used in this report.	3
Figure 2. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2015 monthly precipitation as a percentage of 1981 – 2010 averages.	7
Figure 3. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2015 monthly average daily maximum temperature (Tmax) departure from 1981 – 2010 averages in degrees Fahrenheit.	8
Figure 4. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2015 monthly average daily minimum temperature (Tmin) departure from 1981 – 2010 averages in degrees Fahrenheit.	9
Figure 5a. Monthly precipitation (right) and temperature (left) data collected by RAWS in Channel Islands National Park.	10
Figure 5b. Monthly precipitation and temperature data collected by manual “ranger” weather stations in Channel Islands National Park.	11
Figure 6. U.S. Drought Monitor maps for Channel Islands National Park during calendar year 2015.	14
Figure 7. Sea surface temperature (SST) anomalies for the summer (Jun-Aug) of 2014 and 2015.	16

Tables

	Page
Table 1. Monthly total precipitation in inches during 2015 in Channel Islands National Park.	12
Table 2. Monthly average daily maximum temperatures (Tmax) and average daily minimum temperatures (Tmin) during 2015 in degrees Fahrenheit.	13
Table 3. Accumulated Growing Degree Days (AGDD) and days above or below critical temperature thresholds during 2015 at RAWS in Channel Islands National Park.	15

Executive Summary

This report details the climate (temperature, precipitation, and drought) of Channel Islands National Park (NP) during 2015. 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, a set of data quality control checks were performed by the authors in accordance with a National Park Service (NPS) protocol (Rocky Mountain Climate Working Group 2010). The region entered into drought conditions in April 2012 and became progressively drier throughout 2013 and 2014. By the end of 2014, Channel Islands National Park was classified as “D4 - Exceptional Drought” by the U.S. Drought Monitor, which is the most severe classification on this scale, and it retained this status through the end of 2015. El Niño – Southern Oscillation (ENSO) entered an El Niño phase in the first quarter of 2015, and sea surface temperatures remained above average for the rest of the year. Normally, La Niña conditions produce drier conditions in southern California while El Niño produces wetter conditions. The drought gripping southern California did not materially slacken during 2015. With the exception of June and July, every month during 2015 had below average precipitation. Precipitation during June ranged from 0.18 inches on Anacapa Island to 0.76 inches on Santa Cruz Island. During July, precipitation totals ranged from 0.14 inches on Anacapa and Santa Cruz Islands to 0.26 inches on Santa Barbara Island. Normal summer precipitation totals are quite low on the islands, so the PRISM estimates for these months were > 400% average. According to PRISM, May and December had near to below average temperatures, while the rest of 2015 had temperatures that were significantly warmer than average. February, March, September, and October were notably warm, with temperatures > 6 degrees above the 1981 – 2010 average throughout most of the island. Readers can download the data used in this report and make custom climate graphs and tables by visiting www.ClimateAnalyzer.org.

Acknowledgments

Funding for this report was provided by National Park Service Mediterranean Coast Network Inventory and Monitoring Program.

Glossary

30-year average or “normal” – 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.

Manual station – Park-owned and maintained weather station, with daily observations made by Park rangers.

NOAA – National Oceanic and Atmospheric Administration.

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

RAWS – Remote Automated Weather Station.

U.S. Drought Monitor – A broad brush assessment of drought conditions. See <http://droughtmonitor.unl.edu/>.

Tmax / Tmin – daily Maximum / Minimum Temperatures. Monthly Tmax and Tmin are averages of daily Tmax and Tmin, respectively.

Introduction

Channel Islands National Park is comprised of five offshore islands 20 to 61 kilometers from mainland Southern California, including San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara Islands. 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 Channel Islands NP that were complete enough to support monthly and annual summaries for calendar year 2015, as of August 2016. Only a subset of the weather stations located in Channel Islands NP 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, making them intractable to 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. Also included is a brief update on the state of the California Current and sea surface temperature anomalies (SSTa).

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 Park staff when stationed on the islands (manual 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 manual 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 Channel Islands National Park 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 Park 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 Channel Islands NP 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/>)

U.S. Drought Monitor (<http://droughtmonitor.unl.edu/>)

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>)

Methods

Selection of Datasets

In order to place Channel Islands NP within a regional context, mapped 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, historically 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 manual stations are owned and maintained by Channel Islands National Park. Data from the manual 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 U.S. Drought Monitor (<http://droughtmonitor.unl.edu/>) were used to depict broad-brush conditions across the region.

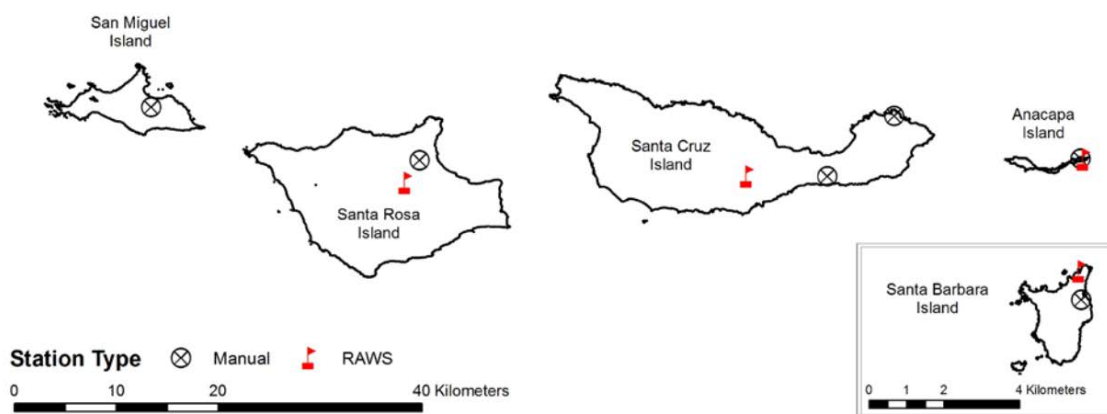


Figure 1. Map showing key climate stations used in this report. There are additional weather stations in Channel Islands NP, but data from those stations was not complete enough for 2015 to merit inclusion.

Quality Control of Ranger-Managed (Manual) Weather Stations

All of the manual stations used in this report are operated and maintained by Channel Islands NP. These stations are sometimes referred to as “Cooperative Observer” stations because in most cases

their measurements are recorded by a human and entered into the Western Regional Climate Center website where the data are 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. Following guidelines from Kittel (2008), Kittel et al. (2009), and Rocky Mountain Climate Working Group (2010), the quality assurance and quality control 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 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 entered into the corrected datafiles available on ClimateAnalyzer.org. 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 daily maximum temperature (Tmax) or daily minimum temperature (Tmin) were missing, monthly average temperatures were not calculated. The data handling was conservative, i.e., no data points were changed unless it was very clear that an erroneous value, for example a precipitation measurement with a missing decimal point that could be verified on the original station records, was found.

Quality Control of RAWS Data

All of the RAWS stations used in this report are maintained by Channel Islands NP. The Park swaps RAWS sensors annually as part of the National Interagency Fire Center Weather Program. The Program maintains a parts depot in Boise, ID which exchanges clean, recalibrated sensors with sensors from the field. A detailed 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, ID, 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 instrumental 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 instrumental error and considered missing; the missing data criteria just described for manual 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. Readers can download the data used in this report and make custom climate graphs and tables of their own by visiting www.ClimateAnalyzer.org.

State of the California Current

Highlights from the scientific literature and NOAA's annual update on the state of the California Current Ecosystem (CCE), as derived from environmental, biological and socio-economic indicators, are provided in this report as a means of making this information readily available to NPS staff. NOAA's California Current Integrated Ecosystem Assessment (CCIEA) team is responsible for this report.

Results

Temperature, Precipitation, and Drought Status During Calendar Year 2015

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 2 – 4) and compare them to the weather station data presented in Figures 5a and 5b and Tables 1 – 2.

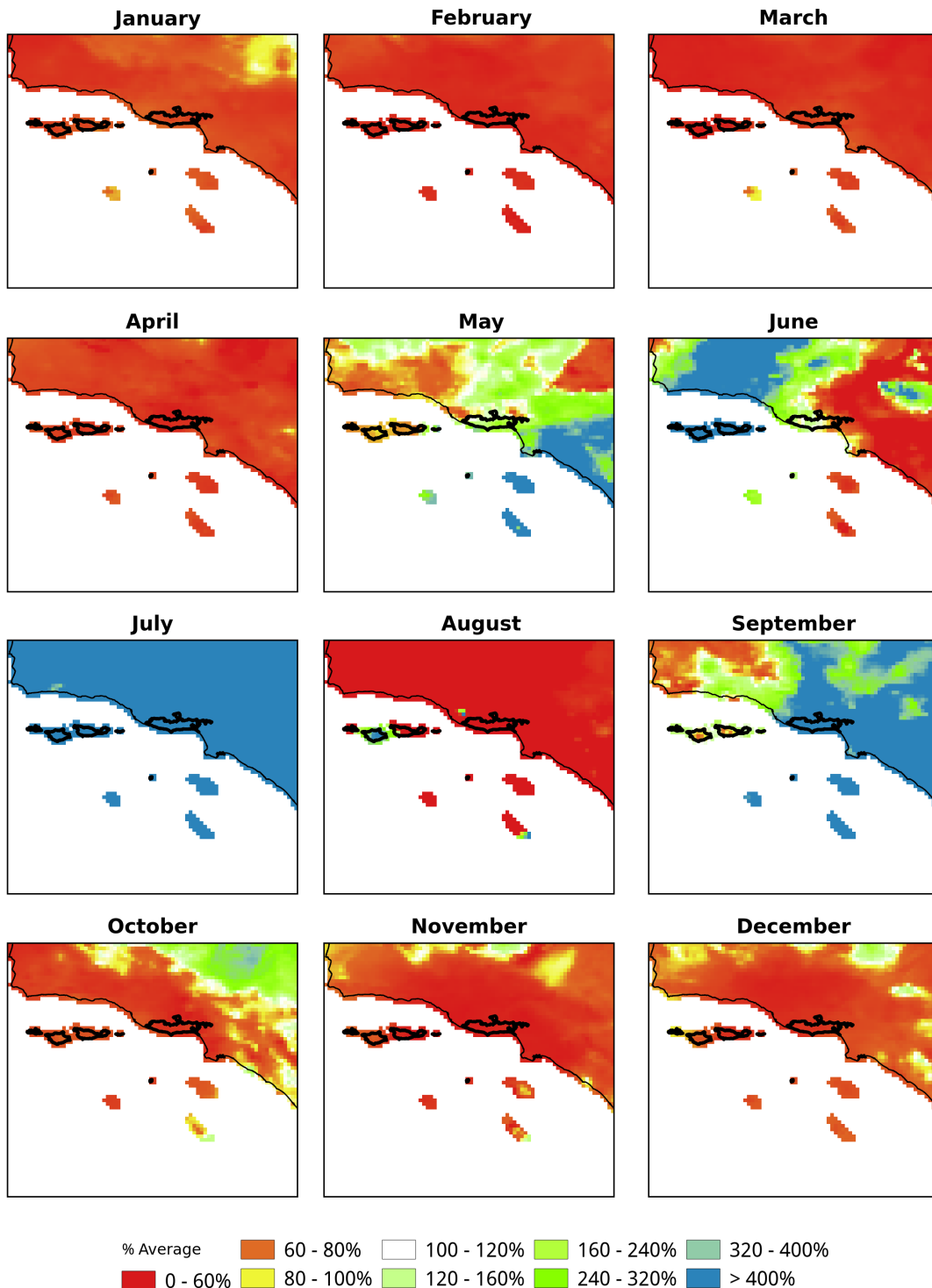


Figure 2. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2015 monthly precipitation as a percentage of 1981 – 2010 averages. White areas = Pacific Ocean. For more information, see <http://www.prism.oregonstate.edu/>.

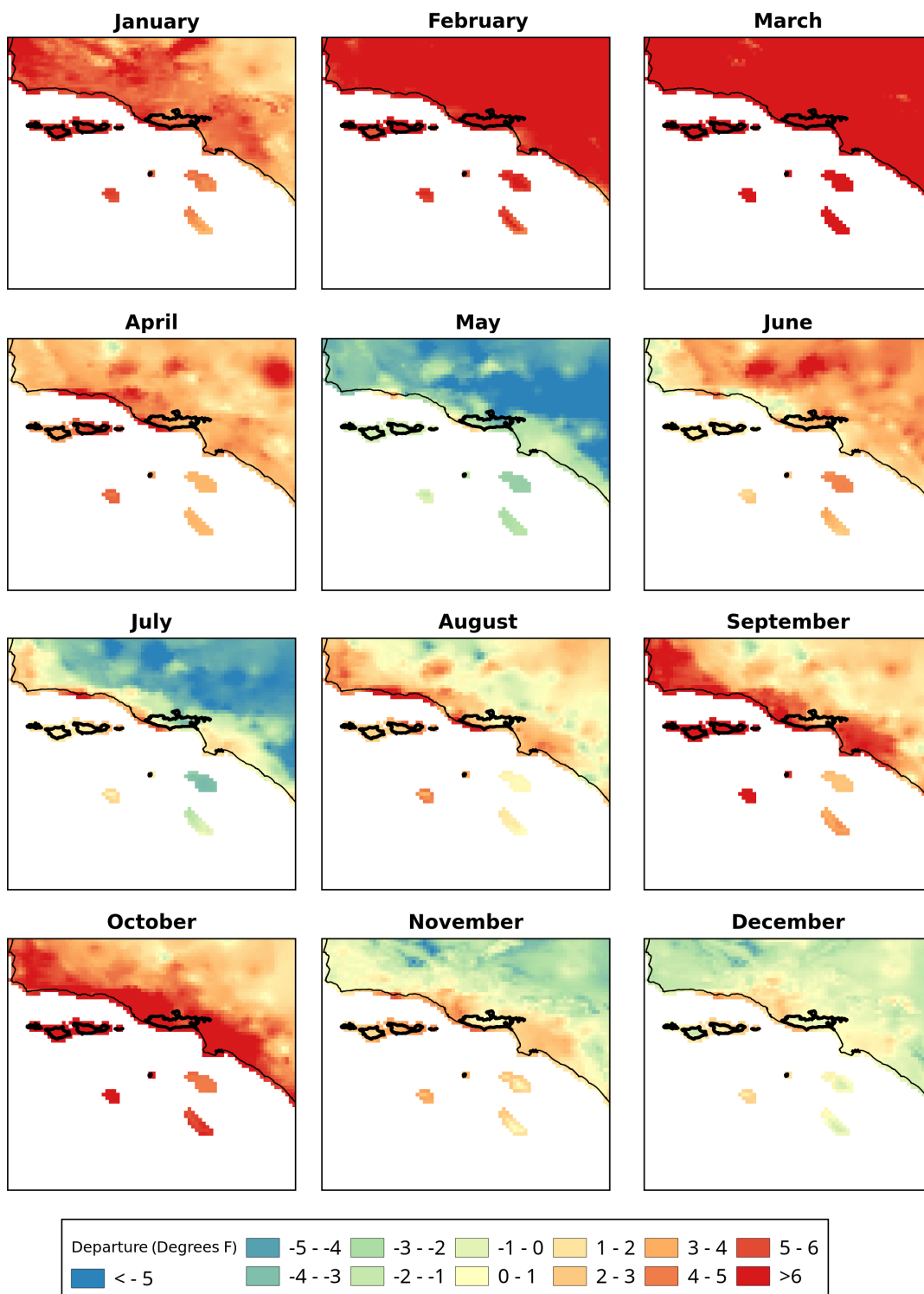


Figure 3. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2015 monthly average daily maximum temperature (Tmax) departure from 1981 – 2010 averages in degrees Fahrenheit. White areas = Pacific Ocean. For more information, see <http://www.prism.oregonstate.edu/>.

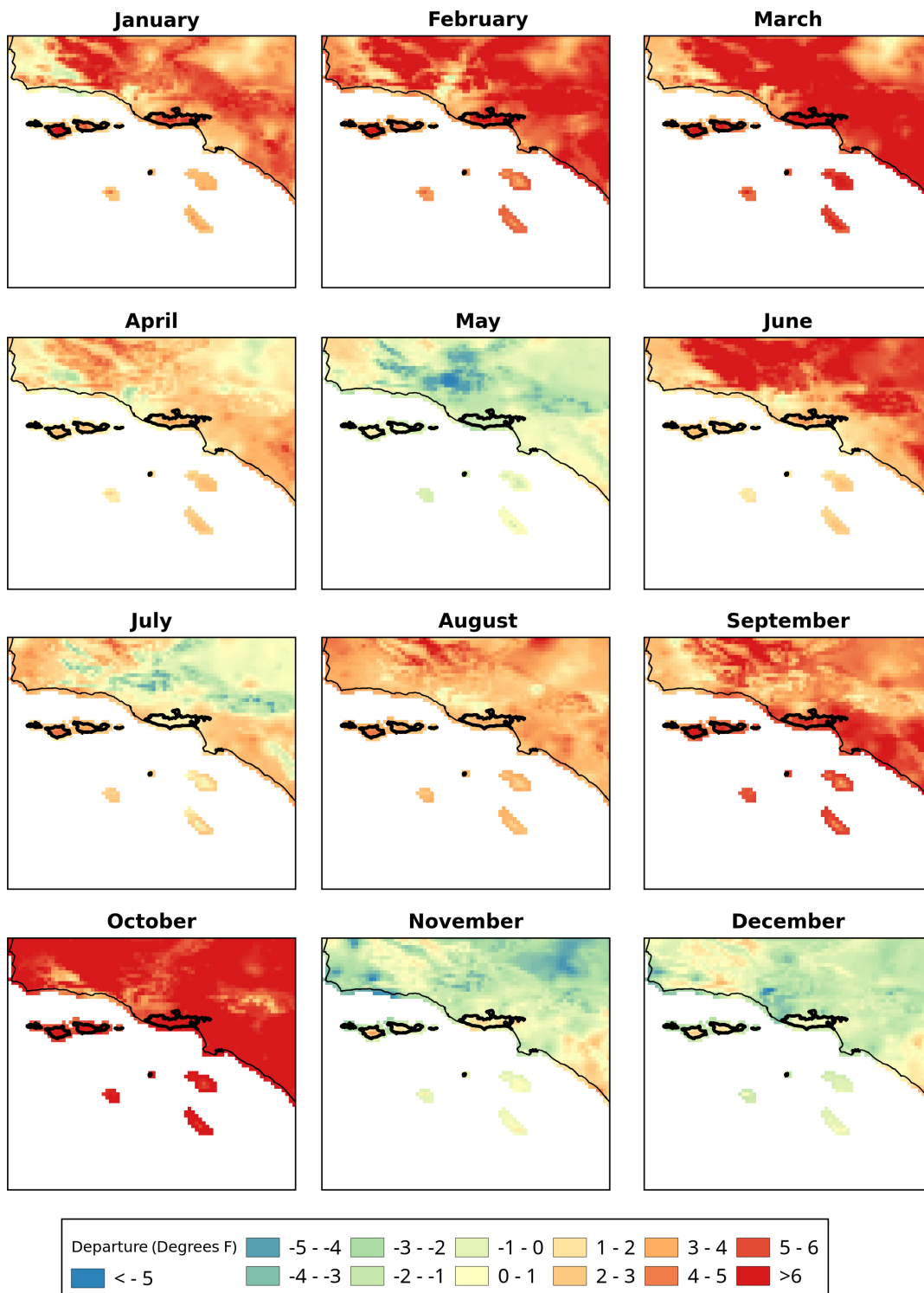


Figure 4. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2015 monthly average daily minimum temperature (Tmin) departure from 1981 – 2010 averages in degrees Fahrenheit. White areas = Pacific Ocean. For more information, see <http://www.prism.oregonstate.edu/>.

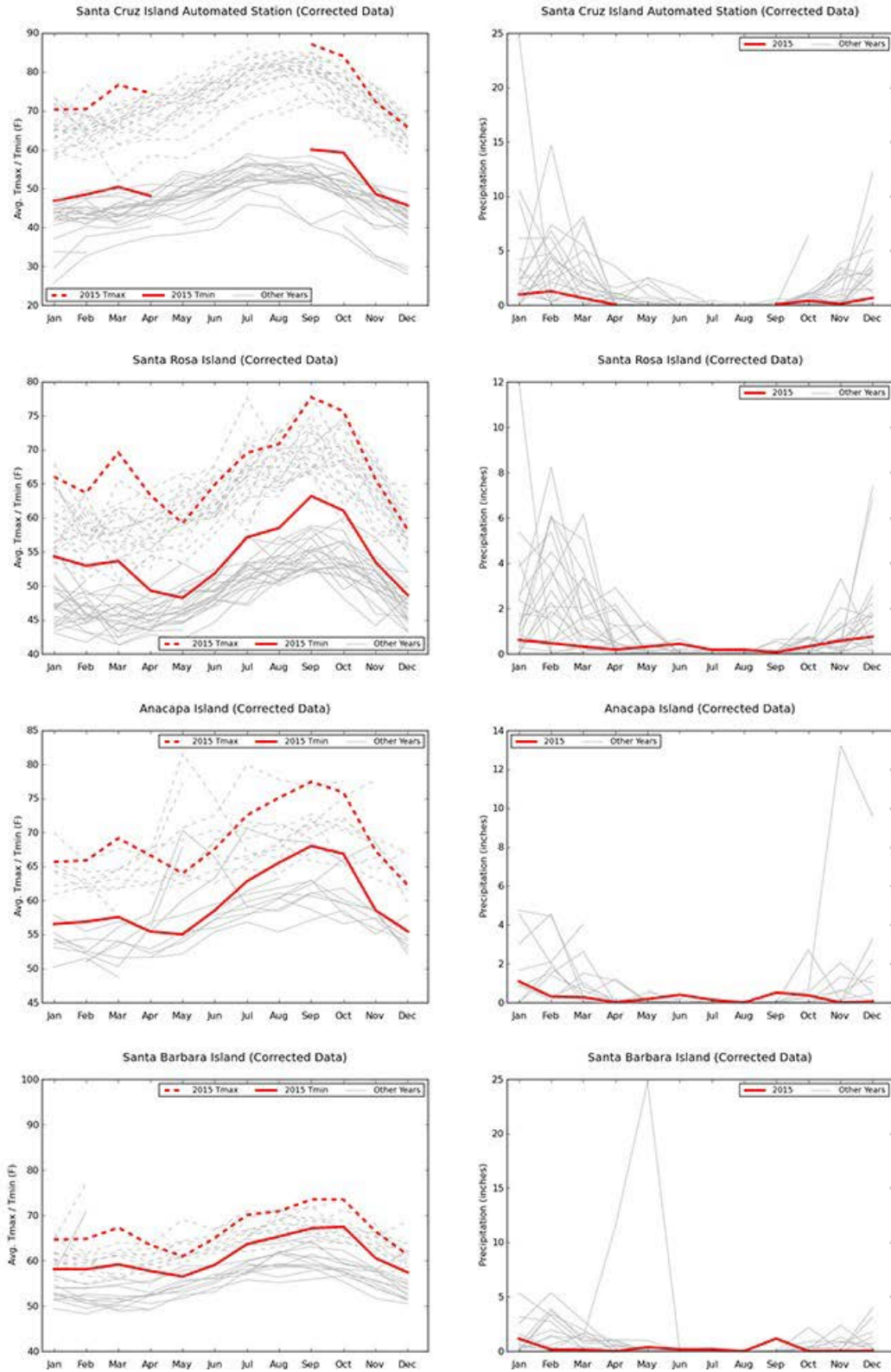


Figure 5a. Monthly precipitation (right) and temperature (left) data collected by RAWS in Channel Islands National Park. Red = 2015 measurements. Gray = other years.

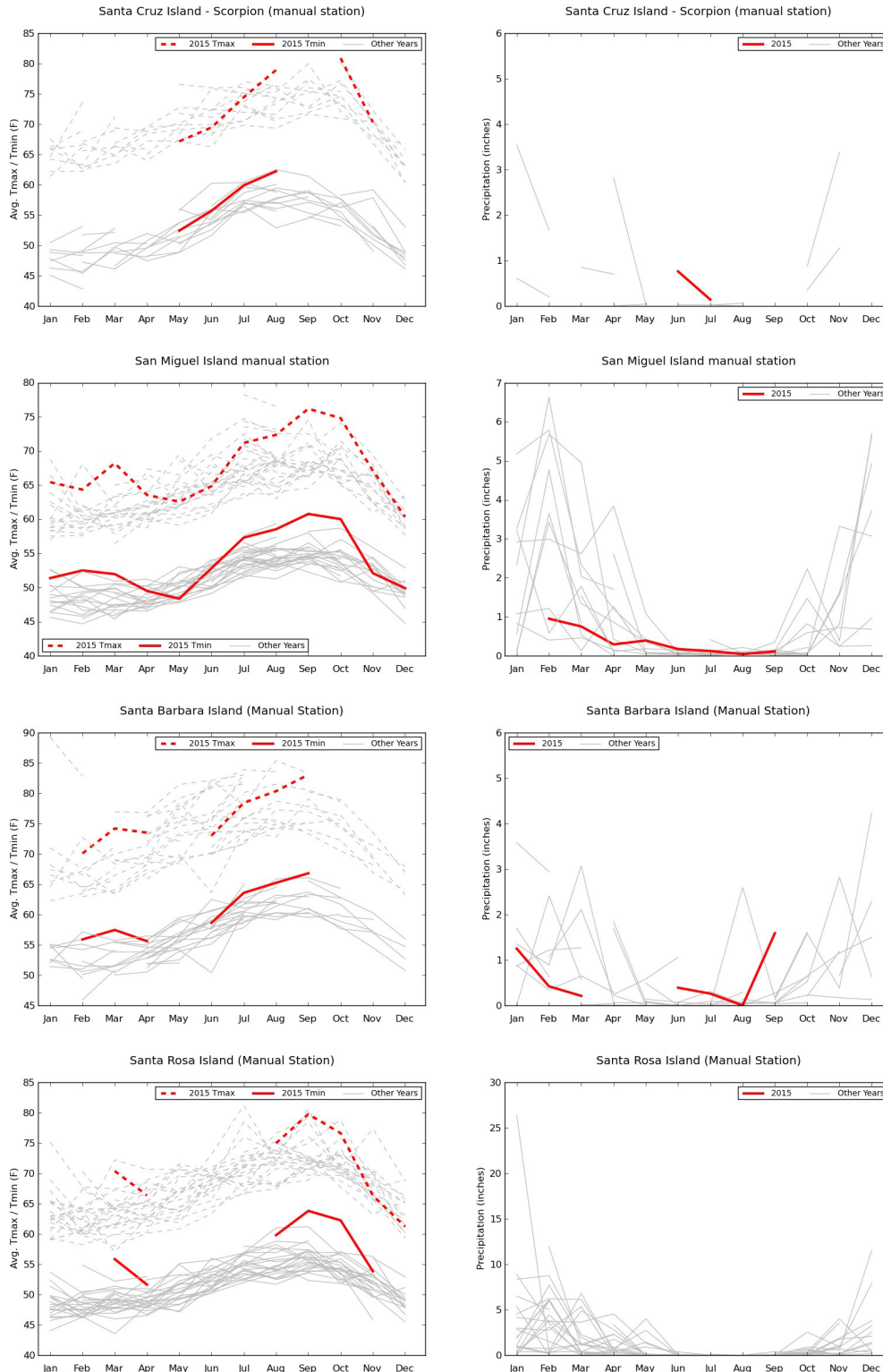


Figure 5b. Monthly precipitation and temperature data collected by manual “ranger” weather stations in Channel Islands National Park. Red = 2015 measurements. Gray = other years.

Table 1. Monthly total precipitation in inches during 2015 in Channel Islands National Park.

Month	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
January	1.09	0.61	1.16	0.97	0.6	N/A	1.25
February	0.31	0.47	0.15	1.28	N/A	N/A	0.42
March	0.27	0.32	0.13	0.64	N/A	N/A	0.21
April	0.02	0.19	0.01	0.05	0.12	N/A	N/A
May	0.18	0.32	0.37	N/A	N/A	N/A	N/A
June	0.4	0.44	0.18	N/A	N/A	0.76	0.39
July	0.14	0.18	0.17	N/A	N/A	0.14	0.26
August	0	0.18	0	N/A	N/A	N/A	0
September	0.51	0.07	1.17	0.06	N/A	N/A	1.59
October	0.37	0.33	0	0.39	N/A	N/A	N/A
November	0	0.58	0	0.11	N/A	0.18	N/A
December	0.05	0.76	0.04	0.67	N/A	N/A	N/A
YR	3.34	4.45	3.38	N/A	N/A	N/A	N/A

N/A = insufficient data for an accurate calculation

Table 2. Monthly average daily maximum temperatures (Tmax) and average daily minimum temperatures (Tmin) during 2015 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	
Month	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin
January	65.7	56.5	66	54.3	64.6	58.1	70.3	46.8	66.26	53.71	67.65	50.08	N/A	
February	65.9	56.9	63.7	53	64.8	58.1	70.5	48.5	N/A	N/A	N/A	N/A	70.07	N/A
March	69.2	57.6	69.6	53.6	67.3	59.2	76.6	50.4	70.38	55.85	74.96	N/A	74.19	55.89
April	66.6	55.4	63.3	49.3	63.4	57.7	74.6	48.1	66.37	51.63	N/A	N/A	73.5	57.45
May	64	55	59.2	48.2	60.9	56.5	N/A	N/A	N/A	N/A	67.15	52.42	N/A	55.61
June	67.6	58.6	64.9	51.8	65	59.1	N/A	N/A	67.84	52.84	69.44	55.7	73.03	N/A
July	72.5	62.8	69.6	57.1	70.1	63.6	N/A	N/A	N/A	N/A	74.43	59.9	78.42	58.63
August	75.1	65.6	70.9	58.5	70.9	65.3	N/A	N/A	74.97	59.8	78.93	62.22	80.35	63.58
September	77.5	68	77.7	63.2	73.5	67.1	87.1	60	79.76	63.8	N/A	N/A	83.07	65.23
October	75.9	66.9	75.7	61.1	73.5	67.5	84.1	59.3	76.62	62.24	80.88	N/A	N/A	66.8
November	67.3	58.6	65.6	53.5	66.4	60.5	72.3	48.6	66.32	53.84	70.31	59.69	N/A	N/A
December	62.3	55.5	58.2	48.6	61.3	57.4	65.8	45.6	61.21	N/A	N/A	N/A	N/A	N/A
YR	69.1	59.8	67.0	54.4	66.8	60.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A = insufficient data for an accurate calculation

Broader Picture – The Ongoing Drought Became More Severe

The region entered into drought conditions in April 2012 (Tercek 2013) and became progressively drier throughout 2013 and 2014. By the end of 2014, Channel Islands National Park was classified as “D4 - Exceptional Drought” by the U.S. Drought Monitor, which is the most severe classification on this scale, and it retained this status through the end of 2015 (Figure 6).

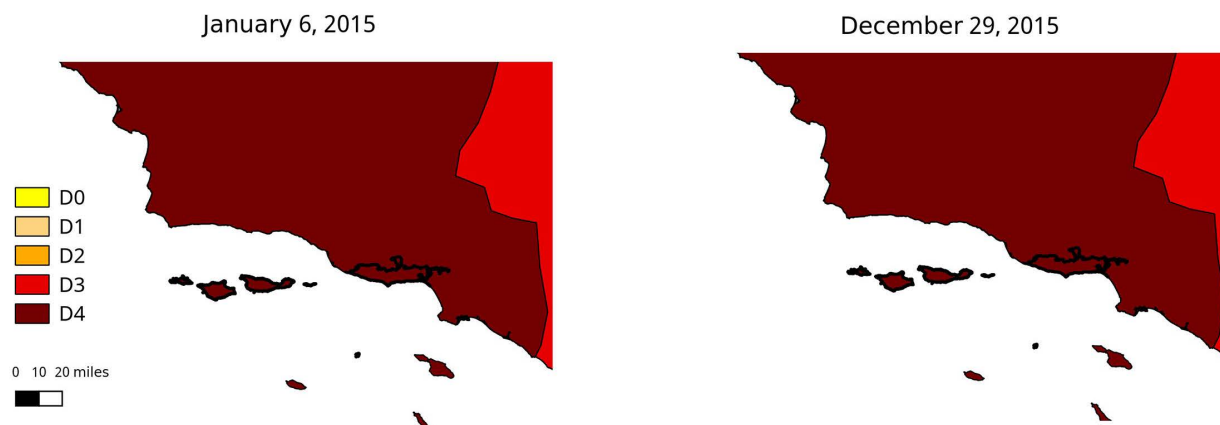


Figure 6. U.S. Drought Monitor maps for Channel Islands National Park during calendar year 2015. Drought classifications range from “abnormally dry” (D0) to “exceptional drought” (D4). White areas = Pacific Ocean. For more information visit: <http://droughtmonitor.unl.edu/>

El Niño – La Niña Status

The El Niño – 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 Niño phase,” sea surface temperatures in the central and eastern tropical Pacific are warmer than average, and 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 Niña 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 an El Niño phase in the first quarter of 2015, and sea surface temperatures remained above average for the rest of the year. Normally, La Niña conditions produce drier conditions in southern California while El Niño produces wetter conditions. The drought gripping southern California did not materially slacken during 2015, but there were very large precipitation events during May, July and September, described below. For long-term El Niño patterns, consult NOAA here: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml.

Precipitation During 2015

There were no weather stations with established 30-year averages within Channel Islands National Park, so we relied instead on PRISM maps (Figures 2 – 4) when comparing 2015 to the past. (See the Introduction for more information on how 30-year averages are calculated by NOAA). With the exception of June and July, every month during 2015 had below average precipitation during 2015 (Figure 2). Precipitation during June ranged from 0.18 inches on Anacapa Island to 0.76 inches on

Santa Cruz Island (Table 1). During July, precipitation totals ranged from 0.14 inches on Anacapa and Santa Cruz Islands to 0.26 inches on Santa Barbara Island. Normal summer precipitation totals are quite low on the islands, so the PRISM estimates for these months were > 400% average (Figure 2).

Temperature During 2015

According to PRISM, May and December had near to below average temperatures, while the rest of 2015 had temperatures that were significantly warmer than average. February, March, September, and October were notably warm, with temperatures > 6 degrees above the 1981 – 2010 average throughout most of the island (Figures 3 – 4).

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. This 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 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).

At the time of writing, the Channel Islands RAWS had not been in operation long enough to calculate a “normal” growing season length. The manual stations had insufficient data for growing season calculations during 2015. Summary calculations for 2015 appear in Table 3.

Table 3. Accumulated Growing Degree Days (AGDD) and days above or below critical temperature thresholds during 2015 at RAWS in Channel Islands National Park.

Station Name	Station ID	AGDD40	AGDD50	# days ≥ 80 F	# days ≥ 90 F	# days ≤ 32F
Anacapa Island	RAWS	8935	5285	16	1	0
Santa Rosa Island	RAWS	7500	3897	42	9	0
Santa Barbara Island	RAWS	8702	5052	11	0	0
Santa Cruz Island	RAWS	N/A	N/A	N/A	N/A	N/A

(-) = insufficient data for an accurate calculation

State of the California Current

The following highlights and figures are excerpts from the State of California Current Integrated Ecosystem Assessment (CCIEA) State of the California Current Report, 2016.

- Since 2013, the Northeast Pacific and Gulf of Alaska has been dominated by the record warm sea surface temperature anomaly (SSTa) that has been nicknamed “the Warm Blob.” This feature started in the Gulf of Alaska in 2013 and expanded in 2014 to cover much of the Northeast Pacific very close to the North American coast and in 2015 evolved into a strong PDO pattern, again with coastal warming. The evolution of the Pacific Decadal Oscillation (PDO) shows two years of increasing values, starting with a low in 2012 to a peak in late 2015. At the same time the Blob was evolving and strengthening, there appeared a similarly large, in magnitude, space and time, anomaly off Baja California. These two features “connected” in 2015 (Figure 7). The magnitude of the SSTa in both features is the highest observed for the entire satellite SST record, which starts in 1982.

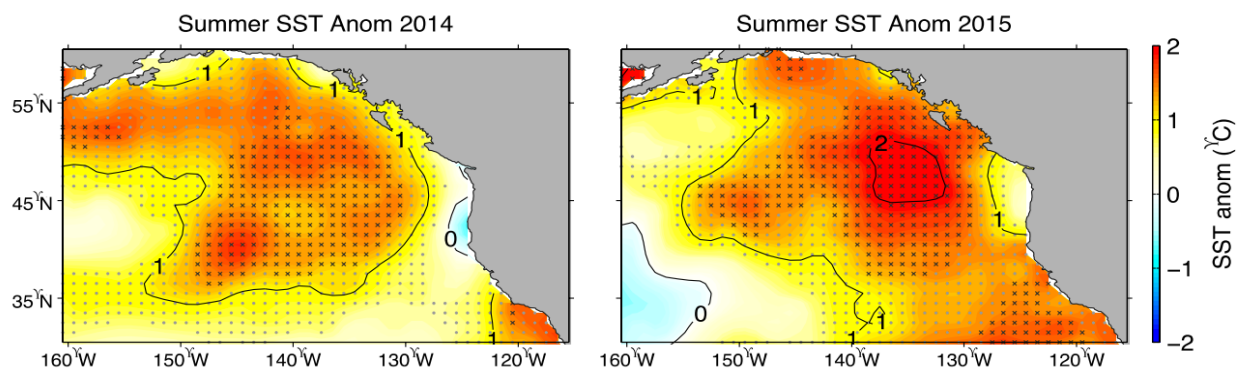


Figure 7. Sea surface temperature (SST) anomalies for the summer (Jun-Aug) of 2014 and 2015. The time series analyzed at each grid point started in 1982. The large warm anomaly in the upper center in 2014 is the “Warm Blob,” with the southern anomaly off Baja California in the lower left. Gray circles mark grid cells where the anomaly was >1.1 standard deviations above the long-term mean. Black x’s mark grid cells where the anomaly was the highest of the time series.

- The present El Niño is the third strongest on record, exceeded only by the 1982-3 and 1997-8 El Niño events. However, this event is different from those preceding events, in that warming started in the fall of 2014 and at that time it was predicted that 2014 would see a monster El Niño. Instead, all the ENSO indices, including the MEI, hovered right around the threshold level for declaring an El Niño and it wasn’t until fall 2015 that the El Niño really became established. So there was a year of El Niño-like conditions in the eastern equatorial Pacific before the present event began. Looking forward, large El Niño events are very often followed by strong La Niña conditions and higher CCE productivity.
- The Warm Blob and the Baja anomaly expressed anomalously warm offshore waters and the presence of these warm waters helped to compress the zone of cold upwelled waters along the coast. Usually during the upwelling season, the strong upwelling creates plumes of cold water extending offshore. During 2014 and 2015 it was observed that whenever the

upwelling winds relaxed or reversed, the offshore warm waters could translate quickly onto the shelf and up to the coast. The regional variation of upwelling led to some of the greatest species variability observed in the CCE. Where upwelling remained dominant, some of the highest yields of local species were found; where upwelling did not dominate, rare or exotic species were often encountered.

- Unusual mortality events for California sea lions and Guadalupe Fur Seals, as well as an unusually large, coast-wide common murre wreck, are further evidence of overall lower productivity in the California Current Ecosystem.

Conclusions

The region entered into drought conditions in April 2012 (Tercek 2013) and became progressively drier throughout 2013 and 2014. By the end of 2014, Channel Islands National Park was classified as “D4 - Exceptional Drought” by the U.S. Drought Monitor, which is the most severe classification on this scale, and it retained this status through the end of 2015 (Figure 6).

ENSO entered an El Niño phase in the first quarter of 2015, and sea surface temperatures remained above average for the rest of the year. Normally, La Niña conditions produce drier conditions in southern California while El Niño produces wetter conditions. The drought gripping southern California did not materially slacken during 2015.

With the exception of June and July, every month during 2015 had below average precipitation during 2015 (Figure 2). Precipitation during June ranged from 0.18 inches on Anacapa Island to 0.76 inches on Santa Cruz Island (Table 1). During July, precipitation totals ranged from 0.14 inches on Anacapa and Santa Cruz Islands to 0.26 inches on Santa Barbara Island. Normal summer precipitation totals are quite low on the islands, so the PRISM estimates for these months were > 400% average (Figure 2).

According to PRISM, May and December had near to below average temperatures, while the rest of 2015 had temperatures that were significantly warmer than average. February, March, September, and October were notably warm, with temperatures > 6 degrees above the 1981 – 2010 average throughout most of the island (Figures 3 – 4).

Literature Cited

- Allen, R., L. Pereira, D. Raes, and M. Smith. 1988. Crop evapotranspiration – guidelines for computing crop water requirements – FAO irrigation drainage paper 56. Available online: <http://www.fao.org/docrep/X0490E/X0490E00.htm> (accessed 26 September 2016).
- Daly, C., M. Halbleib, J. I. Smith, W. P. Gibson, M. K. Doggett, G. H. Taylor, J. Curtis, and P. P. Pasteris. 2008. Physiographically sensitive mapping of climatological temperature and precipitation across the conterminous United States. *International Journal of Climatology* 28(15):2031–2064.
- Kittel, T. 2008. The development and Analysis of climate datasets for National Park science and management: A guide to methods for making climate records useful and tools to explore critical questions. Report prepared for the National Park Service Inventory and Monitoring Program. University of Colorado, Institute of Arctic and Alpine Research, Boulder, Colorado.
- Kittel, T., S. Ostermann-Kelm, B. Frakes, M. Tercek, S. Gray, and C. Daly. 2009. A framework for climate analysis and reporting for Greater Yellowstone (GRYN) and Rocky Mountain (ROMN) networks: A report from the GRYN/ROMN climate data analysis workshop, Bozeman, Montana, 7–8 April 2009. Final draft. Prepared for the National Park Service, Greater Yellowstone Inventory and Monitoring Program, Bozeman, Montana.
- McEachern, K., P. Power, L. Dye, and R. Rudolph. 2008. Weather and climate monitoring protocol, Channel Islands National Park, California. U.S. Geological Survey Techniques and Methods 2–B1. U.S. Geological Survey, Reston, Virginia. Available at <http://pubs.usgs.gov/tm/tm2b1/> (accessed 27 September 2016).
- Redmond, K., and G. McCurdy. 2005. Channel Islands National Park: Design considerations for weather and climate monitoring. WRCC Report 05-02 July 2005, Western Regional Climate Center Desert Research Institute, Reno, Nevada.
- Rocky Mountain Climate Working Group. 2010. Rocky Mountain climate protocol: Climate monitoring in the Greater Yellowstone and Rocky Mountain inventory and monitoring networks, Version 1.0. Natural Resource Report NPS/IMRO/NRR—2010/222. National Park Service, Fort Collins, Colorado.
- State of California Current Integrated Ecosystem Assessment (CCIEA) State of the California Current Report, 2016. <http://www.pcouncil.org/ecosystem-based-management/annual-state-of-the-california-current-ecosystem/> (accessed 16 August 2016).
- Tercek, M. T. 2011. Channel Islands National Park – Climate of 2010. Report submitted to the National Park Service Mediterranean Coast Inventory and Monitoring Program.

Tercek, M. T. 2012. Channel Islands National Park – Climate of 2011. Report submitted to the National Park Service Mediterranean Coast Inventory and Monitoring Program.

Tercek, M. T. 2013. Santa Monica Mountains National Recreation Area – Climate of 2012. Report submitted to the National Park Service Mediterranean Coast Inventory and Monitoring Program.

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.

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.

The following are maintenance records for the RAWS stations maintained by CHIS staff.

Anacapa

01/15/2015 14:19 Rocky Rudolph:

On 1/14/2015 R. Rudolph visited Anacapa station to replace faulty Solar Rad sensor. After swap, readings appeared normal. Sensor was placed on an SDI splitter with PB sensor. No issues detected.

Santa Barbara

07/14/2015 09:39 Rocky Rudolph:

On July 10, 2015 Rocky Rudolph performed annual maintenance on the SBI station. The solar rad sensor was down and needed replacing. The RH/AT sensor was the only sensor on scheduled replacement. I did not replace the second test RH/AT sensor connected to the FM/FT port. Corrosion on the support cables of the mast was noticeable even after less than a year. Overall the station looked good.

Santa Cruz

08/17/2015 18:17 Rocky Rudolph:

R. Rudolph visited site 8/13/2015 to replace faulty Goes antenna and do an annual service. Station was skipping transmits and Goes was suspected culprit. New Goes seemed to have solved the problem. RM Young, RH/AT, and FM/FT was also swapped on annual maintenance. Increased the transmit power to 38 instead of 32. Also noticed one of the guy wires on the mast was totally broken and loose. I truckers hitched it then put tension on all the wires with another truckers hitch of paracord as a surprisingly decent temporary fix. Needs new guy wires ASAP.

Santa Rosa

09/25/2015 11:41 Rocky Rudolph:

D. Adams replaced RH/AT sensor by drilling out the seized lock nut.

08/31/2015 15:49 Rocky Rudolph:

On 8/24/2015 R. Rudolph with maintenance staff D. Adams visited station to swap RH/AT, FM/FT, Omni antenna, and RM Young. Also increased transmit power to 38. RH/AT lock bolt broke due to no lithium grease applied to it when installed. RH/AT will be installed week of 8/31/2015 week by Adams. Waiting for his installation to send back parts.

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 159/134564, September 2016

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

2016

NationalParkService.
CENTENNIAL

EXPERIENCE YOUR AMERICA™