



Climate Monitoring in the Mediterranean Coast Network 2019

Channel Islands National Park

Natural Resource Report NPS/MEDN/NRR—2022/2359



ON THE COVER

Coastline at Channel Islands NP.

NPS / STACEY OSTERMANN-KELM

Climate Monitoring in the Mediterranean Coast Network 2019

Channel Islands National Park

Natural Resource Report NPS/MEDN/NRR—2022/2359

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Executive Summary

This report details the climate (temperature, precipitation, and drought) of Channel Islands National Park (NP) during 2019. 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 author in accordance with a National Park Service protocol (Rocky Mountain Climate Working Group 2010). Key points summarizing calendar year 2019 are presented as bullets in the Conclusion section at the end of the report. 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

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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.

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

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

US Drought Monitor — A broad brush assessment of drought conditions. See <https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?CA>

Introduction

Channel Islands National Park is comprised of five 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 Channel Islands NP that were complete enough to support monthly and annual summaries for calendar year 2019 at the time of writing. 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.

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 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 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 Channel Island 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/>)

Drought Monitor (<https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?CA>)

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, 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 Channel Islands National Park. 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 (<https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?CA>) were used to depict broad-brush conditions across the region.

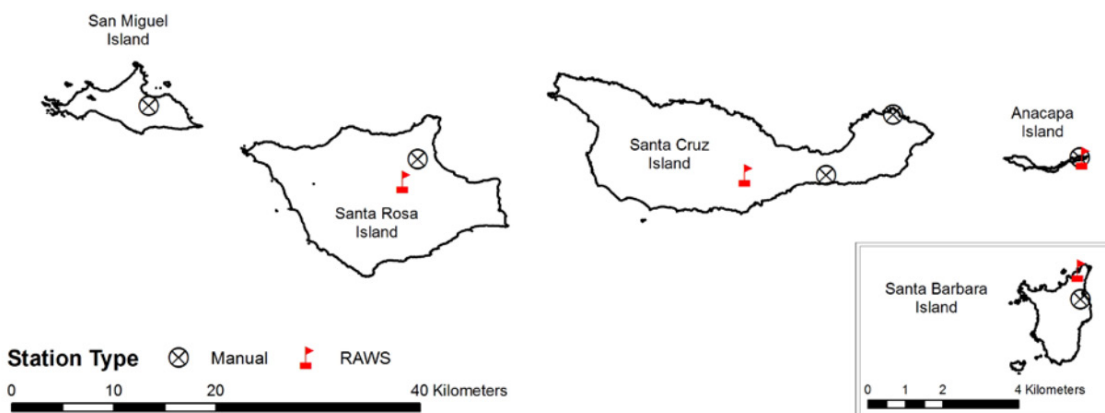


Figure 1. Map showing key climate stations used in this report. There are additional weather stations in Channel Islands NP, but data from those stations was not complete enough for 2019 to merit inclusion.

Quality Control of Ranger-Managed (Manual) Weather Stations

All of the “Ranger stations” used in this report are operated and maintained by Channel Islands NP. These stations are sometimes referred to as “Cooperative Observer” stations because in most cases their measurements are recorded by humans and 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 author of this report 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 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. 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, 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. 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; 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. Readers can download the data used in this report and make custom climate graphs and tables of their own by visiting www.ClimateAnalyzer.org

Results

Temperature, Precipitation, and Drought Status During Calendar Year 2019

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 and compare them to the weather station data presented below.

Broader Picture – The End of Drought

During the course of 2019, a multiyear drought was finally broken. Channel Islands NP started the year with D1 “Moderate Drought” status and finally became drought free during December (Figure 2)

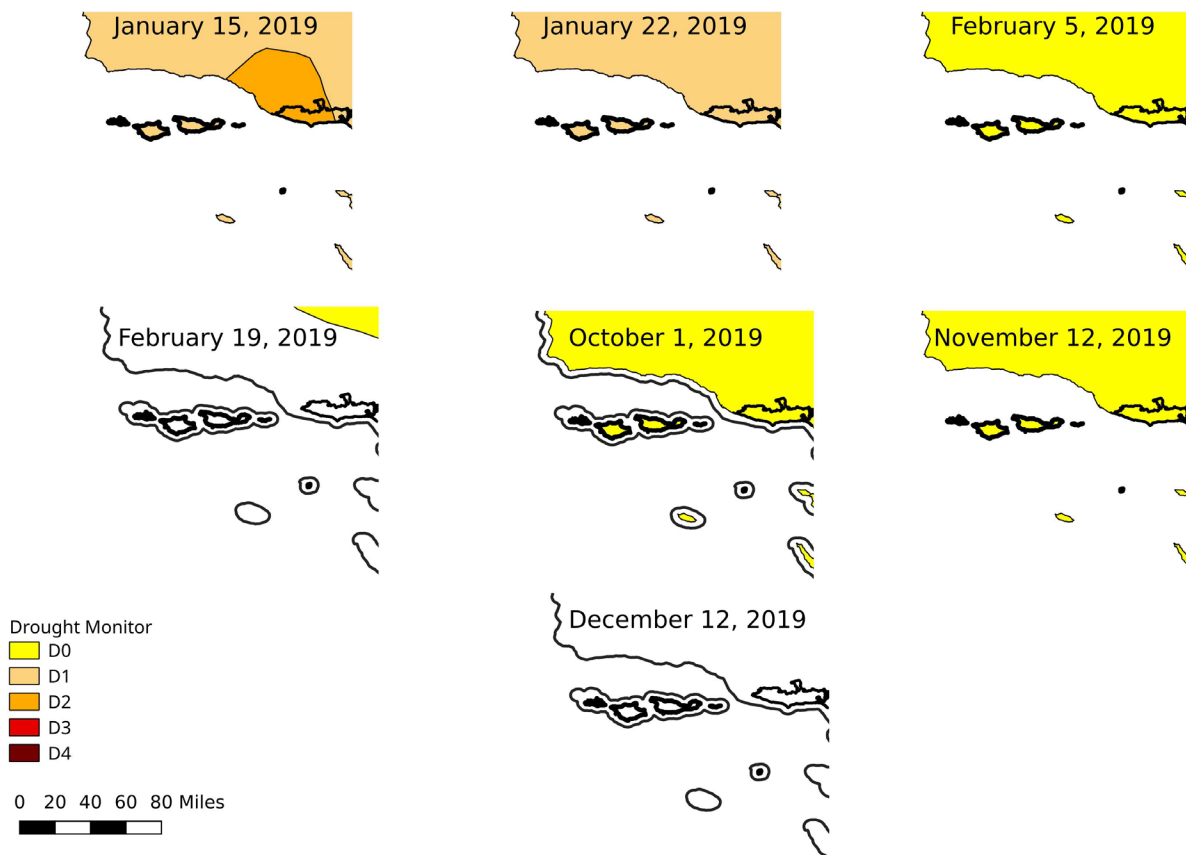


Figure 2. U.S. Drought Monitor maps for Channel Island National Park during calendar year 2019. Drought classifications range from “abnormally dry” (D0) to “exceptional drought” (D4). White areas = Pacific Ocean. For more information visit:

<https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?CA>

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, 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 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>

Calendar year 2019 began with El Nino conditions and transitioned during the course of the year to nearly neutral and then back to El Nino in November and December. For long-term El Nino patterns, consult NOAA here:

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

Precipitation During 2019

There are no weather stations with established 30-year averages within Channel Islands National Park, so we rely instead on PRISM maps (Figures 3–5) when comparing 2019 to the past.

Total annual precipitation was above average. Of the non-summer months, January, February, November, and December had particularly high precipitation (Figure 3). Precipitation during the summer months (May–December) is so slight that calculations of percent average are misleading. An increase of only a few hundredths of an inch can mean the difference between an above vs. below average month.

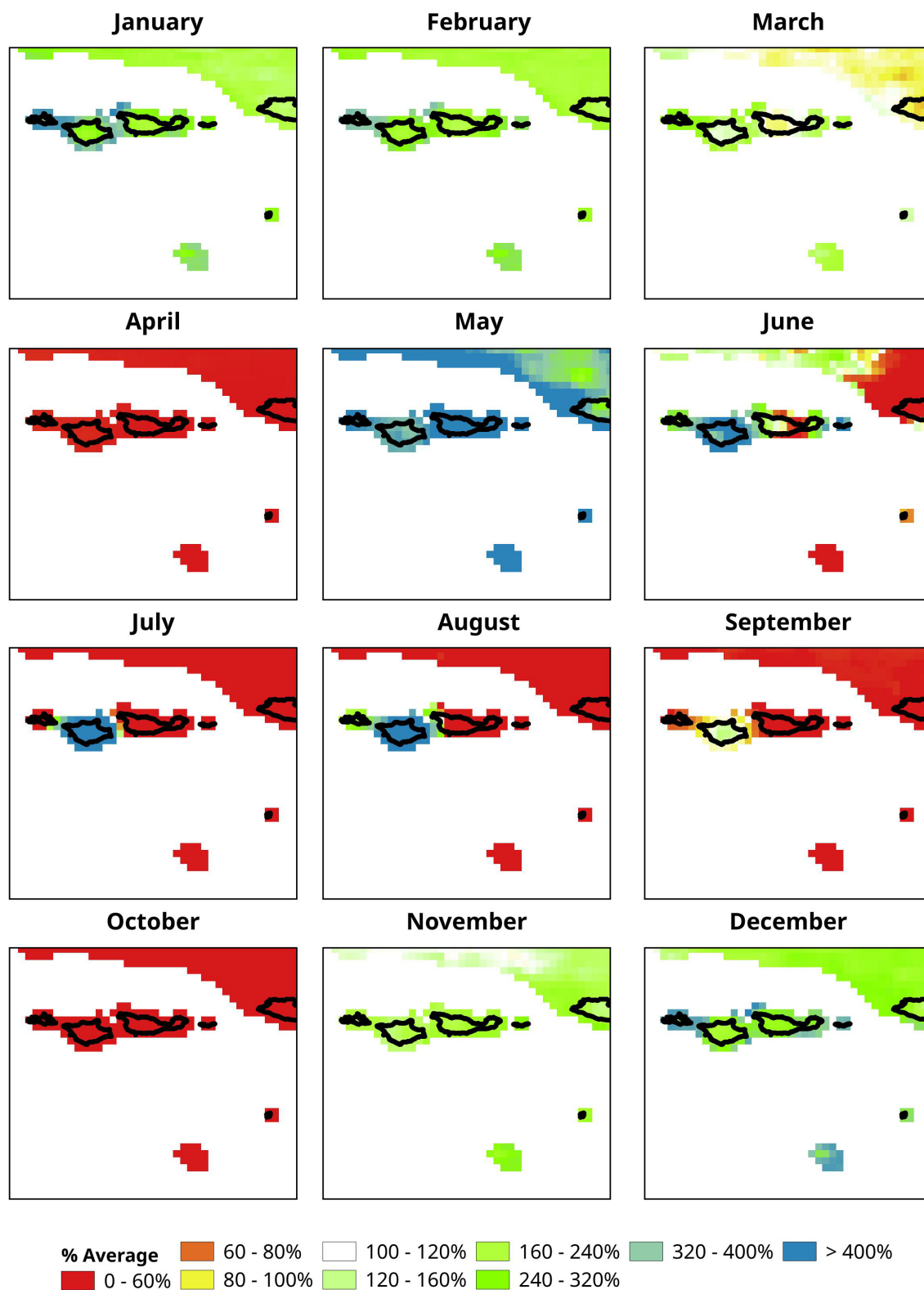


Figure 3. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2019 monthly precipitation as a percentage of 1981–2010 averages. White areas = Pacific Ocean. For more information, see <http://www.prism.oregonstate.edu/>.

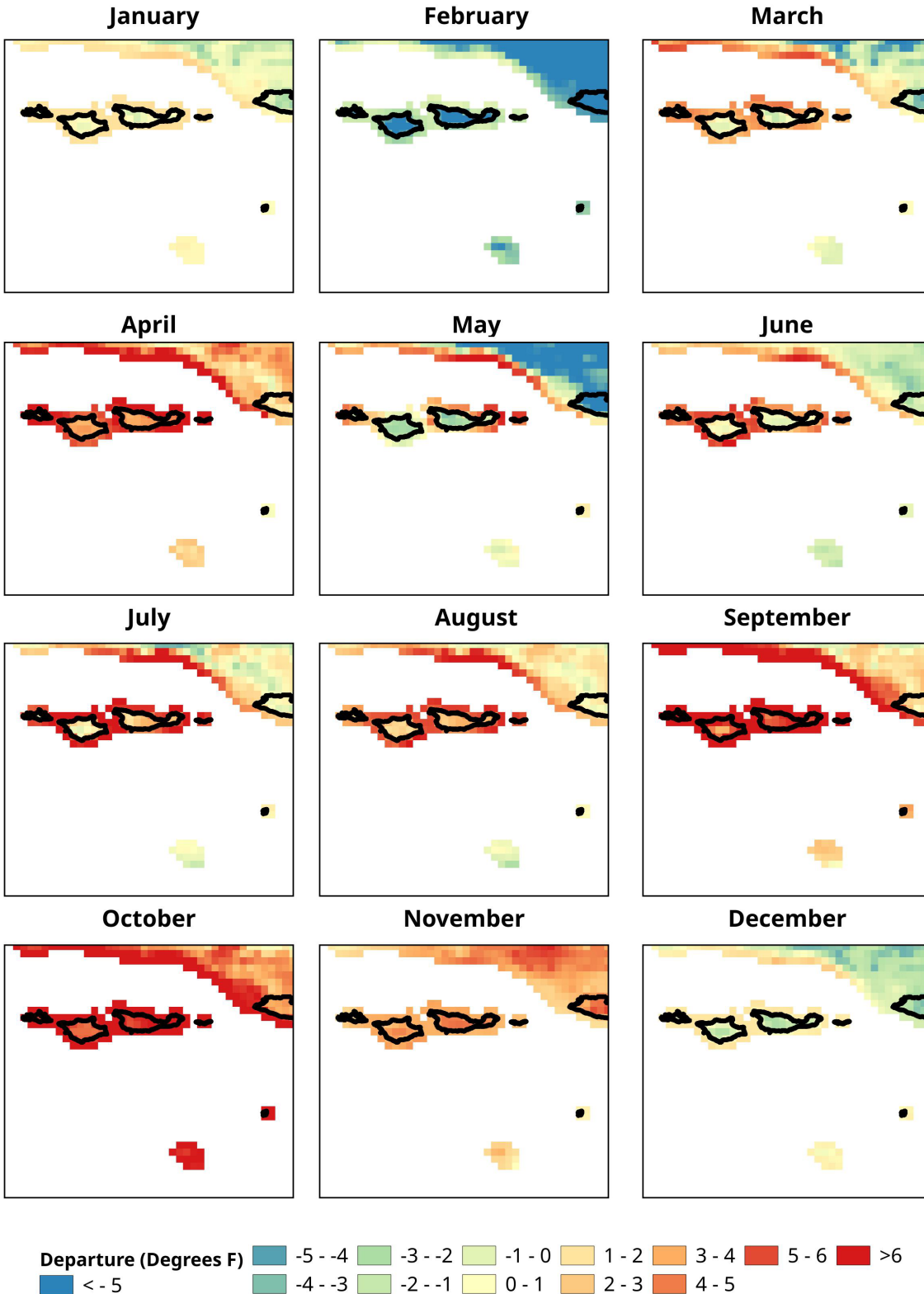


Figure 4. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2019 monthly average daily maximum temperature (Tmax) departure from 1981–2010 averages in degrees Fahrenheit. White areas = Pacific Ocean. For more information, see <http://www.prism.oregonstate.edu/>.

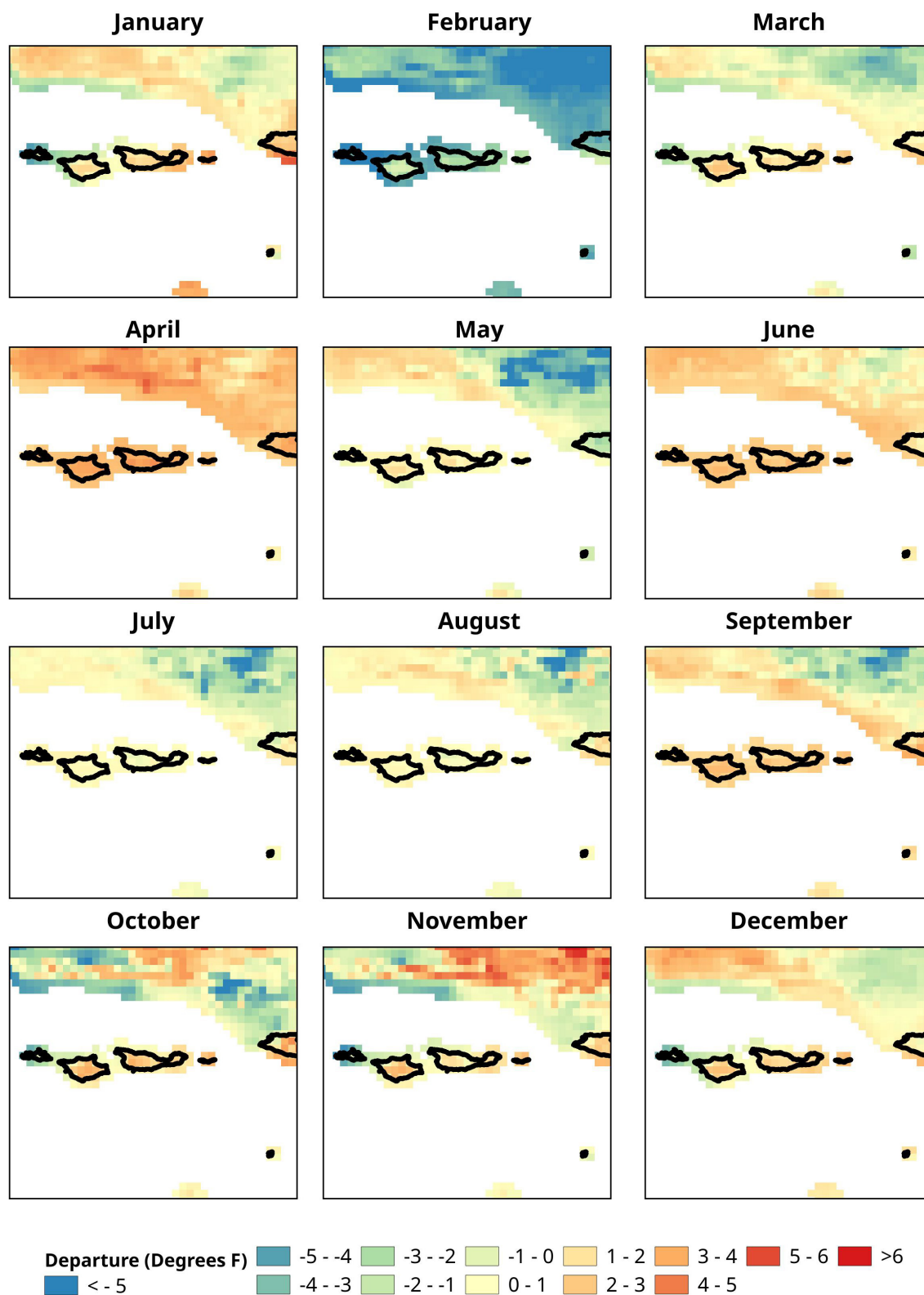


Figure 5. Parameter-elevation Regressions on Independent Slopes Model (PRISM) data showing 2019 monthly average daily minimum temperature (Tmin) departure from 1981–2010 averages in degrees Fahrenheit. White areas = Pacific Ocean. For more information, see <http://www.prism.oregonstate.edu/>.

Temperature During 2019

Annual temperatures (averaged across the entire year) were near average (Figures 6a–6b). According to PRISM, September–November had above average daytime highs, while the other months were near or below average. February, July, and August had below or near- average night-time lows, while the other months generally above average. (Figures 4–5).

Table 1. Monthly total precipitation in inches during 2019 in Channel Islands National Park. N/A = insufficient data for an accurate calculation.

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	4.65	6.7	3.81	6.22	6.7	N/A	3.81
February	2.97	5.43	3.01	5.85	5.43	N/A	3.01
March	1.89	2.98	0.47	2.55	2.98	N/A	0.47
April	0.05	0.2	0.01	0.03	0.2	N/A	0.01
May	0.33	0.96	N/A	2.31	0.96	N/A	N/A
June	0.07	0.26	N/A	0.04	0.26	N/A	N/A
July	0.02	0.25	N/A	0	0.25	0	N/A
August	0.03	0.33	N/A	0.01	0.33	N/A	N/A
September	0	0.14	N/A	0	0.14	N/A	N/A
October	0.01	0.03	N/A	0	0.03	N/A	N/A
November	1.03	1.27	N/A	1.43	1.27	N/A	N/A
December	4.01	2.89	N/A	3.57	2.89	N/A	N/A
YR	15.06	21.44	N/A	22.01	21.44	N/A	N/A

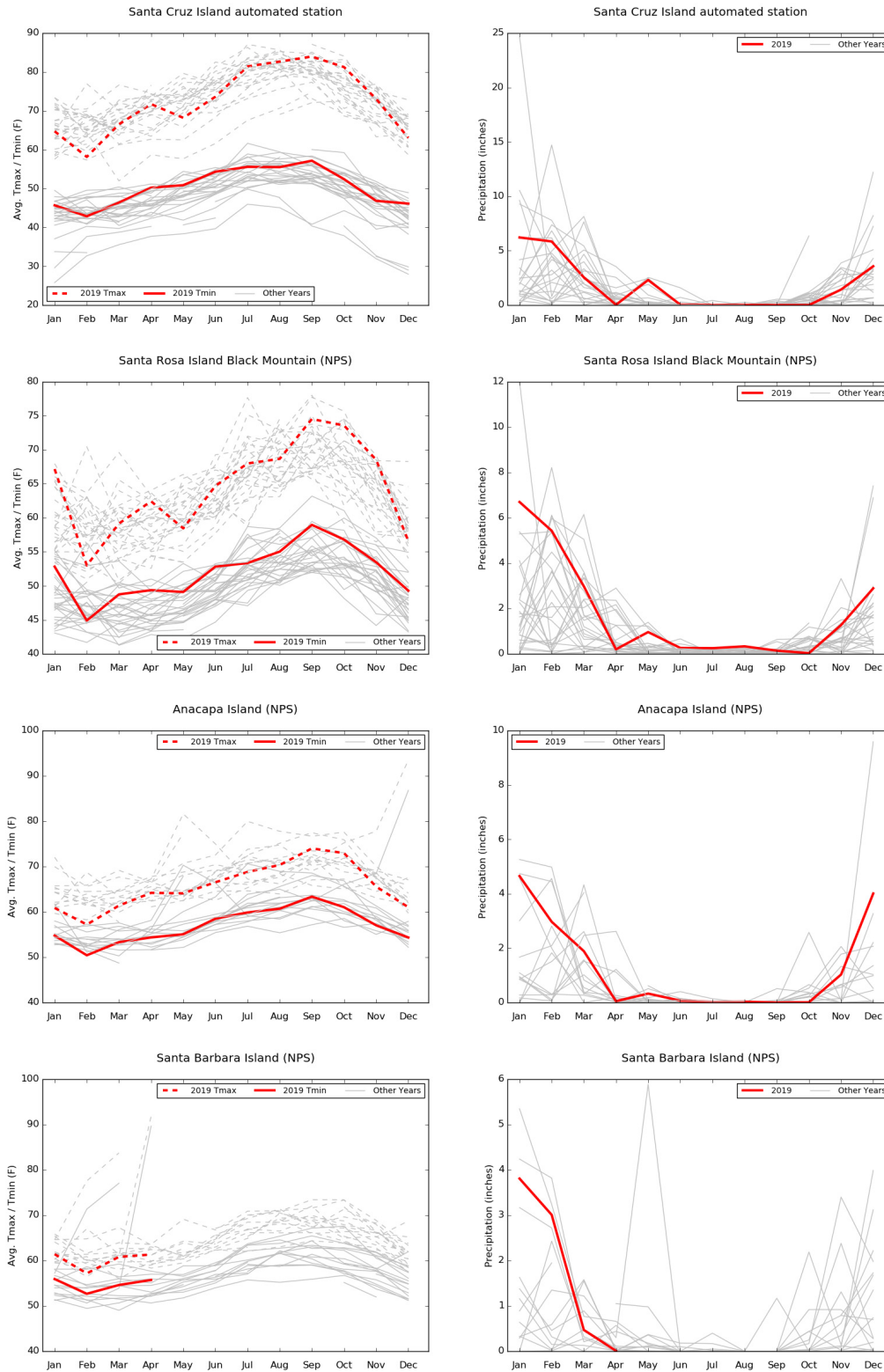


Figure 6a. Monthly precipitation (right) and temperature (left) data collected by RAWS in Channel Islands National Park. Red = 2019 measurements. Gray = other years.

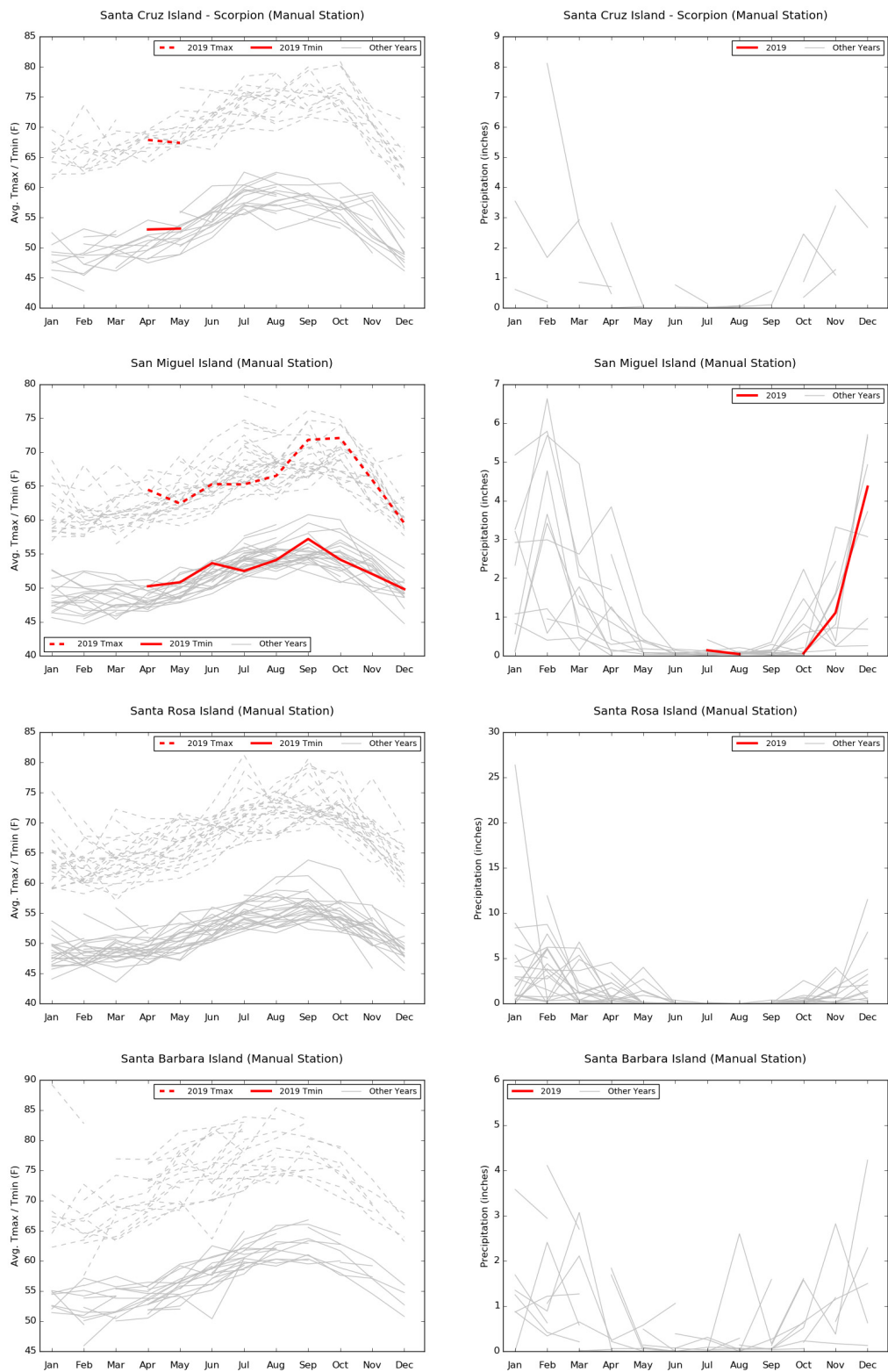


Figure 6b. Monthly precipitation and temperature data collected by manual “ranger” weather stations in Channel Islands National Park. Red = 2019 measurements. Gray = other years.

Table 2. Monthly average daily maximum temperatures (Tmax) during 2019 in degrees Fahrenheit. N/A = insufficient data for an accurate calculation.

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	60.9	67.2	61.4	64.7	67.2	N/A	61.4
February	57.2	53.0	57.2	58.1	53.0	59.9	57.2
March	61.4	59.2	60.8	66.5	59.2	N/A	60.8
April	64.2	62.4	61.3	71.7	62.4	67.8	61.3
May	64.1	58.5	N/A	68.2	58.5	67.4	N/A
June	66.5	64.7	N/A	73.6	64.7	N/A	N/A
July	68.8	68.0	N/A	81.4	68.0	71.9	N/A
August	70.5	68.7	N/A	82.7	68.7	N/A	N/A
September	74.0	74.5	N/A	84.0	74.5	N/A	N/A
October	73.0	73.6	N/A	81.3	73.6	N/A	N/A
November	65.6	68.5	N/A	73.1	68.5	N/A	N/A
December	61.0	56.6	N/A	63.1	56.6	N/A	N/A
YR	65.6	64.6	N/A	72.5	64.6	N/A	N/A

Table 3. Monthly average daily minimum temperatures (Tmin) during 2019 in degrees Fahrenheit. N/A = insufficient data for an accurate calculation.

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	54.8	52.8	55.9	45.7	52.8	N/A	55.9
February	50.48	44.9	52.7	42.9	44.9	48.6	52.7
March	53.38	48.7	54.6	46.4	48.7	N/A	54.6
April	54.4	49.4	55.7	50.2	49.4	53.0	55.7
May	55.1	49.1	N/A	50.9	49.1	53.1	N/A
June	58.5	52.8	N/A	54.3	52.8	N/A	N/A
July	59.9	53.4	N/A	55.6	53.4	56.1	N/A
August	60.7	55.0	N/A	55.5	55.0	N/A	N/A
September	63.4	59.0	N/A	57.2	59.0	N/A	N/A
October	61.0	56.8	N/A	52.4	56.8	N/A	N/A
November	57.0	53.5	N/A	46.8	53.5	N/A	N/A
December	54.4	49.3	N/A	46.1	49.3	N/A	N/A
YR	56.9	52.1	N/A	50.4	52.1	N/A	N/A

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).

The Channel Islands RAWS have not been in operation long enough to calculate a “normal” growing season length. The manual stations had insufficient data for growing season calculations during 2019. Summary calculations for 2019 appear in Table 4.

Table 4. Accumulated Growing Degree Days (AGDD) and days above or below critical temperature thresholds during 2019 at RAWS in Channel Islands National Park.

Station Name	Station ID	AGDD40	AGDD50	# days ≥ 80 °F	# days ≥ 90 °F	# days ≤ 32 °F
Anacapa Island	RAWS	7770	4120	6	1	0
Santa Rosa Island	RAWS	6663	3116	40	9	0
Santa Barbara Island	RAWS	7995	4345	1	0	0
Santa Cruz Island	RAWS	7816	4211	99	22	0

Conclusions

During the course of 2019, a multiyear drought was finally broken. Channel Islands NP started the year with D1 “Moderate Drought” status and finally became drought free during December.

Calendar year 2019 began with El Nino conditions and transitioned during the course of the year to nearly neutral and then back to El Nino in November and December.

Annual temperatures (averaged across the entire year) were near average (Figures 6a–6b). According to PRISM, September–November had above average daytime highs, while the other months were near or below average. February, July, and August had below or near- average night-time lows, while the other months generally above average. (Figures 4–5).

Total annual precipitation was above average. Of the non-summer months, January, February, November, and December had particularly high precipitation. Precipitation during the summer months (May–December) is so slight that calculations of percent average are misleading. An increase of only a few hundredths of an inch can mean the difference between an above vs. below average month.

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Appendix 1

Table A-1. 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

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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