



Cabrillo National Monument – Climate of 2011

Natural Resource Data Series NPS/MEDN/NRDS—2012/373



ON THE COVER

Close up of a brown pelican (*Pelcanus occidentalis*)
Photograph by: Cabrillo National Monument

Cabrillo National Monument – Climate of 2011

Natural Resource Data Series NPS/MEDN/NRDS—2012/373

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Contents

	Page
Figures.....	iv
Tables.....	vi
Executive Summary.....	vii
Acknowledgments.....	viii
Glossary	viii
Introduction.....	1
Approach and Methods	3
Selection of Datasets.....	3
Quality Control of Global Historical Climatology Network Data.....	4
Results.....	6
Comparison of 1971 – 2000 vs. 1981 – 2010 averages.	6
Temperature, Precipitation, and Drought Status During Calendar Year 2011	6
Broader Picture – La Nina conditions.....	7
Annual Summary of Precipitation and Temperature	7
January – May: Highlights.....	7
June – August: Highlights.....	8
September – December: Highlights	13
Accumulated Growing Degree Days, an Index of Growing Season Length	16
Streamflow	16
Fire Risk Conditions	16
Conclusions.....	23
Literature Cited	24
Appendix 1.....	25

Figures

	Page
Figure 1. Map showing key climate stations and stream gauges in and near Cabrillo National Monument.	4
Figure 2. Differences between climatic “normals” (30-year averages) calculated for 1971 – 2000 vs. 1981 – 2010 at two weather stations near Cabrillo National Monument. These normals are issued by the National Weather Service and are not calculated as simple arithmetic averages. Instead, the number of missing values and other factors are taken into account. Note that annual precipitation totals are plotted on the right axis. See methods section for more information.	6
Figure 3. U.S. Drought Monitor maps for Cabrillo National Monument during calendar years 2010 - 2011. Drought classifications range from “abnormally dry” (D0) to “exceptional drought” (D4). White areas on the map indicate lack of drought status. For more information visit: www.drought.unl.edu/dm/monitor.html	9
Figure 4. Maps showing percent of average precipitation relative to 1971–2000 for each month during 2011. Estimates are from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). Gray areas = Pacific Ocean. For more information, see http://www.prism.oregonstate.edu/	10
Figure 5. Maps showing departures from 1971 – 2000 average daily maximum temperatures (Tmax) in degrees Fahrenheit during 2011. Estimates are from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). Gray areas = Pacific Ocean. Cabrillo NM is on the coast, bottom left. For more information, see http://www.prism.oregonstate.edu/	11
Figure 6. Maps showing departures from 1971 – 2000 average daily minimum temperatures (Tmin) in degrees Fahrenheit. Estimates are from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). Gray areas = Pacific Ocean. Cabrillo NM is on the coast, bottom left. For more information, see http://www.prism.oregonstate.edu/	12
Figure 7. Total monthly precipitation, average daily maximum temperature (Tmax), and average daily minimum temperature (Tmin) during 2011 at key weather stations near Cabrillo National Monument. N/A = Insufficient data for an accurate calculation.....	19
Figure 8. Departure of 2011 precipitation, average daily maximum temperature (Tmax), and average daily minimum temperature (Tmin) from 30-year averages at key weather stations near Cabrillo National Monument. Left column = departure from 1971 – 2000 averages. Right column = departure from 1981 – 2010 averages. Asterisks indicate months that had less than 0.2 inches average precipitation. For these months, 0% average precipitation may represent a small difference in absolute precipitation departure. N/A = insufficient data for an accurate calculation.	19

Figures (continued)

Page

Figure 9. Boxplots of average maximum (Tmax) and average minimum (Tmin) temperatures at key climate stations near Cabrillo National Monument. Horizontal lines indicate the median value. Boxes indicate the 25th and 75th percentiles. Whiskers extend 1.5 times the interquartile Range (IQR). Crosses indicate values exceeding 1.5 times the IQR. 20

Figure 10. Streamflow measured on the Dan Diego River near Cabrillo National Monument. Top panel: 2011 water year (October 2010 through September 2011). Bottom Panel: 1982 – 2011. Data courtesy of the U.S. Geological Survey. 21

Figure 11. The Keetch-Byram Drought Index (KBDI) calculated for every day during the period of record for the weather station at San Diego Lindbergh Field. 22

Tables

	Page
Table 1. Total Monthly Precipitation in inches during 2011 and percentage of 1971 - 2000 and 1981 - 2010 Averages	14
Table 2. Average daily maximum temperatures (Tmax), Average daily minimum temperatures (Tmin) during 2011, and departure from 1971 – 2000 and 1981 - 2010 averages expressed as +/- Degrees F. (-) = insufficient data for and accurate calculation.	15
Table 3. Accumulated Growing Degree Days (AGDD) and days above or below critical temperature thresholds during 2011.	17

Executive Summary

This report details the climate (temperature, precipitation, drought, streamflow, and wind conditions) of Cabrillo National Monument during 2011. Gridded GIS maps are used to present broad-brush conditions across the region for each month. This regional presentation is compared to detailed data from weather stations in the Global Historical Climatology Network (GHCN), and data from USGS stream gages. Prior to analysis, a set of data quality control checks were performed by the author in accordance with an established National Park Service protocol (Rocky Mountain Climate Working Group 2010). Key points summarizing calendar year 2011 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 (Figs. 4-6) are key to understanding the climatic patterns for 2011. The Results section contains a narrative that provides details for each season of the year. 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

GHCN – Global Historical Climatology Network.

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

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

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

Tmax / Tmin – mean daily Maximum / Minimum Temperatures

NOAA - National Oceanic and Atmospheric Administration

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. Because 2011 was the first year in which 1981 – 2010 averages were in widespread use, both reference periods were used in this report.

Introduction

This report details the climate (temperature, precipitation, drought, streamflow) of Cabrillo National Monument during 2011. Climatic events 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. The climatic conditions of 2011 are also compared to a historical context, based primarily on a 30-year average or “normal” period.

Typically, when a weather report states that a particular month was “warmer than average” or “cooler than normal,” the comparison is to a set of averages calculated over an agreed upon time period. These averages, which are known as “climatological normals,” are updated every 10 years by the National Oceanic and Atmospheric Administration (NOAA). From 1991 – 2000, meteorological measurements were compared to 1961 – 1990 averages; from 2001 – 2010 the reference period was 1971 – 2000; and starting in calendar year 2011, most weather data will be compared to 1981 – 2010 averages. NOAA further defines climatological normals as follows:

“In the strictest sense, a “normal” of a particular variable (e.g., temperature) is defined as the 30-year average. For example, the minimum temperature normal in January for a station in Chicago, Illinois, would be computed by taking the average of the 30 January values of monthly-averaged minimum temperatures from 1981 to 2010. Each of the 30 monthly values was in turn derived from averaging the daily observations of minimum temperature for the station. In practice, however, much more goes into NCDC’s Normals product than simple 30-year averages. Procedures are put in place to deal with missing and suspect data values. In addition, Normals include quantities other than averages such as degree days, probabilities, standard deviations, etc. Normals are a large suite of data products that provide users with many tools to understand typical climate conditions for thousands of locations across the United States.” (Source: <http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html#WHATARENORMALS>)

Since 2011 was the first year in which 1981 – 2010 averages were commonly used, most of the climate parameters in this report are compared to both 1971 – 2000 and 1981 – 2010 averages. If this approach had not been taken, it would have been difficult to compare this report to its predecessor (Tercek 2011), which summarized the climate of Cabrillo National Monument during 2010. This is because a precipitation measurement that would have been considered below average (for example, during March) when compared to the 1971 – 2000 averages, might instead be near normal when compared to the 1981 – 2010 averages. The differences between these two time periods are described in more detail in the results section.

The content in this report is divided into two sections that discuss: (1) precipitation, temperature and drought, and (2) streamflow. The section on temperature, precipitation and drought is further sub-divided into seasonal narratives that highlight key data and events. Those interested in additional climate-related information for Cabrillo National Monument and the surrounding areas should seek:

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

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

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

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

Approach and Methods

Selection of Datasets

In order to place Cabrillo National Monument 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). At the time of writing, 1981 – 2010 averages (normals) were not available for PRISM data, so 1971 – 2000 PRISM normals were used.

Records from individual precipitation and temperature observing stations were included as a way to highlight intra-regional variability. The process of selecting specific stations included in this report is described in the Rocky Mountain Climate Protocol (Rocky Mountain Climate Working Group 2010). Generally, the selection criteria were:

1. Stations provide good spatial coverage within and near the parks of interest. In the case of Cabrillo National Monument, National Weather Service (NWS) stations were chosen from nearby locations. Data from these stations are available through the Global Historical Climatology Network (GHCN). GHCN stations have several advantages, including their relatively long period of record (Appendix 1), and the availability of established 30-year averages that can be used to quantify the difference between the current year and “normal” conditions.
2. Stations provide a sufficient length of record to provide historical context for current observations. For this report, GHCN stations were not considered if they had not been in operation during the period 1971 – 2000 at a minimum.
3. Instrumentation at individual stations is relatively consistent over the life of the record.
4. Instrumentation and siting standards used in selected networks are suitable for providing consistent, continuous, and long-duration records of climate and streamflow.

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. To present more fine-scale drought conditions, the Keetch-Byram Drought Index (KBDI) was calculated for every day during the period of record at select weather stations in the region. Methods for these calculations were based on Alexander (1990), who identified typographical errors in the original Keetch-Byram (1968) description of the index. The KBDI can be interpreted as the amount of precipitation (expressed in hundredths of inches) that would be needed to restore the soil to full water carrying capacity. A KBDI index of zero indicates soil saturation, and a KBDI of 800 indicates maximum possible drought, in which, theoretically, 8 or more inches of rain would be needed to replenish the soil (Keetch and Byram 1968). The KBDI is used in fire modeling and has been shown to be a good predictor of

conditions that favor fires that burn deeply into the organic soil layers, thus making them more resistant to control efforts (Dolling et al. 2005).

Even though the watercourses in the region are human-controlled and not directly tied to rainfall, USGS stream gage data (<http://waterdata.usgs.gov/nwis>) were used to contrast streamflow during the 2011 water year, which ran from October 2010 to September 2011, with average conditions during the period of record for the gage of interest (in this case 1982 – 2010).

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.

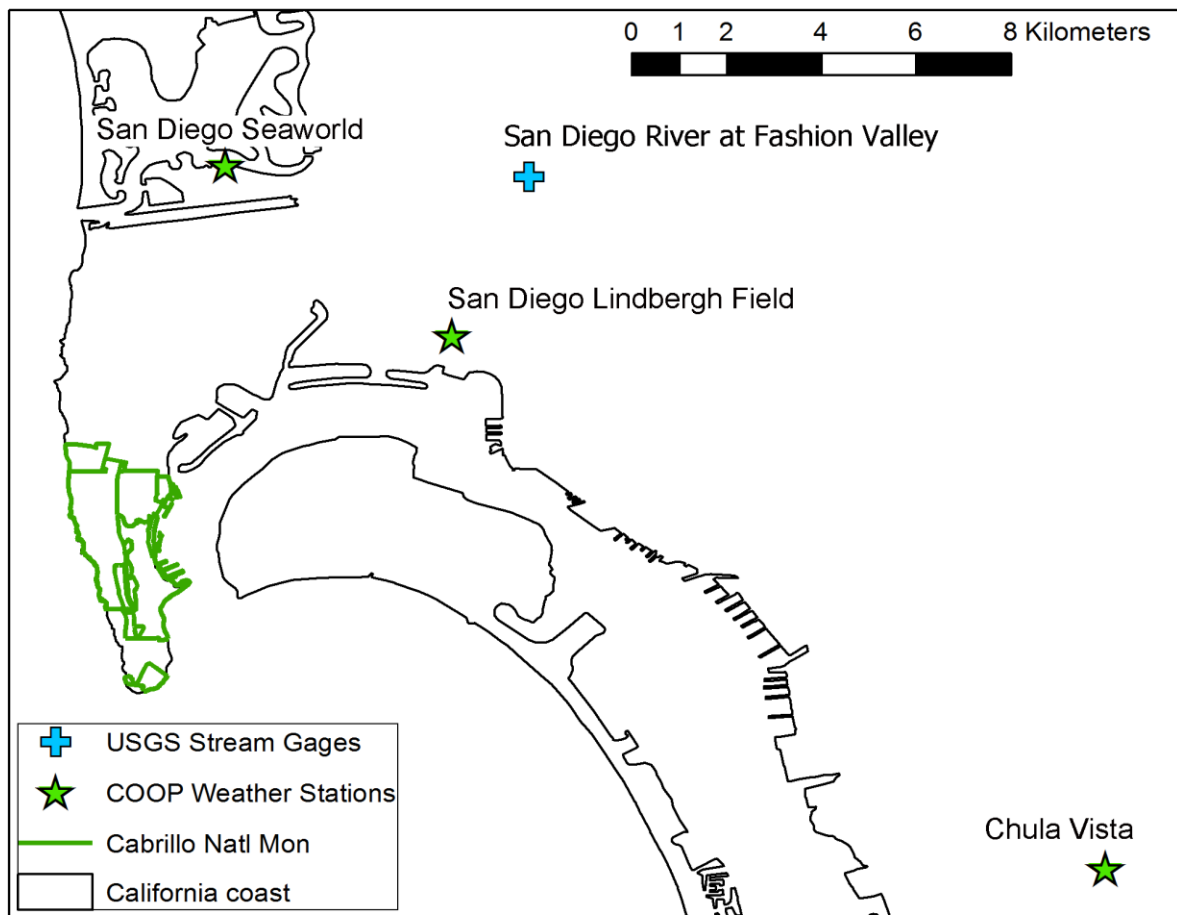


Figure 1. Map showing key climate stations and stream gauges in and near Cabrillo National Monument.

Quality Control of Global Historical Climatology Network Data

As of January 2012, weather station data are no longer available from the internet in the Cooperative Observer Program (COOP) format, and this format is not expected to return “any time soon” (National Climatic Data Center, personal communication to author). All of the weather stations that were served by this data portal have been transferred to the Global Historical Climatology Network (GHCN), which is available online at this address: <http://www.ncdc.noaa.gov/cdo-web/search>.

In addition to using metric units, different methods of expressing missing values, and a different row / column arrangement of values, this format also employs a new set of data quality flags that indicate the level of confidence in each measurement and any modifications that were made to each data point during routine Qa/Qc by the National Weather Service. In response to these changes, the author of this report has 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 GHCN stations were also compared to corresponding estimates from the PRISM datasets and to the original datasheets (B-91 forms) used by weather station staff. When possible, data missing in the electronic records were recovered from the original datasheets and hand entered by the author 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 instead 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. To download the software used for data screening and to learn more about the methods, visit 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

Results

Comparison of 1971 – 2000 vs. 1981 – 2010 averages.

Figure 2 shows the differences between 1971 – 2000 and 1981 – 2010 averages at two weather stations near Cabrillo National Monument. In general, average daily maximum temperatures (Tmax) and average daily minimum temperatures (Tmin) differed little between the two time periods. Precipitation averages for February, October, and December were greater during 1981 – 2010. March and November precipitation averages were lower during 1981 – 2010, and other months had smaller changes in precipitation.

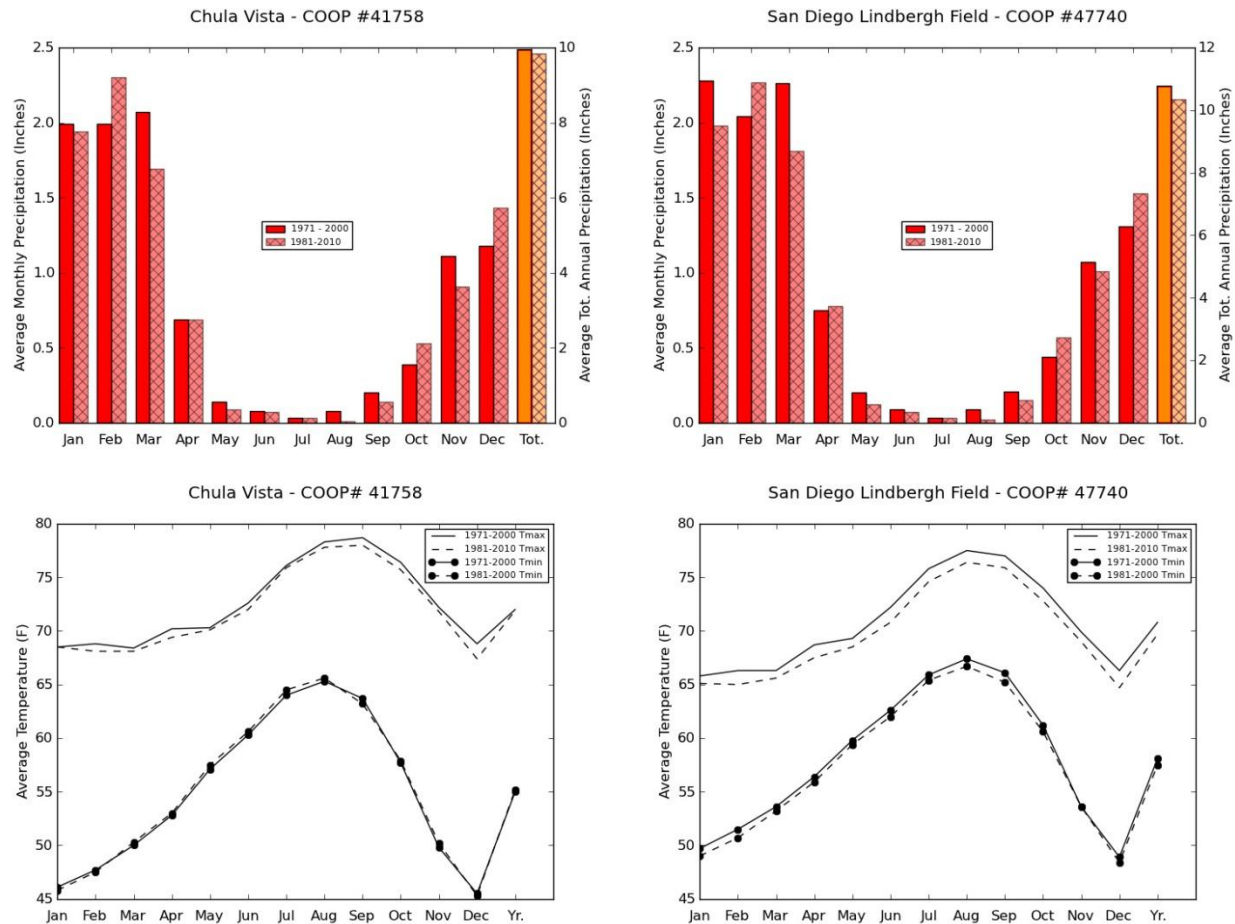


Figure 2. Differences between climatic “normals” (30-year averages) calculated for 1971 – 2000 vs. 1981 – 2010 at two weather stations near Cabrillo National Monument. These normals are issued by the National Weather Service and are not calculated as simple arithmetic averages. Instead, the number of missing values and other factors are taken into account. Note that annual precipitation totals are plotted on the right axis. See methods section for more information.

Temperature, Precipitation, and Drought Status During Calendar Year 2011

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

(Figure 4 – 6) and compare them to the weather station data presented in Figures 7 – 9 and Tables 1 – 2.

Broader Picture – La Nina conditions

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/el-nino/el-nino-story.html> ENSO interacts with another climatological cycle known as the Pacific Decadal Oscillation (PDO), which has similar effects on weather in the United States but cycles over roughly 10 – 30 years. More information on the PDO can be obtained from NOAA here: <http://www.ncdc.noaa.gov/teleconnections/pdo/>

During 2011, ENSO was in a strong La Nina phase and the PDO was in a cool phase that should have reinforced the La Nina effects on climate. For long-term El Nino patterns, consult NOAA here: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

Normally, La Nina conditions would produce drier conditions in southern California. However, in the case of the 2010 - 2011 winter, the expected La Nina effects were not clearly seen. Rather than being dry, December 2010 had 150% - 160% average precipitation at Chula Vista and San Diego Airport. January – March 2011, were indeed drier than average, ranging from 15 – 24% the 1981 – 2010 averages during January and 80% - 100% average during February and March.

Annual Summary of Precipitation and Temperature

After recovering from drought during 2010, the region remained drought free for the entirety of calendar year 2011 (Figure 3). This was true despite below average precipitation during January, March, April, September, and December (Figure 4). Total annual precipitation at Chula Vista was 9.88 inches, which is 101% the 1981 – 2010 average. San Diego Lindbergh Field had 9.09 inches, which was 88% the 1981 – 2010 average. Temperatures were generally near to below the 30-year averages throughout much of the region, with the exception of January and April, which were in some places 2 or more degrees (F) above average. Highlights of interest for each season are described below. See Figures 4 – 9 and Tables 1 – 3 for more details.

January – May: Highlights.

Quick Summary: The region remained drought free because dry and warm conditions during January were compensated by wetter and cooler than average conditions in February. March and April were drier than average but had near normal temperatures.

More Detail: Temperatures were generally above average and precipitation was below average during January. During January, precipitation was 13% - 24% the 1971 – 2000 and 1981 – 2010 averages at Chula Vista and San Diego Lindbergh Field (Table 1) and average daily maximum temperatures (Tmax) were as much as 3.9 degrees (F) above average at San Diego Lindbergh Field. During February, precipitation at key weather stations was near the 30-year averages (89 – 103% the 1971 – 2000 and 1981 – 2010 averages; Table 1) and average daily minimum

temperatures (Tmin) were as much as 5 degrees (F) below average (Table 2, Figure 8). March and April precipitation measurements were roughly 30% - 90% the 30-year averages. March temperatures were near to below average (Tmax as much as 2.5 degrees (F) below average at Chula Vista) and April temperatures were near to above average (Tmin as much as 2 degrees above average at San Diego Lindbergh Field). May had generally above average precipitation (186% – 299% average; Table 1) and average to below average temperatures (Tmin as much as 2 degrees below average at Chula Vista, Table 2). See Figures 4 – 9 and Tables 1 – 2 for more details.

June – August: Highlights

Quick Summary: The region typically has low precipitation during the summer, so maps depicting % of average precipitation should be interpreted with caution. Temperatures were generally below average.

More Detail: Weather stations in the region typically record very little precipitation during June – August. For example, June average precipitation for San Diego Lindbergh Field during 1971 – 2000 was 0.08 inches, and July average precipitation was 0.03 inches at both Chula Vista and San Diego Lindbergh Field. Because average (“normal”) precipitation is low during these months, care should be taken when interpreting statistics that quantify the amount (%) of normal precipitation that fell during the summer months. For example, during 2011 PRISM precipitation maps (Fig. 4) show very complex patterns during July and August, with some parts of the region experiencing very dry (0-25% average) and others very wet (>200% average) conditions. It is important to keep mind that in these cases the absolute difference in precipitation (expressed as inches of rain rather than percent average) was very small. For example, 0.02 inches of rain during June at the Chula Vista weather station was 25% of the 1971 – 2000 average, but if only an additional 0.06 inches of rain had fallen, the measurements would have been approximately 100% normal (Table 1).

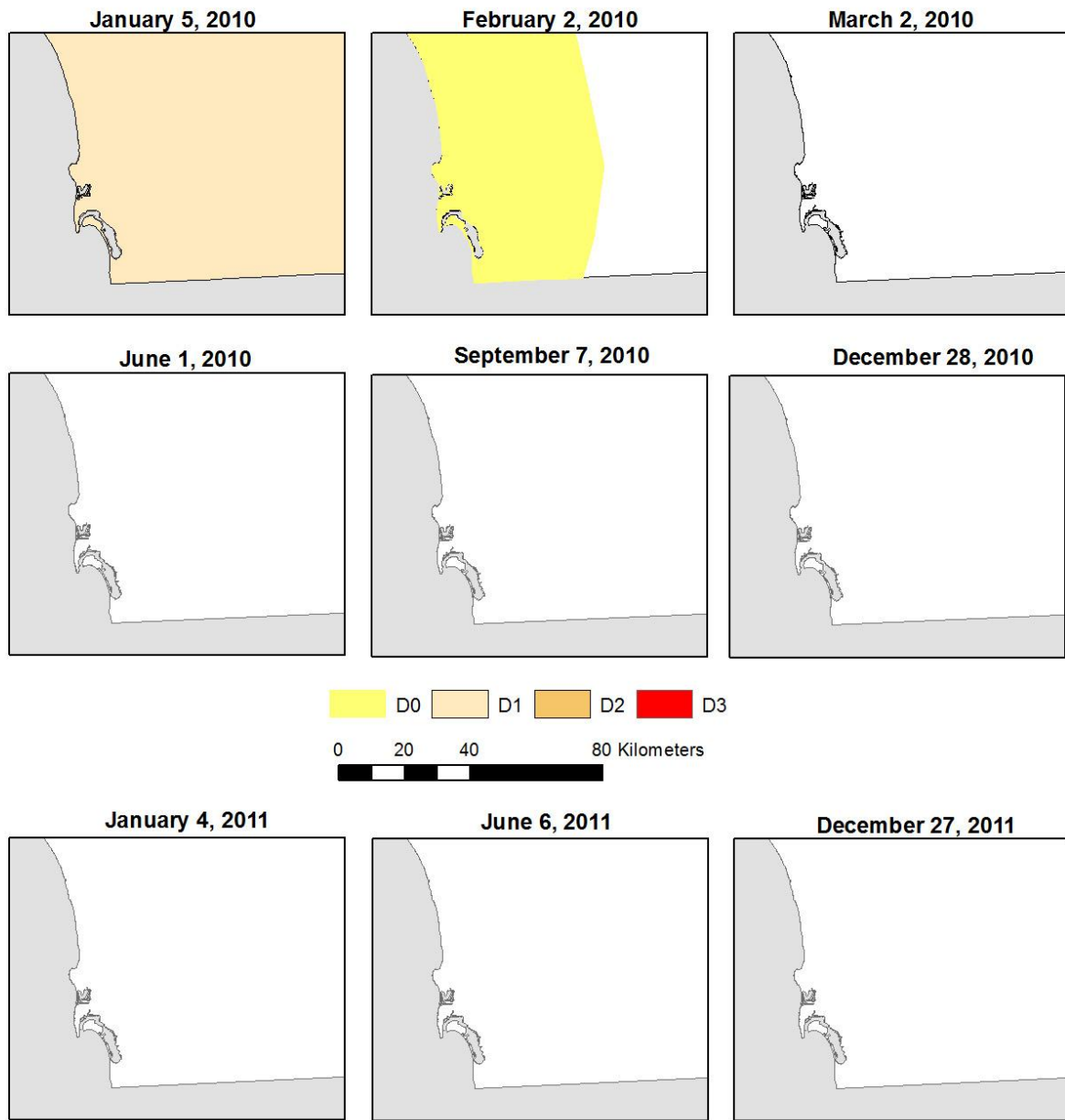


Figure 3. U.S. Drought Monitor maps for Cabrillo National Monument during calendar years 2010 - 2011. Drought classifications range from “abnormally dry” (D0) to “exceptional drought” (D4). White areas on the map indicate lack of drought status. For more information visit: www.drought.unl.edu/dm/monitor.html

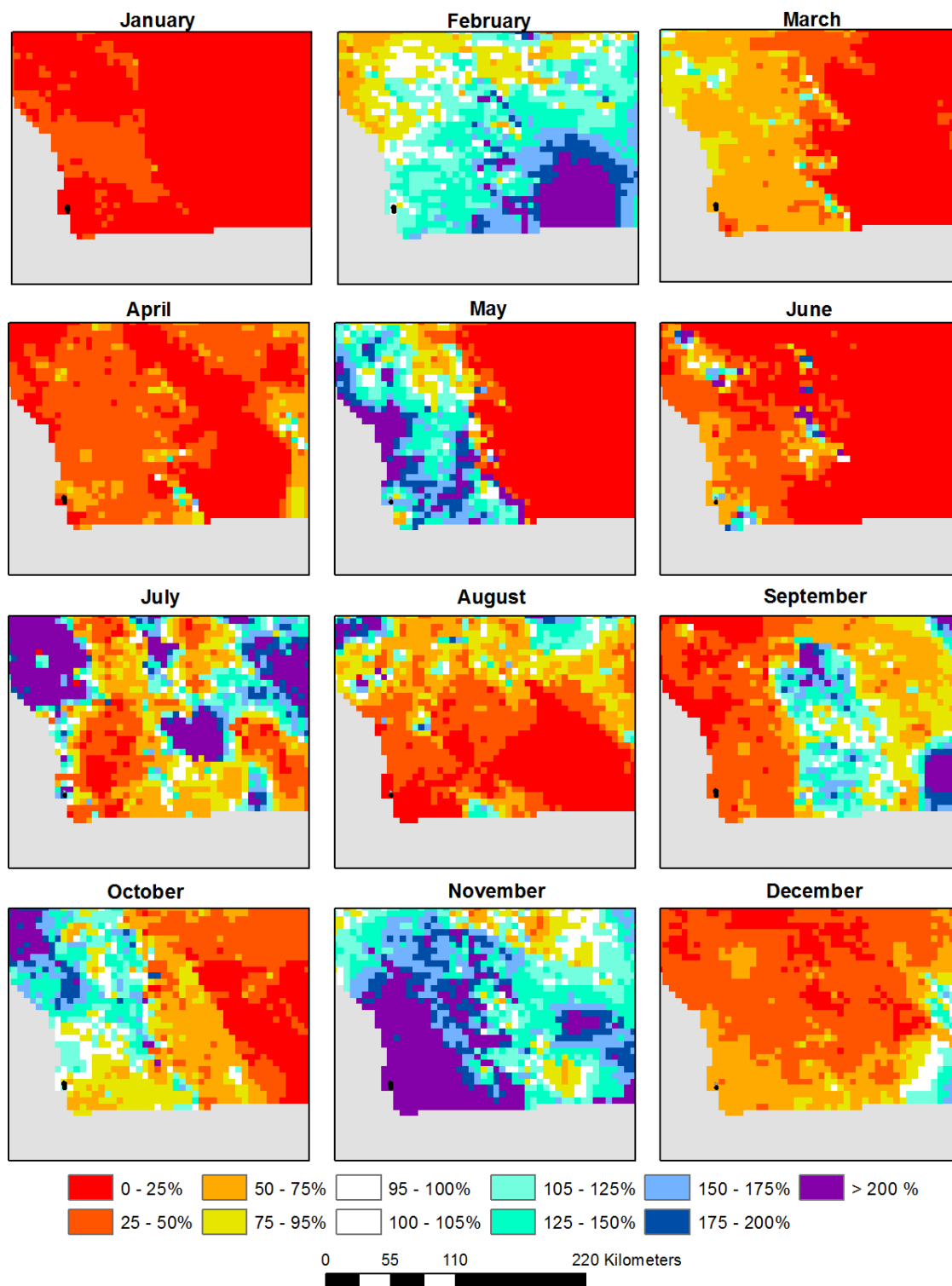


Figure 4. Maps showing percent of average precipitation relative to 1971–2000 for each month during 2011. Estimates are from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). Gray areas = Pacific Ocean. For more information, see <http://www.prism.oregonstate.edu/>.

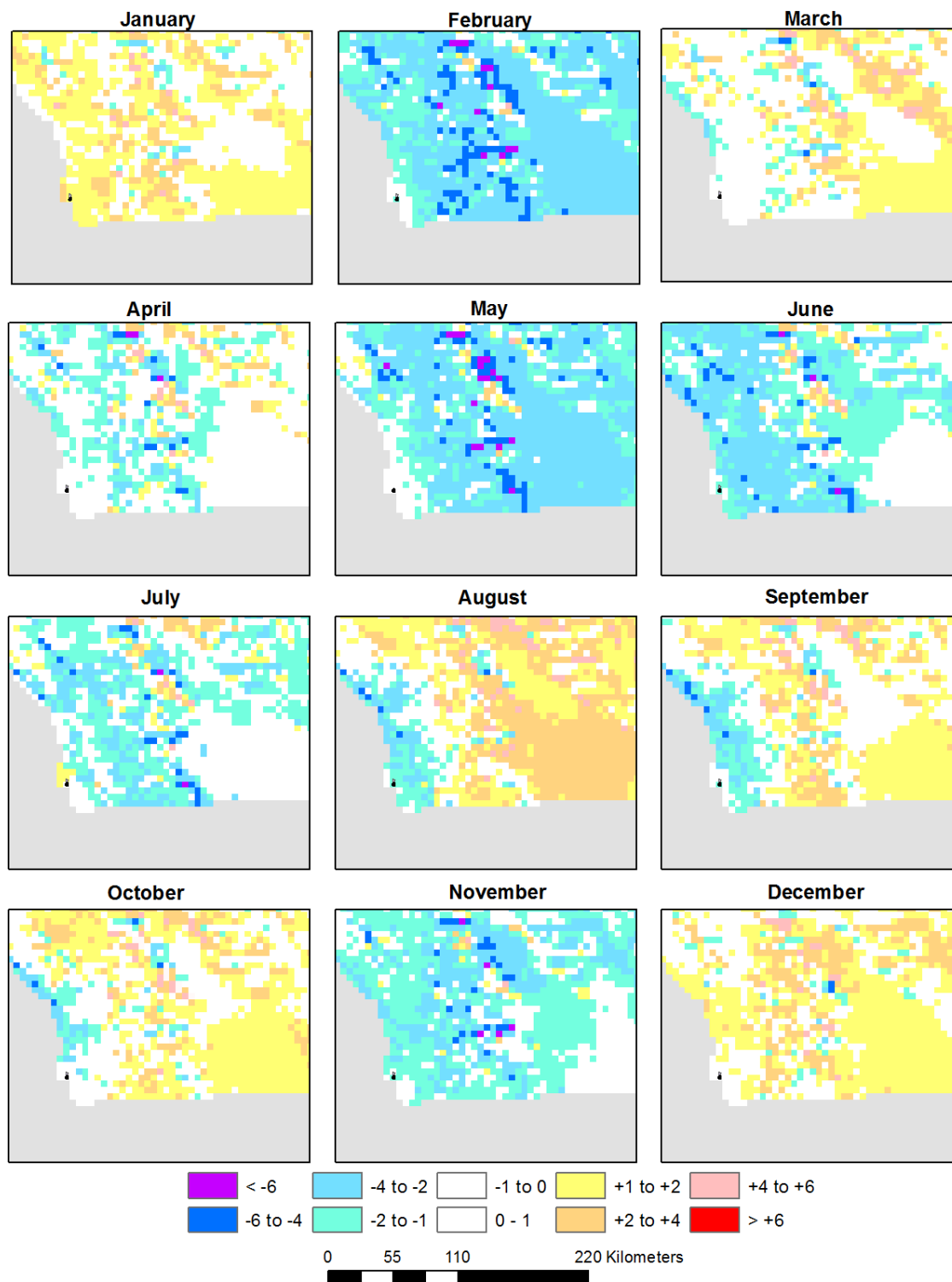


Figure 5. Maps showing departures from 1971 – 2000 average daily maximum temperatures (Tmax) in degrees Fahrenheit during 2011. Estimates are from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). Gray areas = Pacific Ocean. Cabrillo NM is on the coast, bottom left. For more information, see <http://www.prism.oregonstate.edu/>.

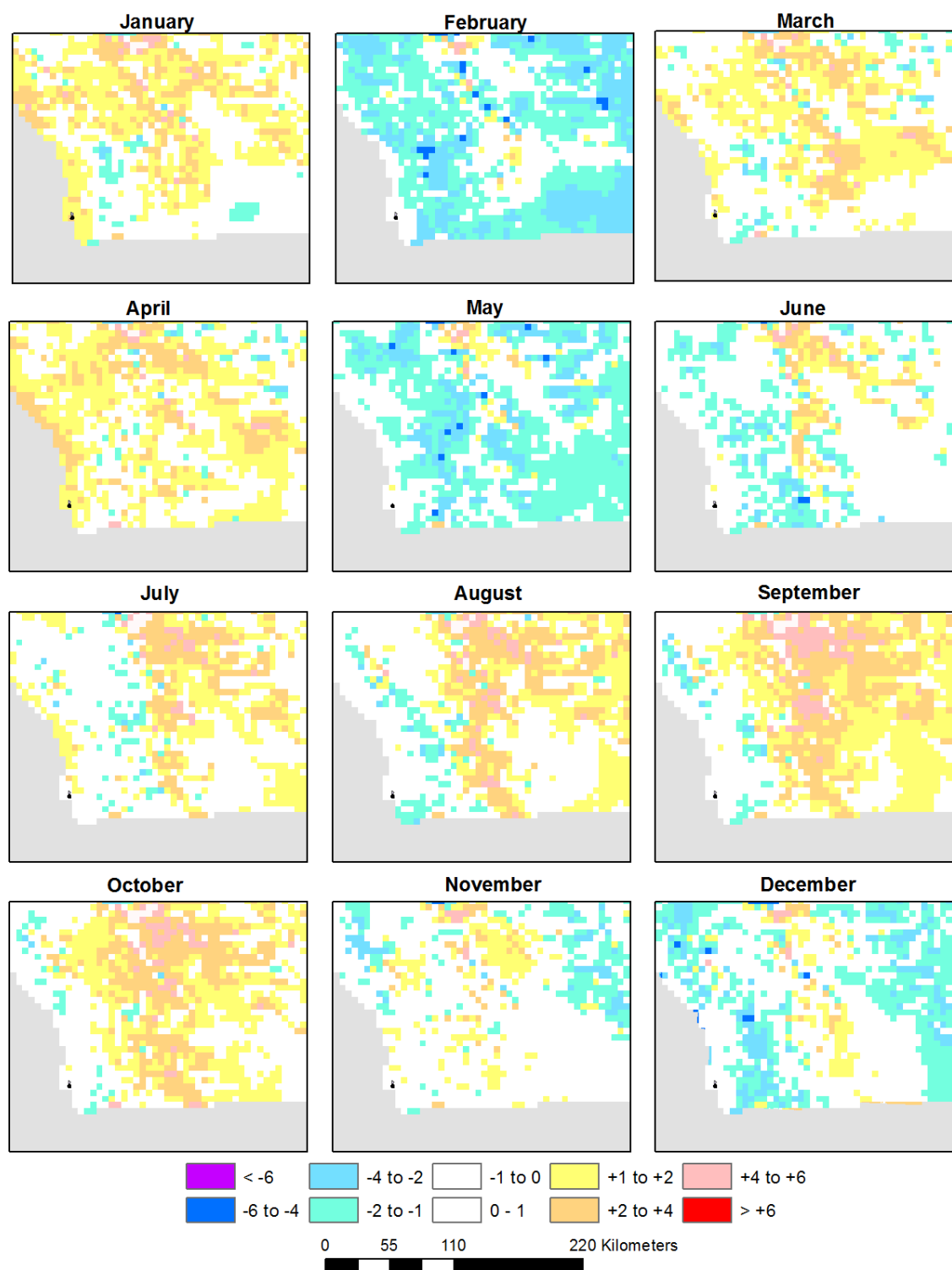


Figure 6. Maps showing departures from 1971 – 2000 average daily minimum temperatures (Tmin) in degrees Fahrenheit. Estimates are from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). Gray areas = Pacific Ocean. Cabrillo NM is on the coast, bottom left. For more information, see <http://www.prism.oregonstate.edu/>.

For the reasons just described, most of the “patchiness” in the PRISM precipitation maps (Figure 4) during June – August can be explained by the region’s characteristically low summer rainfall.

Temperatures during June - August were generally below average (Figures 7- 9; Table 2). Average daily maximum temperatures (Tmax) were as much as 3 degrees (F) below the 1971 – 2000 average during June (Chula Vista, Table 2) and almost 4 degrees (F) below average at San Diego Lindbergh Field during August (Table 2).

September – December: Highlights

Quick Summary: September and December precipitation was generally less than 50% the 30 – year averages (Figure 4). October had near average precipitation and November precipitation was generally 200% or more the 30-year averages (Figure 4, Table 1). Temperatures were generally near to below the 30-year averages.

More Detail: September average daily maximum temperatures (Tmax) were as much as 4.5 degrees (F) below the 1971 – 2000 average (Chula Vista, Table 2). Precipitation at key weather stations during November was 275% - 408% the 30-year averages (Table 2) and Tmax during November was again as much as 4 degrees (F) below the 1971 – 2000 averages (Chula Vista, Table 2). December ended the year with generally below average precipitation (56-71% average, Table 1) and temperatures that were 1.5 – 5 degrees (F) below average at key weather stations (Table 2). See Figures 4 – 9 and Tables 1 – 2 for more details.

Table 1. Total Monthly Precipitation in inches during 2011 and percentage of 1971 - 2000 and 1981 - 2010 Averages

Station Name	Station Type	Station ID	Parameter	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
Chula Vista	COOP	41758	Precipitation (in)	0.47	2.1	1.52	0.58	0.26	0.02	0	0	0.11	0.32	3.71	0.8	9.9
			% of 1971 - 2000 avgs.	24	103	73	84	186	25	0	0	55	82	334	71	99
			% of 1981 - 2010 avgs.	24	89	90	84	289	28	0	0	79	60	408	59	101
San Diego Lindbergh Field	COOP	47740	Precipitation (in)	0.3	2.1	1.46	0.26	0.36	0.03	0	0	0.13	0.46	3.13	0.9	9.1
			% of 1971 - 2000 avgs.	13	103	65	35	179	35	0	0	62	105	292	66	84
			% of 1981 - 2010 avgs.	15	92	81	33	299	45	0	0	87	81	310	56	88
San Diego Sea World	COOP	47741	Precipitation (in)	(-)	6.1	(-)	(-)	(-)	0.02	0	0	0.08	(-)	3.11	1.1	(-)
			% of 1981 - 2010 avgs.	(-)	242	(-)	(-)	(-)	26.3	0	0	35.8	(-)	275	66.8	(-)

(-) = Insufficient data for an accurate calculation

1971 - 2000 averages are not available for the San Diego SeaWorld weather station.

Table 2. Average daily maximum temperatures (Tmax), Average daily minimum temperatures (Tmin) during 2011, and departure from 1971 – 2000 and 1981 - 2010 averages expressed as +/- Degrees F. (-) = insufficient data for and accurate calculation.

Station Name	Station ID	Parameter	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
Chula Vista	41758	Tmax (F)	68.19	63.78	65.89	68.55	70.28	69.5	74.36	74.68	74.19	73	68.14	63.95	69.54
		Tmax Departure (+/- F) from 1971 – 2000	-0.31	-5.02	-2.51	-1.65	-0.02	-3.1	-1.74	-3.62	-4.51	-3.4	-4.06	-4.85	-2.46
		Tmax Departure (+/- F) from 1981 – 2010	-0.31	-4.32	-2.21	-0.85	0.18	-2.5	-1.54	-3.12	-3.81	-2.7	-3.66	-3.45	-2.36
		Tmin (F)	48.44	46.77	49.85	54.7	55.49	58.84	64.3	63.37	62.48	57.4	50.47	43.51	54.63
		Tmin Departure (+/- F) from 1971 – 2000	2.34	-0.93	-0.15	1.9	-1.61	-1.46	0.3	-1.93	-1.22	-0.3	0.67	-1.99	-0.37
		Tmin Departure (+/- F) from 1981 – 2010	2.64	-0.73	-0.45	1.7	-2.01	-1.76	-0.2	-2.23	-0.72	-0.5	0.27	-1.79	-0.57
San Diego Lindbergh Field	47740	Tmax (F)	69	65.05	67.27	69.18	70.06	69.76	74.3	73.6	73.54	71.7	67.5	64.16	69.59
		Tmax Departure (+/- F) from 1971 – 2000	3.2	-1.25	0.97	0.48	0.76	-2.44	-1.5	-3.9	-3.46	-2.3	-2.4	-2.14	-1.21
		Tmax Departure (+/- F) from 1981 – 2010	3.9	0.05	1.67	1.68	1.56	-1.04	-0.3	-2.8	-2.36	-1.1	-1.5	-0.54	-0.11
		Tmin (F)	51.29	50.17	54.52	58.03	59.29	61.11	65.64	64.55	63.96	59.45	52.96	46.92	57.32
		Tmin Departure (+/- F) from 1971 – 2000	1.59	-1.33	0.92	1.63	-0.51	-1.49	-0.26	-2.85	-2.14	-1.75	-0.64	-1.98	-0.78
		Tmin Departure (+/- F) from 1981 – 2010	2.29	-0.53	1.32	2.13	-0.11	-0.89	0.24	-2.15	-1.24	-1.15	-0.64	-1.48	-0.18
San Diego Sea World	47741	Tmax (F)	(-)	(-)	(-)	(-)	67.8	66.9	70.73	69.58	69.51	66.94	64.19	60.56	(-)
		Tmax Departure (+/- F) from 1981 – 2010	(-)	(-)	(-)	(-)	0.9	-1.9	-0.87	-3.22	-2.69	-2.46	-2.01	-2.34	(-)
		Tmin (F)	(-)	(-)	(-)	(-)	55.57	58.96	64.32	63.3	62.44	56.7	50.59	44.32	(-)
		Tmin Departure (+/- F) from 1981 – 2010	(-)	(-)	(-)	(-)	-2.83	-1.24	0.32	-1.9	-0.06	-2.1	-1.41	-2.48	(-)

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).

When viewed from the perspective of growing season length, calendar-year 2011 was near average. At the Chula Vista weather station, AGDD indices were 105% - 109% the long-term average (Table 3).

Streamflow

Unlike other climate parameters in this report, streamflow is presented across a standard water year, ran from October 1, 2010 to September 30, 2011. This better matches the annual cycle of precipitation. Since the rivers near Cabrillo National Monument are all heavily influenced by human activity, including artificial dams, streamflow is as much a result of management priorities as annual climatic events. Nevertheless, a few patterns are worth noting.

The midpoint of annual discharge on the San Diego River was almost two months earlier than the historical average (Figure 10, top panel) and peak flow was at its highest point since records began in 1982 (Figure 10, bottom panel). This was due to heavy rains in December 2010, when, for example, the Chula Vista weather station recorded 417% the 1971 – 2000 average precipitation (not shown in this report, see Tercek 2011 for more detail).

Fire Risk Conditions

The Keetch – Byram Drought Index (KBDI; see Methods above), calculated for every day during the period of record at the San Diego Lindbergh Field weather station, indicated that 2011 was similar to 2010 in being a year of low fire risk (Figure 13). Seasonal patterns in KBDI at this station were similar to patterns at other weather stations in the region (not shown). Drought/fire risk was highest during the summer months, when regional precipitation was at a minimum. This index can be calculated automatically on a near-real-time basis as a prediction tool. Contact the Mediterranean Coast Network Inventory and Monitoring Program to obtain the computer code that was used for these calculations.

Table 3. Accumulated Growing Degree Days (AGDD) and days above or below critical temperature thresholds during 2011.

Station Name	Station Type	Station ID	AGDD40	AGDD50	# days >= 80 F	# days >= 90 F	# days <= 32F
Chula Vista	COOP	41758	8039	4410	20	4	0
		Avg. 1918 – 2009	7674	4054	(-)	1.8	1
San Diego Lindbergh Field	COOP	47740	8576	4926	22	1	0
		Avg 1914 – 2009	(-)	(-)	(-)	(-)	(-)

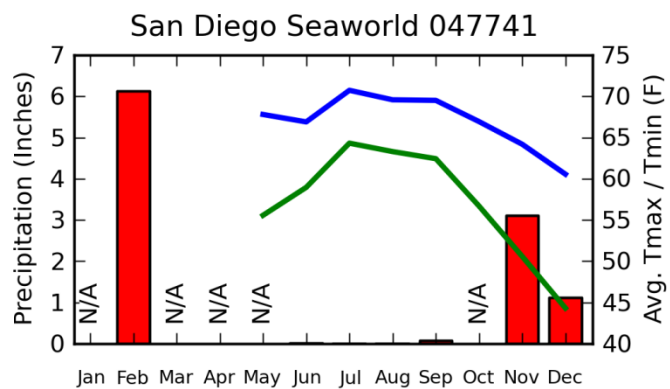
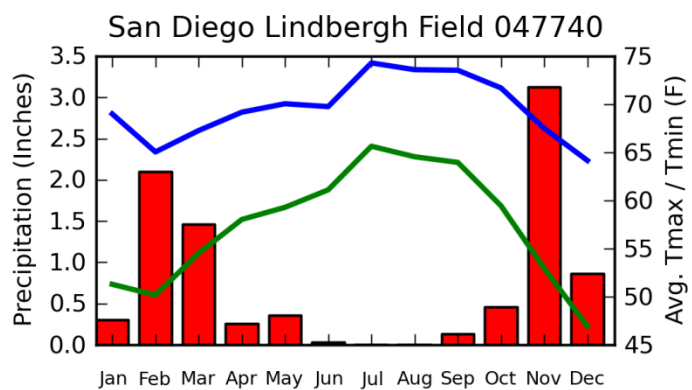
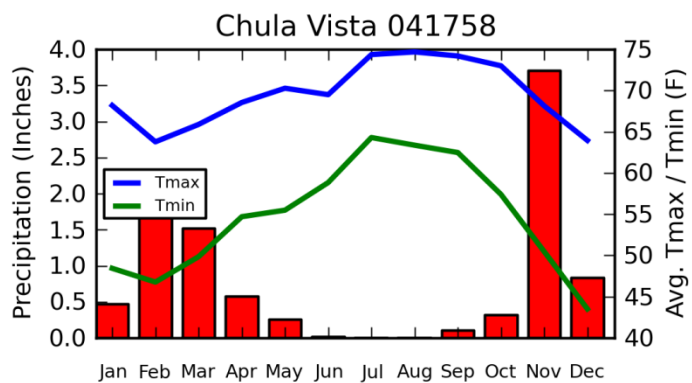


Figure 7. Total monthly precipitation, average daily maximum temperature (Tmax), and average daily minimum temperature (Tmin) during 2011 at key weather stations near Cabrillo National Monument. N/A = Insufficient data for an accurate calculation.

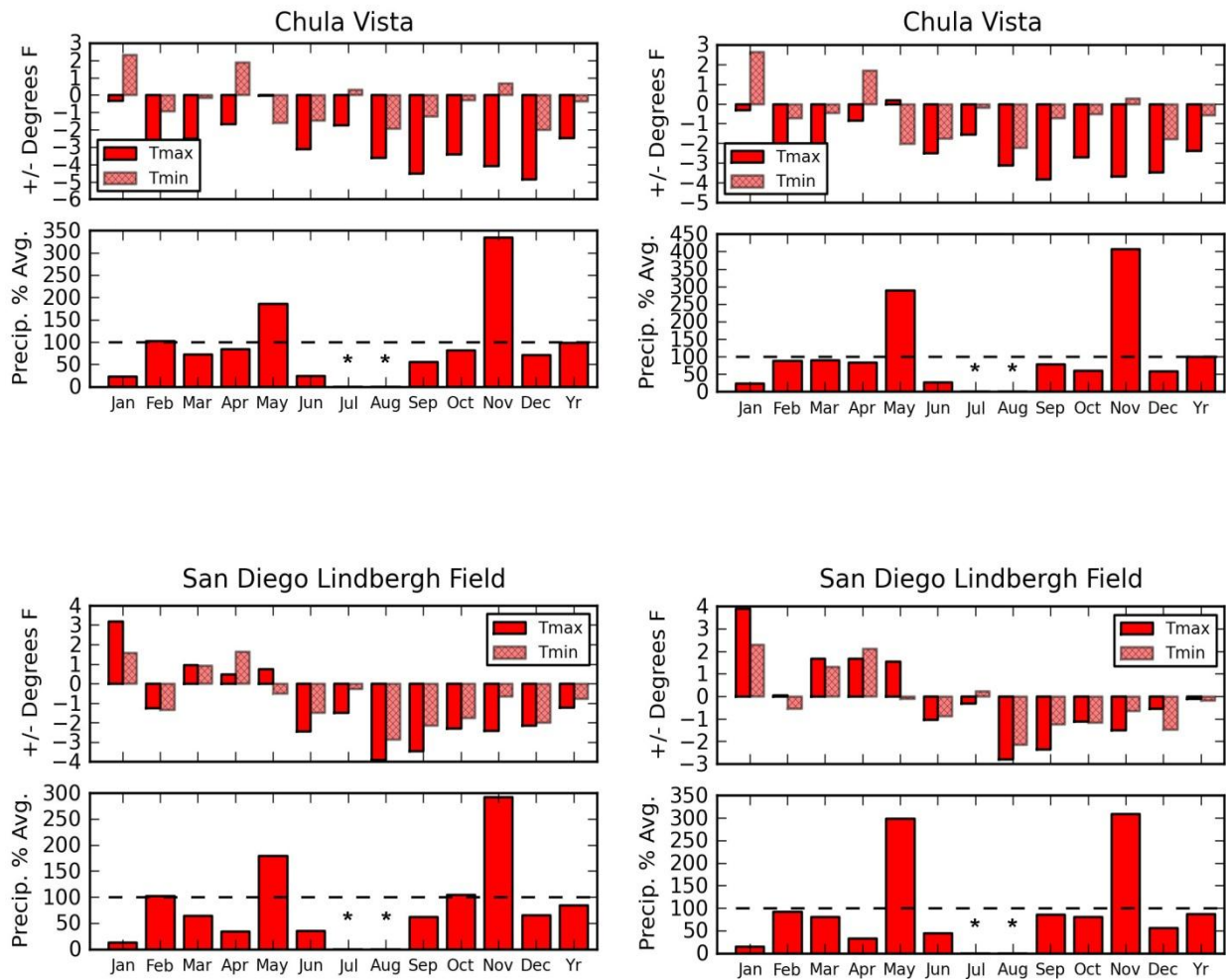


Figure 8. Departure of 2011 precipitation, average daily maximum temperature (Tmax), and average daily minimum temperature (Tmin) from 30-year averages at key weather stations near Cabrillo National Monument. Left column = departure from 1971 – 2000 averages. Right column = departure from 1981 – 2010 averages. Asterisks indicate months that had less than 0.2 inches average precipitation. For these months, 0% average precipitation may represent a small difference in absolute precipitation departure. N/A = insufficient data for an accurate calculation.

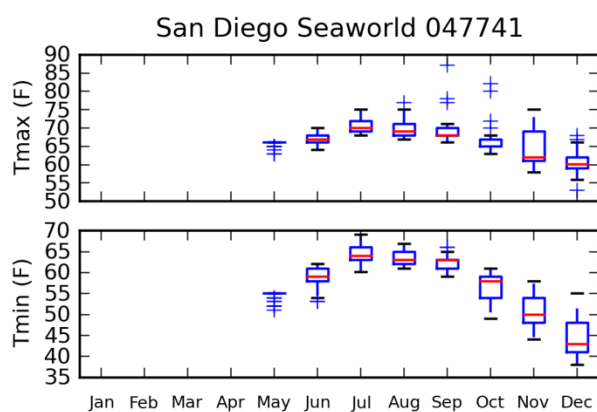
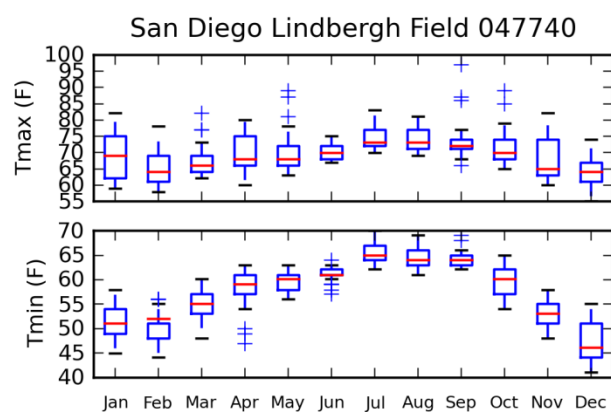
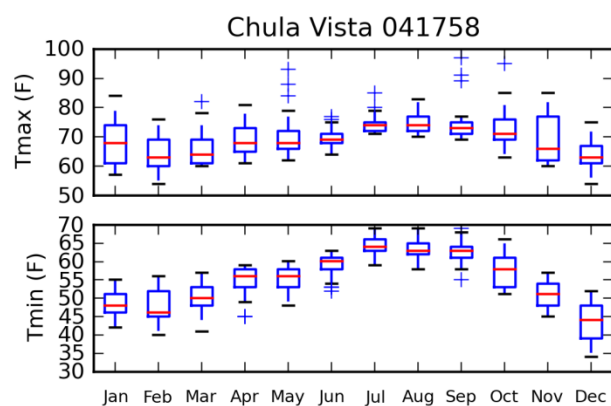


Figure 9. Boxplots of average maximum (Tmax) and average minimum (Tmin) temperatures at key climate stations near Cabrillo National Monument. Horizontal lines indicate the median value. Boxes indicate the 25th and 75th percentiles. Whiskers extend 1.5 times the interquartile Range (IQR). Crosses indicate values exceeding 1.5 times the IQR.

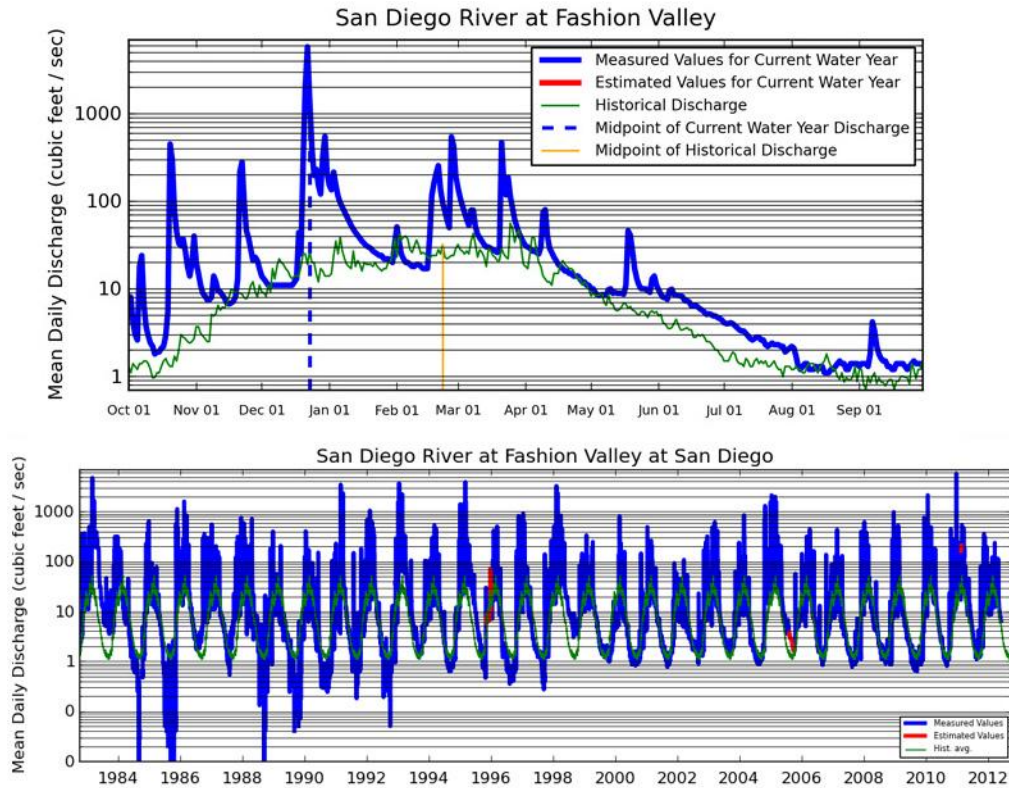


Figure 10. Streamflow measured on the San Diego River near Cabrillo National Monument. Top panel: 2011 water year (October 2010 through September 2011). Bottom Panel: 1982 – 2011. Data courtesy of the U.S. Geological Survey.

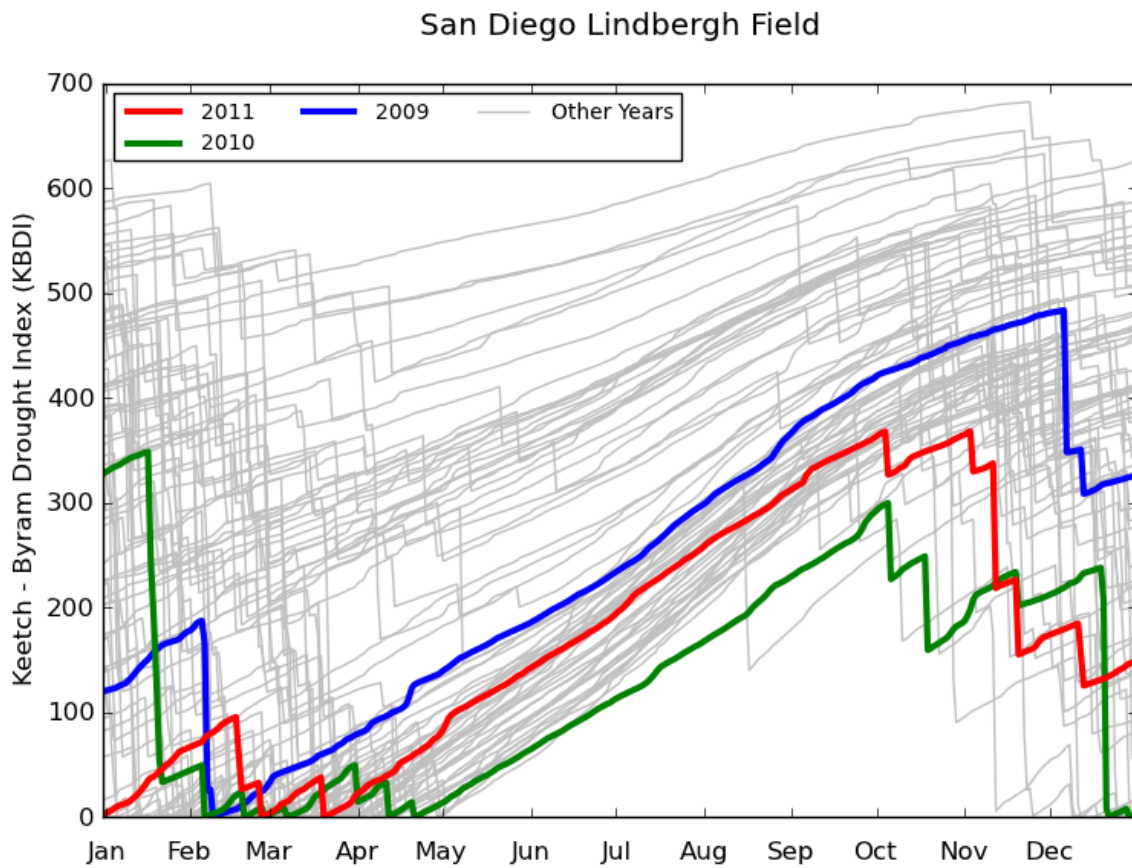


Figure 11. The Keetch-Byram Drought Index (KBDI) calculated for every day during the period of record for the weather station at San Diego Lindbergh Field.

Conclusions

- The region recovered from drought during 2010, and remained drought free during 2011
- Temperatures during 2011 were generally near to below 1971 – 2000 and 1981 – 2010 averages, with the exception of January and April, which were slightly above average.
- January, March, April, September and December had below average precipitation. Other months had precipitation near or above the 30-year averages.
- During the 2010 – 2011 water year, the midpoint of annual streamflow was almost two months earlier than the historical average and streamflows were at their highest point since records began in 1982.
- Fire risk was low.

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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.

Name	Stn type	Stn ID	Metadata
Chula Vista	GHCN	41758	http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca1758
San Diego WSO Airport AKA Lindbergh Field	GHCN	47740	http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7740
San Diego Sea World	GHCN	47741	http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7741
San Diego R at Fashion Valley	Stream Gage	110230 00	http://waterdata.usgs.gov/nwis/dvstat/?format=sites_selection_links&search_site_no=11023000&agency_cd=USGS&preferred_module=sw

GHCN = Global Historical Climatology Network

