California Climate Watch

A monthly newsletter monitoring California climate

December 2004
http://www.calclim.dri.edu

Summary of the Month

by Bill Mork
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December 2004 was warmer than normal in much of the State except close to normal in Southern California. The greatest departures from normal were in the Sacramento Drainage and Northeast Interior where average temperatures were mostly 4 to 5 degrees above normal and as much as 7 degrees above normal at Markleeville, Shasta Dam, and Susanville. This warmth was caused by a strong upper level ridge of high pressure which hung out near the West Coast December 10 - 26 with long periods of fog in the Central Valley and occasional spurts of Santa Ana winds in the Southland.

However, the month will be longer remembered by the strong Pacific storms in Northern and Central California on December 6 - 9 and even stronger storms up and down the Golden State on December 27 - 29 with record rainfall pelting the Southland on December 28. Little did we know that those heavy rains in late December would set the stage for devastating landslides in January as even heavier rains pounded Southern California the first 10 days of the New Year. Monthly precipitation totals ranged from below normal in the Northeast Interior to well above normal in Southern California and the Southeast Desert. The greatest percentage of normal precipitation was in downtown Los Angeles where the monthly total of 8.77 inches was 459 percent of the normal of 1.91 inches. The Northern Sierra 8-Station Precipitation Index had 10.9 inches liquid for the month, 130 percent of average.

A strong Pacific weather system followed by a warm advection pattern with subtropical moisture brought heavy rain and snow to Northern and Central California December 6 - 9. Largest remote sensor precipitation totals include 12.00 inches at Elk Valley in the Smith River basin, 11.48 inches at Honeydew in the Mattole River basin, 9.86 inches at

WEATHER *continued on page 2.*

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Predictable Winters Ahead for California

By Laura Edwards
Western Regional Climate Center

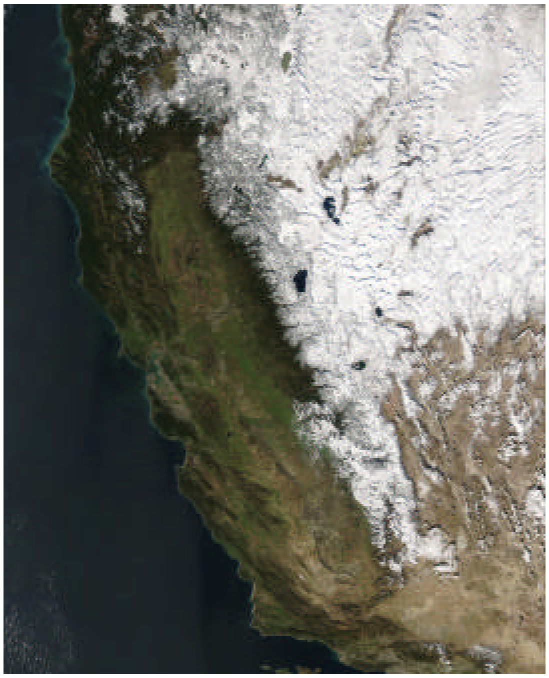


Figure 1. Early December 2004 snow cover over California and Nevada.
http://modis.gsfc.nasa.gov/gallery/index.php#

Snowfall predictability. Oxymoron, right? Before winter was making its presence known in the Sierra Nevada recently, there was talk of a relatively dry season, despite the El Niño conditions in the tropical Pacific Ocean. As the snow was flying, pre-recorded interviews with climatologists discussing their predictions were aired on cable television with sunny skies and dry pavement in the background. Is this just another "reality check" for meteorologists and climatologists, or can winter precipitation really be predicted?

There have been some studies in scientific literature about snowfall forecast skill and accuracy of runoff and streamflow forecasts for hydrologic purposes. Pagano et al. (1) evaluated seasonal water supply forecasts for the western United States. They found some promising results for California's West Walker River in the central Sierra Nevada. Using the April 1 average date for maximum snowpack, the forecast skill greatly improved for the years 1983-2002 at this site in eastern California. The authors noted that longer lead time forecasts also improved steadily throughout the period of record. For this location, forecast skill was greatest after the mid-1980s, while westwide skill was greatest for the periods 1968-1987 and 1980-1999. These results appear to give some indication that snowpack and water supply in California is predictable, and that forecasters are gaining experience to better handle the seemingly unpredictable nature of snow. In addition, Pagano et al. found that despite increased streamflow variability, forecast skill has improved for the period of record.

A number of researchers have investigated the effects of El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) on snowfall and snowpack in the western United States and California. Using a statistical method, McCabe and Dettinger (2) found a strong interannual and a modest interdecadal signal in snowpack variations. PDO proved to be the best predictor for April 1 snowpack for 79 of the 323 stations in their study. PDO and an ENSO index combined were the best predictor for 25 stations. Earlier studies have found a relation between summer and autumn PDO values and the following winter precipitation (i.e. Redmond and Koch (3)). ENSO is often used in snow and water supply outlooks, but it is shown to be best when combined with midwinter snowfall observations to predict spring runoff and streamflow. A caveat to these studies is ENSO and PDO effects vary across the region and the state, so this may not be the best solution for some forecasters. In order to best use these indices, the effect of these phenomena need to be known.

SNOW *continued on page 2.*

WEATHER (continued from page 1):

Brandy Creek west of Redding, 9.32 inches at Brush Creek in the Feather River basin, 8.76 inches at Leggett in the Eel basin, 8.44 inches at Venado in the Russian River basin, and 5.31 inches at Blue Canyon in the American River basin. Cooperative observer and city totals include 9.64 inches at Shasta Dam, 7.96 inches at Paradise, 7.11 inches at Crescent City, 6.18 inches at Kentfield, 5.22 inches at Mount Shasta, 5.10 inches at Grass Valley, 4.95 inches at Santa Cruz, 2.88 inches at Fairfield, and 1.12 inches at Sacramento. Strong south to southeast winds on December 6 - 7 produced wind gusts to 87 mph at Los Gatos, 82 mph at Kregor Peak, 58 mph at Mt Tamalpias, 56 mph at Angel Island and Redding, 48 mph at Golden Gate Bridge, 47 mph at San Francisco International Airport, and 41 mph at Sacramento International Airport.

A strong Pacific weather system brought heavy rain, mudslides, and high winds to Southern California December 27 - 29. Largest storm totals include 16.11 inches at Upper Matilija Canyon in Santa Barbara County, 14.79 inches at Opids Camp in Los Angeles County, and 14.49 inches at Old Man Mountain in Ventura County. Downtown Los Angeles had 6.85 inches of rain during this period. The 5.55 inches which fell on December 28 made that the wettest calendar day in December since weather records began in July 1877 in downtown Los Angeles. This was also the third wettest calendar day in downtown Los Angeles weather history and the wettest day since 5.71 inches fell on January 26, 1956. The wettest calendar day in downtown Los Angeles was March 2, 1938 with 5.88 inches.

The late December storm produced 3 to 5 feet of snow in the Sierra Nevada with some locations buried with 7 to 8 feet of snow. The heavy snow helped the water supply in western Nevada but also hindered transportion in and out of Californa as up to 27 inches of snow fell in Reno. By December 28, a deep low pressure area squatted off the coast of Oregon and produced strong west to southwest winds aloft which gave very heavy, orographic snowfall to the Sierra Nevada. By December 31, the weather observer at the Central Sierra Snow Laboratory at Donner Summit had measured 93 inches of snow. The 6.3 inches liquid made the water content about 15 percent. Seasonal snowfall by the end of the month and year had reached over 200 inches compared to an average of about 120 inches.

SNOW (continued from page 1):

Using climate modeling, Marshall et al. (4) made predictions for snow cover over the western United States. They chose December 1 and February 1 snow cover as starting points. With some example snow cover scenarios from observations (high, low and average values) and some atmospheric condition scenarios, they produced forecasts for snow cover for 4 months ahead. The December start date made a forecast for the target date of March 1 and the February start date forecast for May 1. The authors of this study found that initial snow cover was more important than atmospheric conditions for runs starting in February. Additionally, the albedo effect (ratio of reflected to incident sunlight) is more dominant in the February runs than in December due to the solar angle. In particular, runs with greatly exaggerated snow cover showed that its distinct impact on climate, including lower surface temperatures and increased surface pressures. The December runs were less clear in preference between snow cover and atmospheric initial conditions. The sun is too low in the sky in December to have a strong albedo effect as well.

Piecing all of these factors together, water supply and snow forecasts appear to benefit from more research and knowledge about large-scale climate conditions and their effect on snow in California. Because of the long-term impacts on California and the western U.S., snow forecast improvement continues to be a work in progress, despite the many studies investigating this topic.

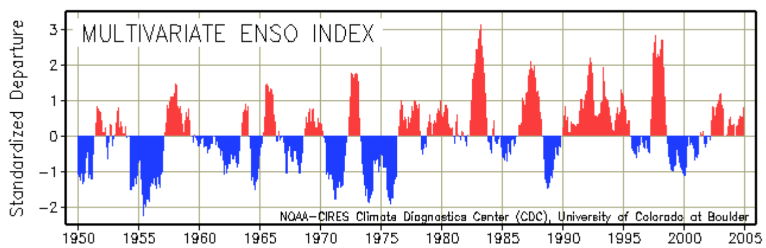


Figure 2. Multivariate ENSO index, one resource for weather and climate prediction.

References:

1. Pagano, T., D. Garen, S. Sorooshian, 2004. Evaluation of official western U. S. seasonal water supply outlooks, 1922-2002. *Journal of Hydrometeorology*, **5,** 896-909.

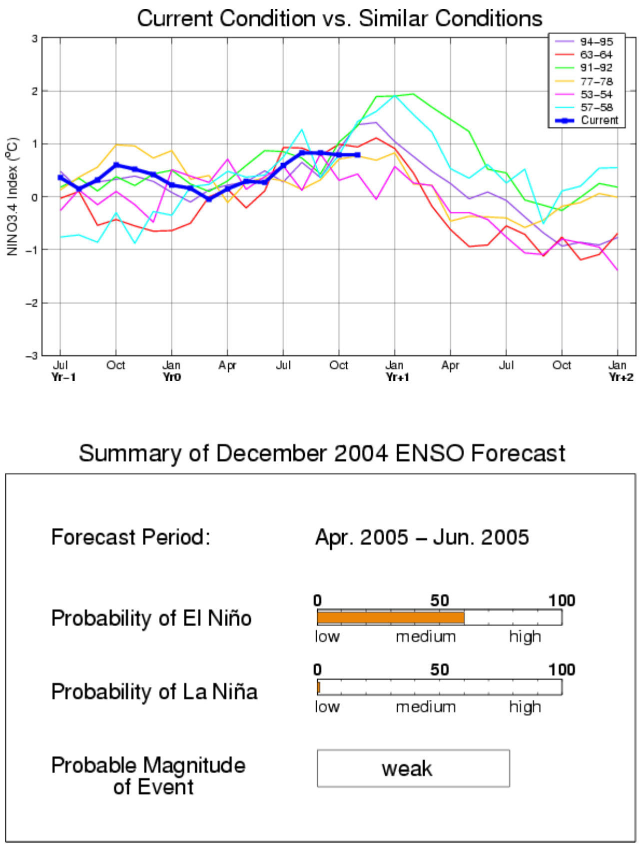
2. McCabe, G. J. and M. D. Dettinger, 2002. Primary modes and predictability of year-to-year snowpack variations in the western United States from teleconnections with Pacific Ocean climate. *Journal of Hydrometeorology*, **3,** 13-25.

3. Redmond, K. T. and R. W. Koch, 1991. Surface climate and streamflow variability in the western United States and their relationship to large scale circulation indices. *Water Resources Research*, **27**, 2381-2399.

4. Marshall, S., R. J. Oglesby, A. W. Nolin, 2003. The predictability of winter snow cover over the western United States. *Journal of Climate*, **16**, 1062-1073.

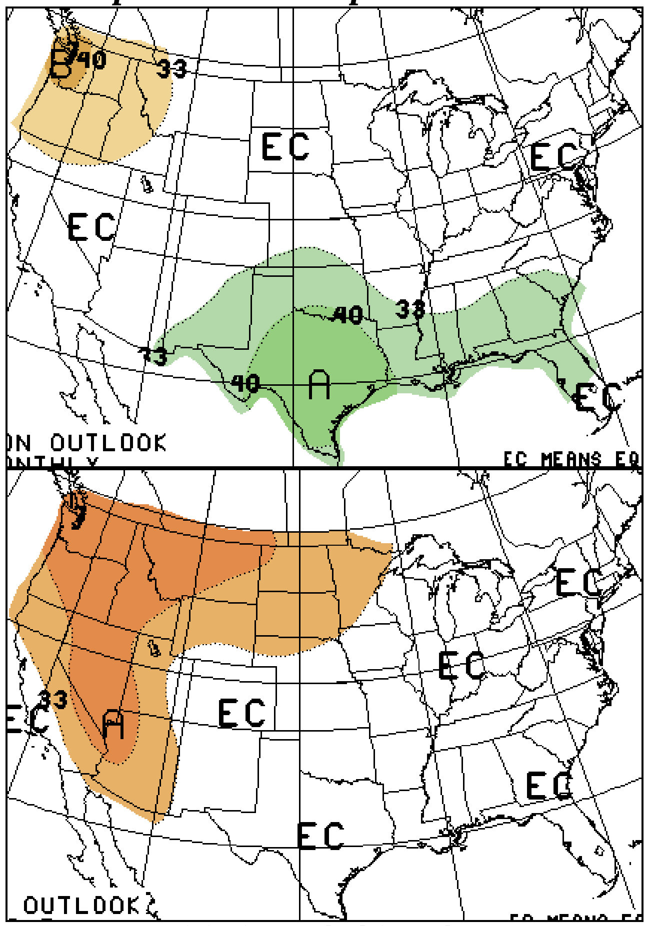
CLIMATE FORECASTS & OUTLOOKS

El Niño-Southern Oscillation forecasts:



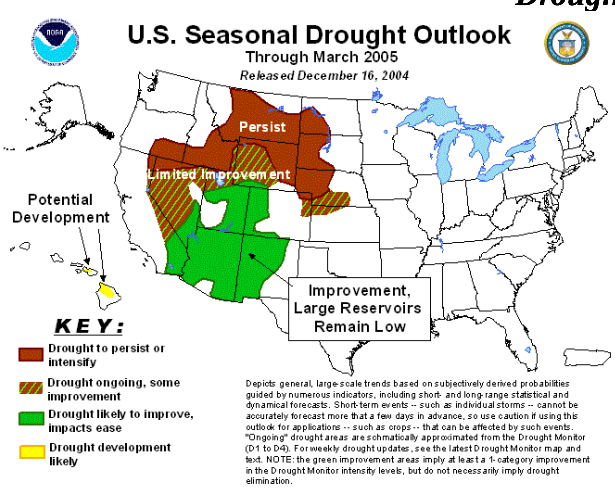
Based on sea surface temperature departures from the long-term average over the "Nino 3.4" region (120-170W, 5S-5N).
http://iri.columbia.edu/climate/ENSO/currentinfo/QuickLook.html

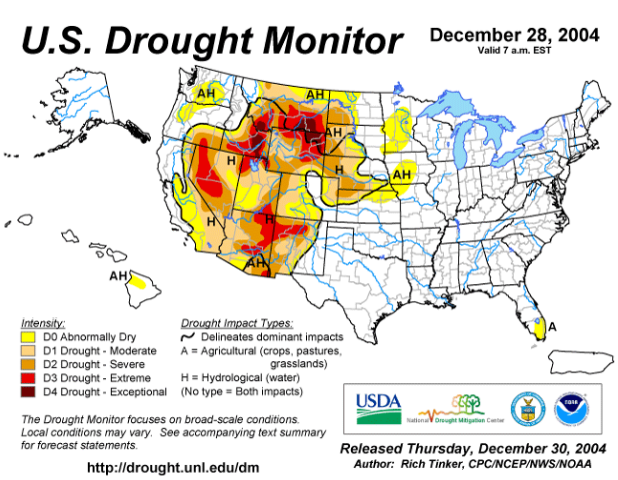
Precipitation and Temperature Outlooks:



Precipitation Outlook is on the top, Temperature Outlook is on the bottom. "A" means above climatology, "B" means below climatology, and "EC" means equal chances of above, normal, or below climatology.
Source: Climate Prediction Center, http://www.cpc.noaa.gov/

Drought Conditions:





Credit: CPC/NCEP & http://www.drought.unl.edu/dm/monitor.html

December Station Data

All data is provisional and subject to change.

STATION NAME/ CLIMATE DIVISION	TA	DA	TX	DX	MGX	XMX	TN	DN	MGN	XMN	PREC	PDP	MGP	XPC	PPCT
North Coast	**48.9**	**2.8**	**57.8**	**3.2**	**0**	**66**	**39.9**	**2.4**	**0**	**44**	**9.84**	**-1.38**	**0**	**1**	**97**
Crescent City	48.9	2.5	54.8	0.8	0	62	43.0	4.1	0	36	12.45	1.22	0	2	111
Eureka	48.4	0.5	55.2	0.1	1	61	41.6	1.0	1	54	9.43	-6.07	0	1	61
Arcata/Eureka	48.1	0.2	56.1	1.0	0	66	40.1	-0.5	0	30	9.33	2.98	0	2	147
Fort Bragg 5N	48.7	1.0	56.4	1.0	2	65	41.0	1.1	2	52	7.62	-4.97	2	1	61
Kentfield	52.7	4.2	60.6	4.3	0	68	44.7	4.1	0	55	15.84	-4.33	0	1	79
Napa	53.3	5.6	62.8	6.0	0	72	43.7	5.1	0	55	7.34	-1.37	0	1	84
Santa Rosa	52.2	3.7	63.3	5.2	0	75	41.1	2.3	0	52	10.46	-2.69	0	1	80
Ukiah AP	46.9	1.0	57.7	2.1	0	66	36.1	-0.1	0	23	10.76	4.79	0	2	180
Yreka	40.5	6.5	52.9	8.4	0	63	28.2	4.7	0	38	5.35	-2.00	0	0	73
Sacramento Drainage	**43.8**	**4.1**	**53.3**	**4.0**	**1**	**63**	**34.3**	**4.2**	**1**	**33**	**6.83**	**-1.27**	**2**	**1**	**108**
Alturas	31.7	1.3	44.0	0.9	0	57	19.3	1.6	0	-1	0.65	-0.58	0	0	53
Adin Ranger Stn	39.8	6.8	51.6	8.9	0	69	27.9	4.6	0	42	1.11	0.46	0	1	171
Blue Canyon	41.2	2.1	46.5	0.9	0	64	35.9	3.3	0	26	6.39	-2.32	0	2	73
Burney	37.8	6.2	49.4	4.6	2	60	26.2	7.8	2	42	7.28	-2.10	2	1	78
Dunsmuir Treatme	46.8	7.1	59.6	9.1	0	74	33.9	5.3	0	46	14.43	-7.82	0	0	65
Marysville	51.0	4.8	60.6	5.3	0	71	41.4	4.3	0	53	2.87	-0.85	0	1	77
Marysville	46.2	0.0	54.4	-0.9	0	65	37.9	0.8	0	27	2.15	-1.21	0	1	64
Mineral	37.7	5.6	47.9	6.1	1	65	27.5	5.1	1	36	5.07	-6.36	3	1	44
Mount Shasta	37.1	2.3	45.2	1.4	0	59	29.0	3.2	0	19	10.63	5.28	0	2	199
Paradise	52.9	7.0	60.8	6.9	1	76	45.1	7.2	1	51	12.47	-5.86	1	1	68
Portola	35.6	5.7	48.8	7.2	11	61	22.5	4.3	11	34	2.53	-2.83	19	0	47
Quincy	40.7	5.6	51.8	5.2	0	65	29.5	6.0	0	44	6.74	-3.21	2	1	68
Redding AP	48.6	3.3	56.9	1.3	0	71	40.4	5.4	0	27	10.82	6.15	0	3	232
Red Bluff FSS	48.4	2.2	56.4	1.0	0	69	40.3	3.2	0	29	7.23	3.76	0	3	208
Sacramento AP	46.7	1.0	54.3	0.4	0	66	39.1	1.4	0	27	4.14	1.69	0	1	169
Sacramento City	48.9	1.2	56.2	1.2	0	0	41.5	1.1	0	0	4.13	1.37	0	0	150
Shasta Dam	54.1	7.5	61.9	8.6	0	80	46.3	6.5	0	51	17.54	-7.17	0	1	71
Northeast Interior	**34.6**	**5.4**	**47.2**	**4.4**	**3**	**61**	**22.0**	**6.4**	**3**	**36**	**1.84**	**-1.57**	**11**	**1**	**57**
Boca	34.8	6.8	49.9	7.3	4	62	19.7	6.4	4	33	4.80	-2.61	4	0	65
Bodie	28.7	5.1	42.2	1.1	2	58	15.1	9.1	2	37	0.70	-0.95	10	0	42
Bridgeport	32.8	6.9	47.5	5.4	2	64	18.0	8.6	2	34	1.57	0.25	9	0	119
Markleeville	38.2	7.5	50.4	5.9	0	67	26.0	9.2	0	37	1.87	-1.23	19	1	60
Susanville 2 SW	38.7	7.4	49.5	7.7	0	67	27.9	7.2	0	44	0.25	-0.76	8	1	25
Tahoe City	34.8	3.8	45.0	3.6	16	55	24.6	4.0	16	35	2.35	-4.28	20	0	35
Tahoe Valley AP	34.2	0.0	45.7	0.0	0	57	22.6	0.0	0	35	1.36	-1.42	4	1	49
Central Coast	**53.3**	**3.0**	**62.4**	**2.3**	**0**	**72**	**44.2**	**3.7**	**0**	**48**	**5.34**	**-0.84**	**1**	**1**	**111**
Hollister	52.5	3.7	63.8	2.7	0	73	41.1	4.6	0	51	2.61	-1.23	0	0	68
King City	53.2	3.5	66.1	2.9	1	76	40.3	4.2	1	51	5.10	-1.13	1	0	82
Morro Bay	55.7	3.6	63.2	0.9	1	74	48.2	6.4	1	55	4.04	-1.35	1	1	75
Oakland Museum	55.5	4.3	63.5	5.9	0	72	47.6	2.8	0	55	6.54	-1.54	0	1	81
Paso Robles AP	47.2	0.2	59.1	-1.7	0	70	35.2	1.9	0	23	5.07	3.34	0	1	293
Redwood City	55.3	7.3	64.5	7.1	1	73	46.1	7.5	1	54	2.67	-2.71	5	0	50
Richmond	55.6	5.4	61.9	4.6	2	71	49.2	6.2	2	58	5.40	-2.31	3	1	70
Salinas AP	51.5	0.8	61.7	0.3	0	71	41.2	1.2	0	30	3.81	2.05	0	1	216
San Francisco	56.8	4.1	62.9	4.3	0	71	50.7	4.0	0	55	7.72	-1.15	0	1	87
San Francisco AP	52.2	2.6	58.1	2.0	0	64	46.3	3.3	0	36	6.42	3.53	0	2	222
San Jose	51.0	1.0	60.0	1.1	0	71	42.0	1.0	0	55	3.11	-2.31	0	0	57
San Luis Obispo	53.5	-0.5	65.0	-1.4	0	75	42.1	0.5	0	54	6.70	-3.10	1	0	68
Santa Cruz	52.9	2.7	61.6	0.8	1	71	44.3	4.7	1	50	10.28	-2.99	1	1	77

San Joaquin Drainage	**44.2**	**2.0**	**53.5**	**1.3**	**1**	**65**	**34.9**	**2.8**	**1**	**37**	**2.42**	**-1.05**	**3**	**1**	**102**
Bakersfield AP	46.4	-0.8	56.0	-0.1	0	66	36.8	-1.4	0	26	1.09	0.33	0	0	143
Coalinga	51.1	3.6	61.7	2.7	7	71	40.4	4.5	7	50	1.96	-0.53	7	0	79
Fresno	46.5	1.3	53.3	-0.1	0	71	39.7	2.7	0	55	3.16	-0.60	0	0	84
Glennville	42.9	1.4	56.8	0.8	0	69	29.0	2.1	0	42	2.94	-1.60	4	1	65
Grant Grove	38.3	2.6	46.2	2.8	2	57	30.4	2.4	2	38	3.93	-4.13	6	1	49
Hanford 1 S	44.4	0.4	52.2	-2.0	0	63	36.6	2.7	0	21	2.13	1.07	0	1	201
Lodgepole	32.7	5.4	43.3	4.6	0	54	22.1	6.2	0	32	3.32	-3.62	0	1	48
Madera	44.6	0.0	51.6	-2.7	0	63	37.6	2.5	0	26	3.30	1.84	0	1	226
Porterville	50.8	2.5	60.7	2.4	0	70	40.9	2.7	0	50	0.73	-0.97	1	0	43
Stockton	47.2	1.9	54.9	1.1	0	67	39.5	2.8	0	26	3.14	1.32	0	1	173
Yosemite	41.4	3.8	52.2	4.3	7	68	30.5	3.3	7	39	0.93	-4.65	14	0	17
South Coast	**53.7**	**1.0**	**64.2**	**-0.1**	**2**	**76**	**43.3**	**2.1**	**2**	**46**	**4.45**	**0.36**	**3**	**1**	**153**
Alpine	53.1	-1.2	63.9	-1.5	11	74	42.3	-0.8	11	52	2.98	-1.34	11	0	69
Anaheim	60.5	2.7	70.8	1.2	2	83	50.2	4.3	2	62	2.30	-0.83	3	0	73
Big Bear Lake	34.4	-0.1	47.6	-0.3	8	58	21.2	0.1	8	33	3.86	0.03	8	2	101
Burbank	56.7	2.1	67.1	-0.8	0	78	46.4	5.1	0	53	4.37	-1.68	0	0	72
Campo	47.9	0.1	59.3	-3.7	0	76	36.5	4.0	0	23	4.07	2.27	0	2	226
Culver City	58.9	1.9	67.4	-0.3	2	75	50.4	4.1	2	57	4.14	-1.65	15	0	72
El Cajon	58.1	3.8	71.5	3.2	5	78	44.8	4.5	5	54	2.79	-0.62	5	0	82
Escondido 2	56.3	0.9	68.2	-1.0	2	78	44.4	2.8	2	55	2.51	-1.30	2	0	66
Idyllwild Fire D	42.7	1.9	55.7	1.1	7	64	29.7	2.8	7	46	5.14	-1.53	7	1	77
Lompoc	54.9	1.4	66.1	-0.6	1	78	43.8	3.6	1	55	2.93	-1.88	1	0	61
Long Beach AP	56.0	-1.1	66.3	-2.5	0	83	45.7	0.4	0	37	3.79	2.03	0	2	215
Los Angeles/USC	57.7	-0.8	67.5	-1.2	0	85	48.0	-0.3	0	40	8.77	6.86	0	6	459
Los Angeles AP	57.3	-0.3	66.3	-0.4	0	82	48.3	-0.2	0	41	6.49	4.70	0	5	363
Mt Wilson No 2	47.1	1.9	56.4	2.6	0	67	37.9	1.2	0	47	10.92	-4.48	1	0	71
Riverside Citrus	57.4	2.9	71.0	3.1	2	81	43.8	2.7	2	55	2.32	-0.79	1	0	75
Newport Beach Ha	59.3	3.2	65.4	1.2	0	78	53.2	5.2	0	59	1.51	-0.94	0	0	62
San Diego AP	57.8	0.2	65.3	-1.0	0	83	50.4	1.5	0	42	4.01	2.70	0	2	306
Sandberg	43.1	0.6	48.8	-0.3	0	66	37.4	1.5	0	29	6.18	4.01	0	3	285
Santa Ana Fire	60.6	2.7	71.6	1.9	0	82	49.5	3.5	0	59	2.45	-1.60	0	0	60
Santa Barbara AP	51.0	-2.1	63.6	-2.8	0	76	38.4	-1.5	0	30	6.26	4.00	0	2	277
Santa Maria AP	51.5	-0.1	64.3	-0.6	0	79	38.7	0.5	0	28	3.95	2.11	0	2	215
UCLA	59.6	1.0	67.3	0.3	3	77	51.9	1.8	3	60	6.05	-2.15	2	0	74
Southeast Desert	**51.3**	**1.7**	**64.4**	**0.8**	**0**	**75**	**38.1**	**2.6**	**0**	**38**	**1.16**	**0.48**	**1**	**1**	**164**
Bishop	44.0	6.0	57.6	3.3	1	68	30.5	8.9	1	47	1.46	0.48	0	1	149
Blythe AP	55.1	1.6	66.3	0.3	0	76	43.8	2.9	0	32	0.58	0.10	0	0	121
Daggett AP	47.8	0.4	59.9	-1.0	0	68	35.7	1.8	0	26	1.10	0.64	0	1	239
Imperial	54.9	0.3	68.1	-0.6	0	78	41.8	1.1	0	31	0.65	0.24	0	1	159
Inyokern	51.4	5.9	64.1	3.6	0	76	38.7	8.3	0	56	0.50	-0.05	6	1	91
Lancaster	43.3	0.5	59.0	2.1	0	70	27.6	-1.1	0	15	2.22	1.21	0	1	220
Needles AP	55.9	2.0	65.2	0.2	0	75	46.7	3.7	0	34	0.14	-0.30	0	0	32
Palm Springs	56.7	0.0	67.5	-2.5	0	80	45.9	2.5	0	36	1.82	1.21	0	1	298
Thermal AP	54.0	0.1	68.9	-1.7	0	84	39.1	1.9	0	60	0.97	0.34	0	1	154
Twentynine Palms	49.4	-0.1	67.8	4.2	1	76	31.0	-4.4	1	40	2.13	0.92	1	1	176
STATEWIDE	**48.3**	**2.6**	**58.6**	**2.0**	**1**	**69**	**38.1**	**3.2**	**1**	**41**	**4.75**	**-0.62**	**2**	**1**	**120**

All data is provisional and subject to change.
Normal period is 1971-2000.

TAVG = average temperature in Fahrenheit
DEP = departure from average
TMAX = average maximum temperature in Fahrenheit
MGX = number of missing daily max temperature values
PPCT = monthly precipitation percent of normal
PDEP = monthly precipitation departure from normal in inches

TMIN = average minimum temperature in Fahrenheit

MGN = number of missing daily min temperature values
MGP = number of missing daily precipitation values
PREC = total monthly precipitation in inches

Climate Maps for December