California Climate Watch

A monthly newsletter monitoring California climate

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

Summary of the Month

by Bill Mork, California DWR

March 2004 turned out to be dry and unusually warm in the Golden State, setting new monthly average temperature records at 82 locations in California according to preliminary data. There were also a number of locations which set records for highest monthly average maximum temperatures. Above normal temperatures and nearly full seasonal sunshine combined to cause early snowmelt and about a 25 percent loss in snowpack water content during the month. As a result, April through July runoff forecasts were reduced about 20 percent from those of last month. Runoff forecasts in the Sacramento River region are still near historic median levels, but southern Sierra river runoff is expected to be considerably below normal. There is enough snowpack and water in storage to avoid drought this year, but supplies may be short in some areas in the southern part of the Central Valley.

March 2004 precipitation in California averaged about 1/3 of normal, with percents of normal a little above this in the north and below this at most locations in the Southland. Pacific weather systems of note were limited to 1 - 3 March and 24 - 27 March. According to preliminary data, the greatest total was 5.88 inches at Gasquet in the Smith basin.

A strong upper level ridge of high pressure and offshore flow contributed to an amazing total of 384 record high temperatures set or tied in California 7 - 23 March. The San Francisco and Monterey Bay areas had 105 of these records. The Sacramento city weather station had high temperature records set or tied on 13 of 14 days March 8 - 21. High temperatures were 80 or higher on all 14 days, easily breaking the old March record of 8 days of 80 or higher set in 2001. The average monthly temperature of 62.5 degrees was 5.8 degrees above normal, breaking the old record of 61.5 in 1934. The average monthly high temperature of 75.4 degrees was 8.4 degrees above normal, smashing the old record of 73.3 in 1997.

WEATHER *continued on page 2.*

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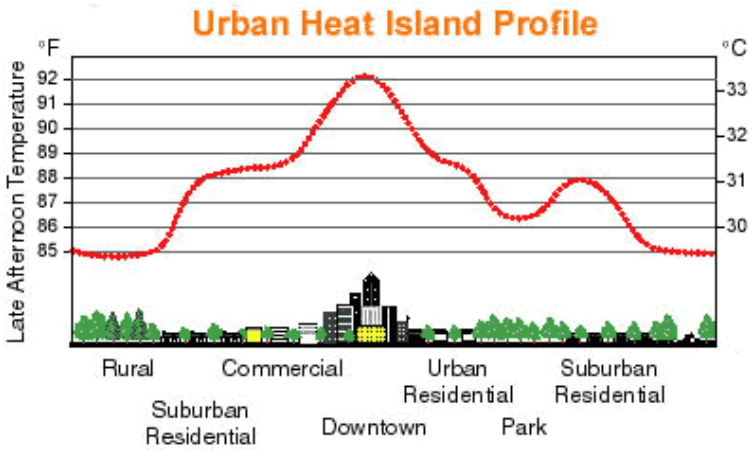
Pavement and Trees: UHI Effect



http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsLocalHeatIslandEffect.html

By Laura Edwards

As population globally migrates from rural to urban areas, climate in cities has become a growing area of study. In 2000, 45% of the world's population lived in urban areas, a number expected to increase to 50% by 2007 if current trends continue[1]. The Urban Heat Island (UHI) effect, or warming of metropolitan areas, is often seen in areas of urban development. This local warming effect can increase global average temperature as more people move to urban locations. The migration of rural habitants to urban areas increases UHI, but does not reduce rural average temperatures.

The primary cause of UHI is the difference between energy gain and loss rates in urban versus rural areas. Several factors determine how UHI is structured[1,3]:

- UHI intensity decreases with increasing wind speed;
- UHI intensity decreases with increasing cloud cover;
- UHI intensity is greatest during anticyclonic (high pressure) conditions;
- UHI intensity is best devloped in the summer or warm half of the year;
- UHI intensity tends to increase with increasing city size and/or population;
- UHI intensity is greatest at night;
- UHI may disappear by day or the city may be cooler than surrounding rural areas;
- Rates of heating and cooling are greater in rural than urban areas.

The negative impacts of UHIs are well-documented. UHIs increase demand for energy to cool buildings as well as enhance smog formation and pollution problems.

Studies have investigated UHIs in metropolitan areas worldwide, including Sacramento and Los Angeles, CA[2]. Methods used to study this effect include: modeling, field experiments and satellite imaging. The best time to measure UHI is on a calm, clear, summer night. Under these conditions, the UHI effect is most pronounced and least affected by meteorological factors.

Grimmond and Oke (1995) compared UHIs in Tucson, Sacramento, Chicago and Los Angeles. They found daytime effects to be similar for the four cities, but nocturnal effects differed greatly. A clear diurnal trend was found in each of the locations.

UHI continued on page 2.

INSIDE THIS ISSUE: Climate Maps, Monthly Station Data, Climate Forecasts

WEATHER (continued from page 1):

Bakersfield set or tied 25 daily high temperature or high minimum temperature records; the average monthly temperature of 65.1 degrees was 7.8 degrees above normal, breaking the old record of 65.0 set in 1934. The high of 94 at Bakersfield on March 29 was the warmest ever in the month of March. Bakersfield also had a record 17 days with 80 or higher and a record 3 days with 90 or higher. The record high temperature of 101 at Death Valley on March 20 was the earliest date on record with 100 degrees or higher at Death Valley.

UHI (continued from page 1):

Others have compared urban to rural sites in similar climate regimes and have verified urban heating. Kukla et al. (1986) determined urban sites have enhanced warming rates of 0.04-0.34 degrees C/decade.

In 1998, UHIPP (Urban Heat Island Pilot Project) performed field experiments and infrared imaging to determine the UHI effect in Sacramento, CA. UHIPP has also taken IR images over Salt Lake City and Baton Rouge, coordinating their air observations with ground measurements.

A related area of research has been devoted to developing construction materials that reduce the UHI effect, including using lighter colors and materials that do not absorb or conduct heat as well as asphalt or concrete. Many scientists agree, however, that the strategic addition of greenspace and vegetation to urban areas is among the best ways to reduce UHI, as well as make the environment more aesthetically pleasing.

Sacramento summer heat as seen by NASA's ATLAS imager on Monday, June 29, 1998. Red and white colors show warmer surfaces, and blue and green colors are cool.

Credit: NASA/Marshall Space Flight Center and Global Hydrology and Climate Center

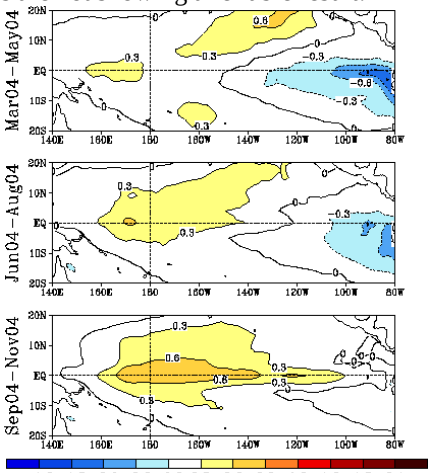
References:

1. Arnfield, AJ, 2003. Two decades of urban climate research: A review of turbulence, exchanges of energy and water, and the urban heat island. *Intl. J. of Climat.* **23**:1-26.
2. Grimmond, C.S.B. & Oke, T.R., 1995. Comparison of heat fluxes from summertime observations in the suburbs of four North American cities. *J. Appl. Met.***34**:873-889.
3. Oke, T.R., 1982. The energetic basis of the urban heat island. *Q. J. Roy. Meteor. Soc.* **108**(455): 1-24.
4. Kukla, G. et al., 1986. Urban warming. *J. Clim. and Appl. Met.* **25**: 1265-1270.
5. WXWISE Urban Heat Islands, http://cimss.ssec.wisc.edu/wxwise/heatisl.html

Climate Forecasts

ENSO April forecast:

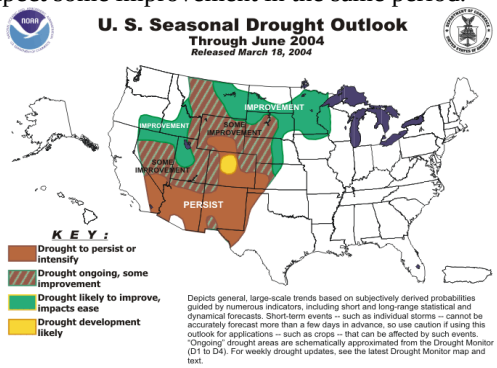
Climate Prediction Center (CPC) has predicted ENSO-neutral conditions through May 2004, with likely persistence for the next 3-6 months. SST anomalies have been decreasing since early December 2003. ENSO-neutral conditions have little effect on continental U.S. temperature and precipitation forecasts. The long-term ensembles are not showing a reliable result.



Credit: CPC/NCEP Markov Model Forecast.

Drought conditions:

CPC has forecast persisting moderate drought conditions in the southeastern desert region of California/east of the Sierra through June 2004. The northeast corner of the state can expect some improvement in the same period.



Credit: CPC/NCEP

Temperature and Precipitation Outlooks:

For April-June 2004, CPC forecasts above normal temperatures in California for all but the southwest corner, which is equal chances or near climatology. Equal chances of below and above normal precipitation are forecast for the state for the same period.

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6. NASA Space Science News, http://science.msfc.nasa.gov/newhome/headlines/essd01jul98_1.htm
7. NASA/GHCC Project ATLANTA & UHIPP, http://wwwghcc.msfc.nasa.gov/uhipp/urban_uhipp.html

March Station Data

All data is provisional and subject to change.

Station Name	# msg T	Ta	Ta dep	Tx	Tx dep	Tn	Tn dep	# msg P	P tot	P dep	P pct
North Coast											
Eureka	0	51.5	1.5	57.8	1.3	45.1	1.5	0	2.38	-3.00	44
Kentfield	0	59.5	4.8	71.7	6.3	47.3	3.4	1	2.06	-4.76	30
Manzanita Lake	9	43.9	8.8	57.8	11.5	30.0	6.0	9	1.85	-3.83	33
Napa	0	57.5	2.8	71.8	5.6	43.2	0.0	0	0.90	-3.01	23
Santa Rosa	0	59.4	5.6	74.6	9.9	44.2	1.3	0	1.42	-3.12	31
Yreka	1	48.3	4.5	64.6	7.6	32.0	1.5	5	1.11	-0.90	55
Sacramento											
Alturas	0	43.7	5.2	60.4	8.5	27.0	2.0	0	0.78	-0.74	51
Adin Ranger Stn	1	47.8	7.5	63.0	10.5	32.6	4.6	5	0.95	-1.05	48
Blue Canyon	0	49.7	10.1	55.8	9.3	43.5	10.8	0	1.48	-7.68	16
Burney	0	46.9	6.7	63.6	8.7	30.1	4.8	0	1.50	-2.33	39
Dunsmuir Treatme	0	52.3	6.1	68.1	9.5	36.6	2.7	0	3.38	-5.85	37
Marysville	0	60.3	4.1	72.8	5.7	47.9	2.5	0	1.42	-1.91	43
Mineral	3	41.9	5.6	55.4	8.5	28.4	2.8	3	1.86	-6.10	23
Mt. Shasta	0	48.6	7.2	62.0	9.5	35.3	5.0	0	1.53	-4.19	27
Quincy	0	49.3	5.0	67.0	8.2	31.5	1.7	0	1.42	-4.60	24
Redding	0	60.8	7.0	74.4	9.5	47.2	4.6	0	1.43	-3.34	30
Red Bluff FSS	0	60.4	5.9	74.3	9.3	46.5	2.7	0	1.47	-1.79	45
Sacramento AP	0	59.8	5.2	72.6	7.6	46.9	2.7	0	0.48	-2.02	19
Sacramento City	0	62.5	5.4	75.4	8.4	49.7	2.6	0	0.49	-2.66	16
Shasta Dam	0	59.9	7.3	71.2	9.5	48.6	5.2	0	4.24	-5.90	42
Northeast Interior											
Bodie	7	34.5	6.2	52.8	8.4	16.2	4.1	1	0.33	-1.22	21
Susanville 2 SW	0	47.9	6.5	62.5	8.5	33.3	4.6	1	0.00	-1.37	0
Central Coast											
Gilroy	2	62.2	6.9	76.8	9.4	47.5	4.3	0	0.54	-2.85	16
Hollister	0	59.8	5.7	74.9	9.1	44.7	2.4	0	0.64	-1.65	28
King City	1	61.3	6.4	77.9	9.0	44.7	3.8	0	0.26	-2.07	11
Oakland Museum	12	62.5	6.2	73.5	10.0	51.6	2.4	13	0.57	-2.79	17
Paso Robles AP	0	59.0	5.9	75.9	9.5	42.0	2.3	0	0.25	-2.24	10
Redwood City	0	61.3	6.4	73.5	8.0	49.0	4.7	0	0.39	-2.71	13
Richmond	1	60.9	5.2	71.2	7.1	50.6	3.4	0	0.68	-2.77	20
Salinas AP	0	59.6	5.4	71.7	7.9	47.5	2.9	0	0.50	-1.75	22
San Fran MD	0	60.5	4.8	69.0	6.9	52.0	2.7	0	1.15	-1.93	37
San Francisco Ap	0	59.6	5.4	68.8	7.3	50.4	3.6	0	0.67	-2.47	21
San Jose	0	61.5	5.2	72.5	6.4	50.4	3.9	0	0.49	-1.93	20
San Luis Obispo	0	60.3	5.1	71.7	5.5	48.8	4.6	0	0.35	-3.74	9
Santa Cruz	0	58.5	4.6	69.9	5.3	47.1	3.9	0	1.34	-3.24	29
San Joaquin											
Bakersfield	0	65.1	7.4	78.3	9.0	52.0	5.9	0	0.53	-0.72	42
Fresno	0	62.4	6.3	74.9	7.6	49.9	5.1	0	1.54	-0.46	77
Glennville	2	52.0	5.3	68.1	8.1	35.9	2.5	2	0.82	-2.57	24
Hanford 1 S	0	61.5	6.2	74.9	7.7	48.1	4.7	0	0.29	-1.22	19
Lodgepole	1	39.3	6.9	53.3	9.0	25.4	4.7	1	0.49	-6.34	7
Madera	1	59.5	4.6	73.7	6.7	45.3	2.6	1	0.67	-1.39	33
Porterville	1	59.3	1.9	73.7	3.7	44.9	0.1	1	0.67	-1.37	33
Stockton WSO	0	58.6	3.5	72.9	6.5	44.3	0.5	0	0.69	-1.43	33
Yosemite	7	58.5	12.9	73.0	14.4	44.1	11.6	8	0.68	-4.51	13

All data is provisional and subject to change.

Station Name	# msg T	Ta	Ta dep	Tx	Tx dep	Tn	Tn dep	# msg P	P tot	P dep	P pct
South Coast											
Alpine	4	61.7	5.2	74.7	6.3	48.8	4.1	4	0.61	-2.94	17
Anaheim	10	65.8	5.3	76.3	5.2	55.2	5.3	6	0.84	-1.65	34
Big Bear Lake	5	44.8	6.7	61.3	9.8	28.4	3.6	5	1.18	-1.99	37
Burbank	0	65.0	6.3	77.1	5.3	53.0	7.2	0	0.61	-2.81	18
Campo	0	57.3	6.1	74.8	8.1	39.7	4.0	0	0.58	-1.93	23
Culver City	9	61.8	2.2	70.0	1.0	53.5	3.5	9	0.70	-1.55	31
El Cajon	12	64.7	5.3	78.3	6.7	51.1	4.0	12	0.34	-2.25	13
Escondido 2	15	61.4	2.5	75.1	4.2	47.8	0.7	15	0.56	-2.46	19
Idyllwild Fire D	2	53.1	9.5	69.7	12.9	36.5	6.2	5	0.90	-3.49	21
Lompoc	0	59.7	3.6	70.2	2.3	49.3	5.0	0	0.57	-2.57	18
Long Beach AP	0	63.2	3.7	72.0	3.3	54.3	4.1	0	1.02	-1.15	47
Los Angeles Down	0	63.1	1.6	72.1	1.8	54.1	1.5	0	1.02	-1.70	38
Los Angeles AP	0	64.8	6.2	74.5	8.8	55.1	3.7	0	1.17	-0.97	55
Mt Wilson No 2	0	61.0	14.1	68.0	12.5	54.0	15.7	0	0.77	-6.74	10
Riverside Citrus	1	66.3	8.3	81.9	11.8	50.8	4.9	1	0.03	-1.92	2
Newport Beach Ha	0	60.3	2.9	65.1	1.4	55.5	4.4	0	0.32	-1.68	16
San Diego AP	0	62.6	2.5	68.4	1.7	56.9	3.2	0	0.22	-1.78	11
Sandberg WSMO	0	55.2	8.9	63.5	9.6	46.9	8.3	0	0.47	-1.72	21
Santa Ana Fire S	2	65.6	5.3	77.4	6.5	53.7	4.0	0	0.00	-2.51	0
Santa Barbara	0	58.1	2.1	67.7	1.7	48.5	2.7	0	0.50	-2.87	15
Santa Maria AP	0	58.1	4.2	69.6	4.5	46.5	3.9	0	0.55	-2.19	20
UCLA	2	63.4	4.5	72.4	5.3	54.4	3.7	1	0.81	-2.21	27
Southeast Desert											
Bishop	0	55.1	7.4	73.9	9.5	36.3	5.3	0	0.10	-0.45	18
Blythe	0	73.0	8.3	87.5	8.6	58.5	8.1	0	0.81	0.43	213
Daggett AP	0	65.1	6.1	79.4	7.7	50.7	4.4	0	0.65	0.16	133
Imperial	0	70.6	5.5	86.9	7.7	54.3	3.3	0	0.28	-0.01	97
Lancaster	0	60.0	7.8	77.0	12.1	43.0	3.5	0	0.24	-1.05	19
Needles AP	0	72.8	8.7	85.9	8.6	59.7	8.8	0	0.06	-0.50	11
Palm Springs	0	73.9	8.7	87.2	7.5	60.6	9.9	0	0.13	-0.50	21
Thermal AP	0	70.6	6.1	88.8	8.4	52.4	4.0	0	0.11	-0.24	31
Twentynine Palms	0	63.7	4.5	82.6	7.8	44.8	1.3	0	0.76	0.35	185
Sums	**111**							**109**			
Averages	**1.48**	**58.6**	**5.8**	**71.6**	**7.5**	**45.5**	**4.2**	**1.45**	**0.85**	**-2.35**	**32.7**

Normal period is 1971-2000.

KEY:

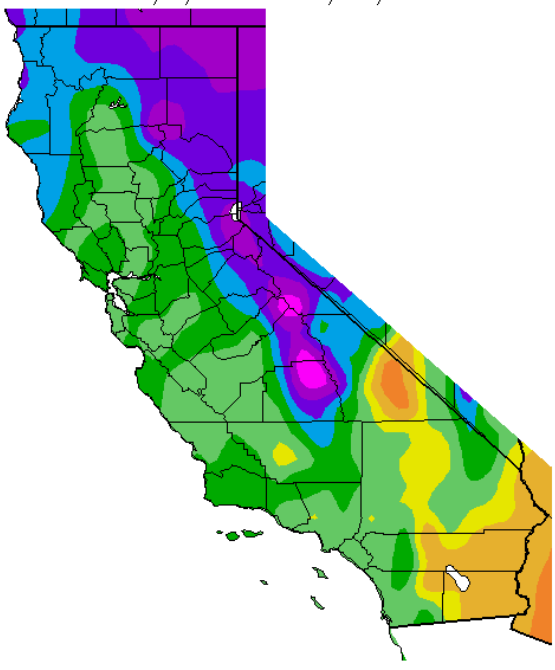
 # msg T = number of missing daily temperature values
Ta = average temperature in Fahrenheit
da = average temperature departure from normal in Fahrenheit
Tx = average maximum temperature in Fahrenheit
dx = average maximum temperature departure in Fahrenheit
Tn = average minimum temperature in Fahrenheit
dn = average minimum temperature departure in Fahrenheit
 # msg P = number of missing daily precipitation values
P tot = total monthly precipitation in inches
P dep = monthly precipitation departure from normal in inches
P pct = monthly precipitation percent of normal

Snow and Hydrological Update

NRCS/DWR/NWS have issued streamflow forecasts for the April-July period. They forecast an average streamflow of 77% of the 1971-2000 average across California, with a maximum at Trinity River (Clair Engle Lake Inflow, 110%) and a minimum at Tule River (Success Dam, 45%). The lack of precipitation and warm temperatures took their toll on the Northern Sierra 8-Station Precipitation Index and snow water content. After February preciptation totalled 180% of average, the 8-Station Index recorded only 2.2 inches in March, or 32% of normal. Snow water content is at 70% of average in the Southern Sierra and 104% of average in the Northern Sierra for the water year so far, Oct 1-Apr 2. One month ago, the Southern Sierra reported 92% of average and Northern Sierra 125%.

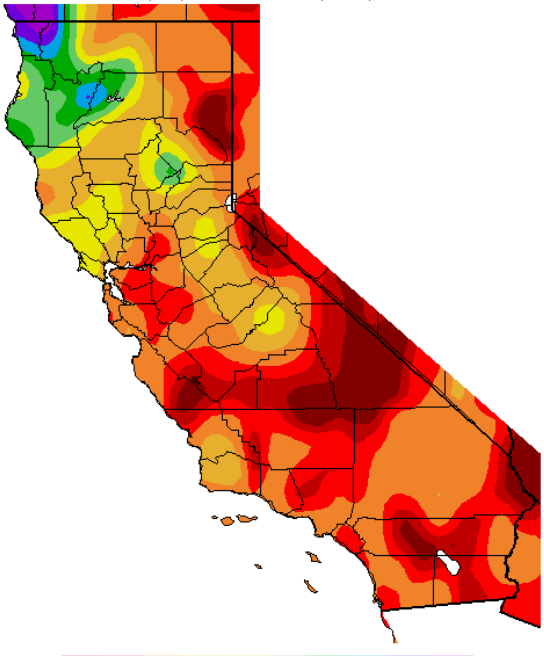
Climate Maps for March

Ave. Temperature (deg. F)
3/1/2004 – 3/31/2004



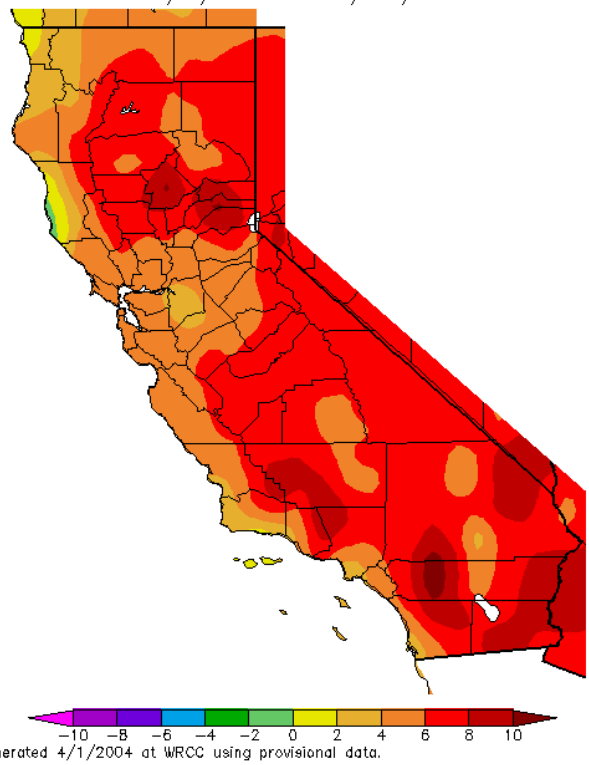
Generated 4/1/2004 at WRCC using provisional data.
NOAA Regional Climate Centers

Total Precipitation (in.)
3/1/2004 – 3/31/2004



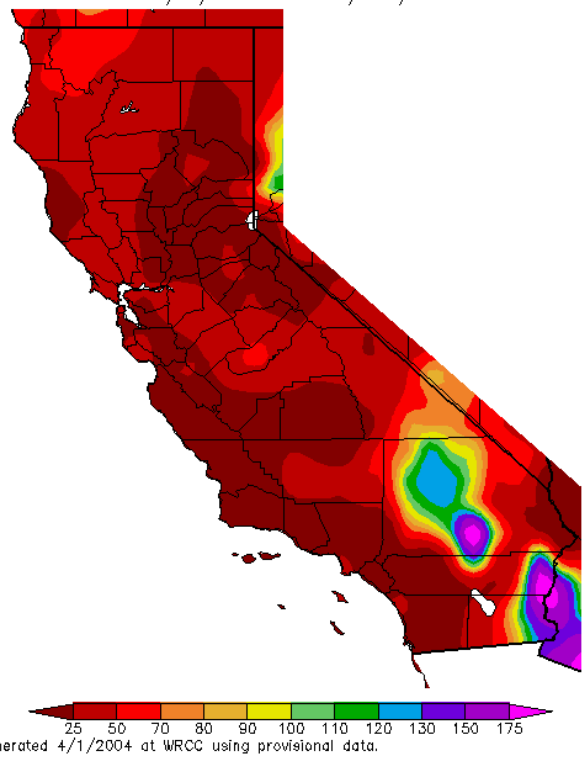
Generated 4/1/2004 at WRCC using provisional data.
NOAA Regional Climate Centers

Ave. Temperature departure from Normal
3/1/2004 – 3/31/2004



Generated 4/1/2004 at WRCC using provisional data.
NOAA Regional Climate Centers

Percent of Average Precipitation (%)
3/1/2004 – 3/31/2004



Generated 4/1/2004 at WRCC using provisional data.
NOAA Regional Climate Centers