California Climate Watch

A monthly newsletter monitoring California climate

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

Summary of the Month

by Bill Mork, California DWR

April 2004 continued in the warm and dry pattern established in March, except the April monthly average temperature departures from normal were not nearly as large as March; largest departure was at the Redding Airport with an average temperature of 62.5 degrees, 4.8 degrees above normal. The only real break was a period of cool, showery weather when the mean long wave trough position was near the West Coast April 13 - 21.

From preliminary data April precipitation averaged about 1/3 of normal. Most locations from the I-80 corridor south to Los Angeles and Santa Barbara had less than 25 percent of normal precipitation. Some locations with no measurable precipitation in April include Culver City, Gilroy, Lompoc, Madera, and San Luis Obispo. An upper level low the first three days of April and a cold upper level trough of low pressure April 16 - 17 provided some moderate to locally heavy precipitation which was enough for above normal monthly totals at some Southeast Desert locations which are normally very dry. The best example of this was Needles with 1.35 inches in April, 614 percent of the average of 0.22 inches.

Heaviest Southland totals the first three days of April include 1.10 inches at Alpine, 1.07 inches at Poway, and 0.99 inches at Yorba Linda. Heaviest totals same area on April 16 - 17 include 1.05 inches at Idyllwild and 0.78 inches at Palomar Mountain. Other large storm totals for April 13 - 21 include 5.88 inches at Stouts Meadow (Shasta drainage), 4.96 inches at Four Trees (Feather drainage), and 4.96 inches at Brandy Creek. The wettest location in April was Gasquet on the Smith River in extreme northwest California with 9.28 inches (143 percent of average), all falling in the wet period of April 13 - 21.

***WEATHER** continued on page 2.*

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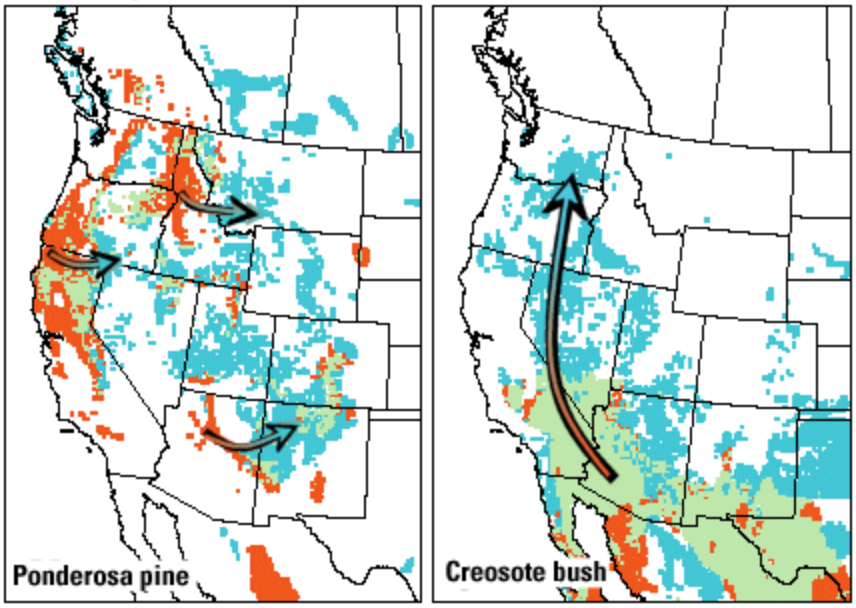
Vegetation Adaptation and Migration



Projected plant migration with 2xCO$_2$ scenario.
http://www.geo.arizona.edu/Antevs/nats104/00lect27usgs2xco2.html

By Laura Edwards

California is home to about 25% of the flora species in the continental United States, and about 25% of these species are endemic to California[1]. How can these unique species, and others that are not as unique, adapt to predicted climate change? Increasing atmospheric greenhouse gas concentrations and changing precipitation and temperature patterns will play defining roles in vegetation distribution and biodiversity.

Increasing atmospheric CO_2 concentration has positive impacts on plant growth rates by way of the CO_2 fertilization effect. Yet, as average temperature increases, as has been observed in the climate record, forests need to migrate northward or to higher elevations in order to maintain their seasonal growing cycle. The majority of climate models agree that annual temperatures are expected to continue increasing by at least a few tenths of degrees Celsius per decade.

Some climate models predict that winter precipitation will increase in the California over the next 100 years, with little change in summer, maintaining the Mediterranean climate that is present today. Precipitation and its interaction with the water cycle are just as important as temperature in their effects on vegetation, but the forecasted trend is uncertain. The seasonality of precipitation also has effects on where various species can survive. In California, the dry summer season across much of the state demands that species be drought-tolerant for survival.

***VEGETATION** continued on page 2.*

INSIDE THIS ISSUE: Fire Season Forecast, Monthly Climate Data & Climate Maps

WEATHER (continued from page 1):
The largest daily precipitation totals in April were 3.60 inches at Gasquet on April 19 and 3.80 inches at Brandy Creek (west of Redding) on Apr 20. The Northern Sierra 8-Station Precipitation Index picked up 1.67 inches in April, 43 percent of average.

The average monthly temperature for all stations in the State was about 2 degrees above normal. The first half of the month was close to normal while the second half of April was much above normal. Only 6 stations in the State had below normal temperatures in April with Oakland the coolest at 1.4 degrees below normal. The record heat of April 24 - 28 had a lot to do with the month going above normal in most of the State. A strong upper level ridge of high pressure and offshore flow were the usual suspects as 157 record high temperatures were set or tied in California in that period. All-time record high temperatures for the month of April included 102 at King City (tied), 100 at Salinas, 99 at Paso Robles (tied), 98 at Sacramento (city), 95 at Napa (tied), and 94 at Richmond. The hottest of the many record highs was 109 at Death Valley on April 28. The greatest number of record highs was 64 on April 27 as 16 cities in Southern California had high temperatures of 100 degrees or more; hottest that day was 103 at Pierce College (Canoga Park).

Hydrological Summary and Outlook:
Snowpack melting continued at much above normal April rates, and only about half the April 1 pack remained on May 1. Snowmelt runoff seems to be about one month early this year and can be expected to taper off relatively early. Runoff forecasts were lowered because of the dry April and still show a strong north to south gradient, with much below average expectations in the southern half of the State. Reservoir storage is near average, which will help meet most water needs this year, but supplies may be short in the southern part of the Central Valley and eastern Sierra. Runoff so far this water year has been about 90 percent of average compared to 100 percent at this time last year. Runoff during April was nearly 80 percent of average for the month.

Forecasts of April through July runoff are 65 percent of average overall, ranging from near normal in the Trinity and northern Shasta Lake tributaries to 55 percent in the southern Sierra. Water year forecasts are somewhat better at 80 percent of average statewide. Snowpack water content dropped at about double the normal rate in April and now stands at about 50 percent of average for May 1 overall or 40 percent of the average for April 1. The rapid rate of melting swelled monthly streamflow to near normal on a number of major snowfed rivers in spite of the lack of rain. Last year the pack was 105 percent of average at this time as a result of a wet and cool April 2003.

Estimated runoff of the 8 major rivers of the Sacramento and San Joaquin River regions was 2.7 million acre-feet during April. Reservoir storage gained about 0.4 million acre-feet during the month, to end at just over average for the date. This was less than the normal gain of about 1.4 million acre-feet expected in April. With the reduction in expected late season snowmelt, not many of the major foothill reservoirs are likely to fill. Last year at this time, reservoir storage stood at 105 percent of average.

VEGETATION (continued from page 1):
Various vegetation models have been run combining these predicted temperature and precipitation changes for regions across the United States, including California. Most of these models agree that the desert areas will be wetter, and some may turn to grassland or scrubland in the next 100 years[1]. There have been mixed results with evergreen forest area expansion or decrease and the advancement of grasslands into wooded areas[1,3]. It is hard to predict how coastal areas will change in the same period, as human migration and urbanization change the natural landscape, as well as difficulty in estimating oceanic effects.

Studies of paleoclimate and paleoecology have shown that tree populations have migrated northward at rates up to 2 km/year in the eastern U.S.[2], but the average rate of plant migration is not as fast as the current rate of climate change. Current studies in Arizona and elsewhere are investigating the potential effects of climate change on western biota. The terrain and climates of the West are difficult factors that need consideration when forecasting changes in vegetation. Other studies are looking at direct CO_2 effects on plant growth.

Not only will species move to higher latitude or higher altitude, but the species mix or biodiversity of a region will change. Each species has different methods of adaptation, rates of migration, and ranges of sustainable habitat.

Human impacts on the landscape are important because of the habitat fragmentation caused by urbanization and other disruptions to the natural environment. There have been documented cases of seeds naturally migrating hundreds of kilometers, but this is rare[4]. The normal methods of long-distance plant migration are by water, wind, and birds and large mammals[4].

Other factors that are important in considering vegetation migration or adaptation are the soil and landscape characteristics in the target areas and existing plant and animal species. Invasive species also play a significant role in an ecosystem's ability to adopt new species. What we know we can expect in the future are changes in forest locations and vegetation species combinations.

References:

1. Lenihan, J. M. et al, 2003. Climate change effects on vegetation distribution, carbon, and fire in California. *Ecol. Appl.* **13(6):** 1667-1681.

2. Roberts, L., Feb. 10, 1989. How fast can trees migrate? *Science* **243(4892):** 735-737.

3. United States Environmental Protection Agency, 1997. Climate change and California.

4. Pitelka, L. F. and Plant Migration Group, 1997. Plant migration and climate change. *Amer. Sci.* **85(5):** 464-474.

5. Gates, D. M., 1993. Climate change and its biological consequences. Sinauer Associates, Inc., Sunderland, Mass.

6. Thompson, R. S. et al., 1998. A strategy for assessing potential future changes in climate, hydrology, and vegetation in the western United States. USGS Circular 1153. http://pubs.usgs.gov/circ/1998/c1153/index.html

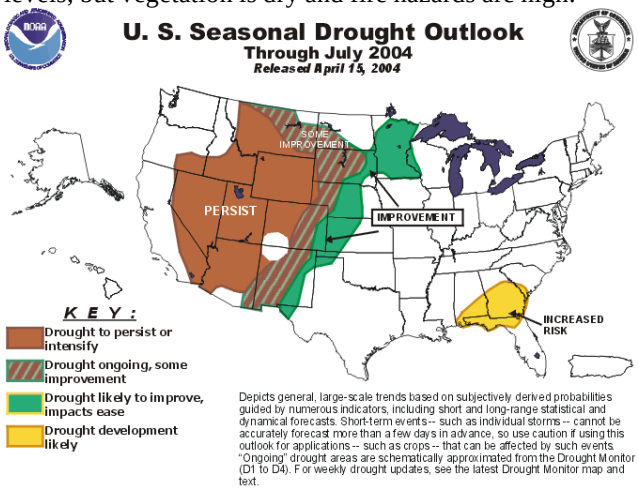
Climate Forecasts

ENSO May forecast:

The current forecast calls for ENSO-neutral conditions through the next three months. The latest long-term forecast ensemble is split with half of the models forecasting near-neutral conditions, and half predicting a developing El Niño event by the end of the year.

Drought conditions:

With dry conditions persisting in April after one of the warmest Marches on record, drought conditions are forecast to continue in much of the West, including the southeastern section and the northeastern corner of California. Most of the state's reservoirs are near-normal levels, but vegetation is dry and fire hazards are high.



Credit: CPC/NCEP

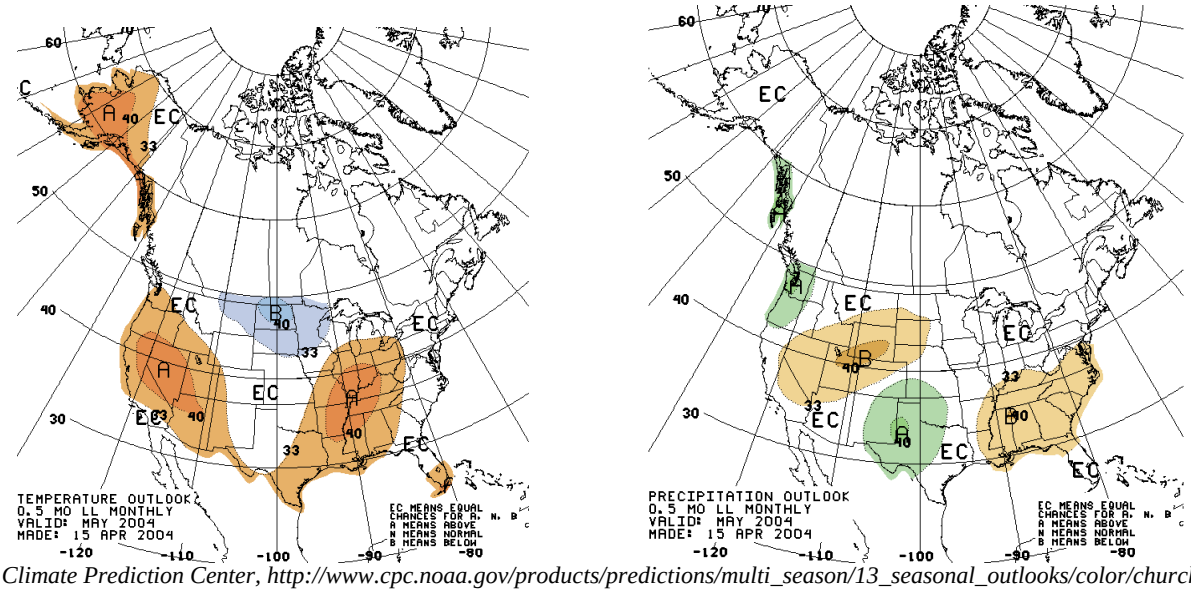
Fire Forecast for California:

The Forest Service has forecast near-normal fire conditions for May. As of April 26, they predicted dry conditions early in the month with wetter conditions the second half of May. Spring vegetative growth has been good and dry fuels are being watched. Their season forecast calls for normal fire conditions over most of the state, with above normal conditions in the south interior, Sierra crest and eastern Sierra regions. (See: http://www.fs.fed.us/r5/fire/north/fwx/htm for more details.)

Credit: http://www.fs.fed.us/r5/fire/north/fwx/SeasonAssessment.htm

Temperature and Precipitation Outlooks:

California temperatures are expected to remain above normal in May, with the exception of the south-southwestern part of the state from Santa Barbara to Blythe. Precipitation is projected to be near normal, with below normal in the central and southern Sierra and eastward. Above normal precipitation is expected in the northwest along the Oregon border.



Credit: Climate Prediction Center, http://www.cpc.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html.

April Station Data

All data is provisional and subject to change.

Station Name	TA	DA	TX	DX	MGX	TN	DN	MGN	PMO	PDP	PCT	MGP
North Coast												
Eureka	52.6	1.9	60.4	3.0	0	44.7	0.7	0	1.68	-1.23	58	0
Kentfield	58.7	0.5	70.2	-0.4	0	47.2	1.4	0	0.20	-2.36	8	0
Manzanita Lake	41.1	1.5	54.1	2.6	12	28.1	0.4	12	0.93	-2.51	27	12
Napa State Hosp	60.8	3.2	74.5	4.0	0	47.2	2.5	0	0.34	-1.11	23	0
Santa Rosa	58.4	0.8	71.6	2.0	0	45.1	-0.5	0	0.68	-0.99	41	0
Yreka	50.8	2.3	68.0	4.5	3	33.6	0.1	3	0.89	-0.31	74	8
Sacramento Drainage												
Alturas	45.8	1.8	62.7	2.9	0	28.9	0.7	0	0.90	-0.21	81	0
Adin Ranger Stn	49.9	3.4	65.2	5.9	0	34.6	0.9	0	0.51	-0.71	42	0
Blue Canyon	48.0	3.5	55.1	2.6	0	40.8	4.3	0	2.16	-2.82	43	0
Burney	49.1	3.6	65.2	2.2	2	33.0	4.9	2	1.17	-0.78	60	2
Dunsmuir Treatment Plt	53.9	3.8	69.5	4.3	1	38.3	3.2	1	3.25	-0.89	79	1
Marysville	62.0	0.7	76.6	2.4	0	47.4	-1.0	0	0.33	-1.10	23	0
Mineral	44.2	3.5	58.0	4.9	2	30.5	2.1	2	1.80	-2.34	43	2
Mt. Shasta	49.8	3.6	63.6	4.4	0	36.0	2.7	0	1.13	-1.52	43	0
Quincy	50.7	2.5	67.8	2.6	0	33.6	2.4	0	0.82	-1.71	32	0
Redding AP	62.5	4.8	75.8	5.2	0	49.2	4.3	0	1.18	-1.22	49	0
Red Bluff FSS/AP	62.5	3.0	76.2	4.3	0	48.9	1.9	0	0.23	-1.16	17	0
Sacramento AP	62.5	3.7	76.1	4.7	0	48.9	2.6	0	0.09	-0.93	9	0
Sacramento City	64.5	2.8	77.9	4.0	0	51.2	1.7	0	0.11	-1.06	9	0
Shasta Dam	61.2	3.3	72.0	3.7	0	50.4	2.9	0	2.91	-1.27	70	0
Northeast Interior												
Bodie	36.1	1.7	55.1	4.3	8	17.0	-1.0	8	0.11	-0.78	12	0
Susanville 2 SW	49.4	2.4	63.5	2.4	0	35.2	2.3	0	0.00	-0.57	0	2
Central Coast												
Gilroy	61.9	2.1	76.5	3.5	2	47.4	0.8	2	0.00	-1.16	0	0
Hollister	59.0	2.0	73.2	2.3	0	44.7	1.6	0	0.08	-0.71	10	0
King City	60.9	1.9	77.8	3.0	3	44.0	0.9	3	0.00	-0.74	0	3
Oakland Museum	57.1	-1.4	64.9	-1.5	6	49.3	-1.3	6	0.21	-1.17	15	3
Paso Robles AP	59.4	2.1	78.7	5.1	0	40.1	-0.9	0	0.07	-0.61	10	0
Redwood City	60.9	3.3	71.8	1.9	0	50.0	4.8	0	0.04	-1.03	4	2
Richmond	60.5	3.2	70.0	3.7	0	51.1	2.7	0	0.26	-1.09	19	0
Salinas AP	58.5	1.9	69.8	2.8	0	47.3	1.2	0	0.00	-0.93	0	0
San Fran MD	58.0	0.7	67.0	2.5	0	50.0	-0.1	0	0.18	-1.07	14	0
San Francisco AP	59.3	3.1	68.0	3.7	0	50.7	2.6	0	0.10	-1.08	8	0
San Jose	61.3	1.1	72.5	0.4	0	50.1	1.8	0	0.27	-0.75	26	0
San Luis Obispo	58.9	0.8	71.5	0.7	0	46.2	0.8	0	0.00	-1.31	0	0
Santa Cruz	57.0	0.4	67.3	-1.5	4	46.7	2.3	4	0.48	-1.49	24	0
San Joaquin												
Bakersfield	67.2	4.6	80.8	5.1	0	53.6	4.0	0	0.02	-0.43	4	0
Fresno	65.8	4.6	79.5	5.5	0	52.0	3.6	0	0.03	-0.73	4	0
Glennville	51.7	2.0	67.4	2.3	1	35.9	1.6	1	0.19	-1.43	12	3
Hanford 1 S	63.7	3.1	79.4	5.0	0	47.9	1.1	0	0.01	-0.62	2	0
Lodgepole	40.2	2.8	52.3	2.4	4	28.2	3.2	4	1.04	-2.02	34	4
Madera	63.2	2.7	79.1	4.8	1	47.3	0.7	1	0.00	-1.00	0	1
Porterville	62.7	-0.9	78.4	1.5	1	47.1	-3.2	1	0.11	-0.76	13	1
Stockton WSO/AP	62.0	2.0	77.2	3.9	0	46.8	0.1	0	0.23	-0.73	24	0
Yosemite	52.9	1.9	67.0	2.3	8	38.8	1.4	8	0.54	-2.03	21	8

Station Name	TA	DA	TX	DX	MGX	TN	DN	MGN	PMO	PDP	PCT	MGP
South Coast												
Alpine	61.5	2.0	72.6	0.7	4	50.5	3.4	4	1.46	0.20	116	4
Anaheim	66.1	4.1	77.0	4.5	5	55.1	3.7	5	1.00	0.34	152	5
Big Bear Lake	45.0	1.9	58.6	0.6	2	31.5	3.2	2	0.25	-0.70	26	2
Burbank	64.1	1.9	74.4	-0.5	0	53.9	4.4	0	0.31	-0.71	30	0
Campo	54.2	-0.5	70.5	-1.6	0	37.8	0.5	0	1.32	0.38	140	0
Culver City	62.3	0.0	70.2	-2.4	8	54.4	2.4	8	0.00	-0.58	0	8
El Cajon	66.7	4.6	80.1	6.0	8	53.3	3.2	8	0.21	-0.58	27	7
Escondido 2	66.3	4.0	80.2	5.5	10	52.5	2.7	10	0.25	-0.79	24	10
Idyllwild Fire D	51.1	4.2	67.2	4.8	1	35.0	3.5	1	1.68	-0.08	95	2
Lompoc	58.2	-0.1	69.4	-1.5	0	46.9	1.3	0	0.00	-0.93	0	0
Long Beach AP	64.1	1.1	73.2	0.5	0	55.0	1.8	0	0.06	-0.54	10	0
Los Angeles DT/USC	65.6	1.9	74.5	1.4	0	56.6	2.2	0	0.04	-0.79	5	0
Los Angeles AP	62.1	1.3	69.5	1.5	0	54.7	1.1	0	0.03	-0.60	5	0
Mt Wilson No 2	53.1	2.4	63.6	2.9	0	42.5	1.9	0	0.85	-1.49	36	0
Riverside Citrus	65.1	3.3	79.3	3.8	5	50.8	2.7	5	0.79	0.19	132	5
Newport Beach Ha	61.7	2.2	66.2	0.7	1	57.1	3.6	1	0.50	-0.20	71	1
San Diego AP	64.4	1.8	69.5	0.8	0	59.3	2.9	0	0.60	-0.15	80	0
Sandberg WSMO	54.4	4.0	64.4	5.3	0	44.3	2.7	0	0.09	-0.51	15	0
Santa Ana Fire S	65.6	2.6	76.2	2.6	1	55.0	2.6	1	0.56	-0.11	84	0
Santa Barbara AP	59.2	0.3	70.0	-0.1	0	48.5	0.9	0	0.03	-0.63	5	0
Santa Maria AP	56.9	1.4	69.6	2.0	0	44.2	0.8	0	0.06	-0.91	7	0
UCLA	61.6	0.3	68.8	-0.4	3	54.3	1.0	3	0.05	-0.81	6	3
Southeast Desert												
Bishop	55.5	1.5	73.6	1.5	0	37.5	1.5	0	0.10	-0.14	42	0
Blythe	73.0	2.0	86.8	1.1	0	59.2	3.0	0	0.06	-0.08	43	0
Daggett AP	67.7	3.4	81.2	2.1	0	54.1	4.7	0	0.13	-0.05	72	0
Imperial	71.2	1.7	86.2	1.4	0	56.3	1.9	0	0.44	0.36	550	0
Lancaster	61.6	3.7	76.3	4.9	0	47.0	2.5	0	0.05	-0.27	16	0
Needles AP	72.9	1.5	84.3	-1.7	0	61.5	4.6	0	1.35	1.13	614	0
Palm Springs	73.5	1.7	86.9	-0.6	0	60.1	4.1	0	0.08	0.00	100	0
Thermal AP	71.5	-0.1	87.5	-0.9	0	55.5	0.7	0	0.36	0.30	600	0
Twentynine Palms	65.8	-0.2	84.9	2.2	1	46.8	-2.5	1	0.42	0.28	300	1
State Averages	**59.0**	**2.2**	**71.9**	**2.6**	**1.4**	**46.1**	**1.9**	**1.4**	**0.51**	**-0.79**	**59.9**	**1.3**

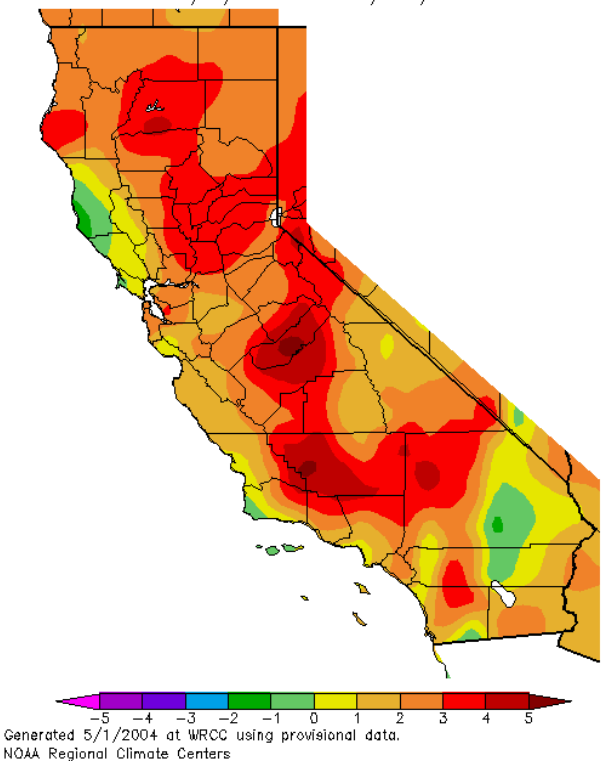
All data is provisional and subject to change.
Normal period is 1971-2000.

KEY:

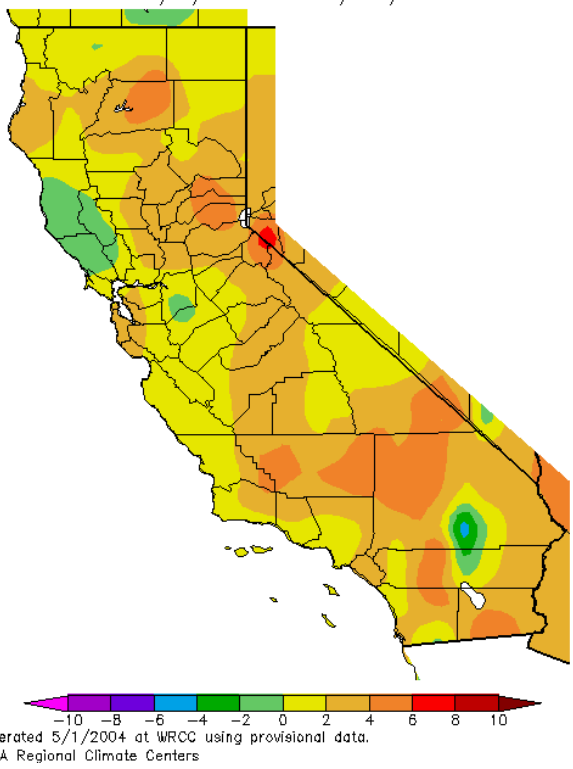
MGX = number of missing daily max temperature values
TA = average temperature in Fahrenheit
DA = average temperature departure from normal in Fahrenheit
TX = average maximum temperature in Fahrenheit
DX = average maximum temperature departure in Fahrenheit
TN = average minimum temperature in Fahrenheit
DN = average minimum temperature departure in Fahrenheit
MGN = number of missing daily min temperature values
MGP = number of missing daily precipitation values
PMO = total monthly precipitation in inches
PDP = monthly precipitation departure from normal in inches
PCT = monthly precipitation percent of normal

Climate Maps for April

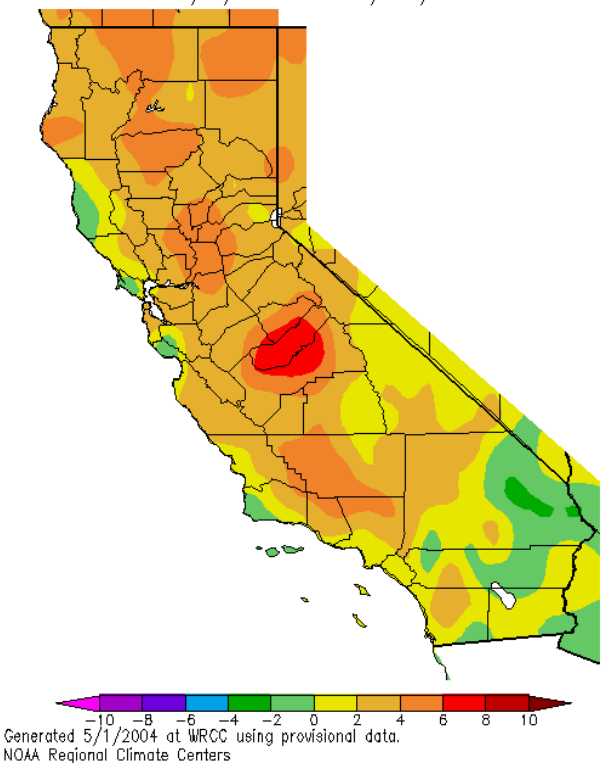
Ave. Temperature dep from Ave (deg F)
4/1/2004 – 4/30/2004



Av. Min. Temperature dep from Ave (deg. F)
4/1/2004 – 4/30/2004



Av. Max. Temperature dep from Ave (deg F)
4/1/2004 – 4/30/2004



Precipitation Departure from Average (in.)
4/1/2004 – 4/30/2004