. . . And the Fog Will Burn Off By Noon—A Brief Introduction to the Weather of the San Francisco Bay Area

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"*Climate is what we expect, weather is what we get.*"—Mark Twain

On the "other" coast, they often say, "If you don't like the weather, wait a few minutes." In the San Francisco Bay area, the phrase that should be spoken might be "If you don't like the weather, take a short walk." In a few hundred yards, the weather can change from gray clouds and drizzle to blue sky. Travel a little farther, and the weather requiring a sweater and parka now requires only shorts and a T-shirt. Changes in annual precipitation over short distances are just as drastic. In the mountains above Santa Cruz, rainfall averages more than 120 cm (47 inches) a year, while in the Santa Clara Valley a few miles to the east, the average precipitation is on the order of 33 cm (13 inches). These drastic variations result from a unique combination of oceanography, meteorology, and physiography.

The "typical" California climate is similar to that of the Mediterranean—a near-desert in summer, a dripping landscape in winter, and filled with glorious wildflowers in the spring. During the summer, the migrating Pacific high-pressure cell (commonly referred to as the Pacific High) deflects storms northward to Oregon and Washington, nearly preventing any measurable precipitation. In the winter, the strength of this high-pressure cell decreases and it shifts to the south, allowing moisture-laden storms to move in from the west. Often, a series of low-pressure cells can deliver heavy rains and gale-force winds. Each cell typically yields two to five days of storms, followed by a week or two of calm, clear weather.

Although dominated by the effects of high- and low-pressure cells, the climate of coastal California is moderated by the temperature of the northeastern Pacific Ocean. Ocean-related modulation reduces the intensity of cold winter temperatures, provides the source of the enormous summer fog banks, and moderates the overall annual range in temperatures (fig. 7.1; tables 7.1 to 7.3). The climate of the region surrounding the waters of San Francisco Bay lies somewhere between the extreme seasonal variations of the Central Valley and the more subdued climate of the coast because of the local topography and the constant interaction of continental and maritime air masses (Elford, 1970).

Although the moderating effect of the southward flowing California Current is apparent even during the winter (mean January temperature in Santa Cruz is 59.9°F while in Sacramento it is 53.2°F), both the magnitude and timing of the highest summer temperature changes drastically with proximity to the coast (fig. 7.1; tables 7.1 and 7.2). July temperatures in Vacaville and Sacramento in the Central Valley reach into the 90's. Two months later, as the strength of the current decreases, Half Moon Bay reaches its thermal zenith, a somewhat more moderate 66.9°F.

The dominant summer winds are from the northwest and west, and they are reinforced by the inland movement of air caused by solar heating of the air in the Central Valley (the primary reason for wind farms at Altamont Pass at the north end of the Diablo Range, east of Livermore). This effect is greatest during the day, creating both a diurnal and seasonal pattern in wind velocity. During the winter, with storm centers to the south of the San Francisco Bay area, winds may come from the east or southeast, though the prevalent wind direction is still from the west.

"*The coldest winter I ever spent was a summer in San Francisco.*"—Attributed to Mark Twain

Throughout the spring, the Pacific High increases in strength and moves closer to the coast. The combination of increased northwest wind stress and Coriolis force causes the southeastward-flowing California Current to turn to the right, away from shore. The water that moves offshore is replaced by cold, nutrient-rich water that is upwelled near the coast from intermediate water depths. The upwelled water makes the surface water temperature colder in June and July than it is during the winter.

This cold water is part of the "natural air conditioning" for which San Francisco is famous. As summer winds travel over the North Pacific, the air absorbs great quantities of moisture through evaporation. As it approaches the coast, the air is cooled by the sea, and condensation occurs. Whether the fog is thin and wispy or is so thick and heavy that anywhere else it would pass for rain depends on the temperature of the California Current and how much moisture is in the air. How far inland the fog travels depends on the temperature in the Central Valley—several days of temperatures over 100° F can draw the fog through the Carquinez Strait to the western edge of the valley. As the strength of the California Current wanes in August, the fog disappears and "summer" comes to San Francisco from August to October, the three hottest months of the year.

"*Let it rain for 40 days and 40 nights . . . and wait for the sewers to back up*"—Bill Cosby

In 1983, a new weather-related term entered the vocabulary of San Franciscans—El Niño. During an El Niño event, the temperature of the eastern tropical Pacific Ocean increases, and part of that warmer water mass migrates northward along the western coast of North America. Over the past century, most of the El Niño events have resulted in an increase in precipitation on the California coast. The 1997-98 El Niño resulted in abnormally high sea levels that contributed to millions of dollars in flood and storm damage in the San Francisco Bay area (Ryan and others, 1999). When compared to the 50-year record (fig. 7.2), the 1997-1998 El Niño showed increases in air and sea-surface temperatures (figs. 7.2*A*, *B*). Sea-surface temperatures off San Francisco and the Oregon-Washington coast were warm enough to support fish normally found in the waters off Baja California. On land, rainfall rates increased drastically, particularly in areas subject to orographic uplift of moisture-laden air masses, such as the coast range in Santa Cruz and Marin counties (figs. 7.2*C*, *D*). As a result of this enhanced precipitation, streamflow rates in northern and central California increased. At numerous sites in the Central Valley, levees in need of repairs broke, flooding many acres of farmland.

References

Elford, C.R., 1970, The climate of California: *in* National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Climates of the States, v. 2, p. 538-546.

Ryan, Holly, Gibbons, Helen, Hendley, J.W., and Stauffer, P.H., 1999, El Niño sea-level rise wreaks havoc in California's San Francisco Bay region: U.S. Geological Survey Fact Sheet 175-99, 4 p.

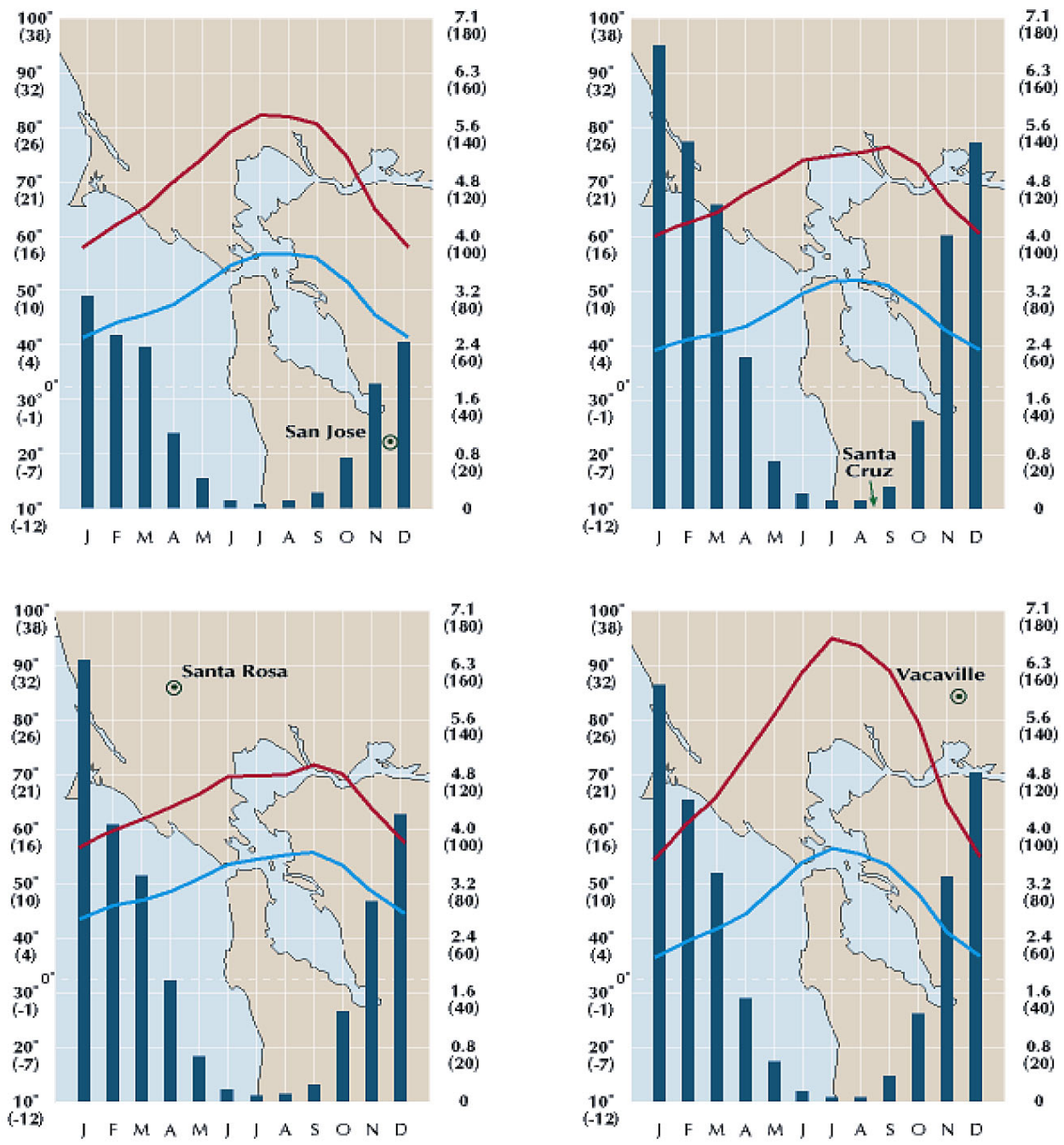

Figure 7.1. Climagraphs for thirteen sites in the San Francisco Bay area. Mean high monthly temperature (°F [°C])—red line; mean low monthly temperature (°F [°C])—blue line; precipitation (in. [mm])– blue histogram. Plotted from data in tables 7.1 to 7.3. (Data derived from the University of California, Berkeley website at http://geography.berkeley.edu/Collections/Weather/Climagraphs/Climagraph.html).

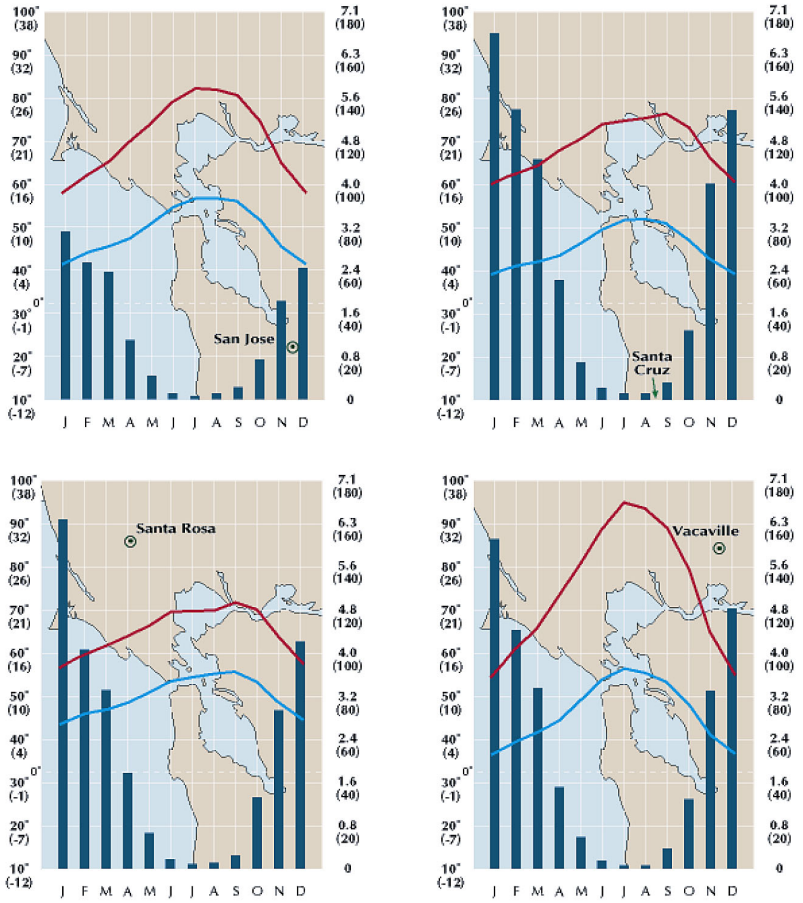

Figure 7.1.—Continued. Climagraphs for thirteen sites in the San Francisco Bay area. Mean high monthly temperature (°F [°C])—red line; mean low monthly temperature (°F [°C])—blue line; precipitation (in. [mm])– blue histogram. Plotted from data in tables 7.1 to 7.3. (Data derived from the University of California, Berkeley website at http://geography.berkeley.edu/Collections/Weather/Climagraphs/Climagraph.html).

Table 7.1. Mean monthly high temperature (°C) for thirteen sites in the San Francisco Bay region. Highest month—red; lowest month—blue (data derived from the University of California, Berkeley website at http://geography.berkeley.edu/Collections/Weather/Climagraphs/Climagraph.html).

Location	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Berkeley	37.87	122.27	56.2	59.3	61.4	63.5	66.1	69.1	69.3	69.5	71.4	69.6	63.5	57.0
Fairfield	38.27	122.07	55.5	61.8	65.9	71.3	77.9	84.3	88.9	88.7	86.4	78.6	65.5	55.8
Half Moon Bay	37.47	122.45	58.1	59.3	59.6	60.5	61.4	63.0	63.8	65.1	66.9	65.9	62.8	58.7
Livermore	37.67	121.77	56.5	60.9	64.8	70.6	76.6	83.1	89.5	88.9	86.4	78.2	66.2	57.3
Los Gatos	37.23	121.97	57.9	62.0	65.4	70.7	75.9	81.6	85.9	85.3	83.1	76.0	65.4	58.2
Mt. Diablo	37.87	121.93	55.0	57.2	59.0	64.5	70.8	78.8	86.8	86.2	82.8	74.3	62.3	56.1
Petaluma	38.27	122.65	56.6	61.7	64.2	68.4	72.2	78.3	82.4	82.7	82.0	76.2	65.7	57.0
Sacramento	38.58	121.50	53.2	59.5	64.6	71.0	77.9	85.5	91.4	90.3	86.0	76.6	64.0	53.8
San Francisco	37.77	122.43	56.7	60.2	61.2	62.9	63.9	66.0	66.0	67.0	70.0	69.4	63.7	57.3
San Jose	37.35	121.90	57.9	62.1	65.3	70.0	74.3	79.2	82.2	81.8	80.6	74.7	65.1	58.0
Santa Cruz	36.98	121.98	59.9	62.5	64.3	67.7	70.6	73.8	74.6	75.3	76.3	73.2	66.2	60.5
Santa Rosa	38.45	122.72	57.4	62.1	65.4	70.0	74.4	80.0	83.2	83.4	83.1	77.3	66.5	58.0
Vacaville	38.40	121.97	54.5	61.5	66.2	73.3	81.0	88.8	95.0	93.7	89.5	79.6	65.2	55.0

Highest Month

Lowest Month

Table 7.2. Mean monthly low temperature (°C). Highest month—red; lowest month—blue (data derived from the University of California, Berkeley website at http://geography.berkeley.edu/Collections/Weather/Climagraphs/Climagraph.html).

Location	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Berkeley	37.87	122.27	43.0	45.5	46.5	48.0	50.5	53.0	54.0	54.7	55.2	52.9	48.4	44.2
Fairfield	38.27	122.07	37.4	40.9	43.2	45.9	50.1	53.7	55.7	55.9	54.3	49.5	42.3	37.5
Half Moon Bay	37.47	122.45	43.0	43.8	44.1	44.7	47.4	49.9	51.6	52.7	51.6	48.6	45.9	43.4
Livermore	37.67	121.77	36.0	38.8	40.8	43.2	47.5	51.5	54.0	53.8	52.2	47.4	40.6	36.6
Los Gatos	37.23	121.97	38.2	40.5	41.9	43.6	47.4	51.5	53.9	53.6	52.6	48.3	42.6	38.4
Mt. Diablo	37.87	121.93	39.0	40.8	40.6	43.3	46.9	52.7	60.2	59.8	57.2	51.9	44.6	40.4
Petaluma	38.27	122.65	37.8	40.3	41.4	43.0	46.5	50.2	51.6	51.8	51.2	47.2	41.8	38.1
Sacramento	38.58	121.50	39.5	43.1	45.6	48.4	52.4	56.7	59.0	58.5	56.9	51.6	44.4	39.8
San Francisco	37.77	122.43	46.0	48.3	48.9	49.7	51.1	53.0	53.7	54.8	55.8	54.7	51.2	46.9
San Jose	37.35	121.90	41.3	44.2	45.6	47.5	51.1	54.6	56.7	56.7	56.0	51.8	45.8	41.5
Santa Cruz	36.98	121.98	39.0	41.0	42.0	43.3	46.4	49.4	51.6	51.8	50.8	47.2	42.7	39.1
Santa Rosa	38.45	122.72	36.8	39.4	40.5	42.5	46.1	49.8	50.9	50.8	49.9	46.1	40.6	37.4
Vacaville	38.40	121.97	36.6	39.7	42.0	44.6	49.4	54.2	56.7	55.5	53.5	48.3	41.5	36.9

Highest Month

Lowest Month

Table 7.3. Monthly precipitation (inches) (data derived from the University of California, Berkeley website at http://geography.berkeley.edu/Collections/Weather/Climagraphs/Climagraph.html).

Location	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Berkeley	37.87	122.27	4.80	4.02	3.23	1.73	0.63	0.18	0.04	0.07	0.27	1.27	2.88	4.14
Fairfield	38.27	122.07	5.16	3.74	3.13	1.33	0.51	0.19	0.02	0.07	0.29	1.27	2.85	3.91
Half Moon Bay	37.47	122.45	5.49	4.20	3.95	1.84	0.73	0.27	0.11	0.21	0.41	1.60	3.31	4.64
Livermore	37.67	121.77	2.98	2.55	2.15	1.09	0.43	0.10	0.02	0.05	0.16	0.72	1.74	2.56
Los Gatos	37.23	121.97	5.64	4.69	3.85	1.63	0.49	0.08	0.03	0.06	0.26	1.09	2.93	4.40
Mt. Diablo	37.87	121.93	5.00	4.06	3.45	1.72	0.77	0.19	0.04	0.07	0.32	1.33	3.18	3.98
Petaluma	38.27	122.65	5.75	4.38	3.40	1.56	0.51	0.19	0.03	0.09	0.26	1.36	3.38	4.39
Sacramento	38.58	121.50	3.72	3.16	2.67	1.40	0.61	0.16	0.01	0.03	0.31	0.92	2.01	3.14
San Francisco	37.77	122.43	4.63	3.28	3.03	1.32	0.50	0.16	0.03	0.08	0.24	1.08	2.92	3.65
San Jose	37.35	121.90	3.05	2.48	2.31	1.06	0.41	0.09	0.04	0.09	0.21	0.71	1.78	2.38
Santa Cruz	36.98	121.98	6.67	5.28	4.36	2.16	0.66	0.20	0.09	0.10	0.29	1.24	3.92	5.27
Santa Rosa	38.45	122.72	6.35	5.04	4.21	2.07	0.83	0.28	0.03	0.11	0.35	1.75	3.75	5.44
Vacaville	38.40	121.97	5.99	4.32	3.27	1.46	0.55	0.12	0.03	0.03	0.34	1.24	3.22	4.73

Highest Month

Lowest Month

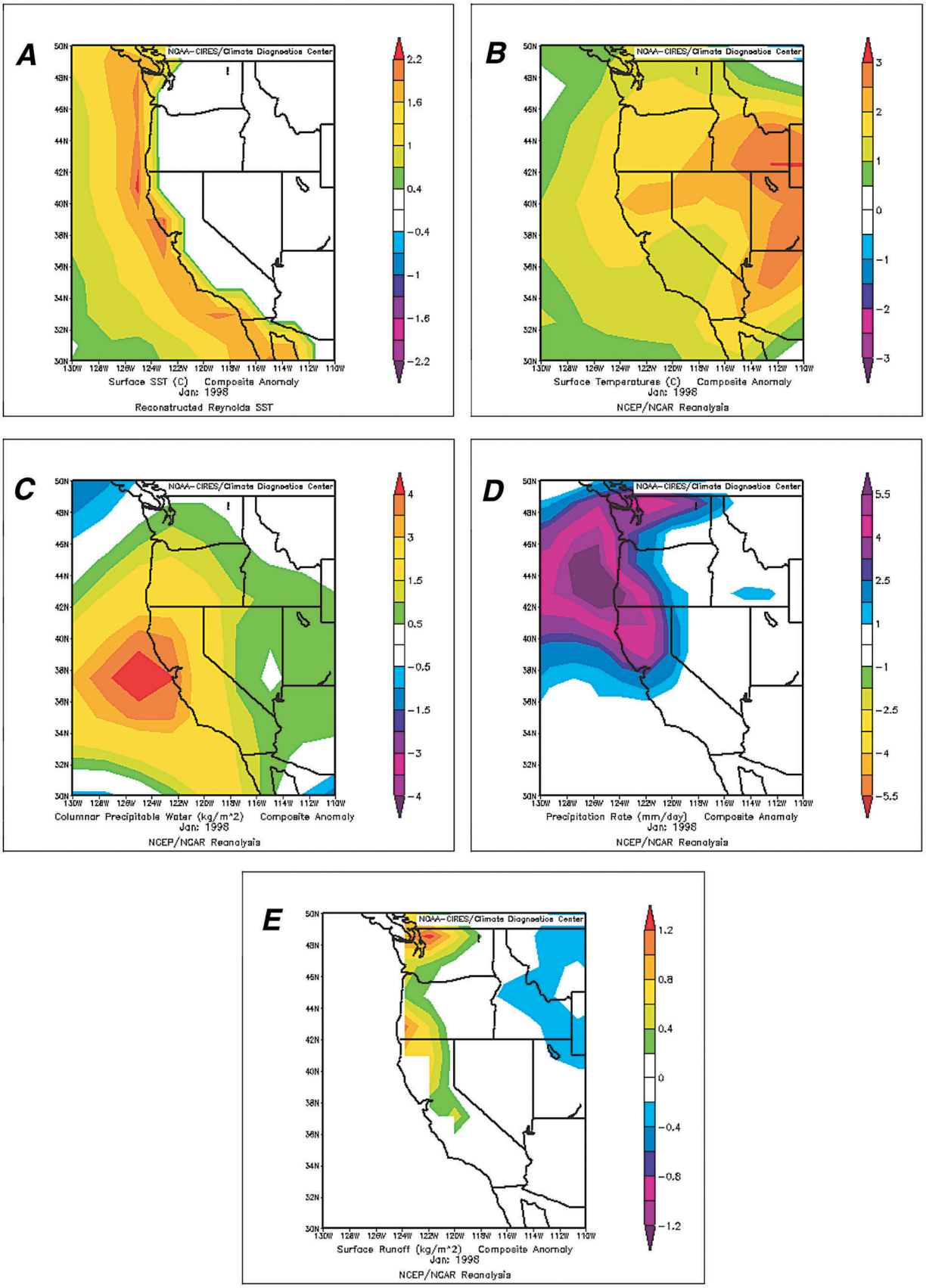

Figure 7.2. January 1998 (El Niño) variations from the mean the for period 1950-99. ***A***, sea surface temperature (°C), ***B***, air temperature (°C), ***C***, available moisture (kg/m2). ***D***, precipitation rate (mm/day), ***E***, surface runoff (kg/m^2) (data derived from the National Oceanic and Atmospheric Administration website at http://www.cdc.noaa.gov/Composites).