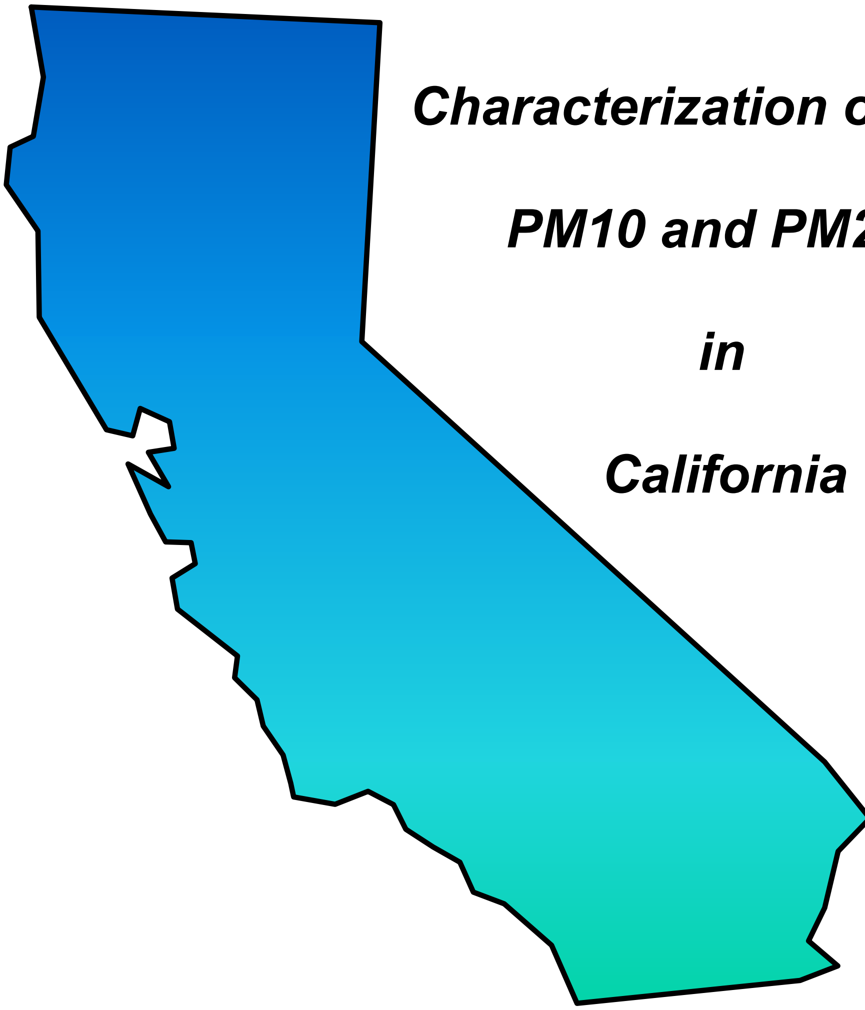
Characterization of Ambient

PM10 and PM2.5

in

California



Technical Report

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Air Resources Board

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"The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our Website at www.arb.ca.gov."

Executive Summary

For each air basin in California, we conducted a preliminary assessment of the characteristics of ambient PM10 and PM2.5, including: 1) ambient concentrations; 2) frequency distribution of the observed concentrations; 3) seasonal variations; and 4) identification of sources leading to the observed ambient particle concentrations. We analyzed ambient PM10 (1998-2000) and PM2.5 (1999-2000) data from the air quality monitoring network and source attribution information from a variety of special studies.

This report presents air monitoring results, including information about the frequency and severity of exceedances of air quality standards. It is important to note that not every exceedance is a violation of a standard from a regulatory standpoint. A very limited number of exceedances, representing unusual occurrences, is generally allowed before a standard is considered to be violated and a region is designated as nonattainment. In terms of attainment status for the federal PM2.5 standards, an additional year of data is required before designations can be made.

The information presented for each air basin regarding the relative contribution of various emission sources to the measured ambient air quality levels came from a variety of studies. As a result, the level of detail presented varies. For the most severely impacted regions, the San Joaquin Valley and South Coast Air Basin, a substantial amount of analysis has been done. For some rural areas with less complex particulate problems, the source apportionment information is less detailed and relies primarily on emission inventory data.

The main findings are summarized below:

- With the exception of Lake County, all air basins exceeded the current health-based State 24-hour PM10 standard. The highest 24-hour concentrations are found in the Great Basin and Salton Sea air basins. Four areas exceeded the current State annual PM10 standard. Six air basins, representing both urban and rural areas, exceeded the federal PM10 standards.

- Most urban areas, as well as some rural areas, exceeded one or both of the federal PM2.5 standards (24-hour or annual). The South Coast Air Basin and the San Joaquin Valley recorded the highest maximum 24-hour and annual average concentrations, with values nearly twice the standards.

- The size, concentration, and chemical composition of PM vary by region and by season. A number of areas exhibit strong seasonal patterns. Other areas have a much more uniform distribution - PM concentrations remain high throughout the year. In yet other areas isolated high PM concentrations can occur at any time of the year.

- Regions such as the San Joaquin Valley, the San Francisco Bay Area, and Sacramento display strong seasonal variations in PM, with higher PM10 and

PM2.5 concentrations in the fall and winter months due to increased activity for some emissions sources and meteorological conditions that are conducive to the buildup of PM. During the winter, the PM2.5 size fraction drives the PM concentrations. In the urban areas, NOx emitted from mobile sources and stationary combustion sources – which, in the atmosphere combines with ammonium to form ammonium nitrate - wood smoke, and direct particle emissions from motor vehicles are the major contributors to high levels of ambient PM. However, in rural areas of the San Joaquin Valley, while ammonium nitrate is a large contributor to winter PM2.5, wood smoke and direct motor vehicle particle emissions are not as prominent as in urban areas. The San Joaquin Valley also records high PM10 levels during the fall. During this season, the coarse fraction (PM2.5-10) drives the PM concentrations, with soil dust as the major PM10 component.

- In the South Coast, PM10 and PM2.5 concentrations remain high throughout the year. The more uniform activity patterns of emission sources, as well as less variable weather patterns, leads to this more uniform concentration pattern. In Downtown Los Angeles, ammonium nitrate is the major contributor to PM10 and PM2.5. Direct particle emissions from motor vehicles, other carbon sources, and soil dust also contribute to the high particulate levels.

- In other areas, high PM is generally caused by isolated emission activities or weather conditions. For example, in Owens Lake in the Great Basin Valleys Air Basin, episodic fugitive dust events lead to very high PM10 levels, with soil dust as the major contributor to ambient PM10.

- In addition to seasonal variations, PM10 concentrations can also vary diurnally. In the San Joaquin Valley, PM10 levels varied significantly in urban Fresno during the course of a winter day, with the highest concentrations occurring at nighttime. The rise in PM10 concentrations in Fresno corresponded mostly to significant nighttime peaks in residential wood burning and mobile source activity. However, PM10 concentrations did not vary much throughout the day in rural SW Chowchilla.

In the future, we will: 1) extend the analyses performed to include data from 2001 to determine compliance with the PM2.5 standards; 2) analyze data from the PM2.5 speciation monitors when it becomes available; 3) conduct further analysis of selected episodes, including assessing the influence of meteorological factors, evaluating the role of transport, and examining variations in emission sources; and 4) integrate analyses from the PM network with data from special studies such as the California Regional PM10/PM2.5 Air Quality Study.

Statewide Overview

Objectives and Data Used

This report describes the characteristics of PM10 and PM2.5 by each air basin in California, including: ambient concentrations; historical trends; seasonal variations; identification of sources leading to the observed ambient particle concentrations; the frequency distribution of the observed concentrations; and particle size distribution.

- To assess the spatial and temporal characteristics of PM10 and PM2.5 concentrations, we analyzed the following ambient air quality data:
  - PM10 observations from Size Selective Inlet (SSI) monitors (from 1998 to 2000) (ARB 1998, ARB 2000a);
  - PM2.5 information from the newly deployed Federal Reference Method (FRM) monitors, available only for two years (1999 and 2000) (ARB 2000b); and PM10-2.5 and PM2.5 data from dichotomous (dichot) samplers (from 1988 to 1999) (ARB 1998).

  The data were extracted from the U.S. Environmental Protection Agency (U.S. EPA) Aerometric Information Retrieval System (AIRS) on May 18, 2001.

- For assessing the chemical composition of ambient PM10 and PM2.5, we reviewed information available from:
  - The State's PM10 and PM2.5 monitoring networks;
  - Two-Week Samplers (TWS) used in the California Children's Health Study (Taylor et al. 1998);
  - The Interagency Monitoring of Protected Visual Environments (IMPROVE) program; and
  - Special studies conducted in Imperial Valley, Sacramento, San Francisco Bay Area, San Joaquin Valley (1995 Integrated Monitoring Study, IMS95), Santa Barbara County, and South Coast Air Basin (1995 PM10 Enhancement Program, PTEP95).

As a result of this mixture of different levels of study data, there are differences among the source profiles. For the severely impacted areas like San Joaquin Valley and South Coast, chemical mass modeling provided detailed source apportionment details. For the rural areas, there was more reliance on emission inventory data rather ambient air quality data.

PM10 and PM2.5 Ambient Concentrations

Table 1 lists maximum 24-hour and annual average PM10 concentrations in micrograms per cubic meter ($\mu g/m^3$) recorded in each air basin in the last three years and PM2.5 concentrations in the last two years – since federally approved PM2.5 monitors have been in operation in California. The table also shows the number of days with measured concentrations over the PM10 State Standard and the number of days with measured concentrations over the federal PM2.5 standard. We used SSI data for

PM10 and FRM data for PM2.5 to generate this table. Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the data listed in the tables include data that in the future may be removed from AIRS.

Table 1. Maximum PM10 and PM2.5 Concentrations per Air Basin

Air Basin	Year	PM10 ($\mu g/m^3$)			PM2.5 ($\mu g/m^3$)		
		Days over State Std.	Max. 24-hour (Std.=50)	Max Annual Geo Mean (Std.=30)	Days * over Fed. Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
Great Basin Valleys	1998	29	1116	20			
	1999	1	514	14		41	7
	2000	14	572	20	2	68	9
Lake County	1998		35	6			
	1999		43	11		15	4
	2000		22	10		9	Incomplete data
Lake Tahoe	1998	2	59	20			
	1999		41	17		21	8
	2000		50	18		23	7
Mojave Desert	1998	8	165	24			
	1999	12	109	28		48	12
	2000	11	80	30		39	8
Mountain Counties	1998	11	92	23			
	1999	13	125	23	4	92	14
	2000	8	98	22		48	8
North Central Coast	1998	5	76	26			
	1999	9	103	28		31	8
	2000	4	74	27		23	Incomplete data
North Coast	1998		50	20			
	1999	11	100	22		37	9
	2000	2	51	20		24	9
Northeast Plateau	1998	4	66	13			
	1999	12	100	30		40	8
	2000	10	80	18		38	7
Sacramento Valley	1998	17	68	19			
	1999	27	171	26	11	108	19
	2000	18	86	25	5	98	12
Salton Sea	1998	62	568	79			
	1999	68	1342	130		53	15
	2000	97	1613	183	1	84	17
San Diego	1998	18	89	39			
	1999	24	121	48		64	18
	2000	25	139	42	2	66	16
San Francisco Bay Area	1998	5	92	22			
	1999	12	114	25	4	91	16
	2000	7	76	24	1	67	14
San Joaquin Valley	1998	51	159	34			
	1999	64	183	50	42	136	28
	2000	66	145	45	29	160	23
South Central Coast	1998	18	73	24			
	1999	18	90	27		65	14
	2000	25	113	28		55	15
South Coast	1998	59	116	49			
	1999	55	183	65	15	121	30
	2000	74	126	52	23	120	28

* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
Note: Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

With the exception of Lake County, all air basins exceed the current State 24-hour PM10 standard of 50 μg/m^3. Only Salton Sea, San Diego, San Joaquin, and South Coast air basins exceed the current State annual standard of 30 μg/m^3. The Salton Sea Air Basin recorded two of the three highest 24-hour PM10 levels in the State, 1613 μg/m^3 in 2000 and 1342 μg/m^3 in 1999, while Great Basin Valleys registered 1116 μg/m^3 in 1998. Salton Sea also had the highest PM10 annual averages in the State, 183 μg/m^3 in 2000 and 130 μg/m^3 in 1999. In air basins exceeding both State PM10 standards, the ratios of maximum 24-hour and annual concentrations compared to the respective standards suggest that the 24-hour State standard is controlling (Table 2).

Table 2. Ratios of yearly maximum 24-hour PM10 and annual average concentrations compared to the respective State standards.

Air Basin	**Year**	**Max 24-hour/Std. (Std. = 50 μg/m^3)**	**Max Annual Avg./Std. (Std. = 30 μg/m^3)**
Salton Sea	1998	11.4	2.6
	1999	26.8	4.3
	2000	32.0	6.1
San Diego	1998	1.8	1.3
	1999	2.4	1.6
	2000	2.8	1.4
San Joaquin Valley	1998	3.2	1.1
	1999	3.7	1.7
	2000	2.9	1.5
South Coast	1998	2.3	1.6
	1999	3.7	2.2
	2000	2.5	1.7

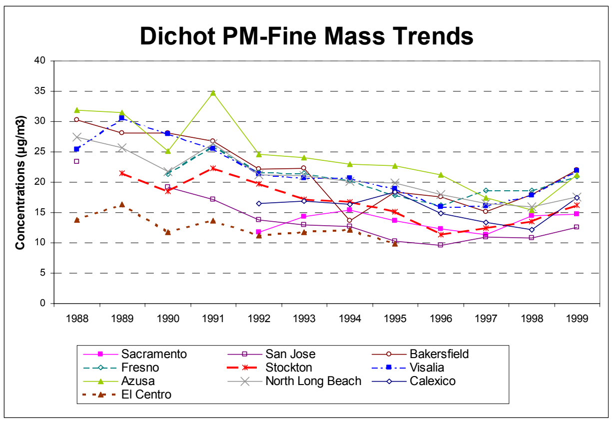
Currently, eight air basins (Great Basin Valleys, Mountain Counties, Sacramento Valley, Salton Sea, San Diego County, San Francisco Bay Area, San Joaquin Valley, and South Coast) recorded 24-hour concentrations over the federal PM2.5 standard. Values over the 24-hour standard in Mountain Counties in 1999 may have been caused by extensive wildfires. With the exception of Great Basin Valleys and Mountain Counties, the other six air basins also recorded maximum annual average concentrations above the federal annual PM2.5 standard.

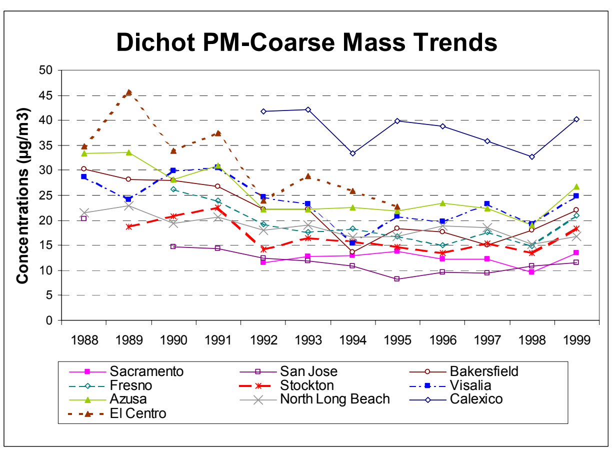
As part of California's PM2.5 program, three locations have been selected to measure background particulate matter concentrations: Point Reyes National Seashore in Northern California and San Rafael Wilderness and San Nicholas Island in Southern California. These sites are located away from populated areas and other significant sources of particulate and particulate precursor emissions. The sites have been in operation since December 2000. Data from these sites are not yet available. However, data obtained from the IMPROVE program for Point Reyes from March 1996 through February 1999 indicate that annual average concentrations were 4.55 μg/m^3 for PM2.5

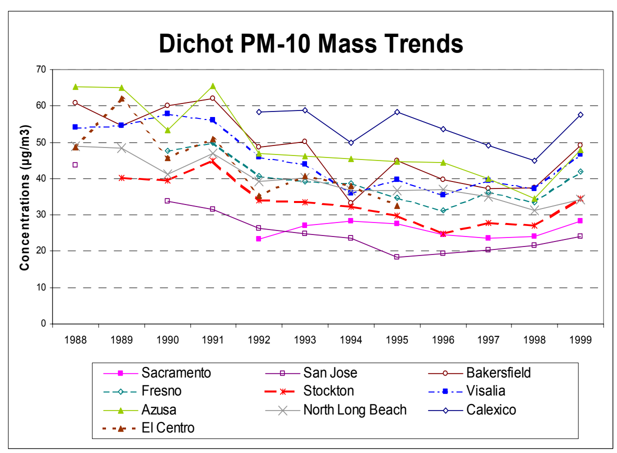
and 10.97 μg/m^3 for PM10 (Malm et al. 2000). PM10 and PM2.5 data collected at San Nicolas Island as part of PTEP95 program show that 24-hour PM10 concentrations ranged from 4.7 to 69.19 μg/m^3, with an annual average of 18.7 μg/m^3 and PM2.5 levels ranged from 2.4 to 14.5 μg/m^3, with an annual average of 6.82 μg/m^3 (Kim et al. 2000).

Historical Trends

We determined PM concentration trends using dichot PM2.5, PM2.5-10, and PM10 data collected from 1988 through 1999 at selected urban sites. The dichot sampler uses a low-volume PM10 inlet followed by a virtual impactor, which splits ambient air samples into fine (PM2.5) and coarse (PM10-2.5) particle fractions. The sum of these two fractions provides a measure of total PM10. We estimated annual arithmetic mean concentrations, by averaging quarterly (January through March, April through June, July through September, and October through December) arithmetic means. Data illustrated on the chart at left indicate that, overall; the annual means of PM2.5 decreased until 1998, increasing in 1999 at most sites. Monthly rainfall data obtained from National Weather Service stations indicate 1999 was a much drier year than 1997 and 1998, contributing to higher particulate matter concentrations in 1999. The coarse PM10-2.5 and the PM10 annual means exhibited similar trends, with a slightly less pronounced decrease in coarse fraction concentrations in the 1994 to 1999 period.

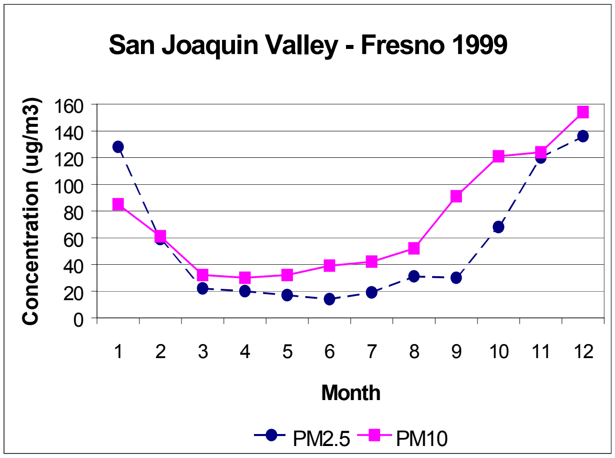




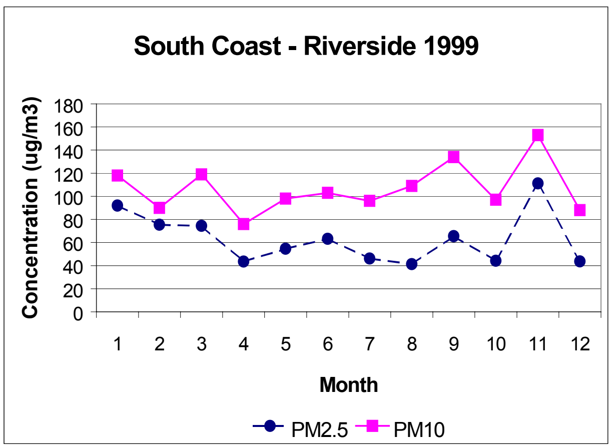


Seasonal Variations

Plots showing seasonal variation in ambient particulate matter concentrations were generated using FRM data for PM2.5 and SSI data for PM10. These seasonality plots are included in the subsections of this chapter describing particulate matter air quality in each air basin. The data represent the peak monthly concentration for each size fraction. In some cases PM2.5 is higher than PM10. This can occur for two reasons. First, the measurements are made on two different sampling systems and therefore have different levels of accuracy, precision, and uncertainty. Second, in some cases peak PM10 and PM2.5 concentrations do not occur on the same day. The plots were generated to provide an understanding of the seasonality of peak concentrations, not to compare specific PM10/PM2.5 concentrations to each other.



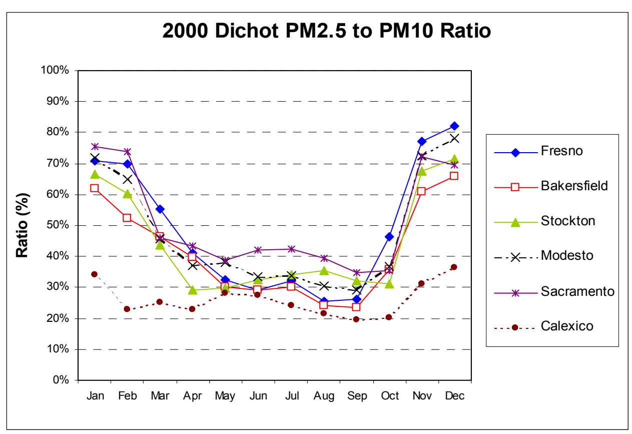
In general, there are a number of air basins which exhibit strong seasonal patterns. Areas such as Sacramento, the San Joaquin Valley, and the San Francisco Bay Area record much higher PM2.5 and PM10 concentrations in the winter months. During this time of year, the PM2.5 size fraction drives the particulate matter concentrations.



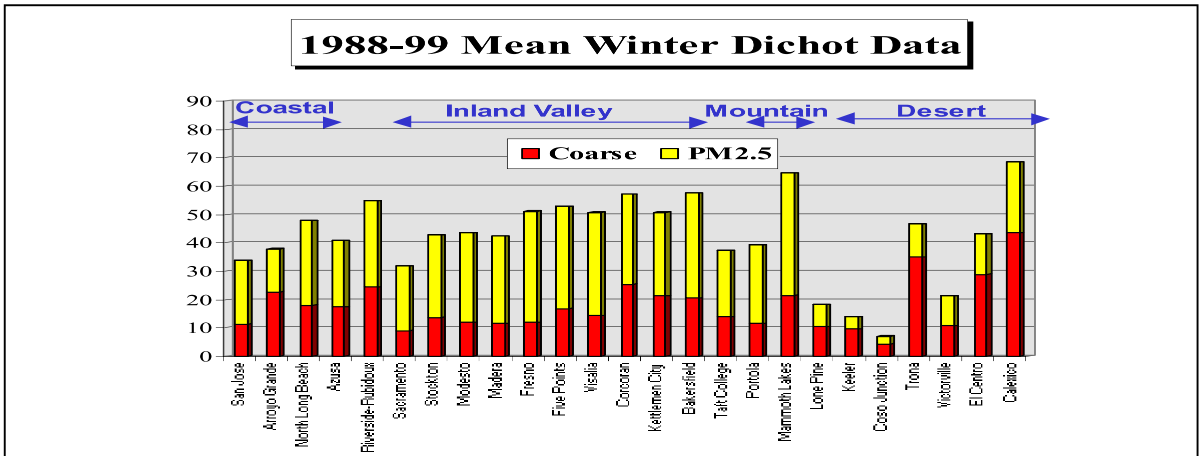
Other areas such as the South Coast, have a much more uniform distribution. In the South Coast, PM10 and PM2.5 concentrations remain high throughout the year.

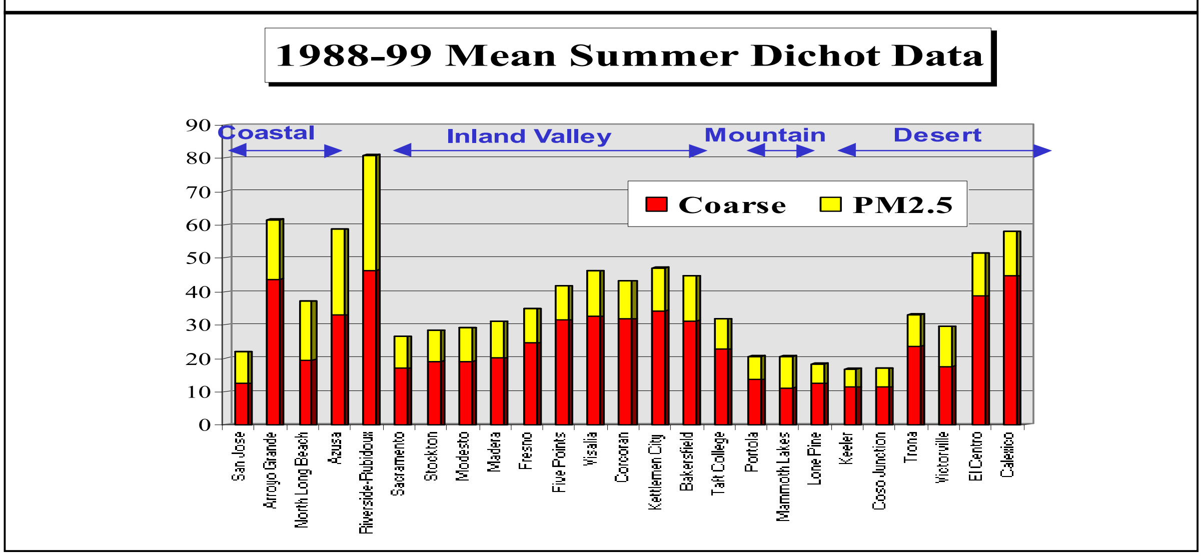
In yet other areas there are specific episodic exceedances due to fugitive dust events (Great Basins, Salton Sea), or fires (Mountain Counties).

We used data collected with dichot samplers from 1998 to 2000 to estimate the ratios of PM2.5 to PM10 concentrations. In general, the average PM2.5 portion of PM10 was higher in the winter (November to February) than during the rest of the year (March to October). These seasonal differences were most pronounced in the San Joaquin Valley (75% in the winter and 38% during the rest of the year) and least prominent in the Mojave Desert (46% in winter and 39% during the rest of the year). No seasonal differences were apparent in the Great Basin Valleys Air Basin.



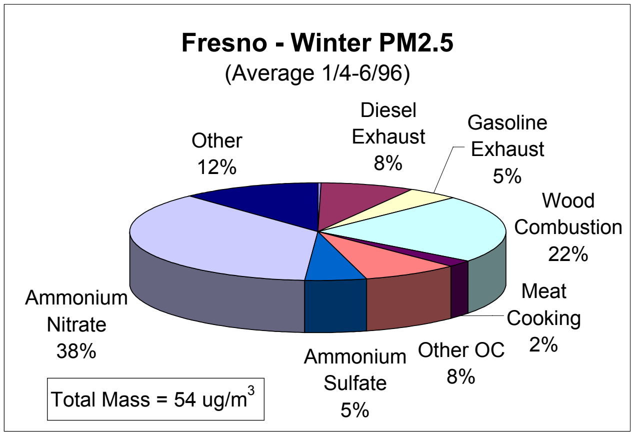
Seasonal variations in meteorological conditions and in the activity of emissions sources cause the size, composition, and concentration of particulate matter to vary in space and time. Because air typically flows inland from the Pacific Ocean, the percent of days exceeding the California 24-hour standard is generally lower along the coast than in inland areas. As the air parcel moves downwind across areas with significant anthropogenic activities, fresh emissions and gas-to particle conversion cause PM concentrations to increase with distance (e.g., along the North Long Beach, Azusa, Riverside-Rubidoux corridor). In general, PM2.5 concentrations are highest during the winter months (November to February). Cool temperatures, low inversion layers, and humid conditions favor the formation of secondary nitrate and sulfate particles, which are found predominantly in the fine fraction. Residential wood combustion also leads to higher PM2.5 concentrations during the winter. From 1988 to 1999, in the San Joaquin Valley, 97 % of the four highest 24-hour PM2.5 concentrations and 68% of the four highest PM10 concentrations occurred during the winter. In the South Coast 53% of the four highest PM2.5 and 58% of the four highest PM10 levels occurred in the winter season. Soil dust is the dominant contributor to PM10 in the summer. A desert environment generally has low PM concentrations, but on occasion high winds cause significant increases in dust.



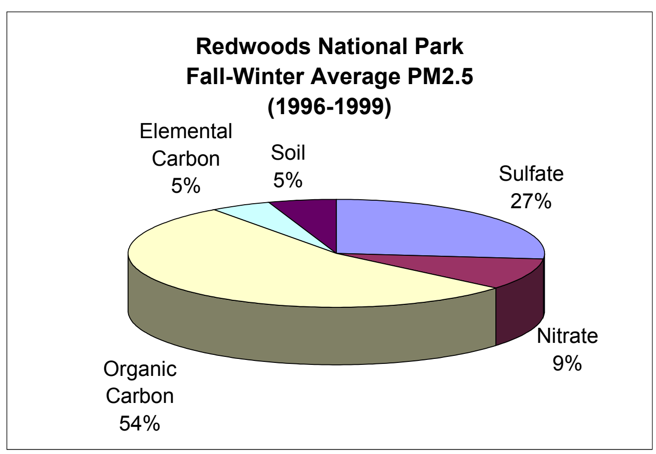


Source Apportionment

Chemical Mass Balance models are used to establish which sources and how much of their emissions contribute to ambient particulate matter concentrations and composition. The models use chemical composition data from ambient PM samples and from emission sources. The source attribution data presented in this report was derived from a variety of studies with differing degrees of chemical speciation. In general however, the source categories can be interpreted in the following manner: The soil, woodsmoke, cooking, motor vehicle, and marine categories represent primary, or directly emitted particulate matter. The marine category represents sea salt. Soil represents the combination of mechanically disturbed soil (paved and unpaved roads, agricultural activities) and windblown dust. Woodsmoke or burning represents residential wood combustion, and can sometimes also represent other biomass burning such as agricultural or prescribed burning. The motor vehicle category represents direct motor vehicle exhaust from both gasoline and diesel vehicles. Nitrate (or ammonium nitrate) and sulfate (or ammonium sulfate) represent secondary species, i.e. they form in the atmosphere from the primary emissions of NOx, SOx, and ammonia. Combustion sources such as motor vehicles contribute to the NOx that forms ammonium nitrate. The "other" category represents the mass that cannot be accounted for by the identified source categories. It can include water, as well as sources not included in the source apportionment analysis.



For some areas, such as the sites represented by the IMPROVE network, specific source apportionment analysis has not been conducted. Instead, the primary chemical components are shown. As discussed above, nitrate and sulfate are secondary species. Soil, elemental carbon, as well as much of the organic carbon are primary species.



New data that is becoming available will allow for better, and more consistent source apportionment. For example, the PM2.5 speciation samplers measure the species needed for source apportionment analysis on the same sampler. Previously, ions and carbon were measured on the SSI, and elements on the dichotomous samplers, requiring data from different samplers to be combined for a complete picture. Data from special studies such as the California

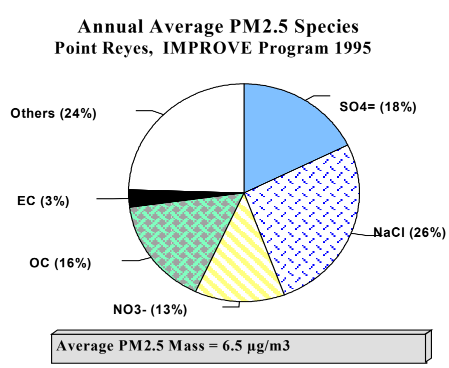
Regional PM10/PM2.5 Air Quality Study (CRPAQS) and the 1997 Southern California Ozone Study (SCOS97) will also provide more detailed speciation data for source apportionment analysis.

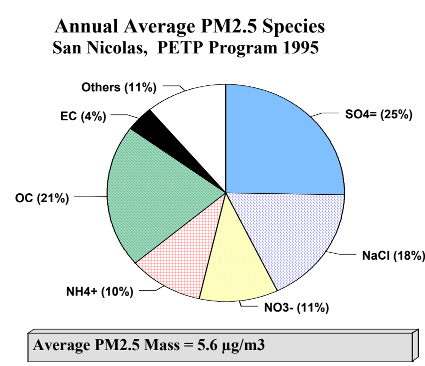
In urban areas where PM concentrations are highest during the winter months, secondary ammonium nitrate, wood smoke, and direct emissions from motor vehicles are the major contributors to high levels of ambient PM. In Fresno and Bakersfield in the San Joaquin Valley and in Sacramento Valley, secondary ammonium nitrate contributes close to 40% of the PM2.5, while in San Jose in the San Francisco Bay Area, ammonium nitrate contributes about 25% to the PM2.5 levels. Wood smoke contributes close to 40% of the PM10 and PM2.5 levels in San Jose and about 20% of the PM2.5 in the Central Valley cities of Fresno, Bakersfield, and Sacramento. The contribution of direct motor vehicle emissions to urban ambient PM2.5 and PM10 concentrations ranges roughly 10% to 25%. Soil dust is a significant component of wintertime PM10, but not of PM2.5. Ammonium nitrate is also the largest contributor to winter PM2.5 levels in rural areas of the San Joaquin Valley. However, wood smoke and direct motor vehicle emissions are not as prominent. In contrast, residential wood combustion and motor vehicle emissions contribute to the high levels of PM10 carbon observed during the winter in the in the towns of Mammoth Lakes in the Great Basin Valleys Air Basin and Quincy in the Mountain Counties.

In other areas, soil dust can be the largest contributor to ambient PM. For example, during the fall, soil dust is the most significant component (55%) of PM10 in rural, agricultural Corcoran in the San Joaquin Valley. In the city of Rubidoux in the South Coast, soil dust constitutes close to one third of the annual ambient PM10 concentration. In the desert city of Calexico, soil contributes 60% to ambient PM10 levels, while motor vehicle exhaust contributes close to 25% of the PM10.

In the South Coast, on an annual basis, secondary ammonium nitrate is also a major contributor to ambient PM10 levels. In Rubidoux and Downtown Los Angeles, ammonium nitrate contributes around 25% to the annual average PM10 levels.

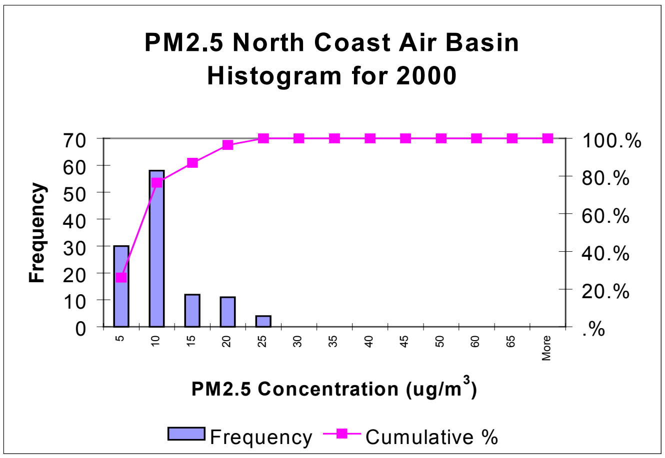
Background sites often exhibit very different profiles. In national parks like Redwoods, Lake Tahoe, and Pinnacles, organic carbon is the major component of annual average fine particulate matter. The charts below show the PM2.5 chemical composition at two of the PM2.5 program background sites.



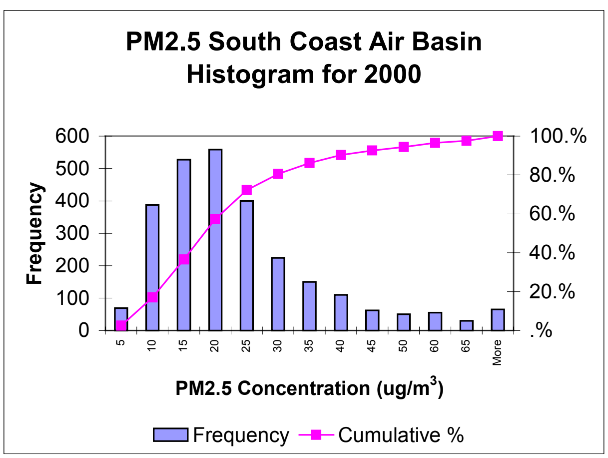


Data for Point Reyes are from analysis of ambient air collected in 1995 as part of the IMPROVE program. Composition data for San Nicholas Island were collected as part of the PTEP95 study. The data show sea salt, sulfate, and organic carbon are the largest contributors to PM2.5 at both sites.

Frequency of Measured PM10 and PM2.5 Concentrations



We generated histograms that represent the frequency distribution of observed particulate matter concentrations at all sites within an air basin. Separate histograms were plotted for 1998-2000 for PM10 and 1999-2000 for PM2.5 observations. As with previous analyses, the PM10 data is derived from the SSI monitor and the PM2.5 data from the FRM monitor. Each bar represents the number of observations within the specified range. For example, for PM2.5 the first bar is the number of observations between 0 and 5 $\mu g/m^3$, the second between 5 and 10 $\mu g/m^3$ and so on. The histograms provide information on the frequency of high concentrations within each air basin, as well as the most frequent, or predominant concentration levels, and can provide insight into the impact of setting air quality standards at varying levels.



In many of the air basins, 80% of the PM10 observations are below 30 to 35 $\mu g/m^3$. However, other air basins, such as the San Joaquin Valley and the South Coast, have significant numbers of observations that are much higher. In these areas, the 80% cumulative frequency is not reached until about 70 $\mu g/m^3$. For PM2.5, in many of the air basins, most of the observations are below 10 to 20 $\mu g/m^3$. However, as with PM10, areas such as the San Joaquin Valley and the South Coast exhibit a distribution such that the 80% cumulative frequency is reached at 35 to 40 $\mu g/m^3$.

Diurnal Variation in PM10 levels

We used PM10 data collected with a Tapered Element Oscillating Monitor (TEOM) at two rural agricultural locations in the Sacramento Valley and filter-based samples collected at one urban and one rural site in the San Joaquin Valley to analyze hourly variations in PM10 levels. TEOM samplers collect PM10 samples continuously, while filter-based samples were collected every three hours. PM10 levels can vary significantly within a day and continuous monitoring data are most useful to study these variations. On a rice straw burning day, in the Sacramento Valley, PM10 concentrations reached from 4 to 5 times the level of the State 24-hour standard for several hours. In the San Joaquin Valley, PM10 levels varied significantly in urban Fresno during the course of a winter day, with the highest concentrations occurring at nighttime, while PM10 concentrations did not vary much throughout the day in rural SW Chowchilla. Chemical composition data indicate diurnal variations in ammonium nitrate were the primary cause of the PM10 variations in SW Chowchilla. The rise in PM10 concentrations in Fresno corresponded mostly to significant nighttime peaks in vegetative burning, mobile sources, and excess organic carbon.

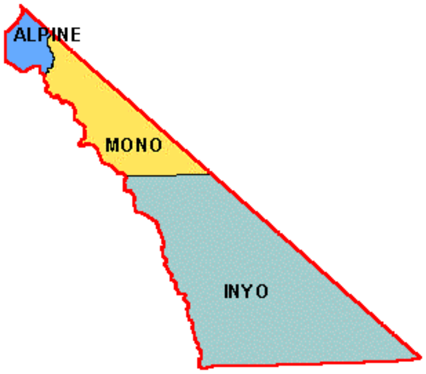
Particle Size Distribution

Data on particle size distribution is limited. During the IMS95 winter study in San Joaquin Valley, air samples using a Micro-Orifice Uniform Deposit Impactor (MOUDI) sampler were collected at Bakersfield (Chow et al. 1997). The MOUDI partitions ambient PM samples into nine size cuts between 0.054 and 15 μm. We used these data to study the size distribution of PM10 components. Soil components were concentrated mainly on the larger size fractions (>3.16 μm), the coarse component of PM10. The size of nitrate particles peaked between 1 and 1.78 μm, while organic carbon particles appeared in both, larger (peak between 0.37 and 1 μm) and smaller (<0.054 μm) fractions.

Characterization of Ambient Particulate Matter by Air Basin

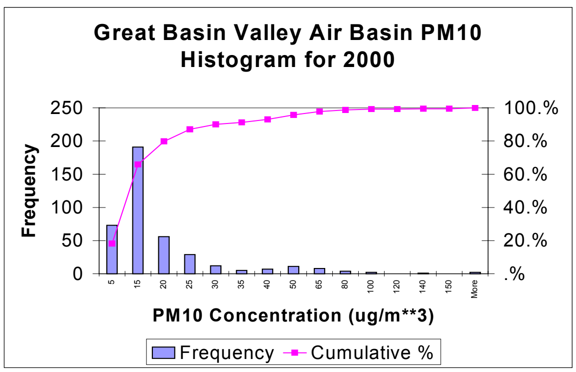
This section describes the characteristics of ambient particulate matter for each of the fifteen air basins in the State. The information presented includes: maximum 24-hour and annual average PM10 and PM2.5 concentrations, seasonal variation of particulate matter levels; frequency of measured PM10 and PM2.5 concentrations, and ratios of PM2.5 to PM10 levels. Where available, source attribution information is also included. For areas where no source attribution analyses are available, the primary chemical composition of ambient PM10 or PM2.5 is illustrated. Based on the 2000 annual average PM10 emission inventory, we identify the main sources of directly emitted PM10.

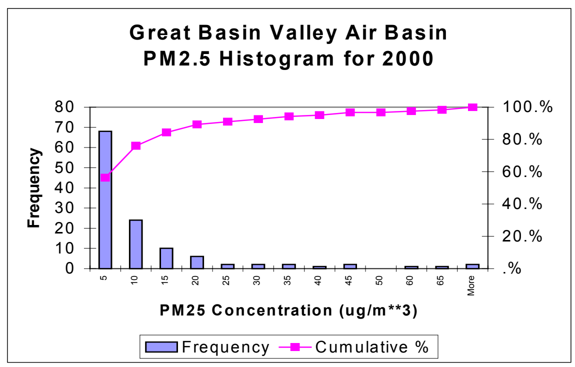
Great Basin Valleys Air Basin



On an annual basis, particulate levels are low in the Great Basin Valleys Air Basin (PM10 = 14 to 20 µg/m^3 and PM2.5 = 7 to 9 µg/m^3). As illustrated on the charts below, eighty percent of the 24-hour PM10 observations were under 10 to 15 µg/m^3 and 80% of the 24-hour PM2.5 observations were under 10 to 15 µg/m^3. However, on a short term, episodic basis, Great Basin Valleys may record some of the highest monitored levels in the State. During windy conditions, dust from the Owens dry lakebed produces extremely high concentrations of particulate in the air, reaching 1116 µg/m^3 in 1998.

The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





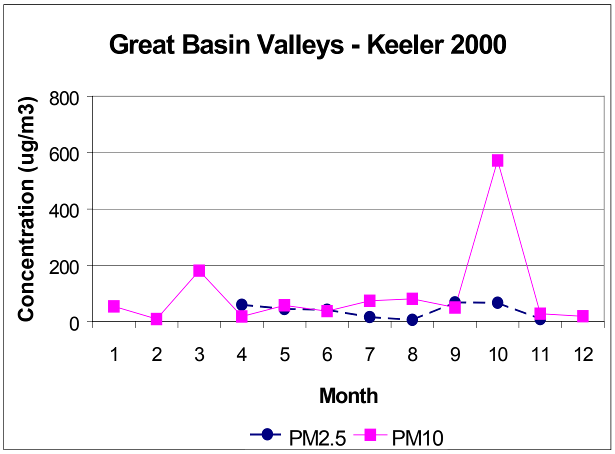
* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 µg/m^3). The line represents the total percent of observations up to the specified range.

The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 (µg/m^3)			PM2.5 (µg/m^3)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	29	1116	20			
1999	1	514	14		41	7
2000	14	572	20	2	68	9

* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

Particulate levels exceeded the 24-hour State PM10 standard 44 times in the last three-year period and two observations over the federal PM2.5 standard were recorded in the last two years. The Great Basin Valleys Air Basin did not exceed either the PM10 or PM2.5 annual standards.

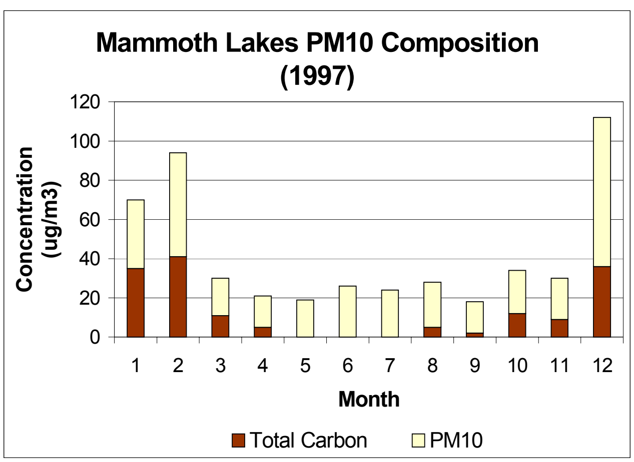


*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

The chart on the left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations at Keeler in 2000. Keeler is located near the Owens dry lakebed. High PM10 concentrations can occur at any time of the year, though more frequently in the spring and fall. PM2.5 concentrations are relatively uniform most of the year.

Data obtained from the Keeler and Coso Junction dichotomous samplers in 1999 indicate the PM2.5 component of PM10 ranges from 14% to 89%, with an annual average of 33%.

Based on the 2000 annual PM10 emission inventory, the major sources of directly emitted particulate matter in the Great Basin Valleys Air Basin are unpaved road dust, windblown dust, residential wood burning, and wildfires.



In the town of Mammoth Lakes, high PM10 concentrations usually occur during the winter months (December – February). The graph on the left shows the monthly variation of the maximum daily PM10 concentrations in 1997. The chart also illustrates how much of the measured PM10 is total carbon. During the winter, total carbon comprises 30% to 50% of the measured PM10. Sources of carbon include residential wood combustion and motor vehicles.

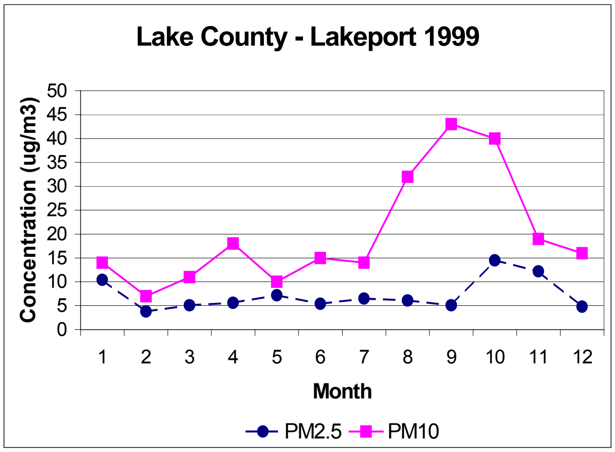
Lake County Air Basin

On average, Lake County has among the lowest particulate levels in the State. Maximum 24-hour PM10 ranges from 22 to 35 µg/m³ and maximum 24-hour PM2.5 from 9 to 15 µg/m³, with no exceedances of either standard.

The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 (µg/m³)			PM2.5 (µg/m³)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998		35	6			
1999		43	11		15	4
2000		22	10		9	Incomplete data

* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

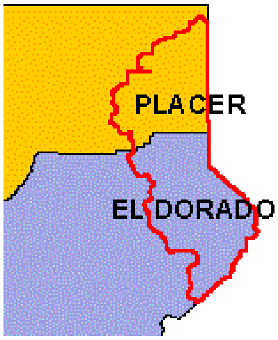


*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

The chart at left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations at Lakeport in 1999. PM10 levels are highest from August through October and are low the rest of the year. PM2.5 concentrations peak in October and November.

Based on estimated 2000 annual average PM10 emission inventory data, the principal sources of directly emitted particulate matter in Lake County are unpaved road dust and residential wood burning. Occasionally, Lake County also has significant levels of particulates from wildfires.

Lake Tahoe Air Basin



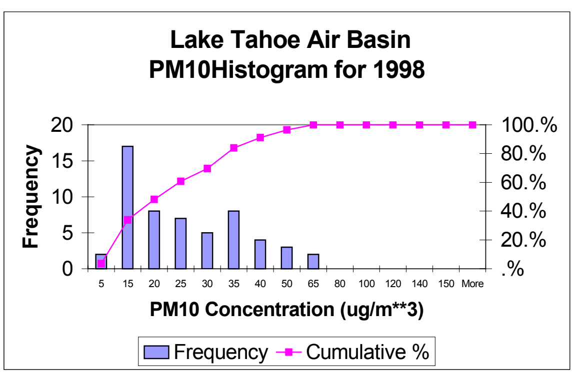
In the Lake Tahoe Air Basin, particulate levels exceeded the 24-hour State PM10 standard two times in the last three-year period, but fine particulate levels were well below the federal PM2.5 standards. The State annual PM10 standard was also not exceeded. As illustrated on the charts below, in 1998, 80% of the PM10 observations were below 40 to 50 ug/m3. In the last two years, 80% of the PM2.5 observations were below 10 to 15 $\mu g/m^3$.

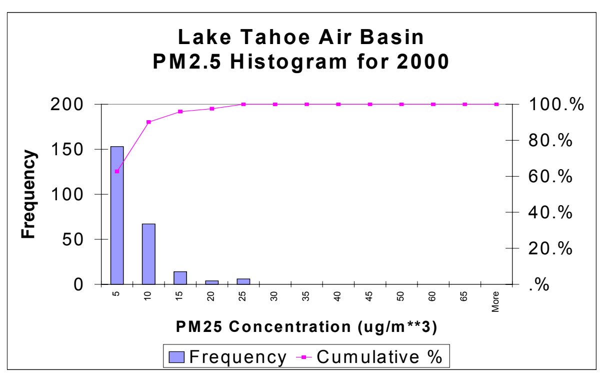
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 ($\mu g/m^3$)			PM2.5 ($\mu g/m^3$)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	2	59	20			
1999		41	17		21	8
2000		50	18		23	7

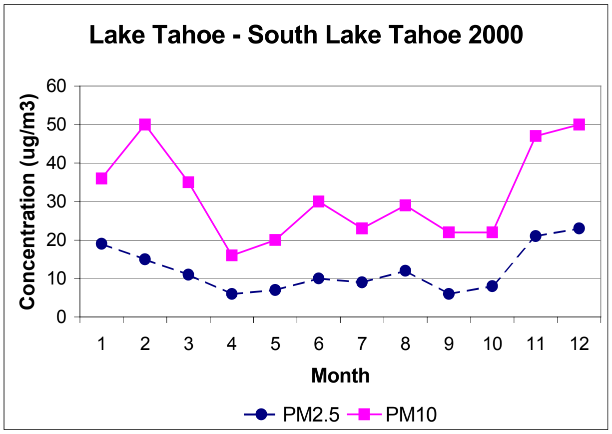
* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





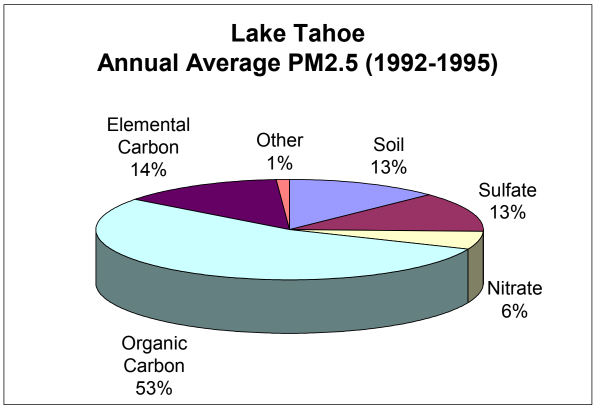
* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 $\mu g/m^3$). The line represents the total percent of observations up to the specified range.



*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

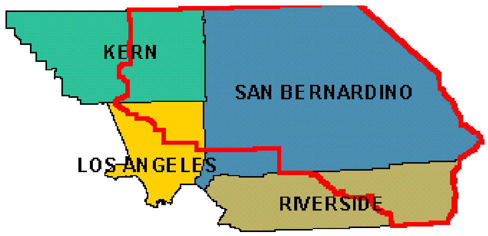
The chart at left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations in South Lake Tahoe in 2000. PM10 as well as PM2.5 levels are highest during the late fall and winter (November through February), and are lowest in the in spring and summer.

Based on the 2000 annual PM10 emission inventory, the major sources of directly emitted particulate matter are unpaved road dust and residential wood burning.



Data for the illustration shown at left are from analysis of ambient air collected in Lake Tahoe from 1992 through 1995 as part of the IMPROVE program (Sisler 1996). The constituents shown can vary substantially daily and seasonally based on a variety of factors such as meteorology and which particulate sources are most active. The data show large carbon contributions, mostly from residential wood combustion in fireplaces and other combustion sources, including motor vehicles. The nitrates and sulfates shown are predominantly formed from reactions from motor vehicle exhaust - nitrogen oxides and sulfur oxides – and other combustion sources. The soil component originates from sources such as paved and unpaved road dust.

Mojave Desert Air Basin



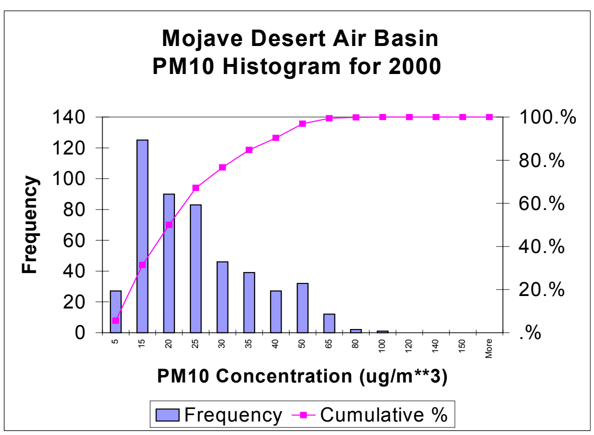
In the Mojave Desert Air Basin, particulate levels exceeded the 24-hour State PM10 standard 31 times in the last three-year period, but fine particulate levels were below the federal PM2.5 standards. The State annual PM10 standard was also not exceeded. As illustrated on the charts below, eighty percent of the PM10 observations were below 30 to 35 $\mu g/m^3$ and 80% of the PM2.5 observations were below 20 to 25 $\mu g/m^3$.

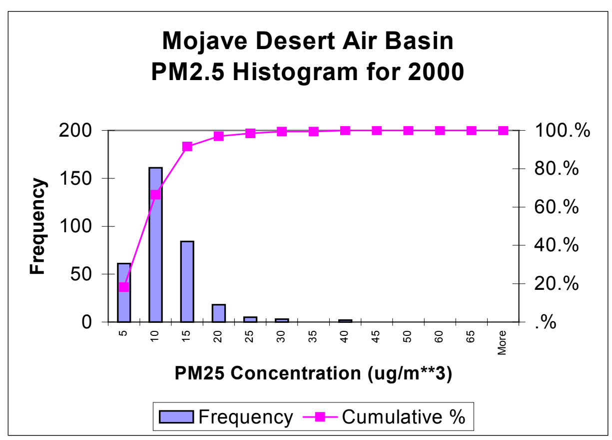
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 ($\mu g/m^3$)			PM2.5 ($\mu g/m^3$)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	8	165	24			
1999	12	109	28		48	12
2000	11	80	30		39	8

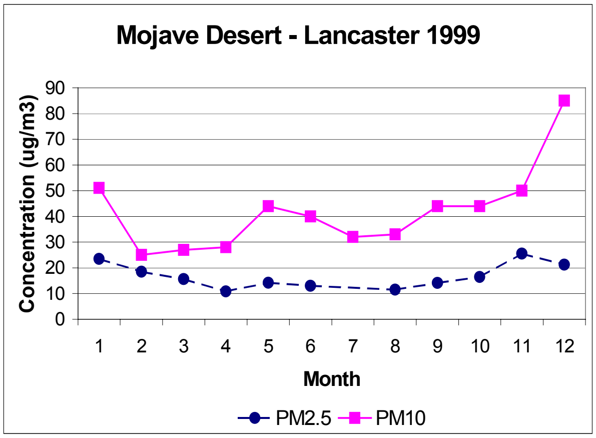
* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 $\mu g/m^3$). The line represents the total percent of observations up to the specified range.



*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

The chart at left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations in Lancaster in 1999. PM10 as well as PM2.5 levels are highest during the winter months - December and January. During the rest of the year, PM2.5 levels are quite low, while PM10 levels fluctuate with no distinct pattern.

Data from the dichotomous sampler at Victorville in 1999 indicate the PM2.5 component of PM10 ranges from 19% to 75%. The average PM2.5 fraction of PM10 is 46% from November to February and 39% from March to October.

Based on the 2000 annual PM10 emission inventory, the major contributors to primary particulates in the Mojave Desert Air Basin are unpaved road dust, windblown dust, paved road dust, and construction related dust. A few point source categories, such as mineral processing facilities, also contribute significant emissions.

Mountain Counties Air Basin

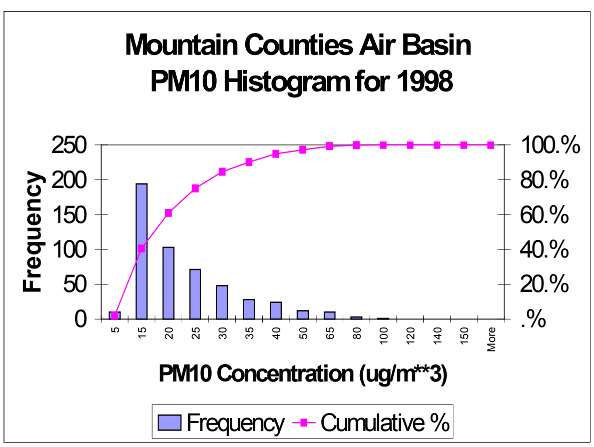
In the Mountain Counties Air Basin, particulate levels exceeded the 24-hour State PM10 standard 32 times in the last three-year period and four observations over the federal 24-hour PM2.5 standard were recorded in 1999. Fine particulate exceedances in 1999 were most probably due to wild fires which occurred in the late summer and early fall. Neither the State or federal PM2.5 annual standards were exceeded. As illustrated on the charts below, in the Mountain Counties 80% of the PM10 observations are below 30 to 35 $\mu g/m^3$ and 80% of the PM2.5 readings are below 10 to 15 $\mu g/m^3$.

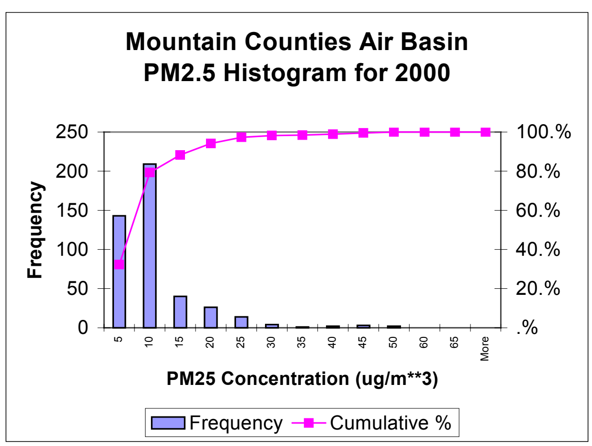
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 ($\mu g/m^3$)			PM2.5 ($\mu g/m^3$)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	11	92	23			
1999	13	125	23	4	92	14
2000	8	98	22		48	8

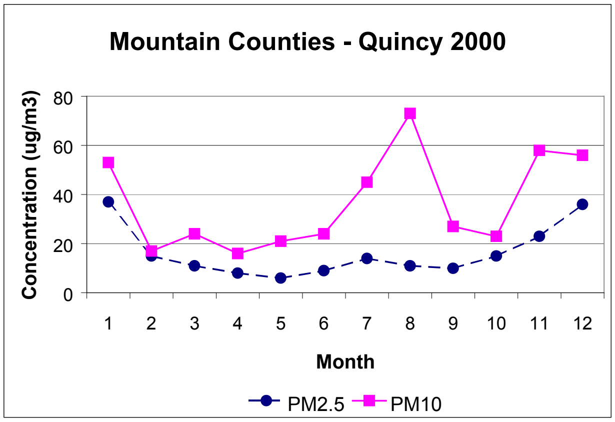
* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 $\mu g/m^3$). The line represents the total percent of observations up to the specified range.

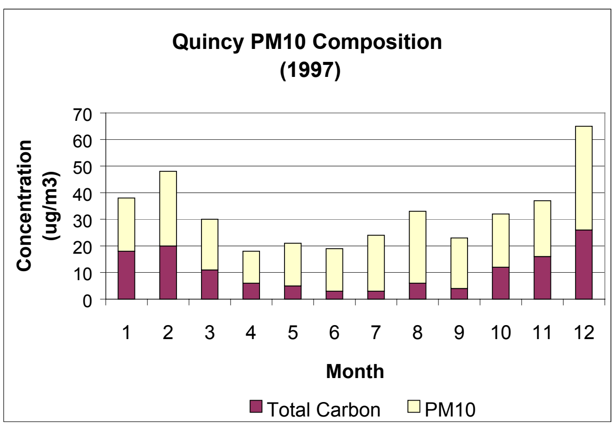


*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

The figure at left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations in Quincy in 2000. Highest ambient concentrations of PM10 occur during the summer and winter months, while fine particulate matter levels are highest in the late fall and early winter months of November through January.

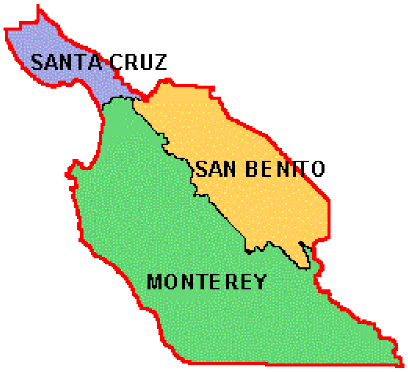
Data obtained from the Portola dichotomous sampler in 1999 show that the PM2.5 portion of PM10 ranged from 19% to 91%. The average PM2.5 fraction of PM10 was 72% from November through January and 41% during the rest of the year.

Based on the 2000 annual PM10 emission inventory, directly emitted particulate sources are unpaved road dust, wood burning stoves and fireplaces, and open burning.



As shown on the chart on the left, substantial levels of organic carbon are observed in the late fall and winter months, most likely due to residential burning and motor vehicles. There may also be episodic particulate emission impacts when forest management burning takes place.

North Central Coast Air Basin



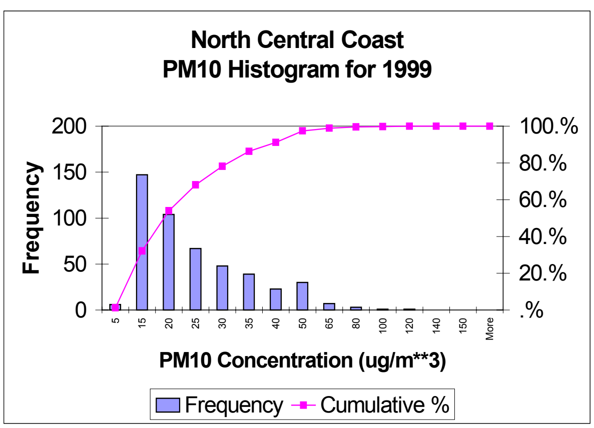
In the North Central Coast Air Basin, particulate levels exceeded the 24-hour State PM10 standard 18 times in the last three-year period, but fine particulate levels were below the federal PM2.5 standards. The State annual PM10 standard was also not exceeded. In the North Central Coast, 80% of the PM10 observations were below 30 to 35 μg/m^3 and 80% of the PM2.5 measurements were below 10 to 15 μg/m^3, as illustrated on the charts below.

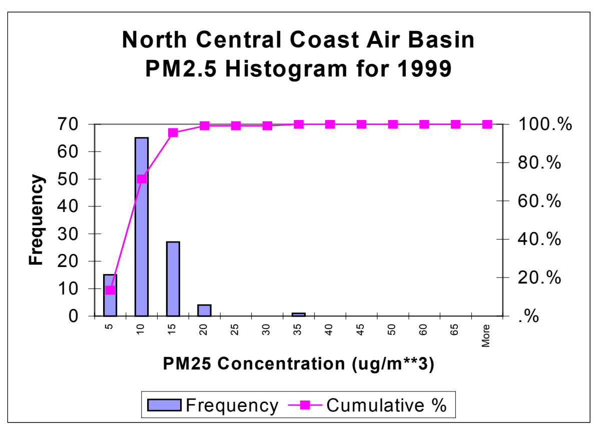
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 (μg/m^3)			PM2.5 (μg/m^3)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	5	76	26			
1999	9	103	28		31	8
2000	4	74	27		23	Incomplete data

* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

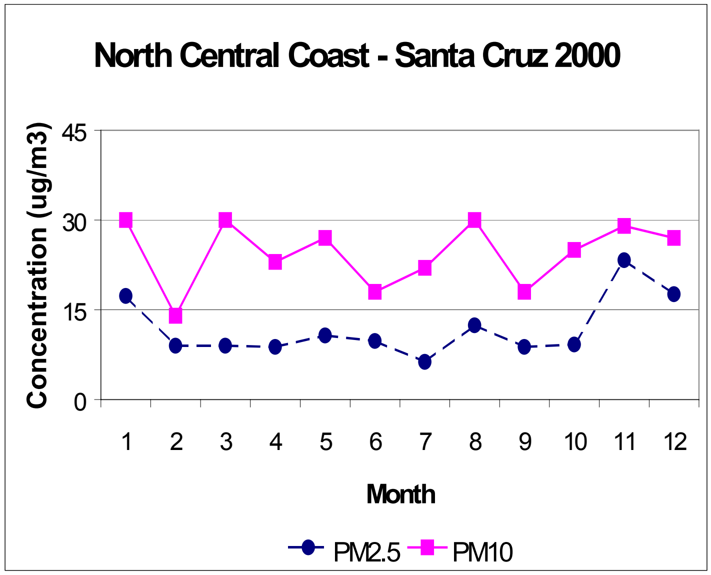
The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





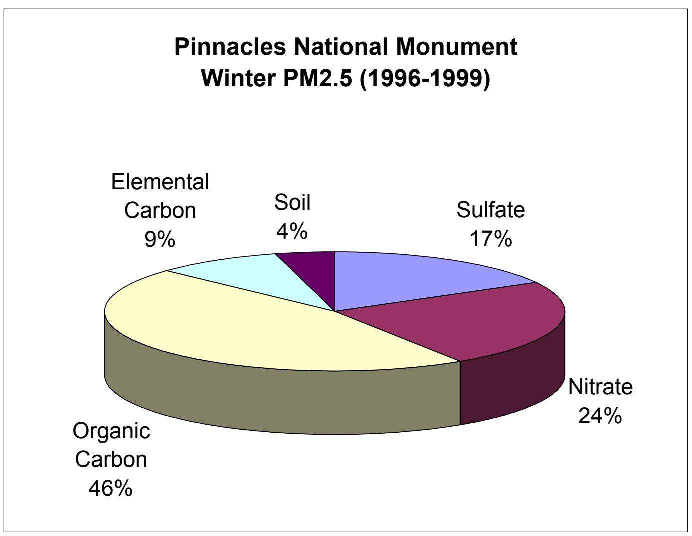
* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 μg/m^3). The line represents the total percent of observations up to the specified range.

The chart on the right illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations in Santa Cruz in 2000. Fine particulate levels are highest from November through January and are very low the rest of the year. PM10 levels fluctuate throughout the year, with no distinct seasonal pattern.



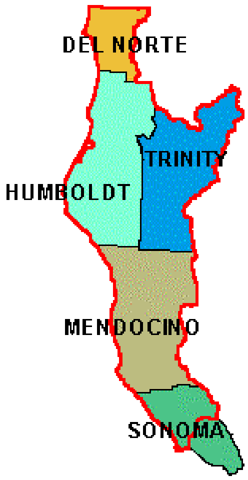
*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

Based on the 2000 annual PM10 emission inventory, the major sources of directly emitted particulates in the North Central Coast Air Basin are unpaved roads, windblown dust, dust from farming operations, paved road dust, and residential wood burning.



Data for the illustration shown at left are from analysis of ambient air collected in the Pinnacles National Monument from 1996 through 1999 as part of the IMPROVE program (Malm et al. 2000). The constituents shown can vary substantially daily and seasonally based on a variety of factors such as meteorology and which particulate sources are most active. The data show carbon as the largest component of fine particulate matter. Smaller contributions are also seen from secondary nitrate and sulfate formed form reactions in the atmosphere of nitrogen oxides and sulfur oxides from motor vehicle exhaust and other combustion processes.

North Coast Air Basin



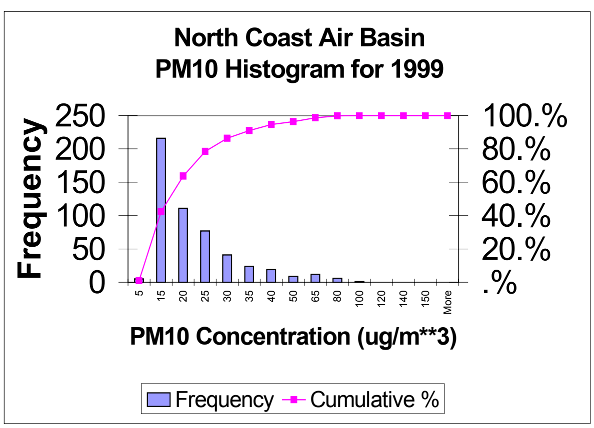
In the North Coast Air Basin, particulate levels exceeded the 24-hour State PM10 standard 13 times in the last three-year period, but fine particulate levels were below the federal PM2.5 standards. The State annual PM10 standard was also not exceeded. In the North Coast Air Basin, 80% of the PM10 observations were below 30 to 35 μg/m^3 and 80% of the PM2.5 measurements fell below 10 to 15 μg/m^3, as illustrated on the charts below.

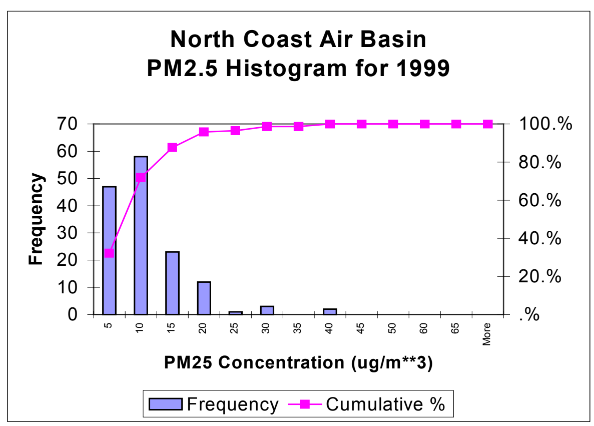
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 (μg/m^3)			PM2.5 (μg/m^3)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998		50	20			
1999	11	100	22		37	9
2000	2	51	20		24	9

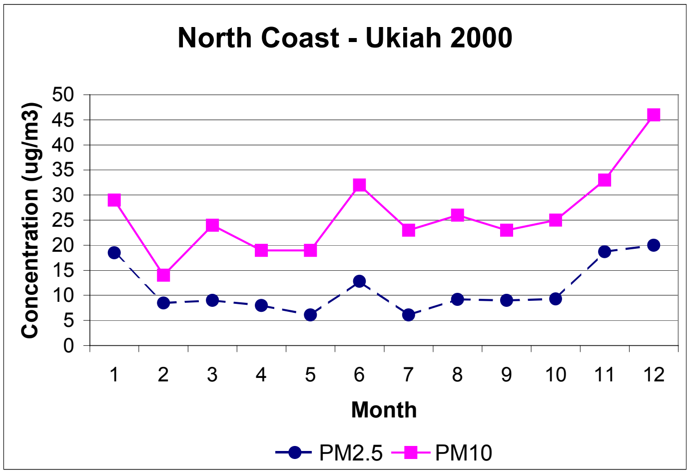
* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





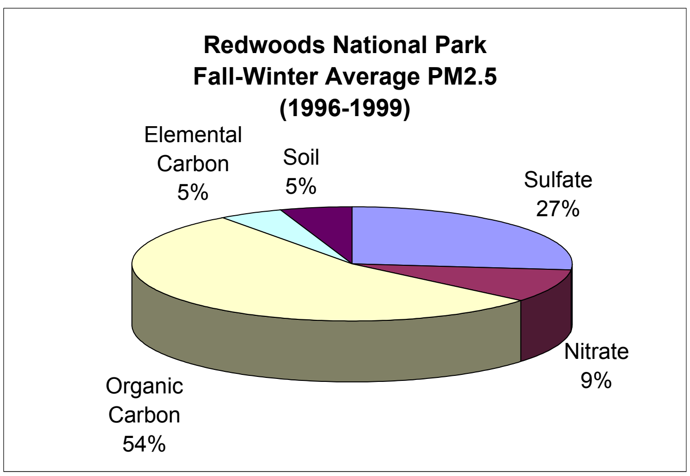
* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 μg/m^3). The line represents the total percent of observations up to the specified range.



*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

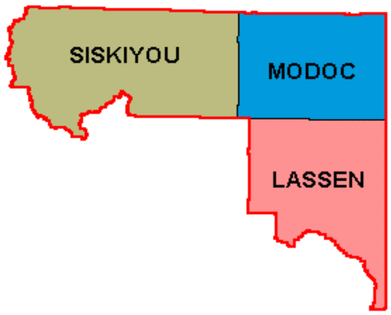
The figure at left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations in Ukiah in 2000. PM10 as well as PM2.5 levels are highest during the months of November through January, with a smaller peak in June.

Based on the 2000 annual PM10 emission inventory, the principal source of directly emitted particulate matter is unpaved road dust. Other significant sources are residential wood burning and waste burning, which could include forest management burning.



Data for the illustration shown at left are from analysis of ambient air collected in the Redwoods National Park from 1996 through 1999 as part of the IMPROVE program (Malm et al. 2000). The constituents shown can vary substantially daily and seasonally based on a variety of factors such as meteorology and which particulate sources are most active. The data show substantial contributions from organic and elemental carbon, as well as secondary sulfate and nitrate formed from reactions in the atmosphere of nitrogen oxides and sulfur oxides from motor vehicle exhaust and other combustion processes.

Northeast Plateau Air Basin



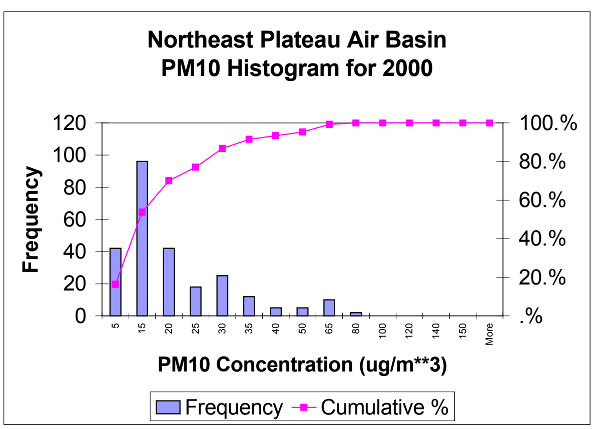
In the Northeast Plateau Air Basin, particulate levels exceeded the 24-hour State PM10 standard 26 times in the last three-year period, but fine particulate levels were below the federal PM2.5 standards. The State annual PM10 standard was also not exceeded. In this air basin, 80% of the PM10 measures were below 30 to 35 $\mu g/m^3$ and 80% of the PM2.5 observations were below 15 to 20 $\mu g/m^3$, as illustrated on the charts below.

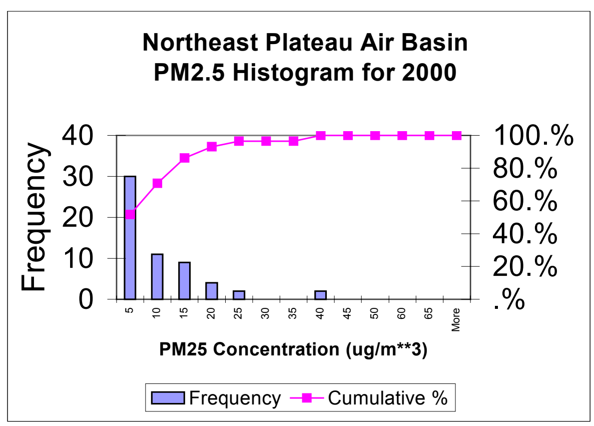
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 ($\mu g/m^3$)			PM2.5 ($\mu g/m^3$)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	4	66	13			
1999	12	100	30		40	8
2000	10	80	18		38	7

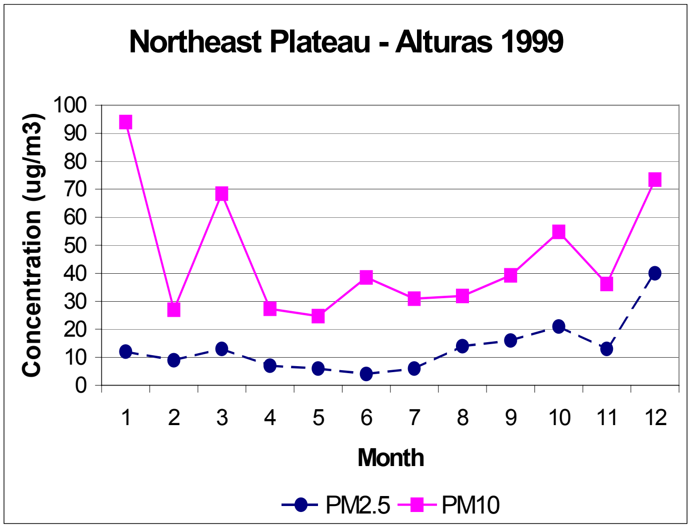
* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 $\mu g/m^3$). The line represents the total percent of observations up to the specified range.

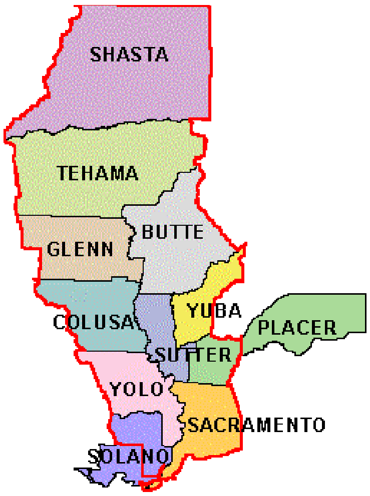


*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

The figure at left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations in Alturas in 2000. PM10 levels are highest during the winter months of December through March with lower concentrations during the spring and summer. PM2.5 levels are highest in December.

The 2000 annual PM10 emission inventory shows that unpaved road dust is the predominant source of directly emitted particulates. The Northeast Plateau Air Basin may also have occasional high emissions from wildfires and forest management burning.

Sacramento Valley Air Basin



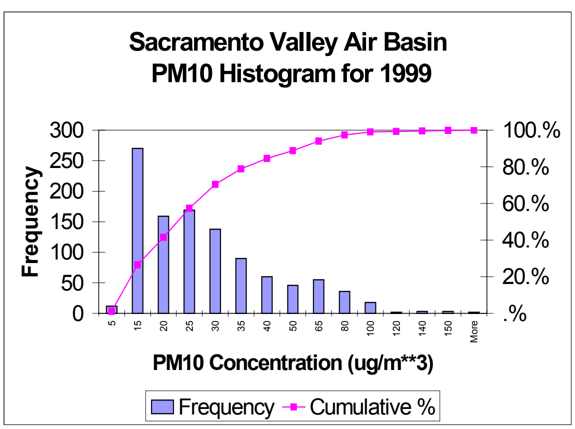
In the Sacramento Valley Air Basin, particulate levels exceeded the 24-hour State PM10 standard 62 times in the last three-year period and PM2.5 concentrations over the federal PM2.5 standard were recorded 16 times in the last two years. Particulate levels also exceeded both the State PM10 and federal PM2.5 annual standards. In the Sacramento Valley Air Basin, 80% of the PM10 observations are below 45 to 50 $\mu g/m^3$ and 80% of the PM2.5 measurements are below 20 to 25 $\mu g/m^3$, as illustrated on the charts below.

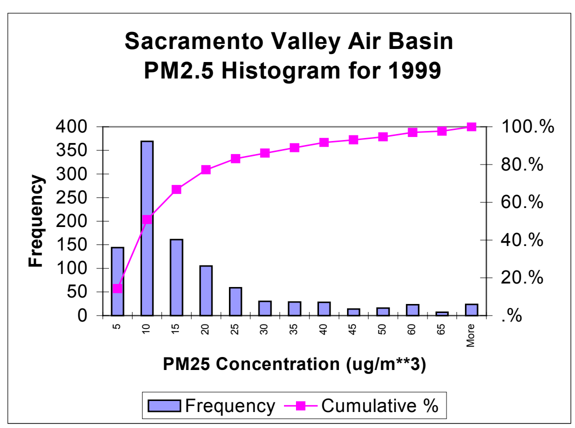
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	**PM10 ($\mu g/m^3$)**			**PM2.5 ($\mu g/m^3$)**		
	Days over State Std.	**Max 24-hour (Std.=50)**	**Max Annual Geo Mean (Std.-30)**	**Days over Federal Std.**	**Max 24-hour (Std.=65)**	**Max Annual Average (Std.=15)**
1998	17	68	19			
1999	27	171	26	11	108	19
2000	18	86	25	5	98	12

* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

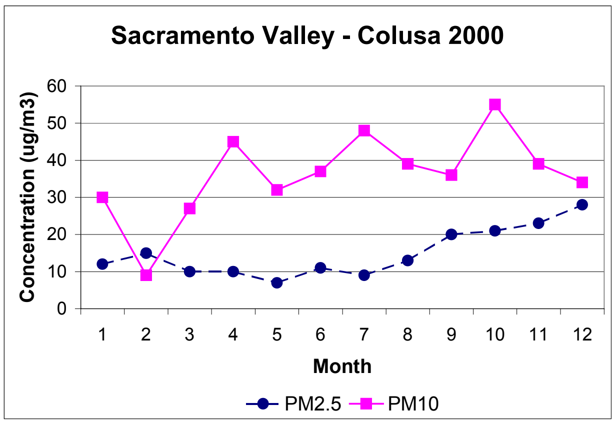
The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.

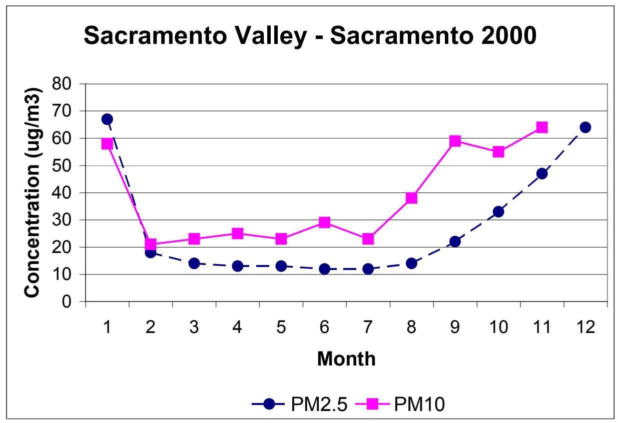




* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 $\mu g/m^3$). The line represents the total percent of observations up to the specified range.

The figures below illustrate the monthly variation of the maximum daily PM10 and PM2.5 concentrations in Colusa, a rural community in the central portion of the Valley, and the city of Sacramento, in the southern portion of the Valley for 2000. In Colusa, PM10 levels oscillate throughout the year with no distinct seasonal pattern. PM2.5 levels are highest in the fall and winter. In contrast, in Sacramento, both PM10 and PM2.5 levels are low during the spring and summer, with PM10 reaching peak values in the fall and early winter and PM2.5 reaching highest values in the winter. Data obtained from the Sacramento dichotomous sampler show that in 1999 and 2000 the PM2.5 portion of PM10 ranged from 13% to 86%. The two-year average PM2.5 portion of PM10 from November through February was 68% dropping to 43% from March through October.

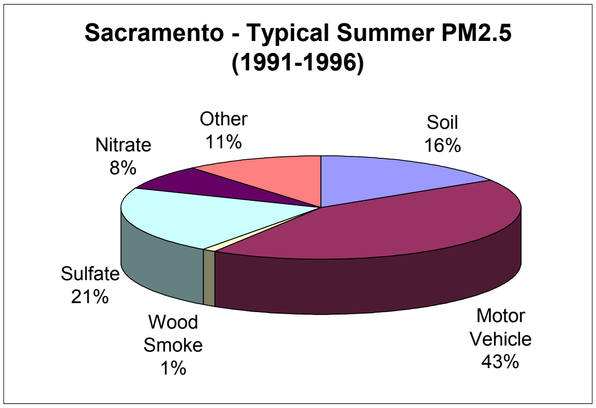


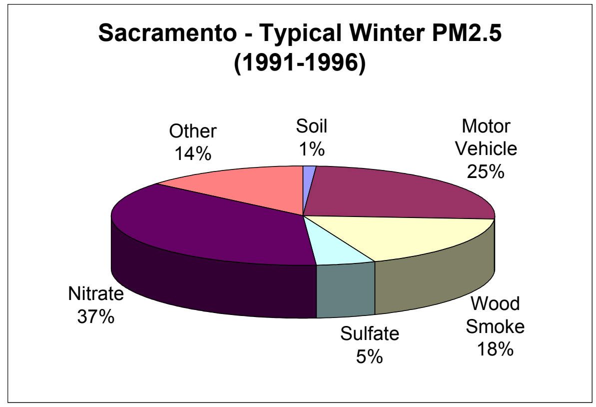


*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

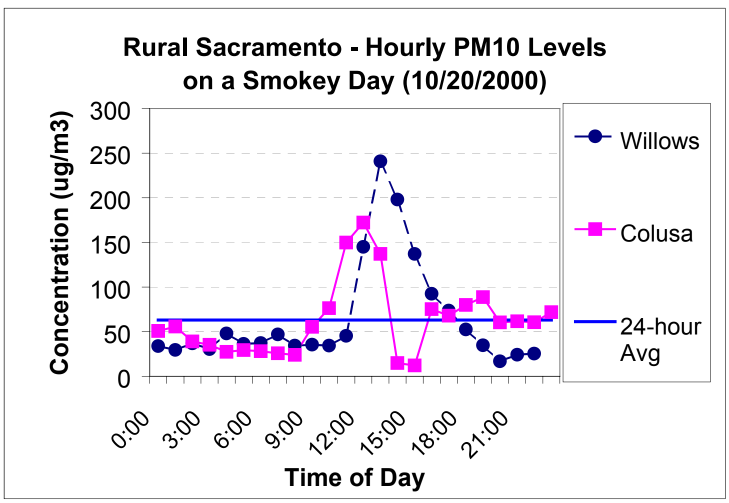
Based on the 2000 annual PM10 emissions inventory, the major sources of directly emitted particulates in the Sacramento Valley include soil from farming, construction dust, paved road dust, smoke from residential wood combustion, and exhaust from mobile sources such as cars and trucks.

Data for the illustrations shown below are from analysis of ambient air collected in the summer (June through September) and winter (November through January) from 1991 through 1996 in Sacramento (Motallebi 1999, Motallebi 2001). The constituents shown can vary based on a variety of factors such as meteorology and which particulate sources are most active.



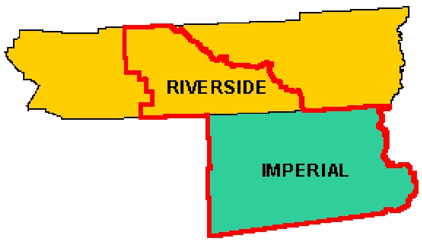


In the summer, directly emitted particles from motor vehicle exhaust and dust from paved roads and construction activities are major contributors to fine particulate ambient levels. The data also show contributions from secondary sulfate and nitrate formed from reactions in the atmosphere of nitrogen oxides and sulfur oxides from motor vehicle exhaust and other combustion processes. During the winter, wood smoke from residential fireplaces becomes a significant source of fine particulates. Winter conditions - cool temperatures, low wind speeds, low inversion layers, and high humidity – also favor the formation of nitrates.



The northern Sacramento Valley can be impacted by seasonal agricultural burning, mostly during the fall. The chart on the left illustrates the hourly variation in PM10 levels on a rice straw burning day in Willows and Colusa in 2000. PM10 levels reached 4 to 5 times the level of the State 24-hour PM10 standard for two hours in Willows and an average of 3 times the level of the standard for three hours in Colusa.

Salton Sea Air Basin



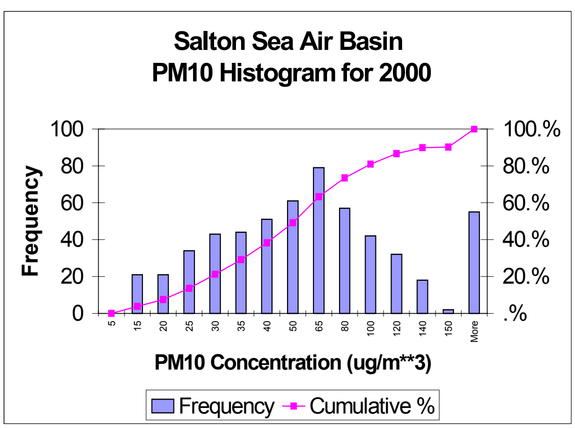
The Salton Sea Air Basin registered the highest 24-hour PM10 concentrations in the State in 1999 and in 2000. Particulate levels exceeded the 24-hour State PM10 standard 227 times in the last three-year period, but only one observation over the 24-hour federal PM2.5 standard was recorded last year. Particulate levels also exceeded both the State PM10 and federal PM2.5 annual standards. Eighty % of the PM10 observations were below 100 to 120 $\mu g/m^3$, while 80% of the PM2.5 measurements fell below 15 to 20 $\mu g/m^3$, as illustrated on the charts below.

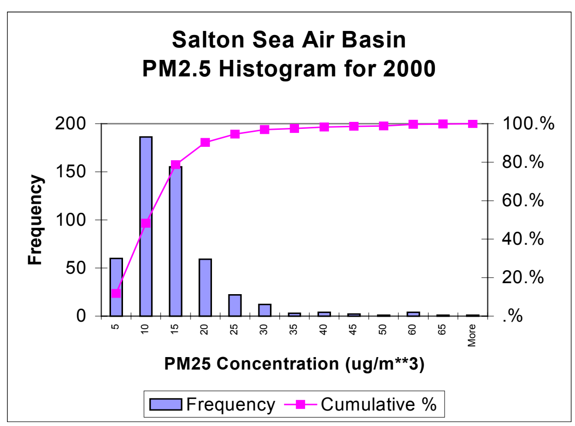
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 ($\mu g/m^3$)			PM2.5 ($\mu g/m^3$)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	62	568	79			
1999	68	1342	130		53	15
2000	97	1613	183	1	84	17

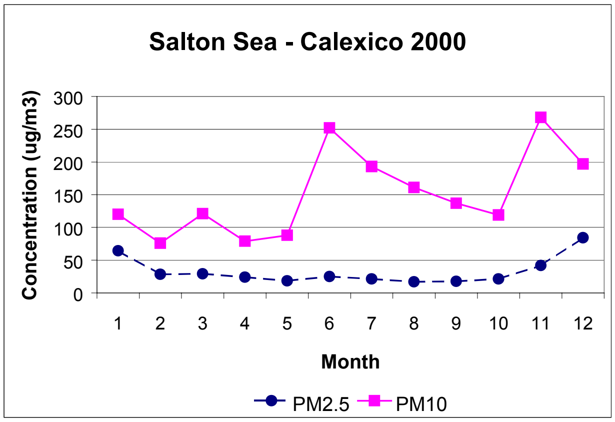
* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 $\mu g/m^3$). The line represents the total percent of observations up to the specified range.

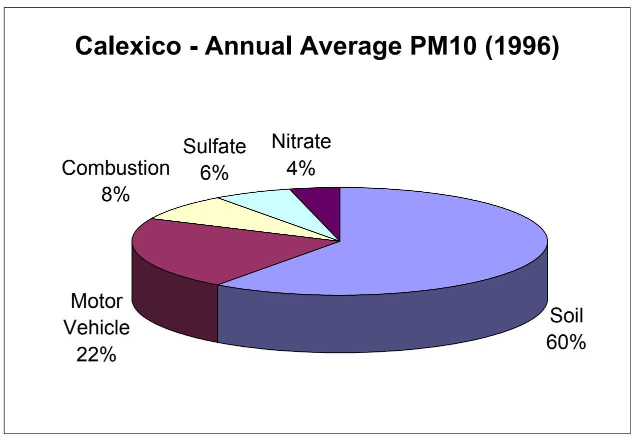


*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

The chart on the left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations in Calexico in 2000. PM10 levels peak in the summer and fall. Fine particulates show a small increase in the fall and winter.

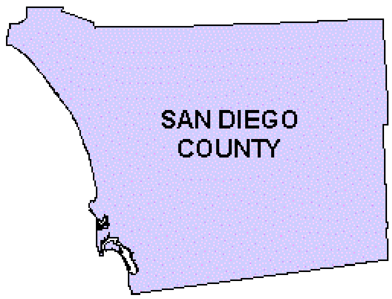
Data obtained from the Calexico dichotomous sampler in 2000 indicate the PM2.5 component of PM10 ranges from 13% to 49%. The average PM2.5 part of PM10 from November to January is 34% and from February to October is 24%.

Based on the 2000 annual PM10 emission inventory, the major contributor of directly emitted particulates in the Salton Sea is windblown dust. Unpaved road dust and farming related dust also contribute.



A detailed chemical analysis of the particulate components in ambient air was used to provide the illustration of the sources of particulate matter in Calexico in 1996 (Woodhouse 2001). Dust is the major component of PM10. The figure also shows significant contributions from motor vehicle exhaust. The observed results could partially be due to transported pollutants from the neighboring city of Mexicali, which has high traffic. Secondary sulfate and nitrate formed from reactions in the atmosphere of nitrogen oxides and sulfur oxides from motor vehicle exhaust and other combustion processes also are small contributors to particulate matter levels in the air basin.

San Diego Air Basin



In the San Diego Air Basin, particulate levels are high year-round, exceeding both the annual State PM10 and federal PM2.5 standards over the last three years. Ambient particulate levels also exceeded the 24-hour PM10 standard 67 times in the last three years and two PM2.5 observations over the federal PM2.5 standard were recorded in the last two years. In San Diego County, 80% of the PM10 measurements were below 40 to 50 µg/m^3 and 80% of the PM2.5 observations were below 20 to 25 µg/m^3, as illustrated on the charts below.

The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	**PM10 (µg/m^3)**			**PM2.5 (µg/m^3)**		
	Days over State Std.	**Max 24-hour (Std.=50)**	**Max Annual Geo Mean (Std.-30)**	**Days over Federal Std.**	**Max 24-hour (Std.=65)**	**Max Annual Average (Std.=15)**
1998	18	89	39			
1999	24	121	48		64	18
2000	25	139	42	2	66	16

* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
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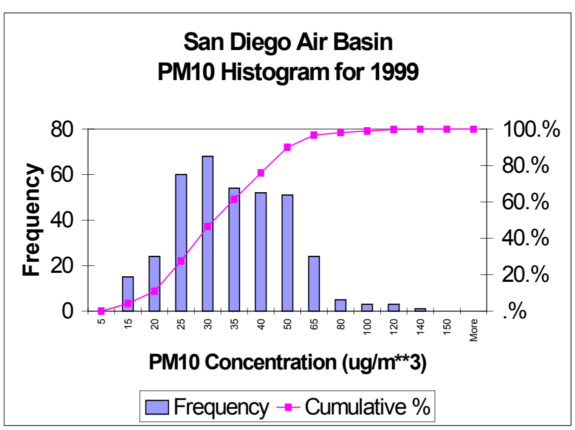
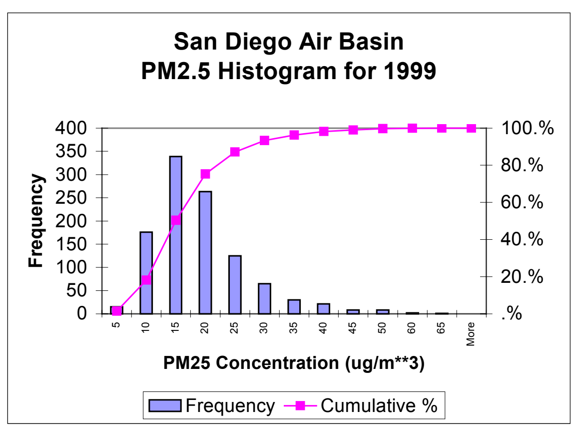
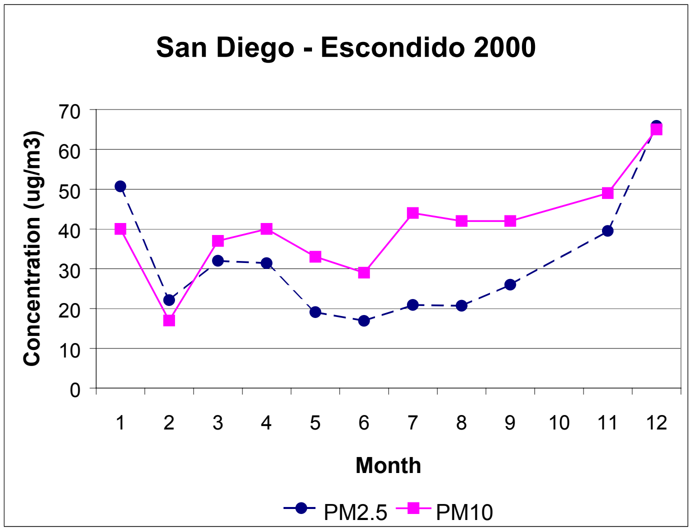
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.





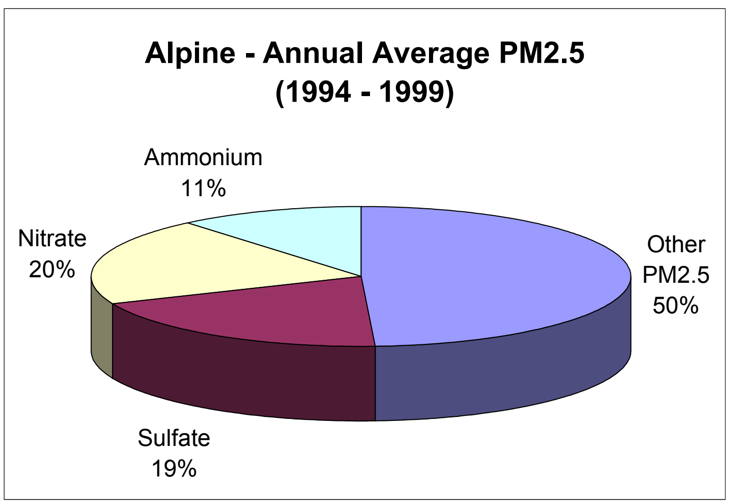
* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 µg/m^3). The line represents the total percent of observations up to the specified range.



*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

The chart at left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations in Escondido in 2000. PM10 concentrations exhibit no distinct seasonal pattern, while PM2.5 concentrations are highest during the fall and winter.

Based on the 2000 annual PM10 emission inventory, the major contributors to directly emitted particulates in the San Diego Air Basin are construction dust, paved road dust, and unpaved road dust. Other sources are fireplaces and woodstoves, mobile sources, and mineral processes.



Data for the illustration shown at left are from analysis of ambient data collected in Alpine from 1994 through 1999 as part of the Southern California Children's Health Study. The data show substantial contributions from secondary nitrate and sulfate formed from reactions in the atmosphere of nitrogen oxides and sulfur oxides from motor vehicle exhaust and other combustion processes. The other PM2.5 represents soil sources and total carbon. Carbon sources include wood smoke, other combustion sources, and motor vehicles (Salmon et al. 2001).

San Francisco Bay Area Air Basin

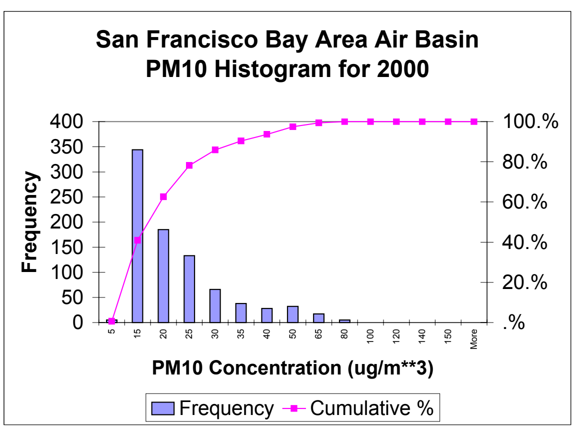
In the San Francisco Bay Area Air Basin, particulate levels exceeded the 24-hour State PM10 standard 24 times in the last three-year period and five PM2.5 observations over the 24-hour federal PM2.5 standard were recorded in the last two years. Particulate levels also exceeded the federal PM2.5 annual standard in 1999. As illustrated on the charts below, eighty % of the 24-hour PM10 observations were below 25 to 30 $\mu g/m^3$ and 80% of the 24-hour PM2.5 measurements were below 20 to 25 $\mu g/m^3$.

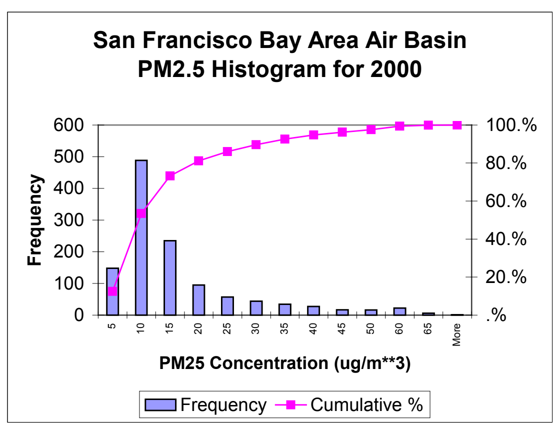
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 ($\mu g/m^3$)			PM2.5 ($\mu g/m^3$)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	5	92	22			
1999	12	114	25	4	91	16
2000	7	76	24	1	67	14

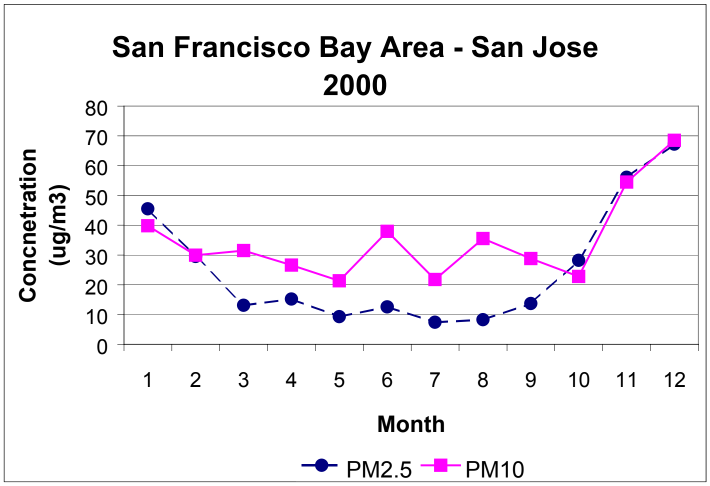
* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 $\mu g/m^3$). The line represents the total percent of observations up to the specified range.



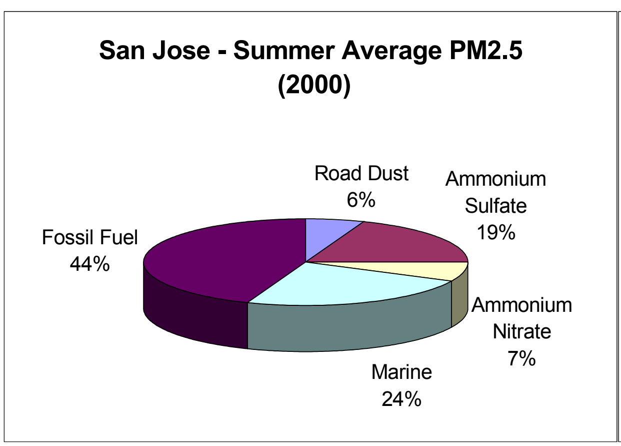
*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

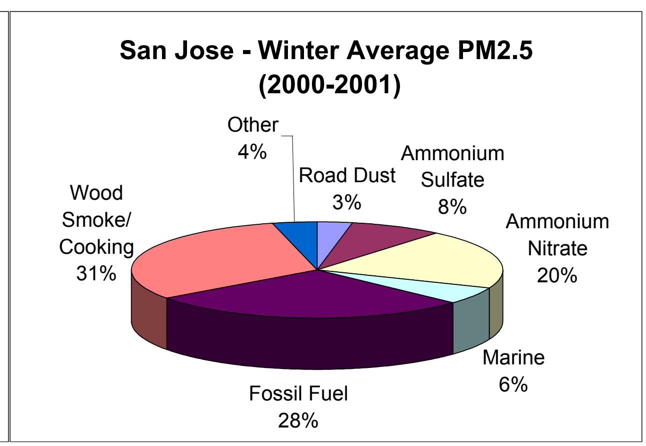
The chart at left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations in San Jose in 2000. Highest concentrations of both PM10 and PM2.5 occur during the winter months of November through January. PM2.5 drives PM10 concentrations during the winter, while smaller summer peaks are driven by PM10.

Data obtained from the San Jose dichotomous sampler in 1999 indicate the PM2.5 portion of PM10 ranges from 30% to 80%. The average PM2.5 portion of PM10 from November to January is 61%, dropping to 46% from February to October.

Based on the 2000 annual PM10 emission inventory of directly emitted particulate matter, major sources include smoke from residential wood combustion, dust from construction operations, and the dust created by vehicles traveling on paved roads. There are also significant emissions from unpaved road dust in some counties and motor vehicle exhaust from cars and trucks.

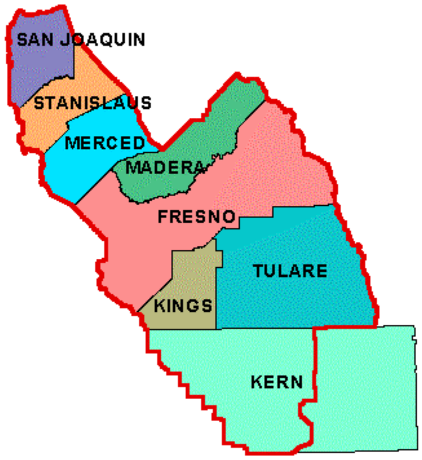
Detailed chemical analyses of the fine particulate components in ambient air were used to provide the illustrations below (Fairly 2001). For this study, "summer" includes April through September and "winter" includes October through March. The constituents shown can vary depending on a variety of factors, such as meteorology and which particulate sources are most active.





During the summer, fossil-fueled sources – motor vehicles, refineries, power plants – contribute most significantly to fine particle levels in the region. Secondary ammonium sulfate and ammonium nitrate, formed from reactions in the atmosphere of nitrogen oxides and sulfur oxides from motor vehicle exhaust and other combustion processes, constitute one fourth of PM2.5. Marine air (sea salt) is also a significant contributor. In the winter wood smoke from residential wood combustion and cooking becomes the main component of fine particulate matter, followed by fossil fuel sources and secondary ammonium nitrate. Winter conditions - cool temperatures, low wind speeds, low inversion layers, and high humidity - favor the formation of nitrates.

San Joaquin Valley Air Basin



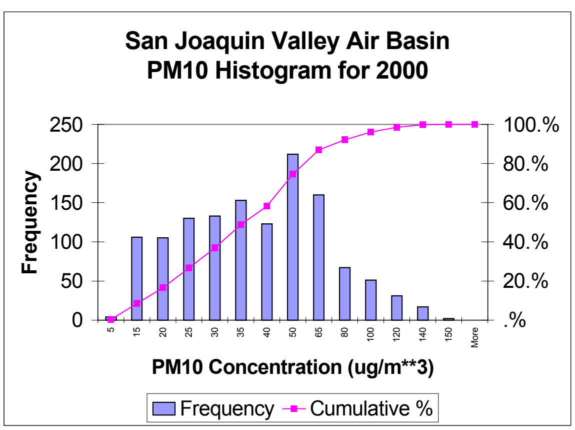
In the last two years, the San Joaquin Valley Air Basin recorded the highest PM2.5 levels in the State – more than twice the federal standard - and 71 PM2.5 observations over the federal standard were recorded. Particulate levels exceeded the 24-hour State PM10 standard 181 times in the last three-year period. Particulate concentrations also exceeded both the State PM10 and federal PM2.5 annual standards. In the San Joaquin Valley Air Basin, 80% of the PM10 observations were below 60 to 65 μg/m^3 and 80% of the PM2.5 measurements were below 35 to 40 μg/m^3, as illustrated on the charts below.

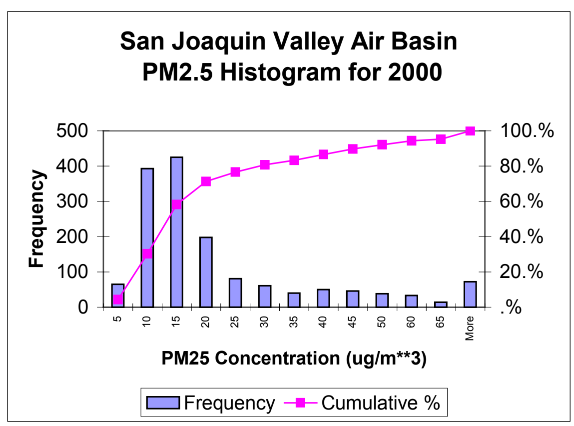
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 (μg/m^3)			PM2.5 (μg/m^3)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	51	159	34			
1999	64	183	50	42	136	28
2000	66	145	45	29	160	23

* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

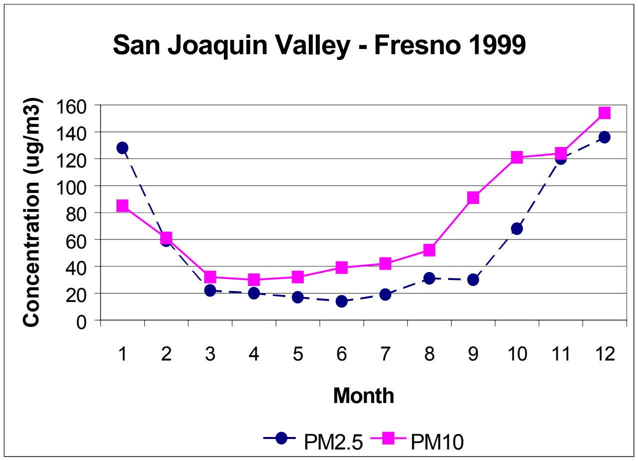
The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.

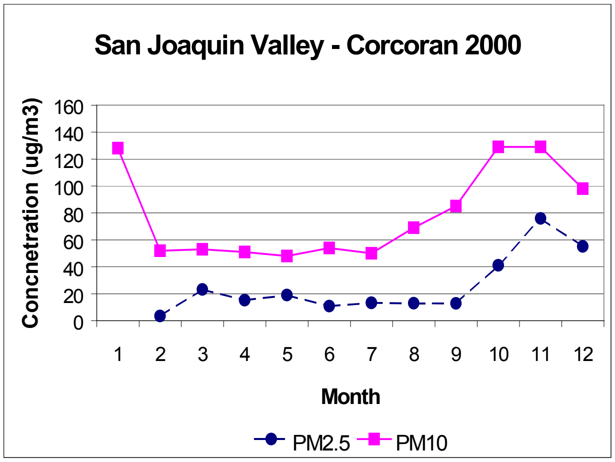




* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 μg/m^3). The line represents the total percent of observations up to the specified range.

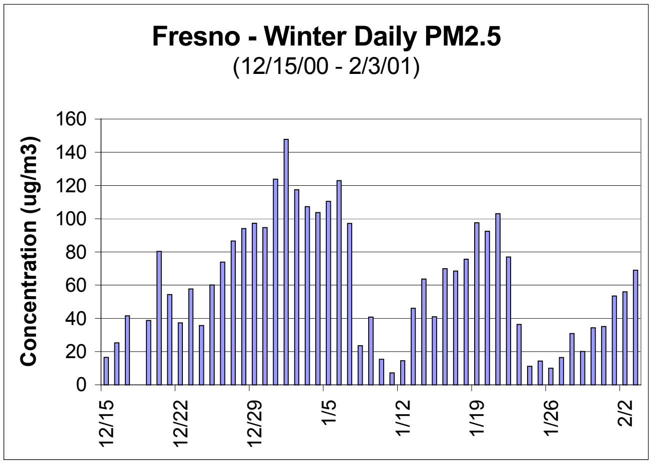
The charts below illustrate the monthly variation of the maximum daily PM10 and PM2.5 concentrations in Corcoran in 2000 and in Fresno in 1999. In Corcoran, PM10 levels are highest in October and November, with PM2.5 peaking in November. In Fresno, PM10 and PM2.5 are highest from October through January. PM2.5 drives PM10 concentrations during the wintertime in Fresno. The PM2.5 fraction of PM10 is smaller in Corcoran with fall peaks driven by PM10.





*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

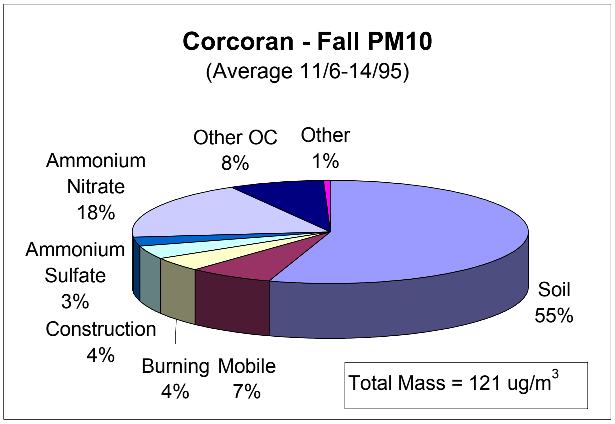
Data obtained from the Fresno dichotomous sampler from 1998 through 1999 indicate the PM2.5 component of PM10 ranges from 19% to 88%. The November through February average PM2.5 fraction is 75% of PM10 and the March through October average is 38%. Data obtained from the Corcoran dichotomous sampler from 1998 and 1999 show that the PM2.5 component ranges from 12% to 90%. The November through February average PM2.5 portion of PM10 is 62% and the March through October average is 28%.

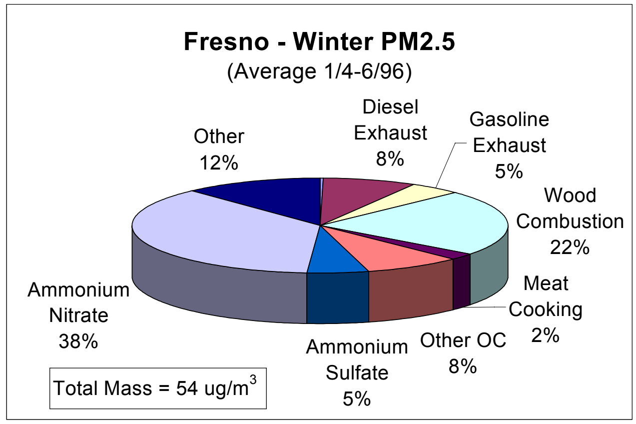


The chart at left shows the daily variations in PM2.5 levels in Fresno during the winter of 2000 to 2001. The data were obtained as part of the CRPAQS study. PM2.5 concentrations were over the federal 24-hour PM2.5 standard close to 40% of the time.

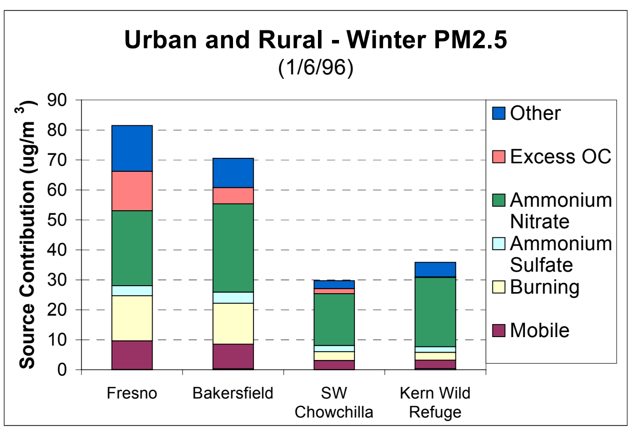
Based on the 2000 annual PM10 emission inventory, the major sources of directly emitted particulates in the San Joaquin Valley are agricultural and unpaved road dust, paved road dust, and windblown dust. Other sources of directly emitted particles include stationary industrial activities, residential wood combustion, and particulates emitted by mobile sources such as cars and trucks.

Detailed chemical analyses of the particle components in ambient air data collected during the 1995-Integrated Monitoring Study (IMS95), were used to provide the following illustrations of the sources of particle matter in the San Joaquin Valley during the fall and winter (Magliano et al. 1999; Schauer et al. 1998).

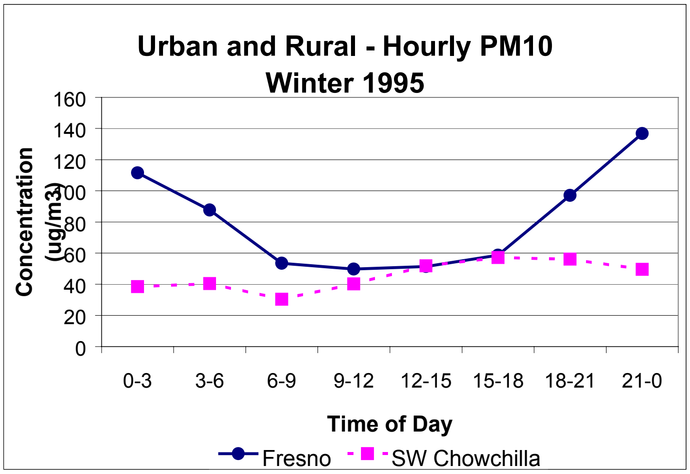




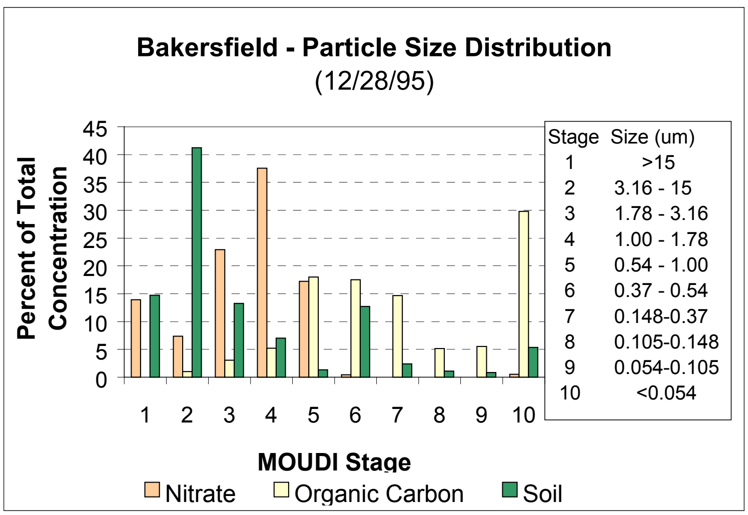
In the fall at Corcoran, high particulate levels were associated with high levels of soil dust. During the winter in Fresno, emissions from biomass burning (primarily residential wood combustion), direct motor vehicle emissions, organic carbon, and secondary particles – formed from reactions in the atmosphere of nitrogen oxides and sulfur oxides from motor vehicle exhaust and other combustion processes - are major contributors to ambient particulate matter. Winter conditions - cool temperatures, low wind speeds, low inversion layers, and high humidity – favor the formation of secondary particles.



The Bakersfield and Fresno sites were located in large urban areas; the Kern Wild Refuge site was located amidst natural vegetation, while the SW Chowchillla site was in a rural area, surrounded by agricultural fields. At the peak of a winter PM2.5 episode, PM2.5 concentrations at the two rural sites were about half of the PM2.5 levels at the two urban sites. Secondary ammonium nitrate was the largest contributor at all four sites. Vegetative burning and direct mobile source exhaust contributed 19% and 12% of the PM2.5 mass in the urban areas, but only an average of 8% and 9% at the rural sites. The excess organic carbon - resulting from combustion sources other than vegetative burning and mobile sources, as well as secondary organic carbon –was significant at the urban, but not at the rural sites.



In the winter, PM10 levels varied significantly during the course of the day, with the highest concentrations occurring during the nighttime. In contrast, in rural SW Chowchilla PM10 levels did not vary much within a day. Chemical composition data indicate diurnal variations in ammonium nitrate were the primary cause of the PM10 variations in SW Chowchilla. The rise in PM10 concentration in Fresno corresponded mostly to significant nighttime peaks in vegetative burning, mobile sources, and excess organic carbon (Magliano et al. 1999).



Data for the illustration shown at left are from air samples collected with a Micro-Orifice Uniform Deposit Impactor (MOUDI) sampler at Bakersfield during IMS95 (Chow et al. 1997). The size distribution of nitrate particles peaked between 1 and 1.78 μm. Organic carbon particles appeared in both larger (peak between 0.37 and 1 um) and smaller (<0.054 μm) stages. The ultrafine carbon particles (< 0.08 μm) result from direct emissions from combustion sources or from the condensation of gases cooled down soon after they are emitted. The soil components were concentrated mainly on the larger particle size fractions (>3.16 μm), the coarse fraction of PM10.

South Central Coast Air Basin

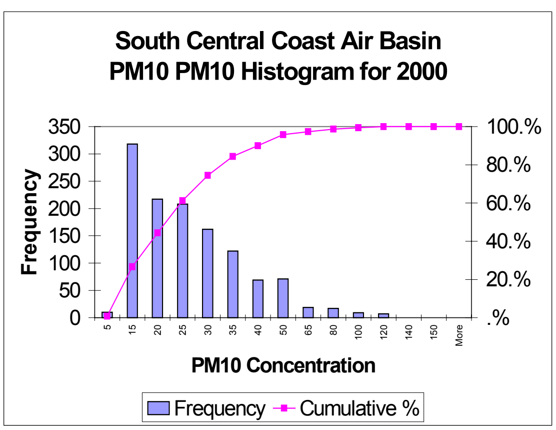
In the South Central Coast Air Basin, particulate levels exceeded the 24-hour State PM10 standard 61 times in the last three years. Neither of the federal PM2.5 standards or the State annual PM10 were exceeded in the last few years. As illustrated on the charts below, Eighty percent of the 24-hour PM10 observations were below 30 to 35 $\mu g/m^3$ and 80% of the 24-hour PM2.5 measurements were under 15 to 20 $\mu g/m^3$.

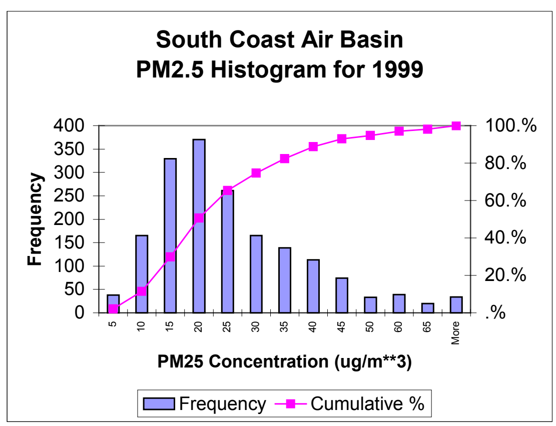
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 ($\mu g/m^3$)			PM2.5 ($\mu g/m^3$)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	18	73	24			
1999	18	90	27		65	14
2000	25	113	28		55	15

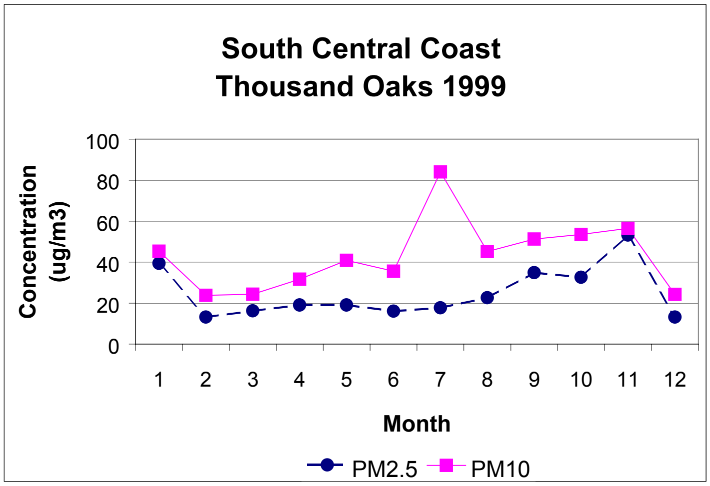
* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 $\mu g/m^3$). The line represents the total percent of observations up to the specified range.

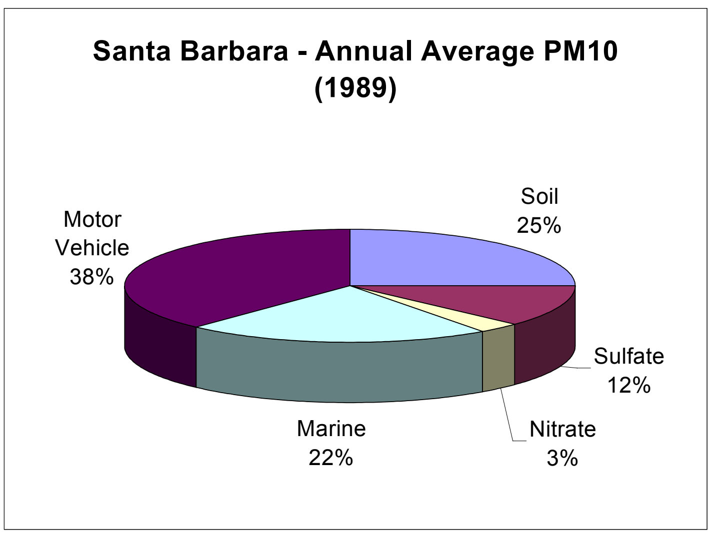


*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

The figure at left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations at Thousand Oaks in 1999. PM10 concentrations tend to peak in the summer, while highest PM2.5 levels occur in November and January.

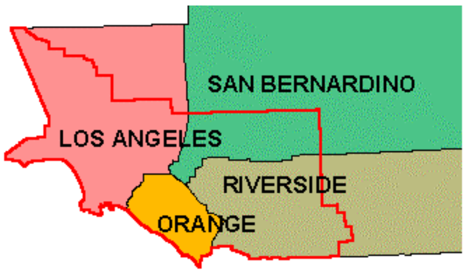
Based on the 2000 annual PM10 emission inventory, the major contributors of directly emitted particles in the South Central Coast Air Basin are paved and unpaved road dust, dust from farming operations, and residential and waste burning. This region can also have significant seasonal wildfire emissions

A detailed chemical analysis of particle components in ambient air was used to provide the following illustration of the sources of particulate matter in Santa Barbara County (Chow et al. 1996). The constituents shown can vary substantially daily and seasonally based on a variety of factors such as meteorology and which particulate sources are most active.



Motor vehicles are the major contributor to PM10 levels in the region. Marine aerosols (sea salt) and soil each account for one fourth of the PM10 composition. Secondary ammonium nitrate and sulfate are relatively small contributors.

South Coast Air Basin



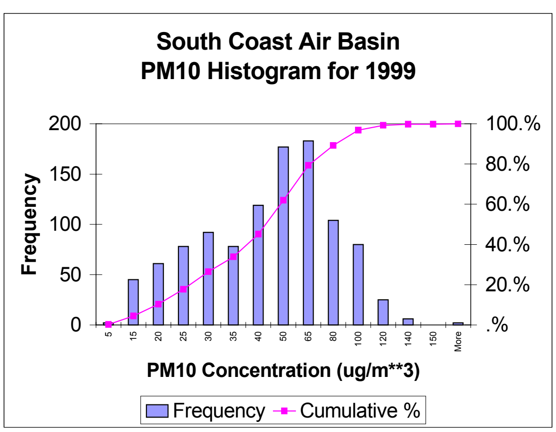
In the South Coast Air Basin, particulate levels exceeded the 24-hour State PM10 standard 188 times in the last three-year period and 38 PM2.5 observations over the 24-hour federal PM2.5 standard were recorded in the last two years. Particulate levels also exceeded both, the State PM10 and federal PM2.5 annual standards. The South Coast recorded some of the highest levels of PM2.5 in the State – almost twice the level of the standard. Eighty percent of the 24-hour PM10 observations were below 65 to 80 $\mu g/m^3$ and 80% of the 24-hour PM2.5 measurements were below 35 to 40 $\mu g/m^3$.

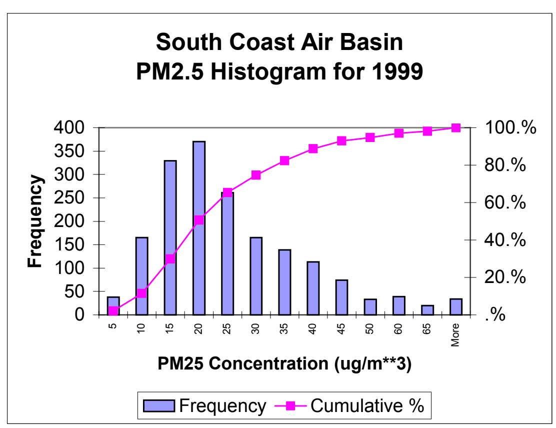
The following table lists PM10 concentrations recorded in the last three years and PM2.5 levels in the last two years – since federally approved PM2.5 monitors have been in operation in California.

Year	PM10 ($\mu g/m^3$)			PM2.5 ($\mu g/m^3$)		
	Days over State Std.	Max 24-hour (Std.=50)	Max Annual Geo Mean (Std.-30)	Days over Federal Std.	Max 24-hour (Std.=65)	Max Annual Average (Std.=15)
1998	59	116	49			
1999	55	183	65	15	121	30
2000	74	126	52	23	120	28

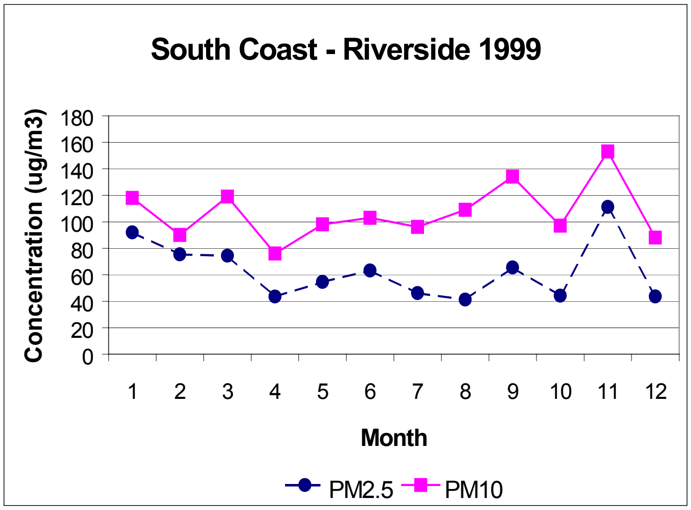
* No conclusions on attainment for the federal PM2.5 standard should be drawn from these data, since attainment designations will be based on three years of data.
**Monitoring data are presently being evaluated for occurrences of exceptional events, consequently the table includes data that in the future may be identified as recorded during an exceptional event and be removed from consideration.

The charts below illustrate the frequency distribution of observed 24-hour PM10 and PM2.5 concentrations at all sites within the air basin.





* Each bar represents the number of observations within the specified range (e.g., for PM10 the first bar is the number of observations between 0 and 5 $\mu g/m^3$). The line represents the total percent of observations up to the specified range.



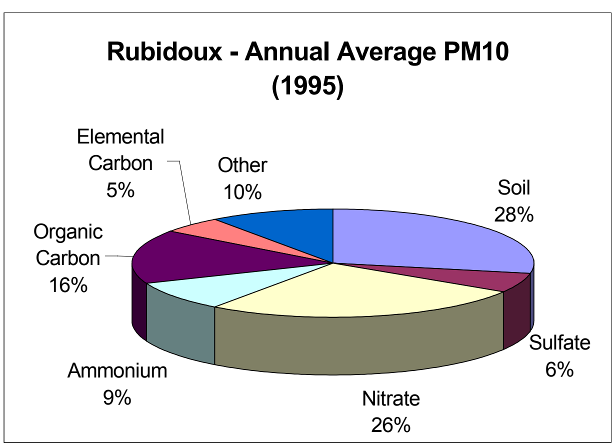
*The monitors used to measure PM10 and PM2.5 are different and occasionally recorded concentrations of PM2.5 which are greater than PM10.

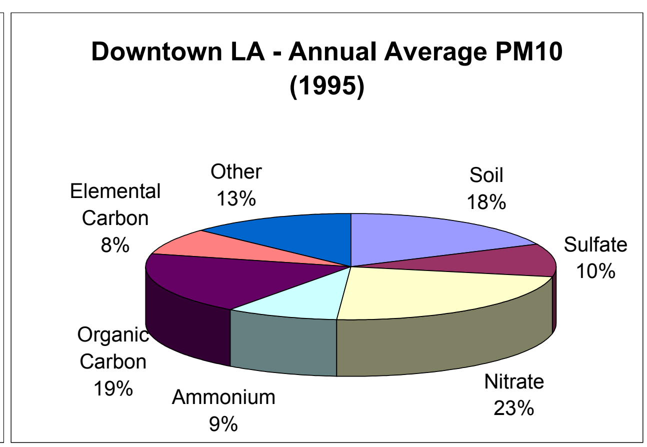
The chart at left illustrates the monthly variation of the maximum daily PM10 and PM2.5 concentrations in Riverside in 1999. Both PM10 and PM2.5 concentrations exhibit no distinct seasonal pattern, with high concentrations throughout the year.

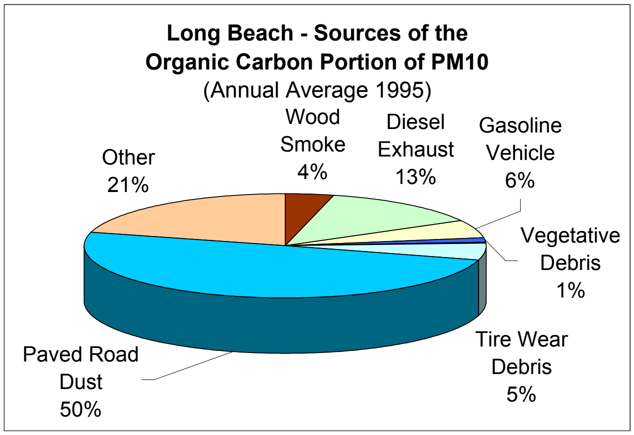
Data obtained from the Long Beach dichotomous sampler in 1999 indicate the PM2.5 portion of PM10 ranges from 30% to 96%. The average PM2.5 portion of PM10 from November to February is 59% dropping to 45% from February to October.

The 2000 annual PM10 emission inventory shows that the major sources of directly emitted particulates in the South Coast Air Basin are paved road dust, unpaved road dust, construction related dust, and the general categories of motor vehicle emissions and industrial emissions.

Data for the illustrations shown below are from analysis of ambient data collected during a one-year special study conducted from January 1995 to February 1996 as part of the PM10 Technical Enhancement Program (PTEP) (Kim et al. 2000). The constituents shown can vary substantially daily and seasonally based on a variety of factors such as meteorology and which particulate sources are most active. The figures show that secondary particulates – formed from reactions in the atmosphere of nitrogen oxides and sulfur oxides from motor vehicle exhaust and other combustion processes - contribute most significantly to particulate matter in the region. Carbon - elemental and organic - also derived from motor vehicles and other combustion sources contribute to approximately one fourth of the particulate levels. Dust from soil is more prevalent in Riverside (Rubidoux site) as compared to Downtown Los Angeles.







Data from a detailed chemical analysis conducted as part of the Children's Health Study were used to provide the illustration on the sources of the organic compound portion of PM10 in Long Beach in 1995 (Salmon et al. 2001). Road dust is the major contributor to the organic carbon portion of PM10 in Long Beach, followed by diesel- and gasoline-powered vehicle exhaust. The "other" category – resulting from combustion sources other than vegetative burning and mobile sources, as well as secondary organic carbon - is also significant

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