System Indicators

Water & Air Quality, Temperature, Precipitation, and Snowpack

Air Quality (2009)

September 2012

Air Quality

A great deal of air pollution in the Sierra Nevada is beyond any possible local control. Most of the ozone, and some of the particulates, are blown into the Region from the west. Much of the particulates come from dusty roads associated with the rural nature of the Region or from wildfires. There are not easy technological fixes. Still, it is important to understand and characterize the extent and distribution of air pollution so the Region can tackle what is possible in its role to meet state and federal air quality standards.

Three pollutants are assessed for the air quality Indicators:

- Ozone
- PM10 (suspended particulate matter smaller than 10 micrometers in size)
- PM2.5 (suspended particulate matter smaller than 2.5 micrometers in size)

Ozone pollution is generally discussed in terms of the number of days per year that it exceeds a health-based standard, rather than the actual level of the pollutant. The standard used here is the California state 8-hour standard (where a monitoring site indicates an exceedence for any day in which the ozone level averages over .070 ppm for any 8-hour period during that day. Particulate Matter can also be portrayed through daily exceedences of a standard, but data is also available for average annual levels (micrograms per cubic meter of air) which better addresses actual year-to-year trends.

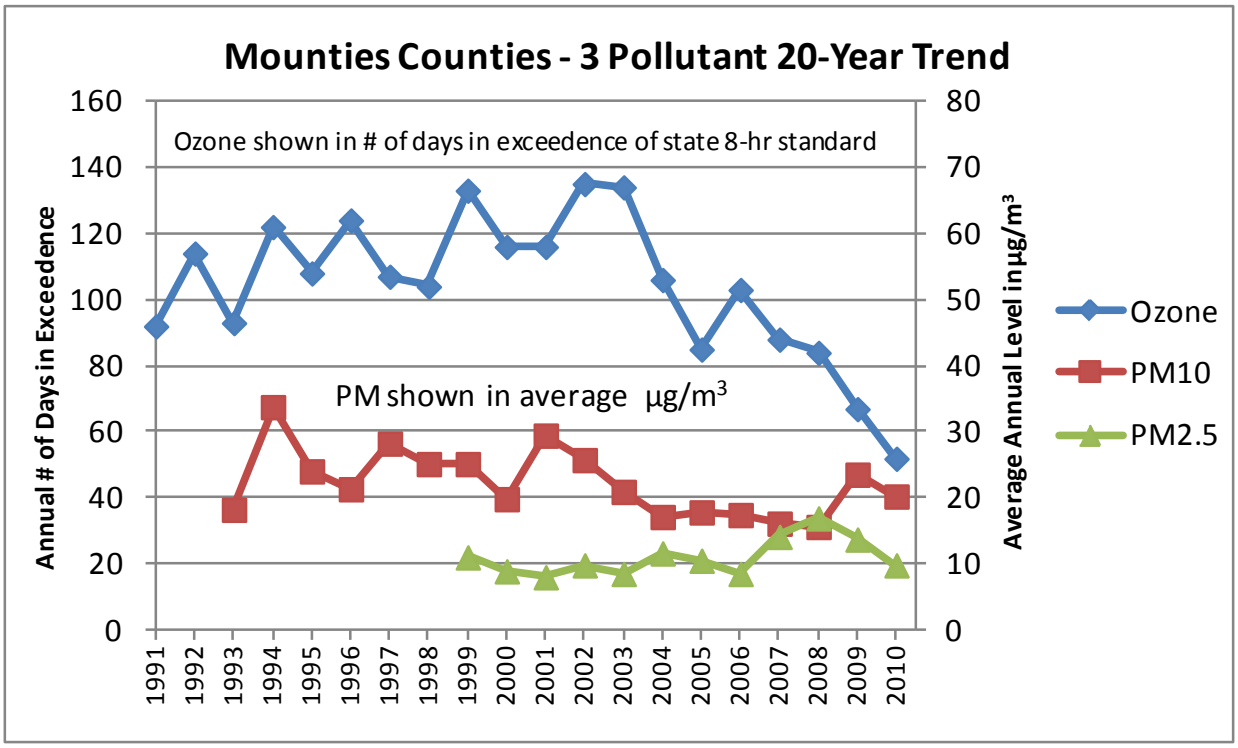
Although data is available at the county level, the low number of monitoring sites in some counties and other data issues limit analysis of PM10 and PM2.5. Some of these data problems can be mitigated by looking at Air Basins rather than counties. These basins include many more monitoring sites, so that clearly bad data points can be excluded without serious consequence and other anomalous data tends to be suppressed. The Air Basin data sets also include data for every year since 1990 (except 2008 for PM2.5). It should be noted that for ozone, the Air Basin (especially the Mountain Counties) will indicate more days of exceedences than any of the individual counties, since an exceedence in any of its counties' monitoring sites will be included in the Basin totals.

The five Air Basins included in this analysis are:

- Mountain Counties - includes all four counties of the South-Central Subregion, El Dorado and Placer Counties (but excluding the Tahoe Basin and Valley portions of those two counties), plus Nevada, Sierra and Plumas Counties
- San Joaquin Valley – includes all of the counties of the South Subregion
- Sacramento Valley Basin - Yuba, Butte, Tehama, and Shasta Counties
- Northeast Plateau - Lassen and Modoc, along with Siskiyou County
- Great Basin Valleys – corresponds to the SNC East Subregion

The Mountain Counties Air Basin is a good starting point to look at air pollution in the SNC Region. It is entirely within the Region and includes a substantial portion of the Sierra Nevada range. The Sacramento and San Joaquin Basins include substantial parts of the Sierra, but their data are dominated by the Central Valley.

The Mountain Counties graph compares the 20-year trend from 1991-2010 for the three pollutants. Strong trends over time are difficult to substantiate because of large yearly fluctuations. For ozone, after a general trend to worsening pollution up to 2002 there appears to have been significant improvement between 2003 and 2010; but without looking at a longer trend and potential confounding weather impacts, care should be exercised in interpretation. However, since 2007-2009 were drought and heavy fire years, the trend looks encouraging. No clear trends in PM pollution is evident since consistent data has been available (Mountain Counties data only extends back to 1993 for PM10 and 1999 for PM2.5)



Ozone

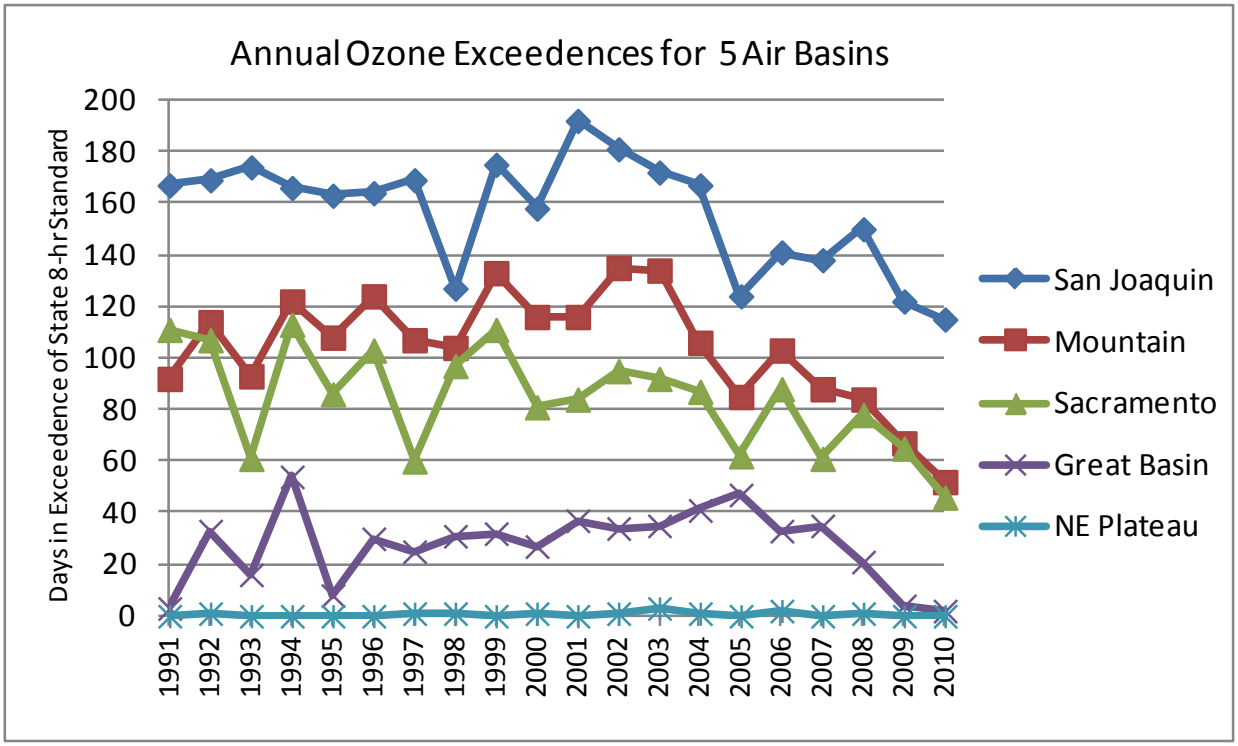
Ozone (O_3) is not a directly emitted pollutant, but rather is formed from precursor pollutants (nitrogen oxide and various hydrocarbons) in the presence of strong sunlight, which is why ozone pollution is largely a summer phenomenon. The source of the precursors, and where those precursors are converted to ozone, is the key issue to understanding ozone pollution in the SNC Region. It is well documented that little ozone is formed in the mountains – the vast majority of ozone is formed in the Central Valley or beyond and transported into the foothills and mountains.

Key points regarding ozone pollution in the five Air Basins that relate to the SNC Region:

- The San Joaquin Valley, encompassing the South Subregion, has the most unhealthful air.
- The Mountain Counties often has worse air quality than the Sacramento Valley, despite the fact that most of the ozone enters the mountains from the Central Valley, indicating

that significant pollution is actually 'blown' out of the Valley into higher ground. (This has been dubbed the 'bathtub ring' effect—see later discussion on Ozone Transport.) The more remote and sparsely populated Northeast Plateau counties almost never exceed the ozone standard.

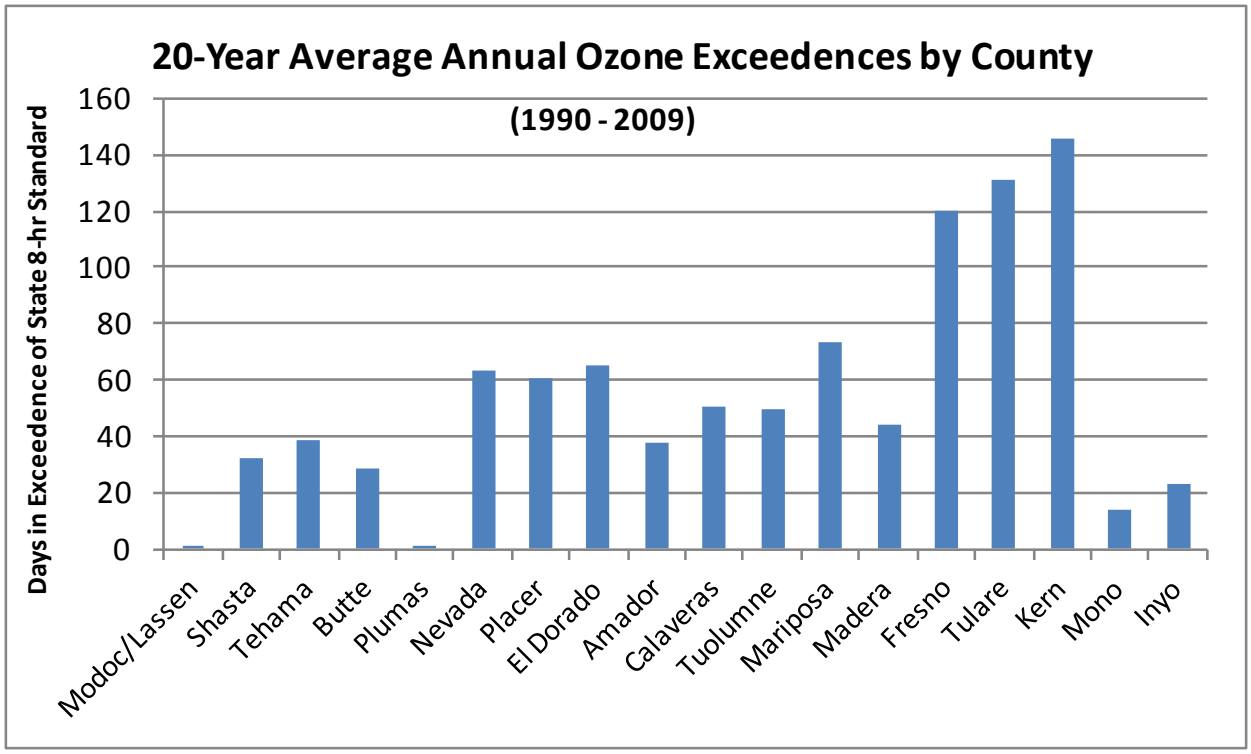
- The Air Basin trends do indicate improvement in ozone levels since the early to mid 2000's, but it should be noted that the California Air Resources Board indicates that 2009 was an anomalously good air-quality year, though 2010 showed continued improvement. More time is required to know how consistent this trend may be.



In addition to this air basin level analysis, the chart below depicts a 20-year average of annual ozone exceedences based on county level data. This county breakdown provides a better representation of the actual number of days of high ozone levels at a finer resolution than provided by air basin data, but does not indicate change over time for the counties. While it is generally consistent with the Basin-scale analysis, there are a couple of additional key points regarding differences in ozone pollution in different counties of the SNC Region (Note: Data is for the entire county, not just for the portion inside the SNC Region; also suitable data was not available for Sierra County):

- Plumas County has very few bad-air days, no doubt because of its topographic isolation from transport from the Sacramento Valley. Plumas is much more in line with the Northeast Plateau counties. [There was one anomalous year - 2002 - that was excluded from the data.]

- Counties of the southern San Joaquin Valley have particularly high ozone levels.



Ozone Transport

According to the CARB report *Ozone Transport: 2001 Review*, "The Mountain Counties Air Basin violates the State ozone standard due to transport from the Sacramento Valley, the San Joaquin Valley and the San Francisco Bay Area." The 2001 report (the most recent update on ozone transport in California) further states that "all ozone violations" in the Mountain Counties are attributable to transport from these outside regions, whose pollutants "have a dominant effect on ozone concentrations in the Mountain Counties". This includes the Sierra foothills towns of Grass Valley and Colfax, where violations are considered entirely due to transport from the Broader Sacramento Area. (The western portions of Placer and El Dorado Counties within the SNC Region, including the town of Auburn, are considered part of the Broader Sacramento Area.)

For the northern and central portion of the Mountain Counties, ozone primarily flows east and north from the Broader Sacramento Area, the Bay Area, and/or the San Joaquin Valley, largely driven by a circulation pattern pushed by the 'delta breeze' during the summer. Ozone transport from and through the Sacramento region "dominates the air quality of the Upper Sacramento Valley, as far north as Butte and Tehama Counties." This ozone can then be pushed up into the Sierra foothills. Transportation is the largest cause of ozone that is *generated* in the Sierra Nevada, particularly along the 80 and 50 corridors, and contributes to ozone pollution in portions of the Central Subregion; but is not significant enough on a county or air basin scale to lead to violations on its own.

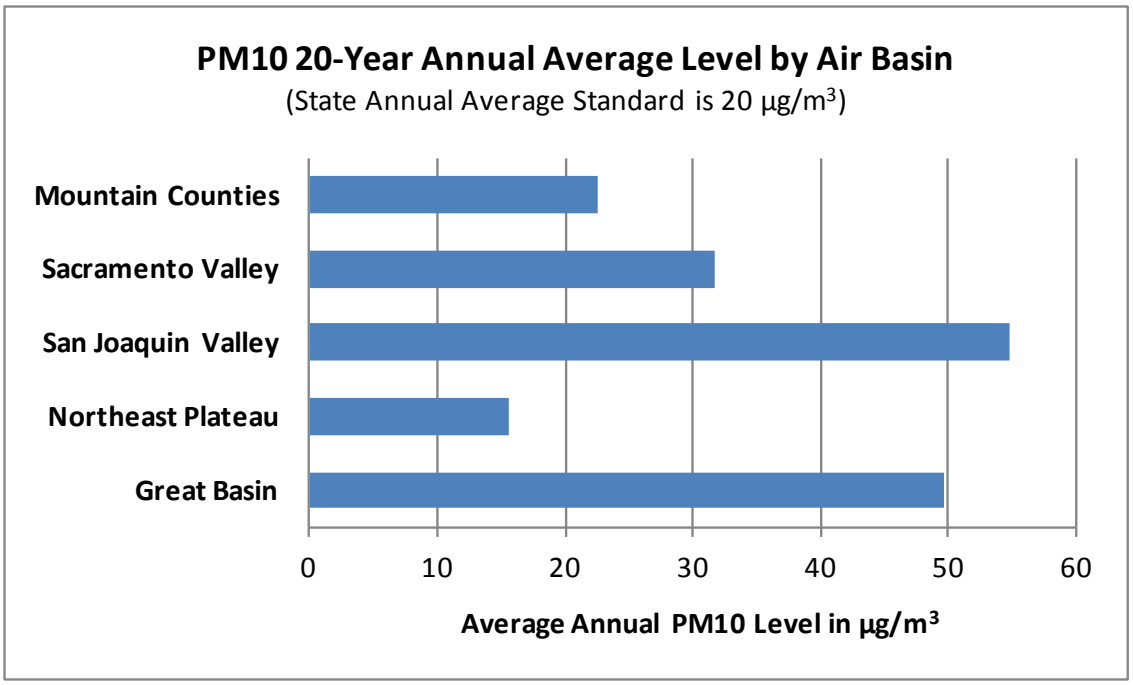
For the southern portion of the Mountain Counties, afternoon breezes push ozone into the Sierra Nevada foothills from the San Joaquin Valley, where it can cause ozone violations in areas such as Sonora and Yosemite, and even cross over the Sierra and cause violations in Mammoth Lakes. Eddy currents within the San Joaquin Valley also carry ozone into the Sierra foothills of Fresno, Tulare, and Kern Counties.

Note that "Under the California Clean Air Act, when emissions from one region contribute to ozone violations in a downwind area, the upwind area shares responsibility for controlling those emissions sources. The State and federal government also share in this responsibility…"[2]

Particulate Matter

PM10

PM10 are very small particles that can stay suspended in air for significant periods (hours to days) but are nonetheless large enough to irritate the lungs when inhaled and are associated with respiratory ailments. These particles tend to be composed of the fine components of dust and soot. The state standard for PM10 is an annual average level below 20 micrograms per cubic meter of air. PM10 would best be analyzed at the county level, but data are not available by county, so are analyzed at the Air Basin level.



As shown in the chart above, there are a few key points regarding PM10 pollution in the five Air Basins that relate to the SNC Region:

- Most of the Air Basins do not come close to meeting the state standard; only the Northeast Plateau has consistently met the state standard. However, it is impossible to know from this data set how the portions of the Sacramento and San Joaquin Basins

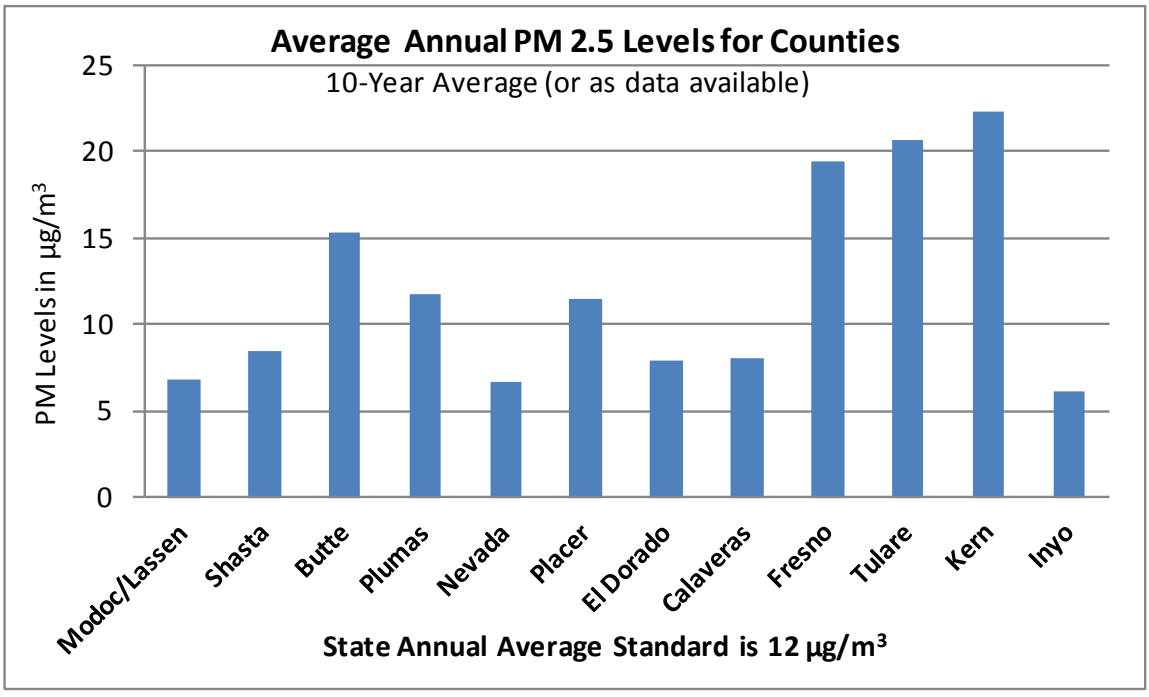
[2] From Page 3 of the CARB "Ozone Transport: 2001 Review" report

within the SNC Region compare to the Sacramento and San Joaquin Basins on the whole. The up-slope parts of the basins might have much lower pollution levels.

- The Mountain Counties Basin has not met the state standard many of the past 20 years (with annual exceedence days between 6 and 95), but did meet the state standard from 2004-2008 with virtually no days in exceedence of the standard.
- The high PM10 levels in the Great Basin are due largely to arid and windy conditions.

PM2.5

PM2.5 are smaller particles than PM10, and are of particular health concern. They penetrate deeper into the lungs, are less physically irritating, but can lead to a greater variety of health risks beyond respiratory irritation. The state standard for PM2.5 is an annual average level below 12 micrograms per cubic meter of air. PM2.5 data is available for some counties of the SNC Region, but the data don't extend back very far (it is a newer standard) and there are substantial data gaps. Data is sporadic at the air basin level too, so that level of analysis provides no advantage. With these caveats in mind, the chart below shows average annual PM 2.5 levels for the thirteen counties in the SNC Region where sufficient data are available.



In viewing the chart above, several key points emerge:

- Fresno, Tulare, and Kern Counties, in the San Joaquin Valley, are consistently well above state standard for PM2.5. In Inyo County (in the Great Basin) PM2.5 levels are much lower than PM10 corroborating that larger dust particles are the predominant issue there.

- Placer and Butte Counties tend to have levels at or above the state standard, but how much of it is associated the valley outside the SNC Region is not discernable from the data.
- Plumas County seems surprisingly high for its geographic location, but data is only available since 2005, though it is fairly consistent for the five years in which PM2.5 is reported (2004, 2005, 2007, 2009, and 2010).

Generation and transport of particulate matter

Airborne particulate matter may be directly emitted or formed as a secondary pollutant in the atmosphere. The larger PM10 pollutants are generally directly formed emissions, such as dust or soot. PM2.5, a subset of PM10, may be direct emissions (such as fine soot) or secondarily formed in the atmosphere – mostly small particulate nitrates and sulfates.

As compared to ozone, long distance transport is not particularly relevant to PM10 pollution; the particles are generally too heavy to be suspended long enough to travel great distances. PM2.5 is another matter; small particles carried by wind from China form a component of particulate pollution in the Sierra Nevada.

The nature of PM10 varies considerably by location, as well as the season. In more urban areas along the western foothills of the Sierra, a high percentage of particulates are generated by transportation and industry, though a large portion of PM10 in the rural portions of the Valley consists of dust from dirt roads and soot from residential and agricultural combustion. In the more rural areas, the majority of PM2.5 is combustion related, with a smaller component consisting of ammonium nitrates and sulfates from transportation and industrial processes. PM10 tends to be heaviest in summer and fall, while PM2.5 is highest in late fall and winter.

In the Mountain Counties, most of PM10 in late spring to early fall (wildfires excluded) is due to dust from unpaved roads, and in the colder months results from residential and controlled combustion. PM2.5 accounts for a majority of total PM10. The vast majority of PM2.5 is related to combustion, with very little from secondary nitrate and sulfate creation. Certainly, summer wildfires can produce huge localized spikes in PM10 and PM2.5.

In contrast, PM2.5 accounts for a much smaller portion of PM10 in the Northeast Plateau and Great Basin Valley. PM10 derives primarily from dust, particularly in the Great Basin, where winds can cause huge spikes in PM10 measurements. Particulate pollution is less seasonal in these remote areas than in the mountains or Central Valley.

This description of PM generation and transport comes primarily from the California EPA Air Resources Board report *Characterization of Ambient PM10 and PM2.5 in California: Technical Report June 2005*.