

Annual Report on California Air Resources Board's Fine Particulate Matter Monitoring Program April 2021

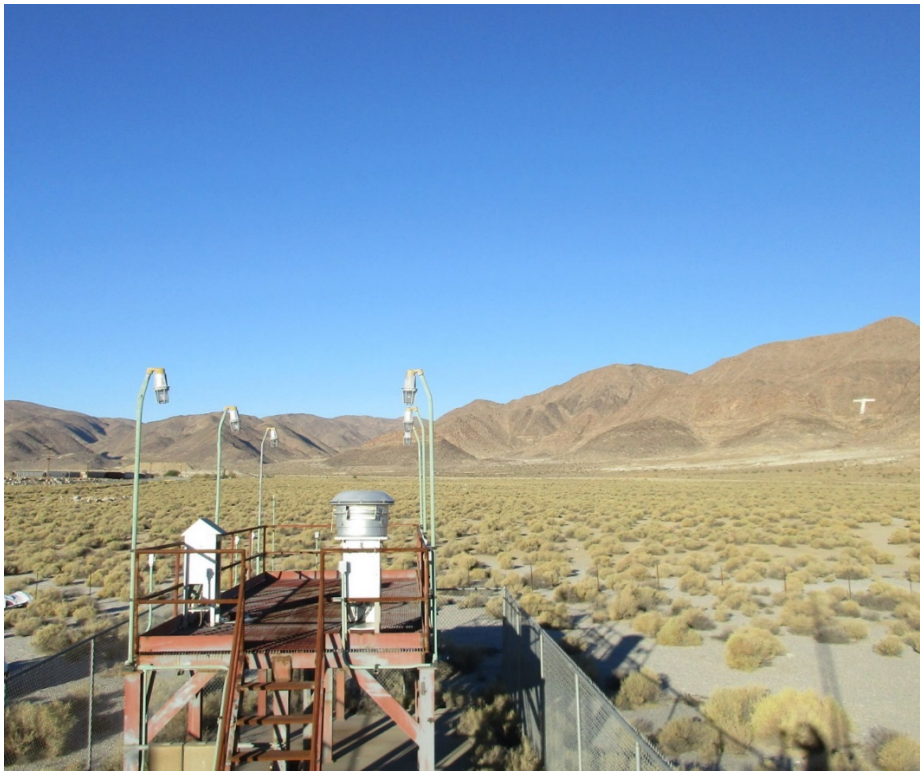


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Background

Health and Safety Code, Section 39619.5(g) requires California Air Resources Board (CARB) to provide an update each year on the status and results of the fine particulate matter (PM_{2.5}) monitoring program. This report provides a summary of PM_{2.5} monitoring activities in 2020 and how the data are being used to support CARB programs.

California's PM_{2.5} air quality monitoring program provides information used for determining which areas violate PM_{2.5} standards, characterizing the sources that contribute to PM_{2.5} pollution, determining background concentrations, assessing pollution transport, and supporting health studies and other research. Monitoring data also provide information to develop and evaluate programs for improving air quality. Newly emerging technologies are evaluated and incorporated continuously in California's PM_{2.5} monitoring program to provide improved monitoring data.

California's PM_{2.5} regulatory monitoring network, which is jointly operated by CARB and the local air districts, began collecting data in 1998. A number of different types of PM_{2.5} regulatory monitors are operated to provide data on PM_{2.5} mass and chemical composition which are summarized below. The type and number of PM_{2.5} regulatory monitors in operation has changed from year to year depending upon programmatic needs and available funding. Figure A1 displays the locations of PM_{2.5} regulatory monitors throughout the State as of the end of 2019. Additional information on PM_{2.5} monitoring can be found on our [Ambient Air Monitoring-Regulatory](#)¹ and [Community Air Monitoring](#)² webpages.

Due to the statewide stay-at-home order in March 2020, CARB was forced to reduce its air monitoring operations. Air monitoring operations were reduced to essential functions for the ozone, PM_{2.5}, and PM₁₀ programs. CARB continued to remotely operate the other continuous parameters (CO, NO_x, SO₂) as resources allowed. All operations were implemented with personnel health and safety requirements following recommendations from the California Department of Public Health and Center for Disease Control guidelines.

In early December 2020, a new statewide stay-at-home order required CARB to further reduce its operations. CARB's air monitoring support was limited to only 3 sites (Bakersfield-California, Bakersfield-Southeast Planz, and Portola), which were deemed critical for attainment determinations. CARB worked closely with the U.S. Environmental Protection Agency (U.S. EPA) and local agencies to inform them of the situation and the potential impacts. In February 2021, CARB received approval to resume its air monitoring operations for all programs at all sites.

¹ <https://ww2.arb.ca.gov/our-work/programs/ambient-air-monitoring-regulatory>

² <https://ww2.arb.ca.gov/capp-resource-center/community-air-monitoring>

PM_{2.5} monitors intended to provide PM_{2.5} data for regulatory purposes are identified as either Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitors. FRM PM_{2.5} monitors use a method that relies on weighing PM_{2.5} collected on filters. Measurement of PM_{2.5} in air has evolved over time as new instruments have been developed. FEM PM_{2.5} monitors, for example, continuously measure PM_{2.5} mass concentration using more recently developed measurement technologies. PM_{2.5} non-regulatory monitors are not used to provide PM_{2.5} data for regulatory purposes primarily due to concerns about their accuracy.

Federal Reference Method Monitors

The installation of federally-approved PM_{2.5} mass monitors throughout California began in 1998. Prior to stay-at-home orders in March 2020, FRM (Figure 1) monitors were operated at 57 sites. To address the COVID stay-at-home order and minimize staff travel, many of these FRM monitors were replaced with FEM monitors that operate on a continuous basis and report PM_{2.5} concentrations on a real-time basis. The three FRM monitors that remained collect particulate samples on filters, later weighed and analyzed in a laboratory. Because of this two-step process, PM_{2.5} air quality data collected with FRM monitors are not immediately available. This approach is more labor intensive and provides less temporal resolution than the continuous PM_{2.5} mass monitors CARB began to add to the network in the late 1990s.

Figure 1. Federal Reference Method Monitor

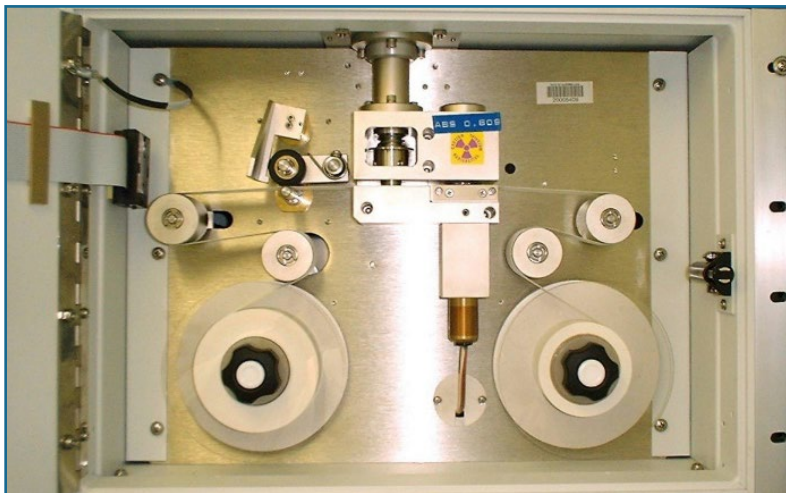


Continuous Mass Monitors

Continuous PM_{2.5} mass monitors provide valuable information for public reporting on PM_{2.5} levels, temporal representation, health studies, transport studies, and background monitoring. PM_{2.5} mass can be measured continuously with several different commercially available technologies. CARB chose the Beta Attenuation Monitor (BAM, Figure 2) for use in California and several other types of continuous monitors (e.g., laser light scattering monitor) for limited use. BAM was first introduced to CARB PM_{2.5} network in 1999. The U.S. EPA designated certain models of the continuous monitors as *FEM monitors*.³ They are considered equivalent to the FRM monitors and therefore may be used to determine compliance with federal standards. In addition to being less labor intensive than filter-based methods, continuous mass monitors provide data at an hourly temporal resolution. CARB is continuously conducting a comprehensive evaluation of California's PM_{2.5} monitoring network to determine if the existing sites met U.S. EPA requirements and State programmatic needs.

Before stay-at-home orders in March 2020, 67 sites were measuring PM_{2.5} mass. As a result of the orders, more FEM monitors were added to air district networks in place of the FRM monitors.

Figure 2. Beta Attenuation Monitor



Air Quality Sensors

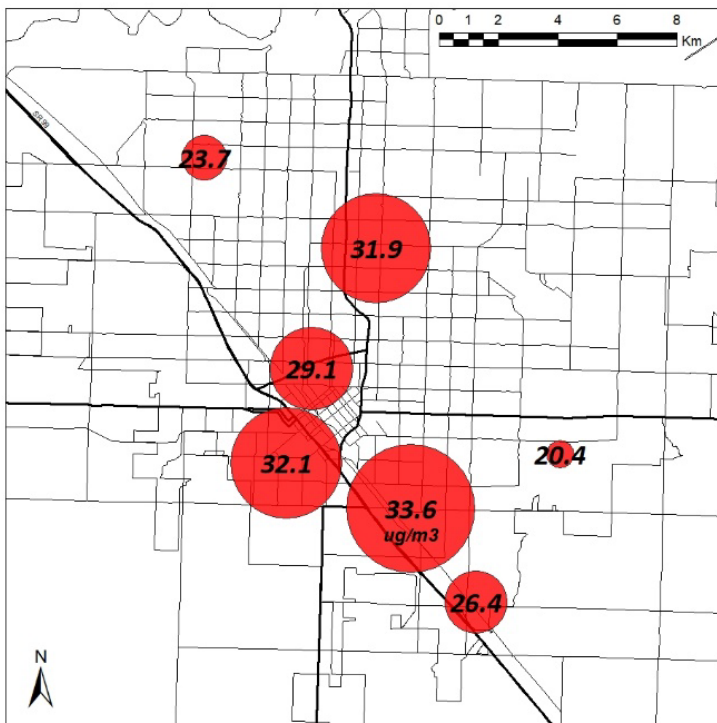
PM_{2.5} mass can be estimated in real time with air quality sensors. Air quality sensors for PM_{2.5} are newly emerging, low cost methods using optical sensors to count PM_{2.5} particles and then estimate PM_{2.5} concentrations. PM_{2.5} sensors are non-regulatory monitors that are not used to

³ <https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants>

provide PM_{2.5} data for regulatory purposes because of concerns about their accuracy. However, PM_{2.5} sensor data can be accessed instantly via the Internet and provide data at a 5-minute or better temporal resolution. As of December 2020, more than 6,000 non-regulatory air quality sensors have been purchased and deployed across California by community groups, government agencies, private citizens, and others. Figure A2 displays the locations of PM_{2.5} sensors across the State as of December 2019. As an example, Figure 3 shows average PM_{2.5} sensor concentrations in Fresno in the winter of 2018-2019. Real-time PM_{2.5} data from air quality sensors can be found on the [PurpleAir: Real-time Air Quality Monitoring](#) website⁴ as well as the

[VAN \(Identifying Violations Affecting Neighborhoods\) Imperial Air Monitoring](#) website⁵.

Figure 3. Average PM_{2.5} concentrations measured by PurpleAir Sensors in Fresno in the winter of 2018-2019



Satellite Remote Sensing

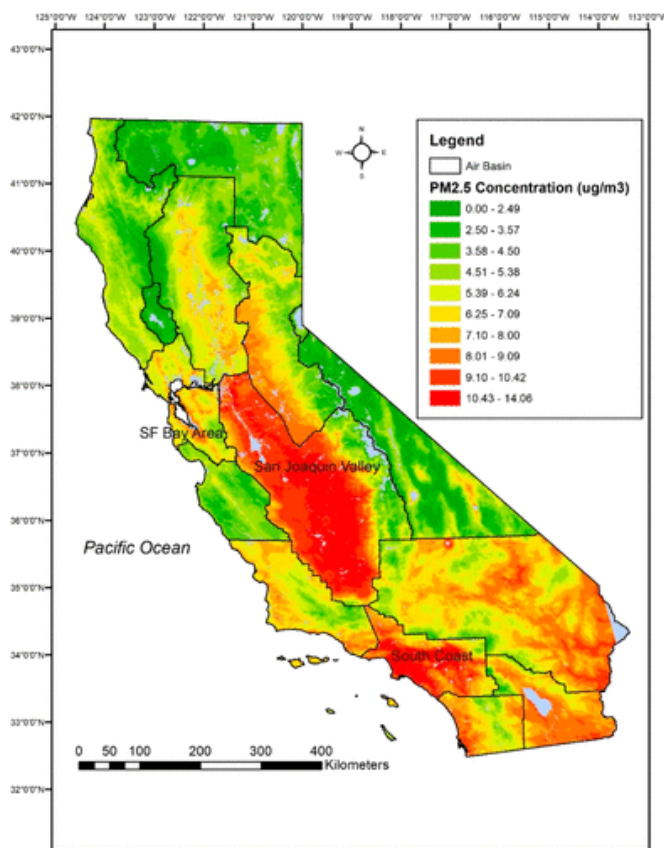
Satellite remote sensing has been used to estimate PM_{2.5} concentrations and subsequently evaluate the spatial variabilities in PM_{2.5} concentrations. Technologies have improved such

⁴ <https://www2.purpleair.com/>

⁵ <https://ivan-imperial.org/air/list>

that certain types of satellite data (e.g., aerosol optical depth) can be used to estimate the concentrations of PM_{2.5} components, such as nitrate, sulfate, organic carbon, and elemental carbon. Satellite remote sensing can fill in PM_{2.5} data in areas where there are no land-based PM_{2.5} monitors. Satellite remote sensing refines our understanding of PM_{2.5} spatial distribution and tracks PM_{2.5} trends that assess the effectiveness of PM_{2.5} mitigation strategies. The main disadvantage of satellite-based PM_{2.5} measurements compared to land-based measurement methods is accuracy and temporal resolution (typically daily snapshots). For example, Figure 4 shows satellite-based PM_{2.5} concentrations in 2016 (Lee, H.J., 2019. *Environ. Sci. Technol.* 53(21), 12774-12783)

Figure 4. Statewide variability in satellite-based PM_{2.5} concentrations in 2016



Speciation Monitors

Another major stage of network implementation is the deployment of PM_{2.5} speciation monitors (Figure 5). Speciation monitoring provides valuable information about the composition, and ultimately, the sources of PM_{2.5} pollution. In 2014, along with states, U.S. EPA conducted a nationwide assessment of the PM_{2.5} speciation network to determine whether the sites were meeting programmatic objectives and were still needed. The review

determined that all of the sites in California were needed and should continue to operate. The locations of California's speciation monitors are shown in Figure A1.

Figure 5. Speciation Monitor



Federally-Required Speciation Monitors

There are two components to the $PM_{2.5}$ speciation network in California. The first component, mandated by the U.S. EPA, requires filter-based $PM_{2.5}$ speciation monitoring at seven California sites that are now part of a national trends network for $PM_{2.5}$ speciation. These monitors are the Speciation Trends Network (STN) monitors for the speciation network. The seven STN $PM_{2.5}$ speciation monitors are located in Bakersfield, El Cajon, Fresno, Sacramento, San Jose, Simi Valley, and Riverside.

Additional Speciation Monitors

The second component of California's $PM_{2.5}$ speciation network is the deployment of samplers at Chemical Speciation Network (CSN) sites located at selected State and Local Air Monitoring Stations (SLAMS). Data from these sites provide additional information needed for developing effective air quality attainment plans. The focus of the $PM_{2.5}$ CSN is to enhance the spatial coverage of the STN sites, particularly in areas with elevated PM levels.

CARB and local air districts nominally operate filter-based speciation monitors at six sites- Calexico, Chico, Modesto, Portola, Visalia, and Sacramento.

In 2007, CARB began monitoring for specific wood smoke tracers to determine the contribution of wood burning sources to PM_{2.5} levels. Wood smoke tracers are nominally being monitored at all six of the CSN sites-Calexico, Chico, Modesto, Portola, Sacramento, and Visalia during the winter season.

Accessing PM_{2.5} Data

Data collected as part of California's PM_{2.5} monitoring program may be obtained in several ways. Daily PM_{2.5} values as well as summary statistics can be accessed through the interactive query tool on CARB's *iADAM: Air Quality Data Statistics* webpage.⁶

Real-time hourly PM_{2.5} data from California's continuous monitors can also be found at our *Air Quality and Meteorological Information System (AQMIS)* webpage.⁷

PM_{2.5} Designations

The Clean Air Act requires the U.S. EPA to set national ambient air quality standards to protect public health, and to designate nonattainment areas for the national standards. U.S. EPA has set PM_{2.5} ambient air quality standards with two averaging periods, 24-hour and annual. Further, CARB has established a more health protective State PM_{2.5} ambient air quality standard as required by California State law. California State law also requires CARB to designate each area as attainment, nonattainment, or unclassified for the State standard. State and national PM_{2.5} ambient air quality standards are shown in Table 1.

Table 1. State and National PM_{2.5} Ambient Air Quality Standards (µg/m³)

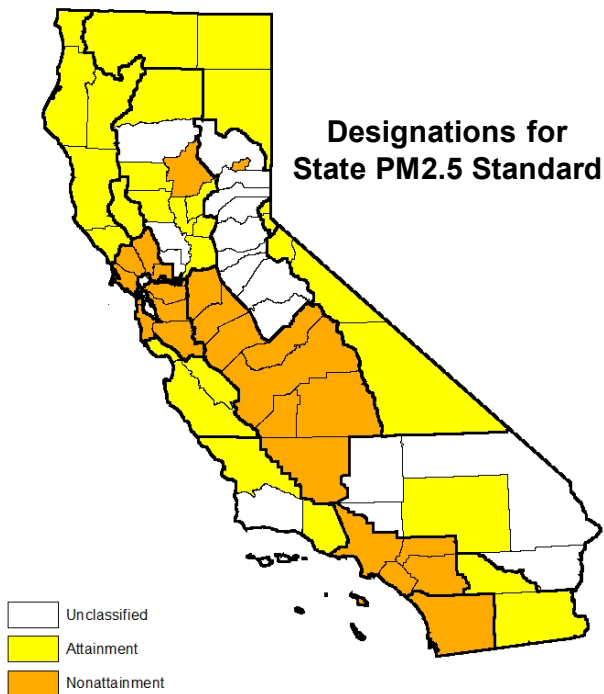
| AAQS | California | National |
|---------|------------|----------|
| Annual | 12 | 12.0 |
| 24-hour | --- | 35 |

Based on 2018-2020 air quality data collected as part of California's PM_{2.5} monitoring network, CARB designates the attainment status of areas with respect to the State annual average PM_{2.5} ambient air quality standard of 12 µg/m³. Most urban areas of California, as well as several more isolated sub-areas, exceed the State PM_{2.5} standard (Figure 6). However, as air pollution control programs have reduced PM_{2.5} concentrations, more areas now meet the State PM_{2.5} ambient air quality standard.

⁶ <https://www.arb.ca.gov/adam>

⁷ <https://www.arb.ca.gov/aqmis2/aqmis2.php>

Figure 6. Designations for the State annual PM_{2.5} ambient air quality standard



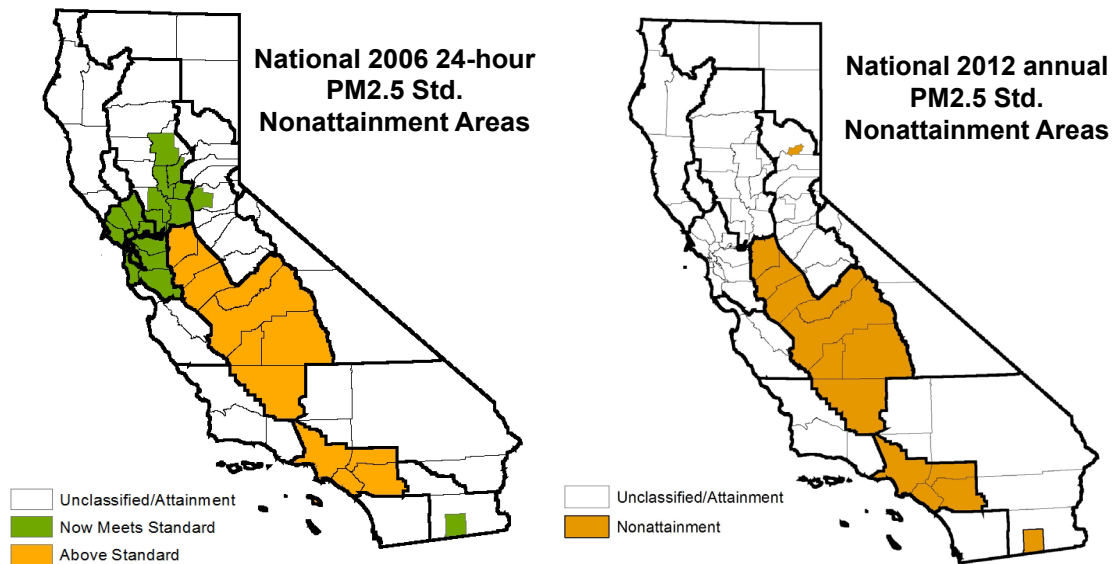
In 2006, U.S. EPA strengthened the national 24-hour PM_{2.5} standard from 65 µg/m³ to 35 µg/m³. The U.S. EPA issued designations for this standard which became effective in December 2009. Seven areas in California were designated as not meeting the strengthened federal 24-hour PM_{2.5} standard—the South Coast Air Basin, San Joaquin Valley Air Basin, Bay Area Air Basin, Sacramento Metropolitan area, a portion of the Feather River Air Pollution Control District, a portion of Butte County, and a portion of Imperial County. Since 2009, the Bay Area Air Basin, Sacramento Metropolitan area, Butte County and Imperial County have attained the standard, and Feather River Air Pollution Control District and Butte County have been redesignated to attainment. (Figure 7). Information on the final designations may be found on the U.S. EPA webpage, [Nonattainment Areas for Criteria Pollutants](#).⁸

In 2012, U.S. EPA lowered the annual PM_{2.5} standard from 15.0 µg/m³ to 12.0 µg/m³. The U.S. EPA issued designations for this standard in December 2014. Four areas in California were designated as not meeting the lowered annual PM_{2.5} standard—South Coast Air Basin, San Joaquin Valley Air Basin, and portions of Imperial and Plumas Counties (Figure 7). Information on the State and federal designations may be found on the [CARB Federal Area Designations](#) webpage.⁹

⁸ <https://www.epa.gov/green-book>

⁹ <https://ww2.arb.ca.gov/our-work/programs/state-and-federal-area-designations/federal-area-designations/pm25>

Figure 7. Designations for the national PM_{2.5} ambient air quality standards



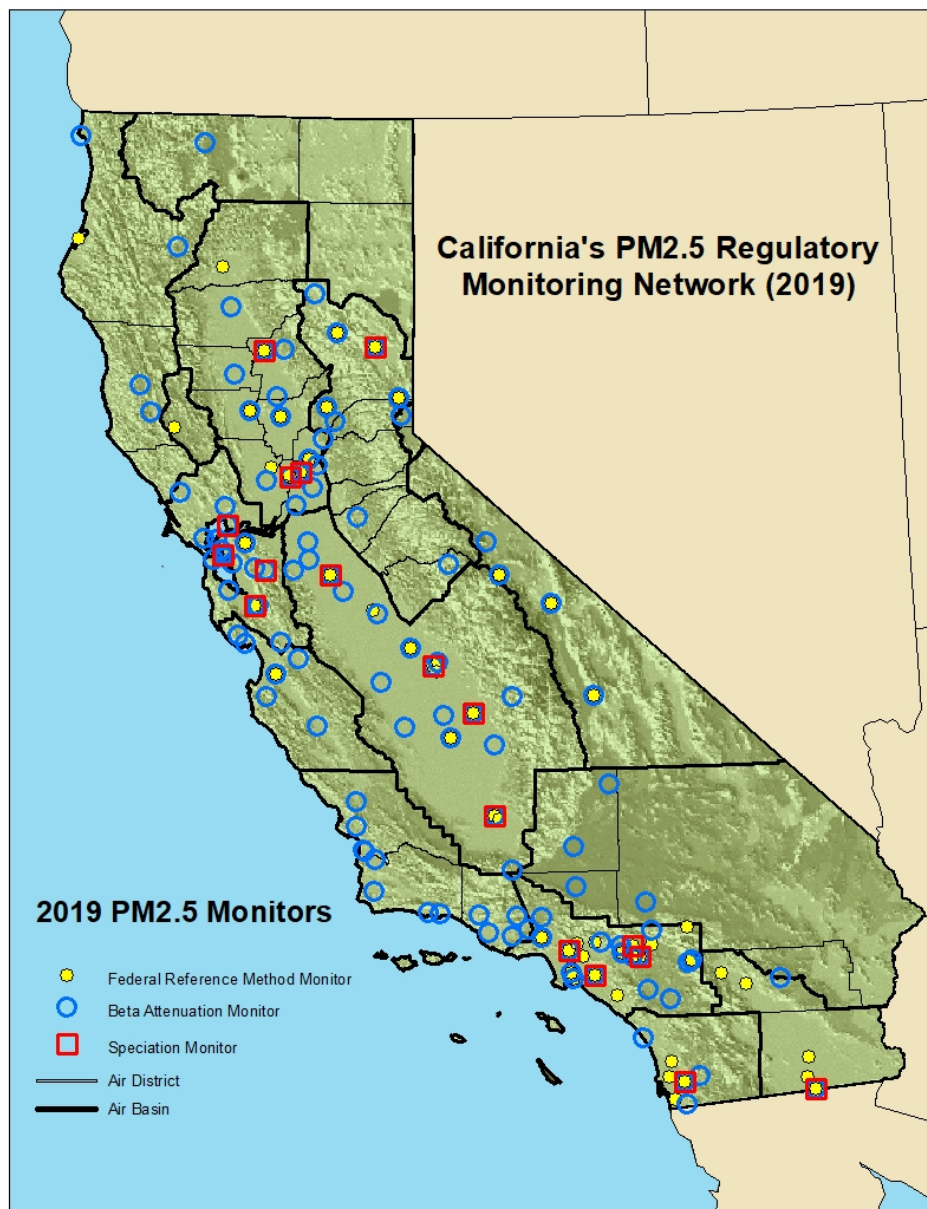
PM_{2.5} Attainment Plans

Progress in reducing PM_{2.5} levels has occurred throughout the State. As shown in Figure 7, four areas remain above the standards and have developed State Implementation Plans (SIPs). On March 14, 2019, U.S. EPA approved the South Coast Serious 24-hour PM_{2.5} Plan. On October 15, 2020, U.S. EPA determined that the South Coast failed to attain the 35 µg/m³ 24-hour PM_{2.5} standard by its December 31, 2019 attainment date. On December 31, 2020, CARB submitted a new plan for the 35 µg/m³ standard for the South Coast. The San Joaquin Valley Air Pollution Control District adopted a comprehensive SIP in 2018 to address multiple PM_{2.5} standards: the 65 µg/m³ and 35 µg/m³ 24-hour and the 15.0 µg/m³ and 12.0 µg/m³ annual PM_{2.5} standards. The SIP was approved by CARB in January 2019. U.S. EPA approved the portions of the SIP pertaining to the 35 µg/m³ standard in July 2020 and is reviewing the remaining portions. The District and CARB will continue to work jointly to implement the SIP. The Imperial County Air Pollution Control District submitted the PM_{2.5} SIP for the 24-hour standard in 2018 for the nonattainment area, which represents a portion of Imperial County. The Imperial County PM_{2.5} SIP was approved by CARB and transmitted to U.S. EPA in 2018, and was approved by U.S. EPA in October 2020. The Plumas County SIP for the annual PM_{2.5} standard was submitted to U.S. EPA in 2017 and approved by U.S. EPA in March 2019.

Information on SIPs for the South Coast, the San Joaquin Valley, Imperial County, and Plumas County are available on the CARB [California State Implementation Plans](https://ww2.arb.ca.gov/our-work/programs/california-state-implementation-plans) webpage.¹⁰

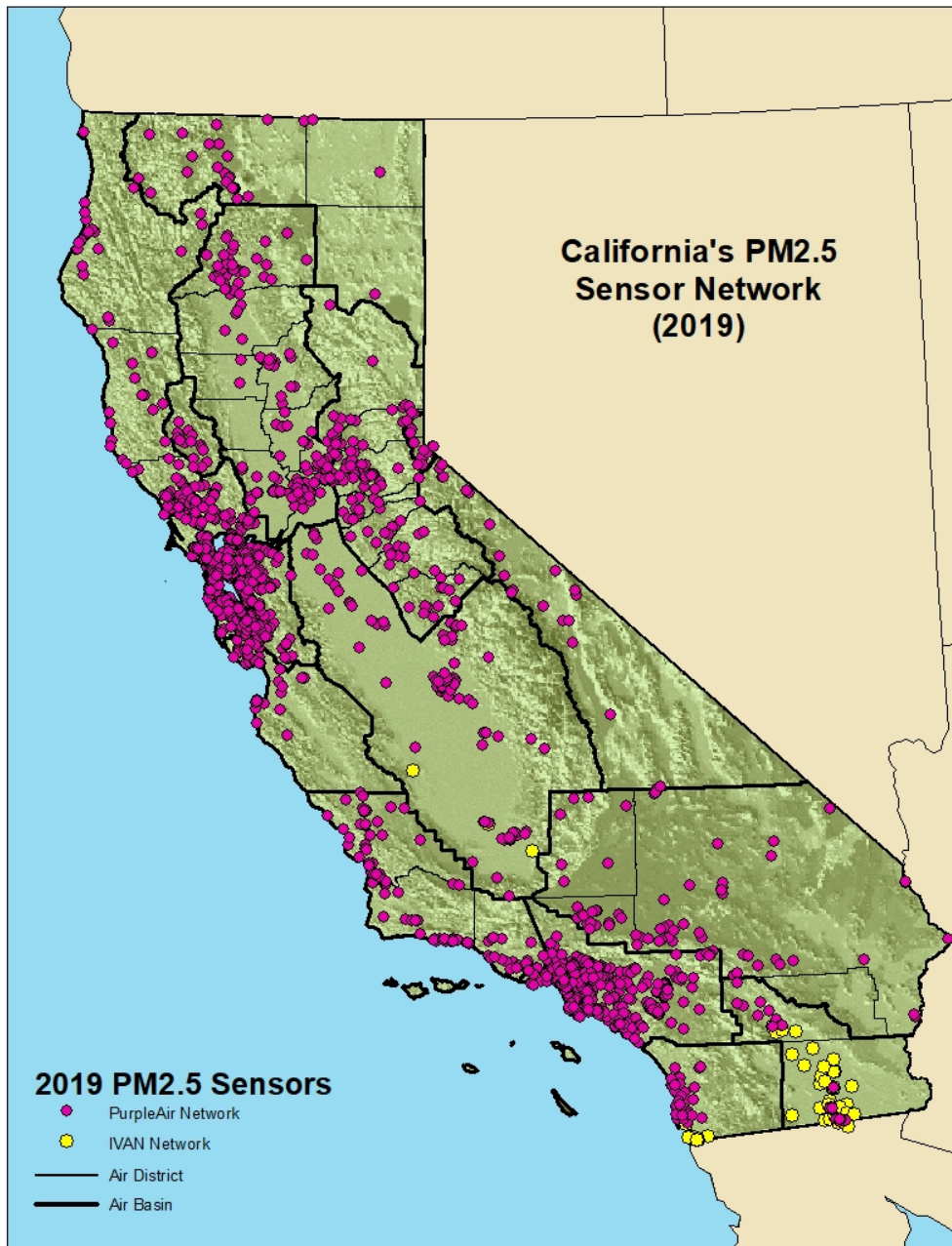
¹⁰ <https://ww2.arb.ca.gov/our-work/programs/california-state-implementation-plans>

Figure A1: PM_{2.5} Monitoring Stations in California*



*Represents locations of operating monitors prior to 2020 stay-at-home orders.

Figure A2: PM_{2.5} sensor locations in California*



*Represents locations of outdoor sensors prior to expansion of network due to public acquisition and installation of more than 4,000 units during and after the 2020 wildfire season.