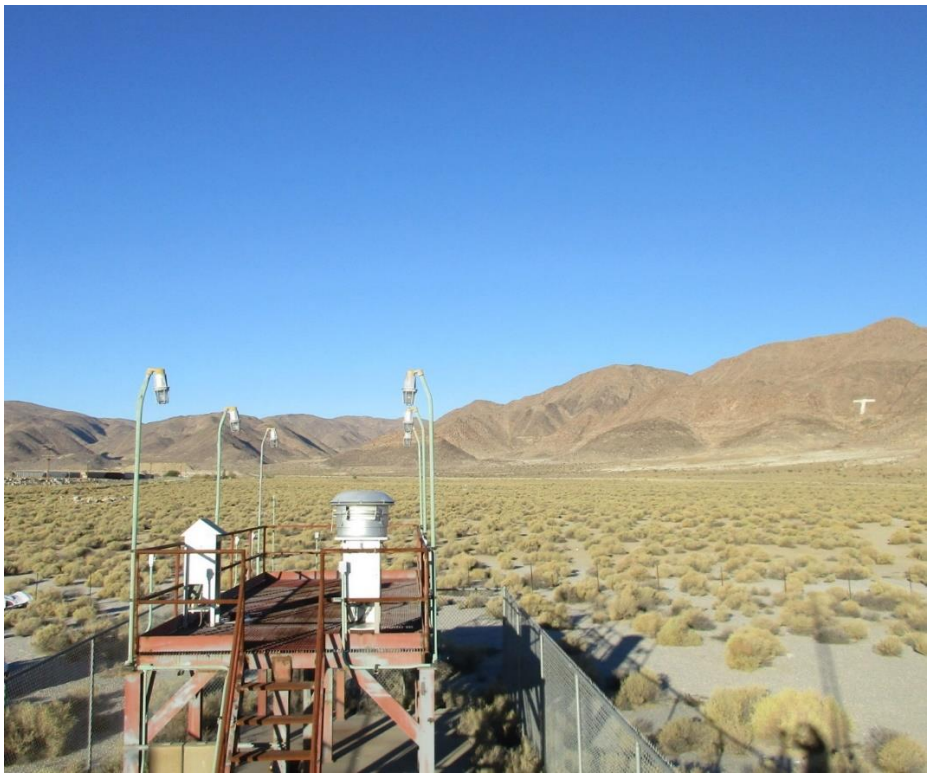
Annual Report on the California Air Resources Board's Fine Particulate Matter Monitoring Program



March 2020

CALIFORNIA AIR RESOURCES BOARD

State of California
California Environmental Protection Agency
California Air Resources Board

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PM2.5 Air Quality Monitoring Program

Health and Safety Code, Section 39619.5(g) requires the California Air Resources Board (CARB) to provide an update each year on the status and results of the fine particulate matter (PM2.5) monitoring program. This report provides a summary of PM2.5 monitoring activities in 2019 and how the data are being used to support CARB programs.

California's PM2.5 air quality monitoring program provides information used for determining which areas violate PM2.5 standards, characterizing the sources that contribute to PM2.5 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 PM2.5 monitoring program to provide improved monitoring data.

California's PM2.5 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 PM2.5 regulatory monitors are operated to provide data on PM2.5 mass and chemical composition which are summarized below. The type and number of PM2.5 regulatory monitors in operation has changed from year to year depending upon programmatic needs and available funding. Figure A1 displays the locations of PM2.5 regulatory monitors throughout the State as of the end of 2019. Additional information on PM2.5 monitoring can be found at: https://ww3.arb.ca.gov/aqd/pm25/pmfdsign.htm

Figure 1. Federal Reference Method Monitor

PM2.5 Air Quality Monitoring Program

PM2.5 monitors intended to provide PM2.5 data for regulatory purposes are identified as either Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitors. FRM PM2.5 monitors use the oldest method, which relies on weighing PM2.5 collected on filters. Measurement of PM2.5 in air has evolved over time as new instruments have been developed. FEM PM2.5 monitors, for example, continuously measure PM2.5 mass concentration using more recently developed measurement technologies. PM2.5 non-regulatory monitors are not intended to provide PM2.5 data for regulatory purposes primarily due to concerns about their accuracy.

Federal Reference Method Monitors

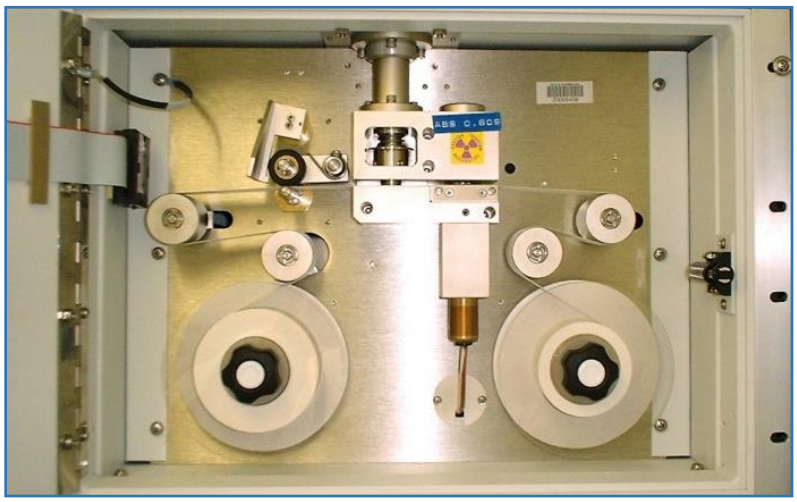
The installation of federally-approved PM2.5 mass monitors throughout California began in 1998. As of the end of 2019, FRM (Figure 1) monitors are operated at 59 sites. These monitors collect particulate samples on filters, which are later weighed and analyzed in a laboratory. Because of this two-step process, PM2.5 air quality data collected with these monitors are not immediately available. In addition, this approach is very labor intensive and provides at best daily temporal resolution. To provide “real-time” PM2.5 air quality information, continuous PM2.5 mass monitors were added to the CARB network in the late 1990s.

Continuous Mass Monitors

Continuous PM2.5 mass monitors provide valuable information for public reporting on PM2.5 levels, temporal representation, health studies, transport studies, and background monitoring. PM2.5 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 PM2.5 network in 1999. There are 114 sites continuously measuring PM2.5 mass. The U.S. Environmental Protection Agency (U.S. EPA) designated certain models of the continuous monitors as FEM monitors. They are considered equivalent to the FRM monitors and therefore may be used to determine compliance with federal standards.[1] Sixty-eight of California’s continuous monitoring sites have FEM monitors. 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 PM2.5 monitoring network to determine if the existing sites met U.S. EPA requirements and State programmatic needs.

[1] https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants

Figure 2. Beta Attenuation Monitor

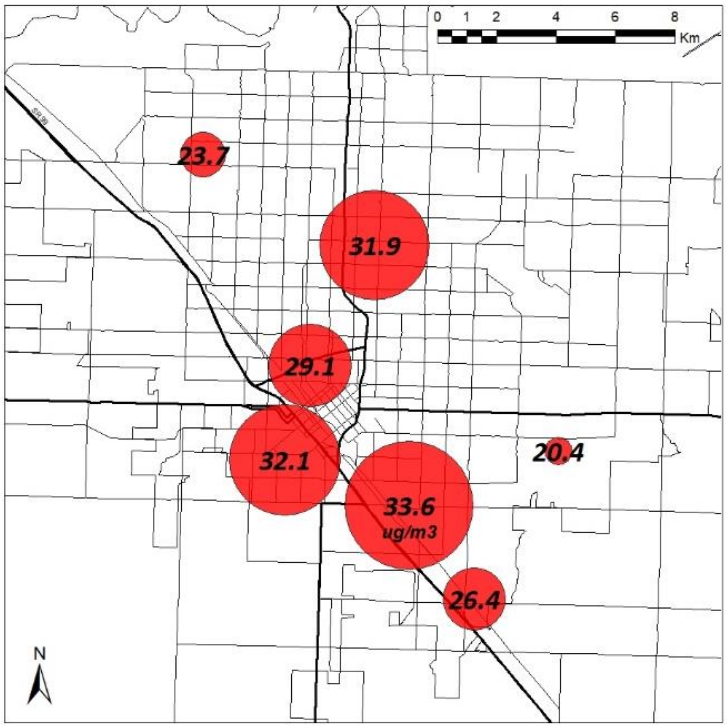


Air Quality Sensors

PM2.5 mass can be continuously measured with air quality sensors. Air quality sensors for PM2.5 are newly emerging, low cost methods using optical sensors to count PM2.5 particles and then estimate PM2.5 concentrations. PM2.5 sensors are non-regulatory monitors that are not intended to provide PM2.5 data for regulatory purposes because of concerns about their accuracy. However, PM2.5 sensor data can be accessed instantly via the Internet and provide data at a 5-minute or better temporal resolution. As of December 2019, more than 2900 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 PM2.5 sensors across the State as of December 2019. As an example, Figure 3 shows average PM2.5 sensor concentrations in Fresno in the winter of 2018-2019. Real-time PM2.5 data from air quality sensors can be found at:

https://ivan-imperial.org/air/list and https://www.purpleair.com/map

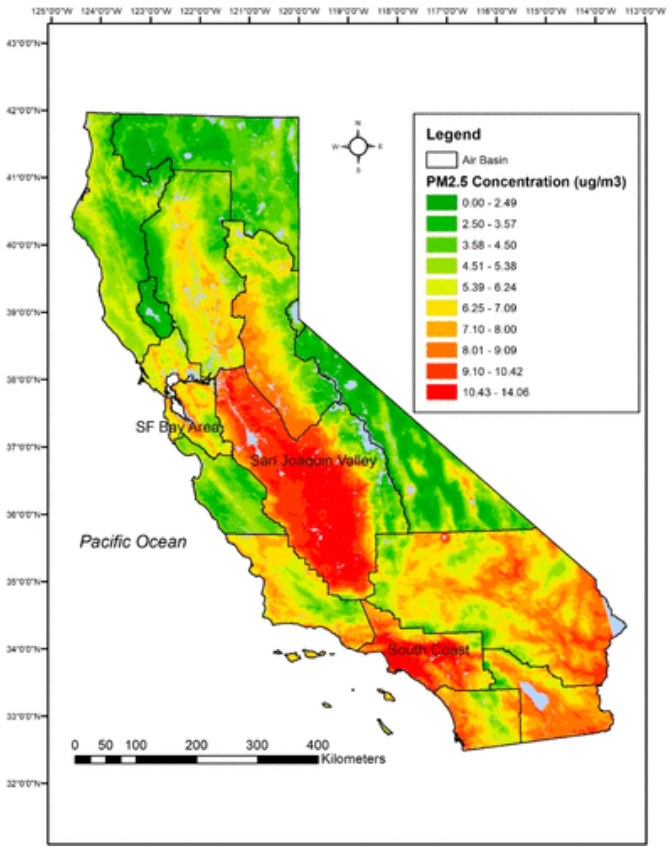
Figure 3. Average PM2.5 concentrations measured by PurpleAir Sensors in Fresno in the winter of 2018-2019



Satellite Remote Sensing

Satellite remote sensing has been used to estimate PM2.5 concentrations and subsequently evaluate the spatial variabilities in PM2.5 concentrations. Technologies have improved such that certain types of satellite data (e.g., aerosol optical depth) can be used to estimate the concentrations of PM2.5 components, such as nitrate, sulfate, organic carbon, and elemental carbon. Satellite remote sensing can fill in PM2.5 data in areas where there are no land-based PM2.5 monitors. Satellite remote sensing refines our understanding of PM2.5 spatial distribution and tracks PM2.5 trends that assess the effectiveness of PM2.5 mitigation strategies. The main disadvantage of satellite-based PM2.5 measurements compared to land-based measurement methods is accuracy and temporal resolution (typically daily snapshots). For example, Figure 4 shows satellite-based PM2.5 concentrations in 2016 (Lee,H.J., 2019. Environ. Sci. Technol. 53(21), 12774-12783)

Figure 4. Statewide variability in satellite-based PM2.5 concentrations in 2016



Speciation Monitors

Another major stage of network implementation is the deployment of PM2.5 speciation monitors (Figure 5). Speciation monitoring provides valuable information about the composition, and ultimately, the sources of PM2.5 pollution. In 2014, along with states, U.S. EPA conducted a nationwide assessment of the PM2.5 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 location of California's speciation monitors is shown in Figure A1.

Figure 5. Speciation Monitor

Federally-Required Speciation Monitors

There are two components to the PM2.5 speciation network in California. The first component, mandated by the U.S. EPA, requires filter-based PM2.5 speciation monitoring at seven California sites that are now part of a national trends network for PM2.5 speciation. These monitors are the National Air Monitoring Stations (NAMS) monitors for the speciation network. The seven PM2.5 speciation monitors are located in Bakersfield, El Cajon, Fresno, Sacramento, San Jose, Los Angeles, and Riverside.

Additional Speciation Monitors

The second component of California's PM2.5 speciation network is the deployment of samplers 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 SLAMS PM2.5 speciation network is to enhance the spatial coverage of the NAMS sites, particularly in areas with elevated PM levels.

CARB and local air districts operate filter-based speciation monitors at eleven sites - Anaheim, Calexico, Chico, Fontana, Modesto, Portola, Visalia, Sacramento, Vallejo, Livermore, and Oakland.

In 2007, CARB began monitoring for specific wood smoke tracers to determine the contribution of wood burning sources to PM2.5 ambient levels. Wood smoke tracers are being monitored at six of the speciation SLAMS sites - Calexico, Chico, Modesto, Portola, Sacramento, and Visalia during the winter season.

Accessing PM2.5 Data

Data collected as part of California's PM2.5 monitoring program may be obtained in several ways. Daily PM2.5 values as well as summary statistics can be accessed through the interactive query tool on CARB's web page at:

https://www.arb.ca.gov/adam

Real-time hourly PM2.5 data from California's continuous monitors can also be found at:

https://www.arb.ca.gov/aqmis2/aqdselect.php

PM2.5 Designations

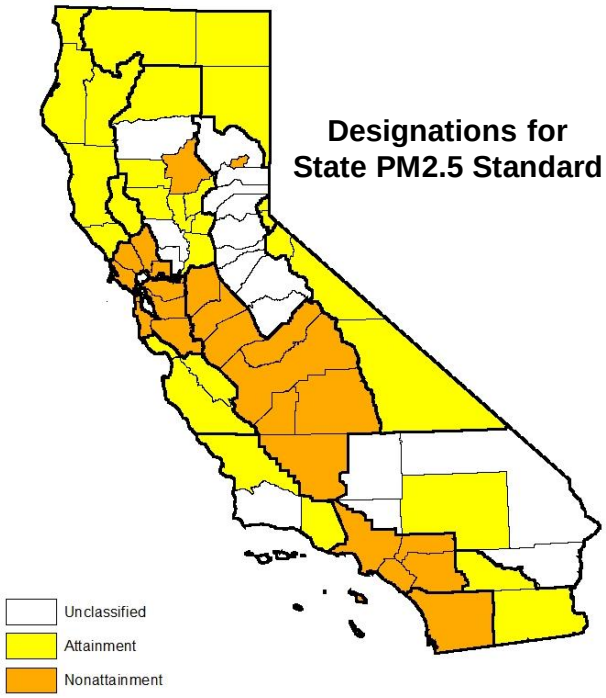
The Clean Air Act requires the U.S. EPA to set national ambient air quality standards to protect public health, and to designate nonattainment areas for the national standards. U.S. EPA has set PM2.5 ambient air quality standards with two averaging periods, 24-hour and annual. Further, CARB established a more health protective State PM2.5 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 PM2.5 ambient air quality standards are shown in Table 1.

Table 1. State and National PM2.5 Ambient Air Quality Standards ($\mu g/m^3$)

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

Based on 2016-2018 air quality data collected as part of California's PM2.5 monitoring network, CARB designates the attainment status of areas with respect to the State annual average PM2.5 ambient air quality standard of 12 $\mu g/m^3$. Most urban areas of California, as well as several more isolated sub-areas, exceed the State PM2.5 standard (Figure 6). However, as air pollution control programs have reduced PM2.5 concentrations, more areas now meet the State PM2.5 ambient air quality standard.

Figure 6. Designations for the State annual PM2.5 ambient air quality standard



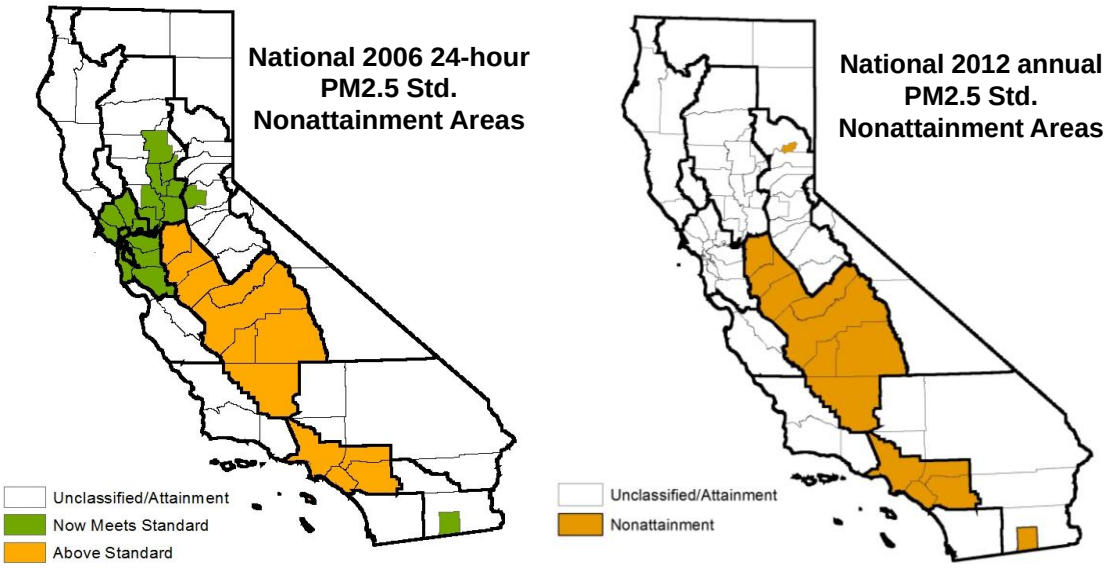
In 2006, U.S. EPA strengthened the national 24-hour PM2.5 standard from 65 µg/m^3 to 35 µg/m^3. The U.S. EPA issued final designations for this standard which became effective in December 2009. Seven areas in California were designated as not meeting the strengthened federal 24-hour PM2.5 standard – 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, U.S. EPA has determined that the Bay Area Air Basin, the Feather River Air Pollution Control District, Sacramento Metropolitan area, Imperial County, and Butte County have attained the standard (Figure 7). Information on the final designation may be found at:

https://www3.epa.gov/region9/air/actions/ca.html

In 2012, U.S. EPA lowered the annual PM2.5 standard from 15.0 µg/m3 to 12.0 µg/m3. The U.S. EPA issued final designations for this standard in December 2014 based on 2011-2013 air quality data. Four areas in California were designated as not meeting the lowered annual PM2.5 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 at:

https://www.arb.ca.gov/desig/pm25desig/pm25desig.htm

Figure 7. Designations for the national PM2.5 ambient air quality standards



PM2.5 Attainment Plans

Progress in reducing PM2.5 levels has occurred throughout the State. As shown in Figure 7, four areas now remain above the standards and are required to develop State Implementation Plans (SIPs). The South Coast 2016 Air Quality Management Plan (2016 AQMP) includes a comprehensive approach for attaining multiple PM2.5 air quality standards, including the 12.0 µg/m^3 annual and the 35 µg/m^3 24-hour standards. The South Coast 2016 AQMP was approved by CARB and transmitted to U.S. EPA in 2017. The San Joaquin Valley Air Pollution Control District adopted a comprehensive SIP in 2018 to address multiple PM2.5 standards: the 65 µg/m^3 and 35 µg/m^3 24-hour and the 15.0 µg/m^3 and 12.0 µg/m^3 annual standards. The SIP was approved by CARB in January 2019. The District and CARB will work jointly to implement the SIP. The Imperial County Air Pollution Control District submitted the PM2.5 SIP for the annual standard in 2018 for the nonattainment area, which represents a portion of Imperial County. The Imperial County PM2.5 SIP was approved by CARB and transmitted to U.S. EPA in 2018. The Plumas County SIP for the annual PM2.5 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, respectively, at:

https://www.arb.ca.gov/planning/sip/planarea/scabsip/scabsip.htm

https://www.arb.ca.gov/planning/sip/planarea/sanjqnvllysip.htm

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https://www.arb.ca.gov/planning/sip/planarea/imperial/imperialsip.htm

https://www.arb.ca.gov/planning/sip/planarea/nsierra/nsierra.htm

Figure A1: PM2.5 Monitoring Stations in California

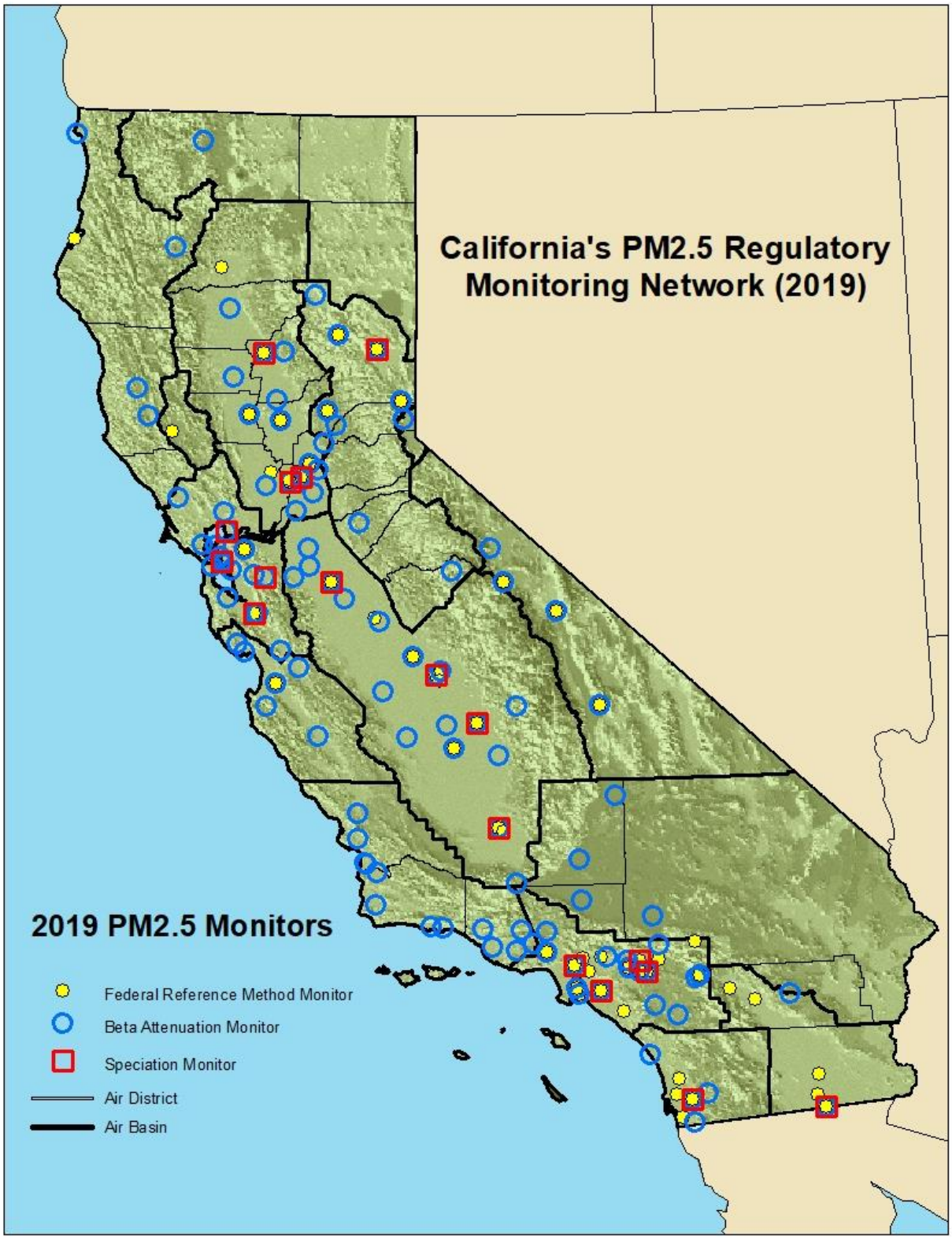

Figure A2: PM2.5 sensor locations in California