October 2017 Northern California Wildfires

Daniel Alrick, Bay Area Air Quality Management District

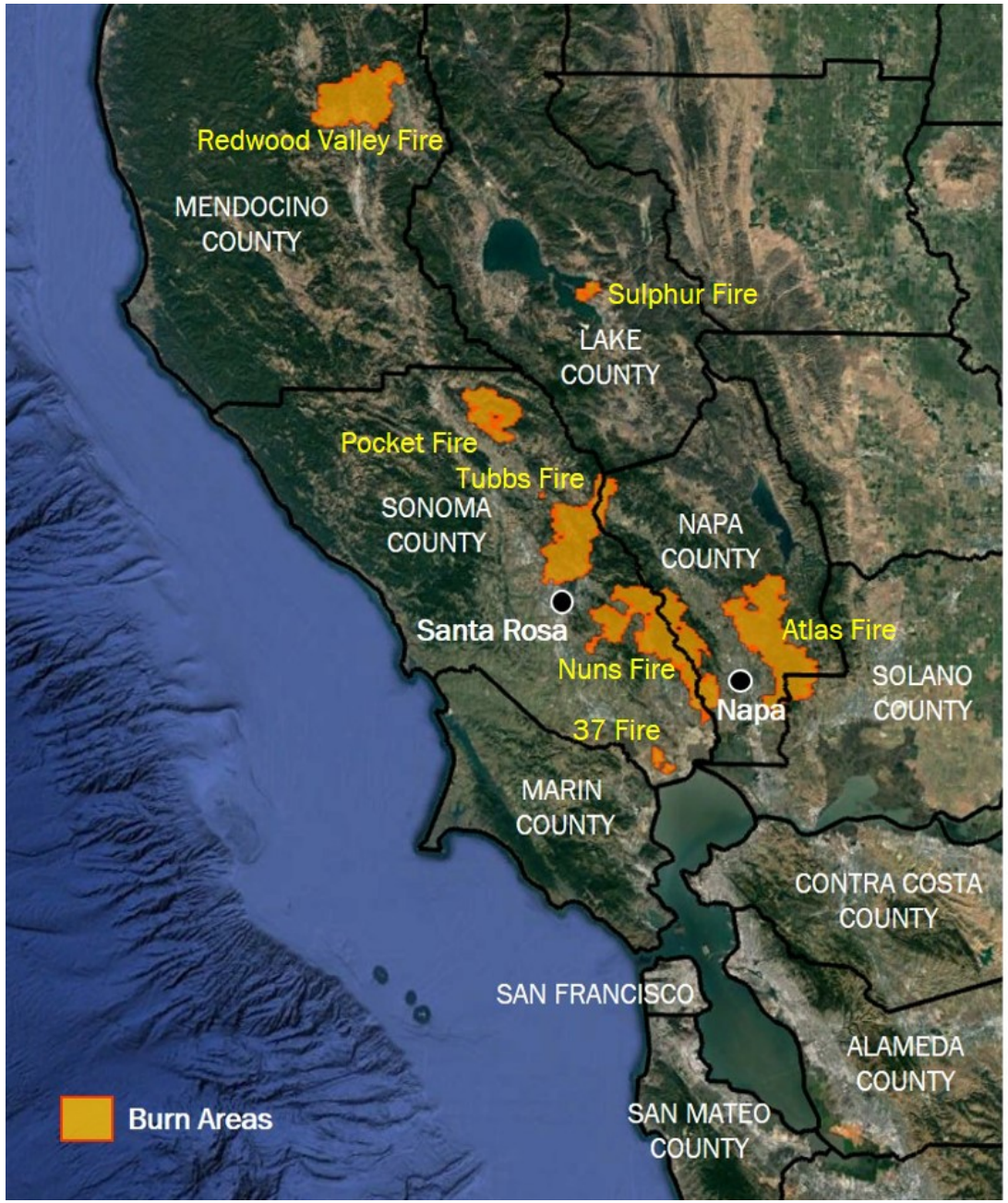
NAQC 2018, Austin, TX

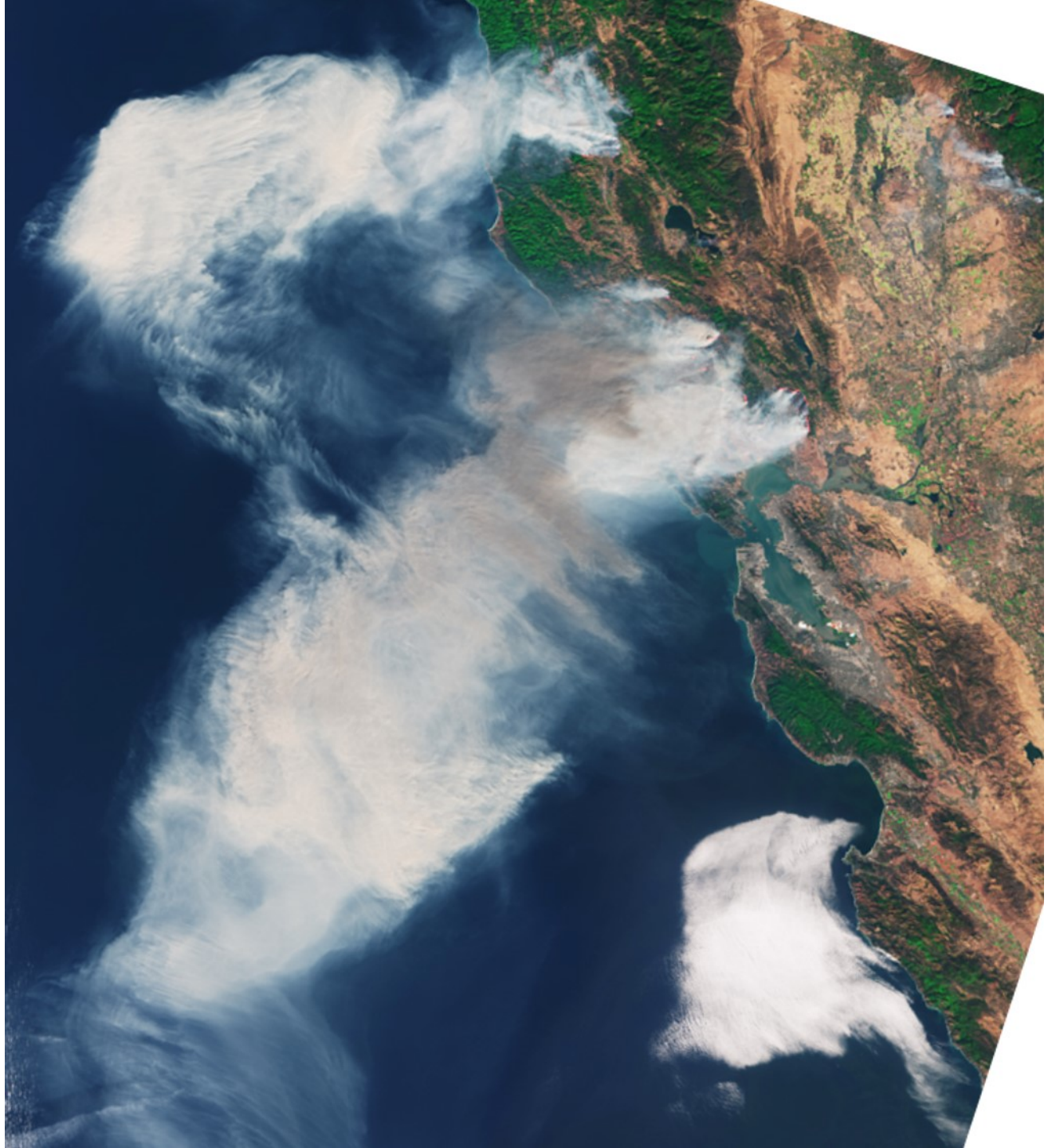
January 25, 2018

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Overview

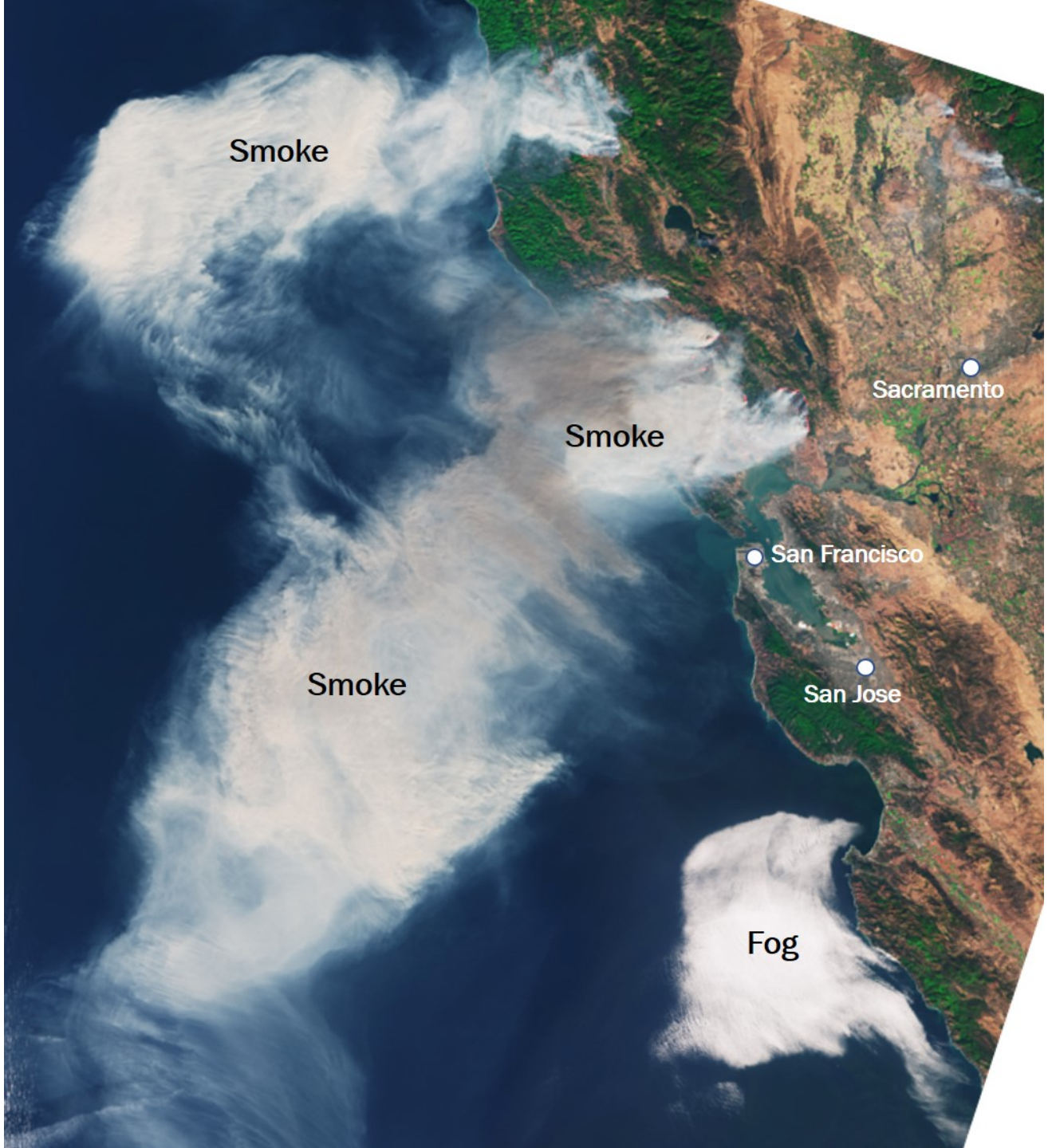
- Fires started on the evening of Sunday, October 8, with the largest fires occurring in Napa and Sonoma counties
- Conditions at the time were very favorable for rapid fire growth
- Fires collectively burned over 240,000 acres
- 44 fatalities
- Nearly 9,000 buildings destroyed
- $9+ Billion in insured damages





Copernicus Sentinel-3A Satellite image

October 9, 2017

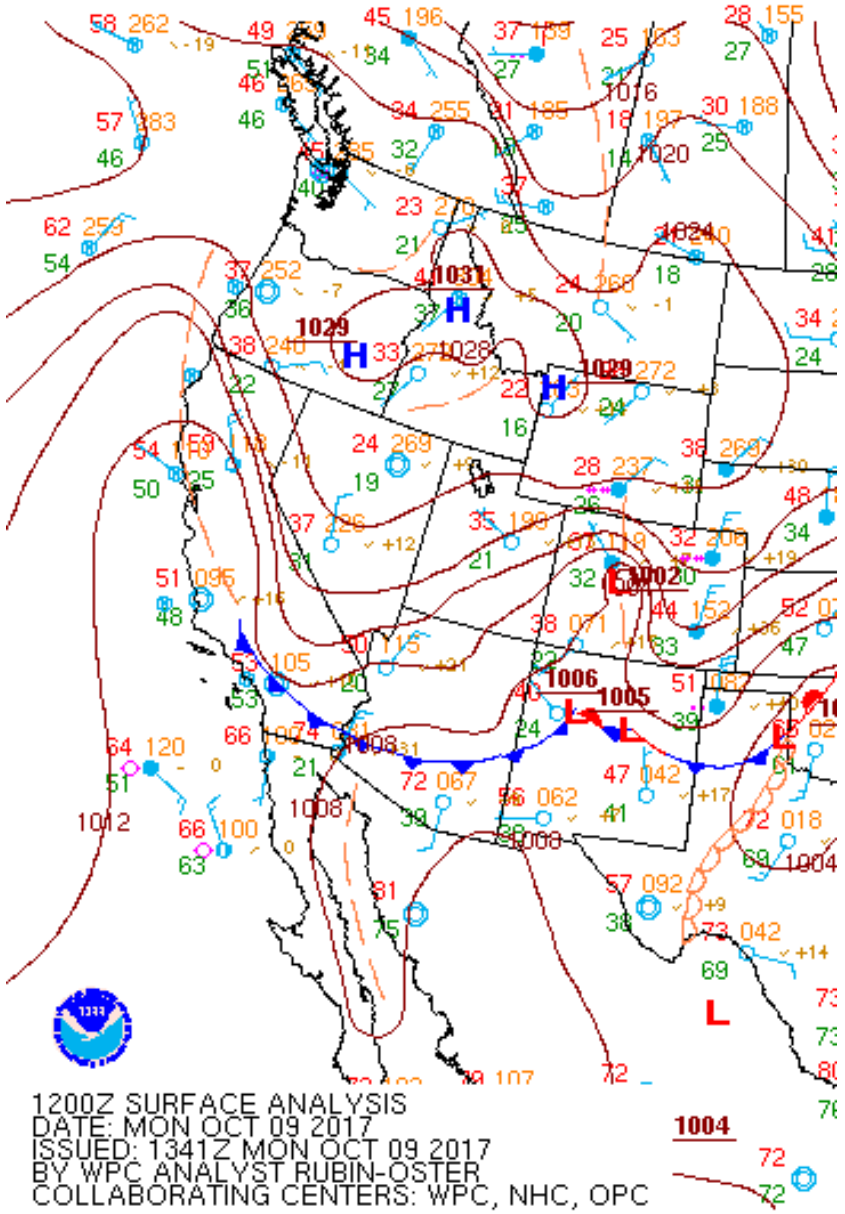


Copernicus Sentinel-3A Satellite image

October 9, 2017

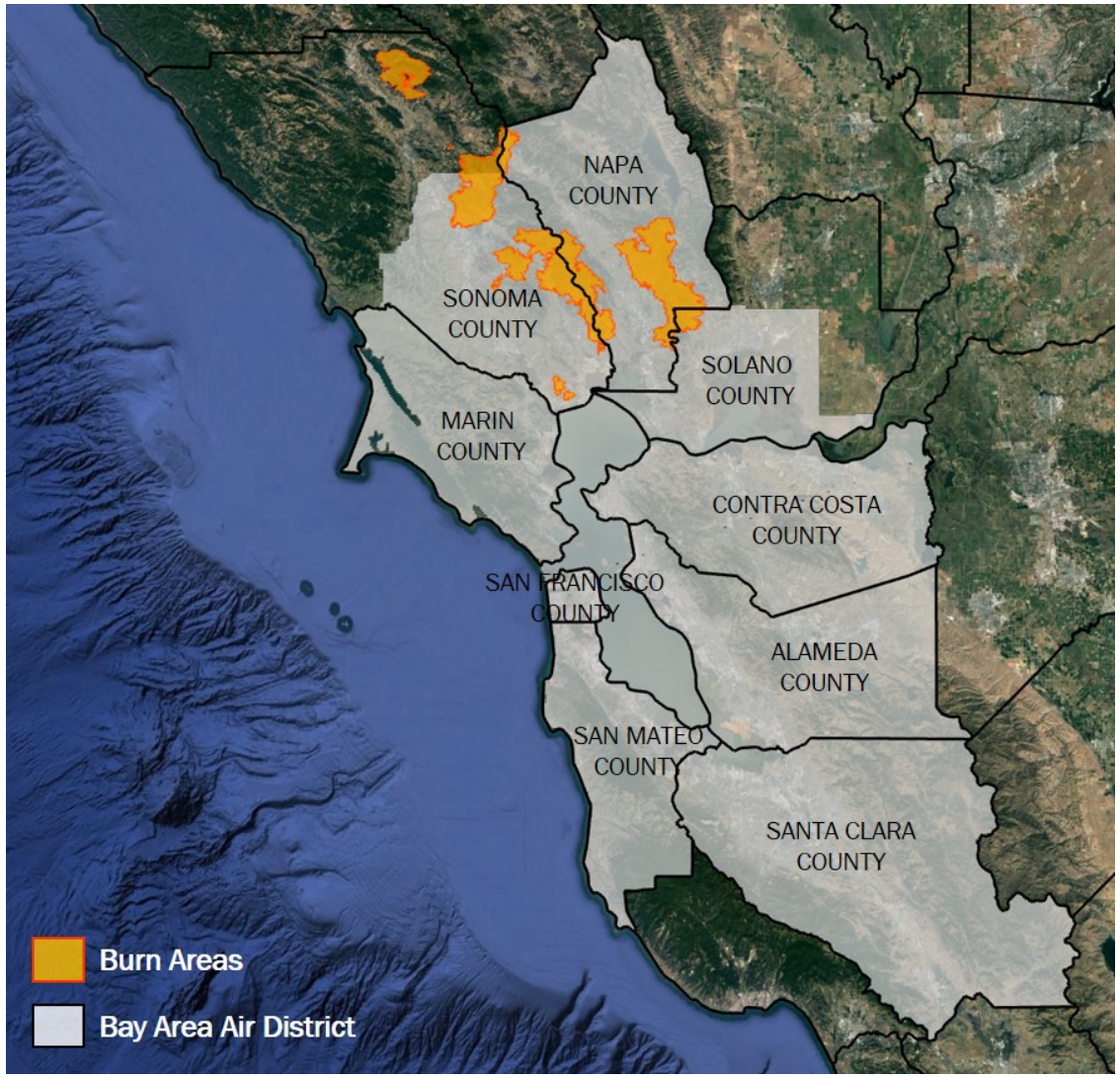
Weather Conditions

- Fires started on the evening of Sunday, October 8 and spread rapidly
- Conditions at the time were very favorable for rapid fire growth
  - Strong pressure gradient between the Bay Area and a surface high over Idaho resulted in very gusty offshore winds (at times over 70 mph)
  - Offshore “Diablo” winds also resulted in very low humidity levels
  - Vegetation was very dry (end of the dry season)
  - Red Flag Warnings were in effect for the area



Smoke Forecasting

- The Air District is the local air quality agency responsible for regulating air pollution in the San Francisco Bay Area, and led the air quality-related response for the region
- Meteorologists at the Air District quickly incorporated the wildfire smoke into forecasting products
- North to northeasterly winds transported smoke from the fires directly into the urban core of the Bay Area, causing air quality to become unhealthy for a large population
- The Air District issued a smoke and health advisory for the region starting the morning after the fires began (October 9)

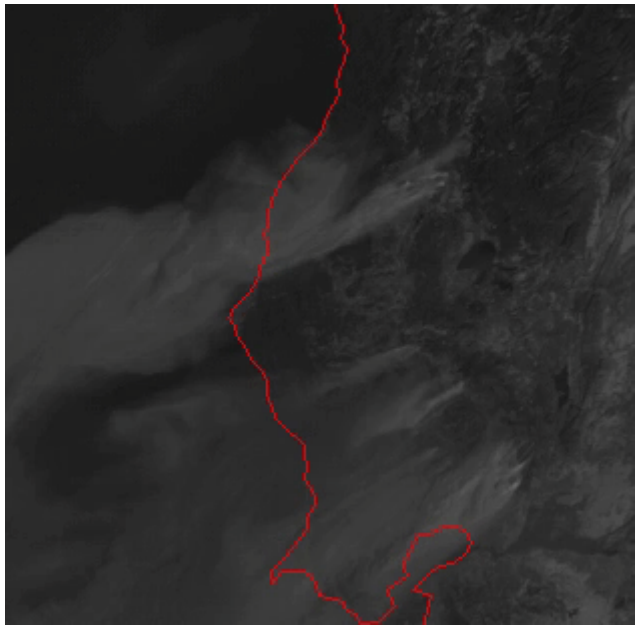


Smoke Forecasting

- The close proximity of the fires and their resulting narrow but dense smoke plumes resulted in highly-variable air quality conditions
- Several tools were employed to help address this forecasting challenge, including
  - Satellite imagery from MODIS and GOES-16
  - HYSPLIT modeling
  - Wildfire smoke models, such as BlueSky and the HRRR
  - Surface air quality observations

MODIS satellite image from Thursday 10/12/2017

GOES-16 Imagery



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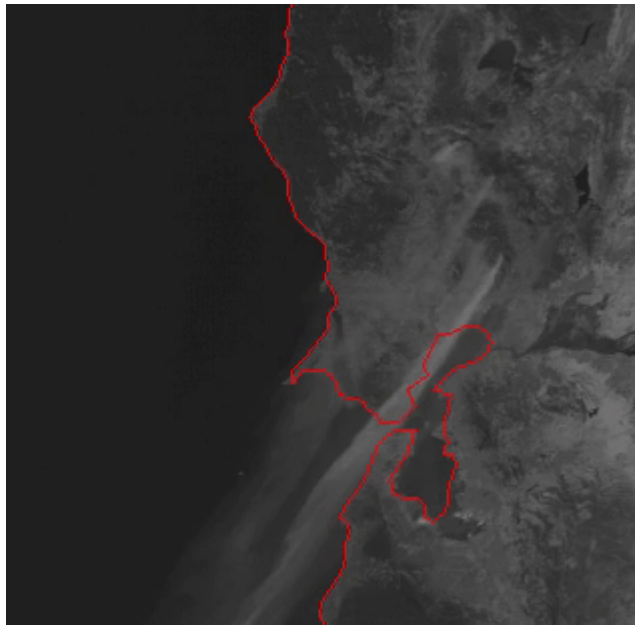
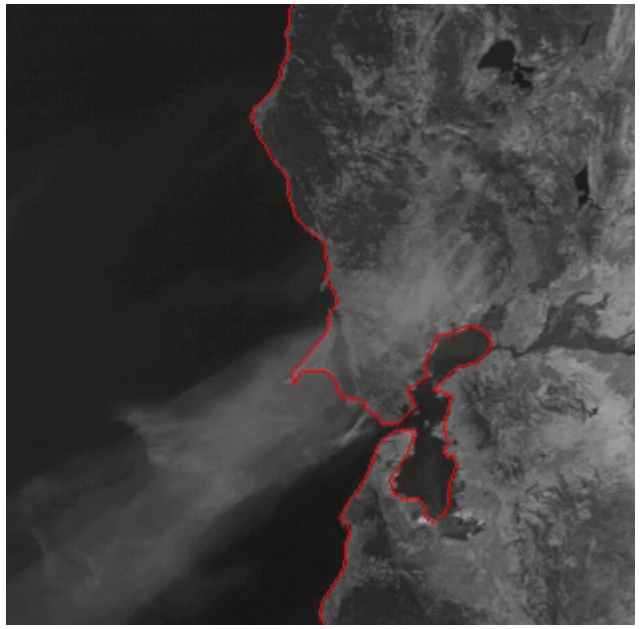


Thursday 10/12/2017

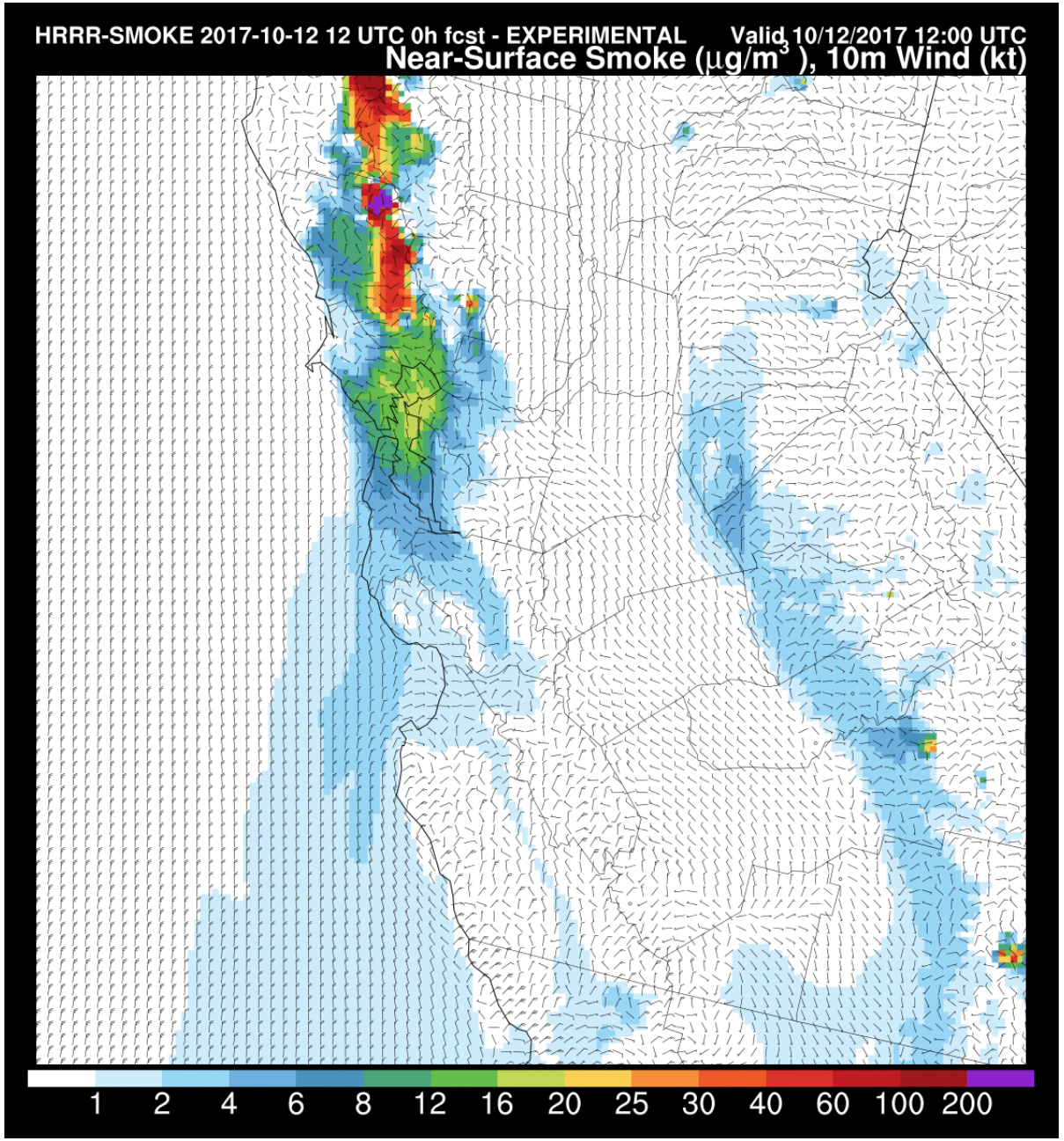


Saturday 10/14/2017

- GOES-16 (launched November 2016) provides imagery at greater spatial and temporal resolution than its predecessor satellite
- Variations in smoke plume diffusion were evident from day to day, attributable to amount of vertical mixing and vertical wind shear

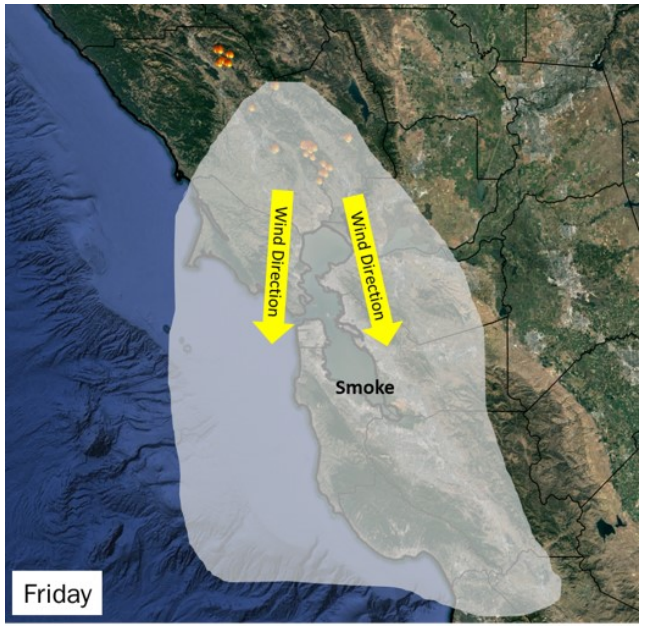
Smoke Models

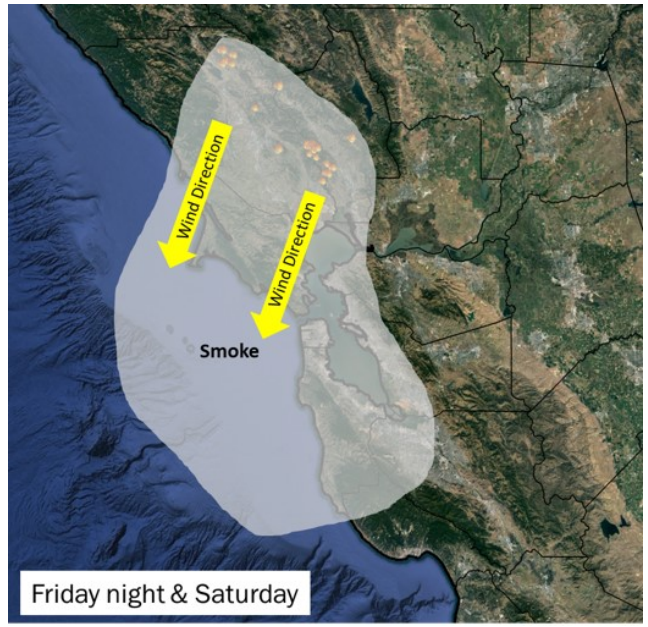
- Primarily used the BlueSky and High-Resolution Rapid Refresh (HRRR) Smoke models
- Both were useful in forecasting short-term spatial extent of the smoke plumes and shifts with wind direction
- HRRR model produces predictions for near-surface smoke and vertically-integrated smoke concentrations
- A limitation was the estimated emissions data going into the model, as fire behavior/size was changing rapidly
- Air District plans to do some validation of model output against surface PM observations

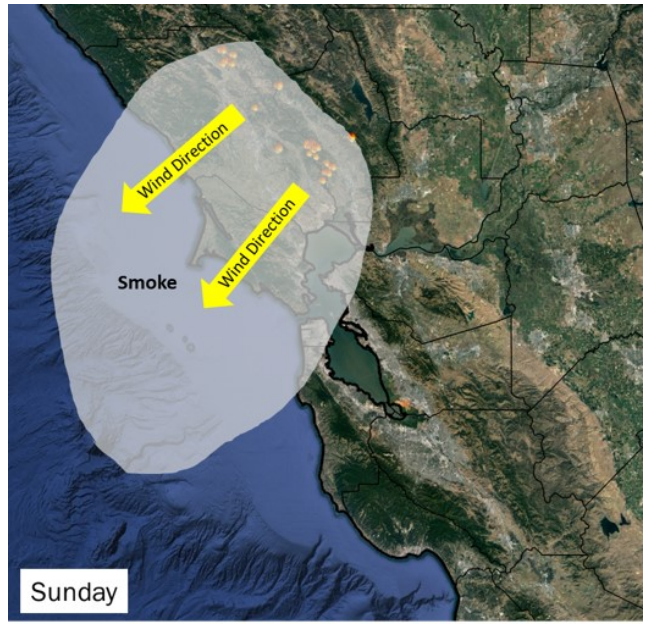


Smoke Forecasting

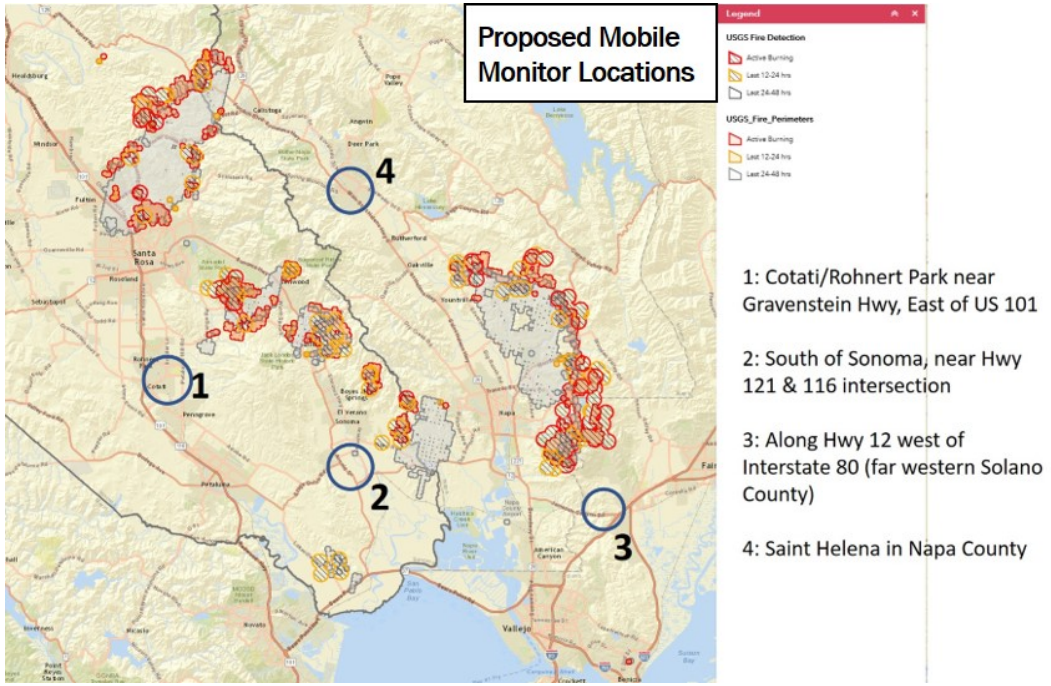
- Distilling the complex and rapidly changing air quality situation into a format easily accessible by the public was another challenge
- Air District meteorologists drew up simple maps to conceptualize the forecasted location of the smoke plume based on shifts in wind direction
- The maps were routinely updated and used in Air District messaging and alerts through the course of the event







Air Monitoring

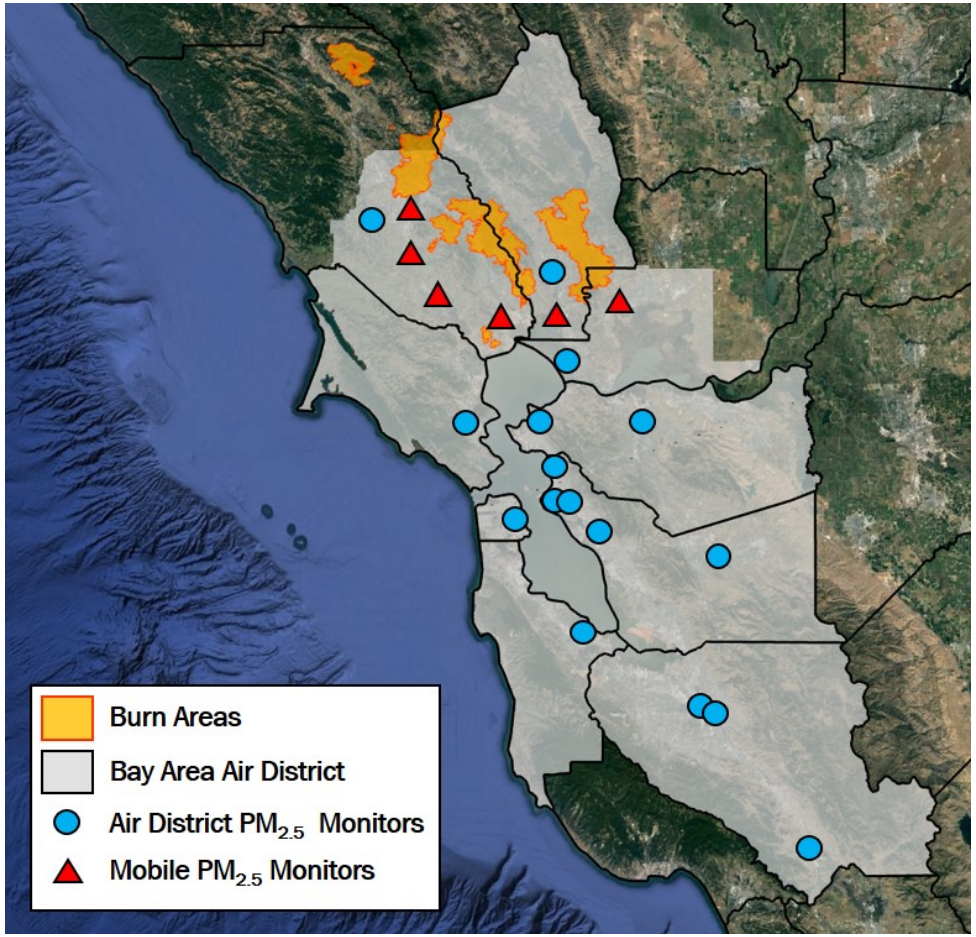


1: Cotati/Rohnert Park near Gravenstein Hwy, East of US 101

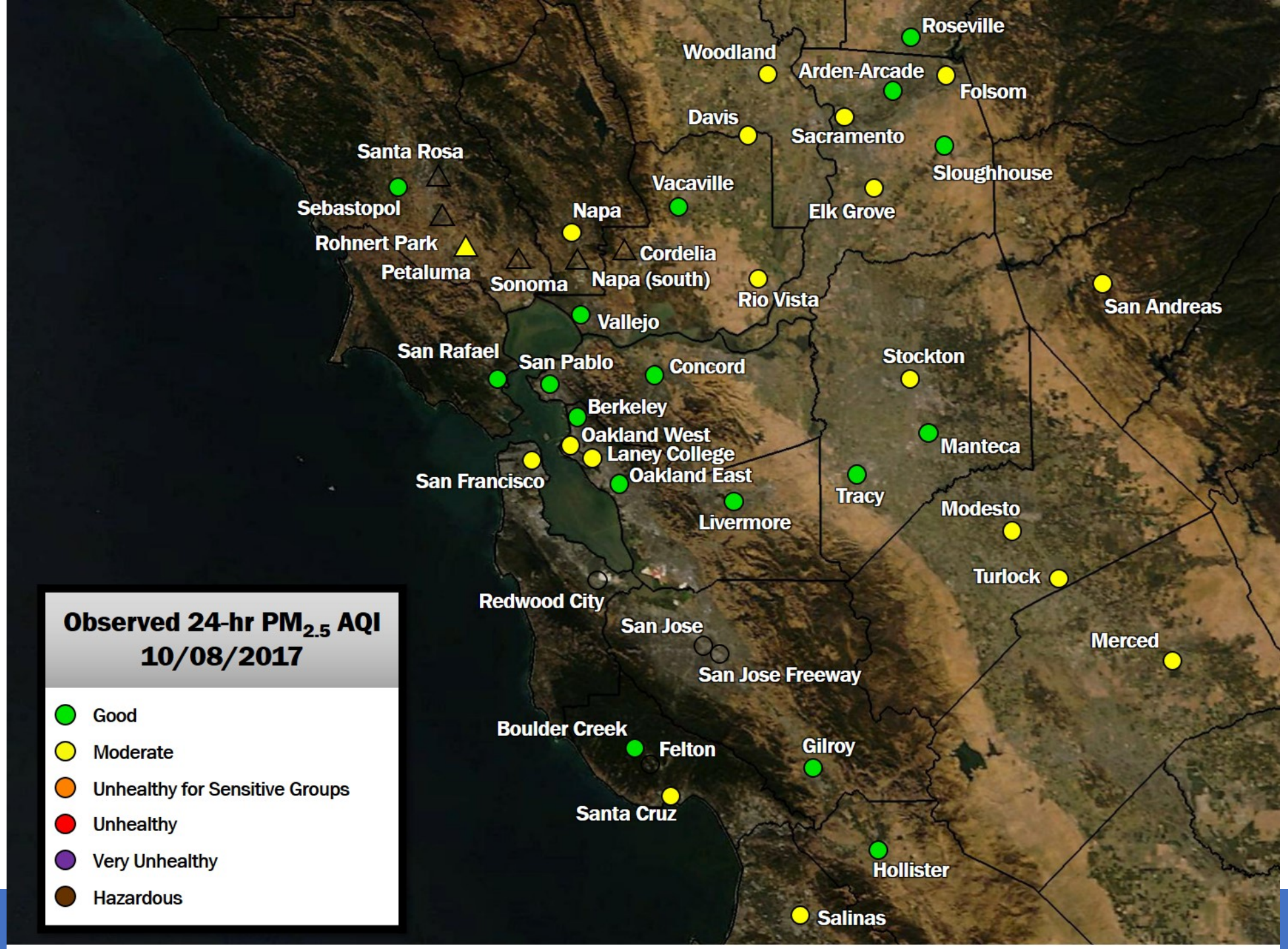
2: South of Sonoma, near Hwy 121 & 116 intersection

3: Along Hwy 12 west of Interstate 80 (far western Solano County)

4: Saint Helena in Napa County



- The Air District coordinated with the California Air Resources Board (CARB) to place temporary $PM_{2.5}$ monitors downwind of the fires
- Four general locations were identified for monitor placement, but not all areas were accessible or logistically feasible due to fire impacts
- Mobile monitor deployment began on October 11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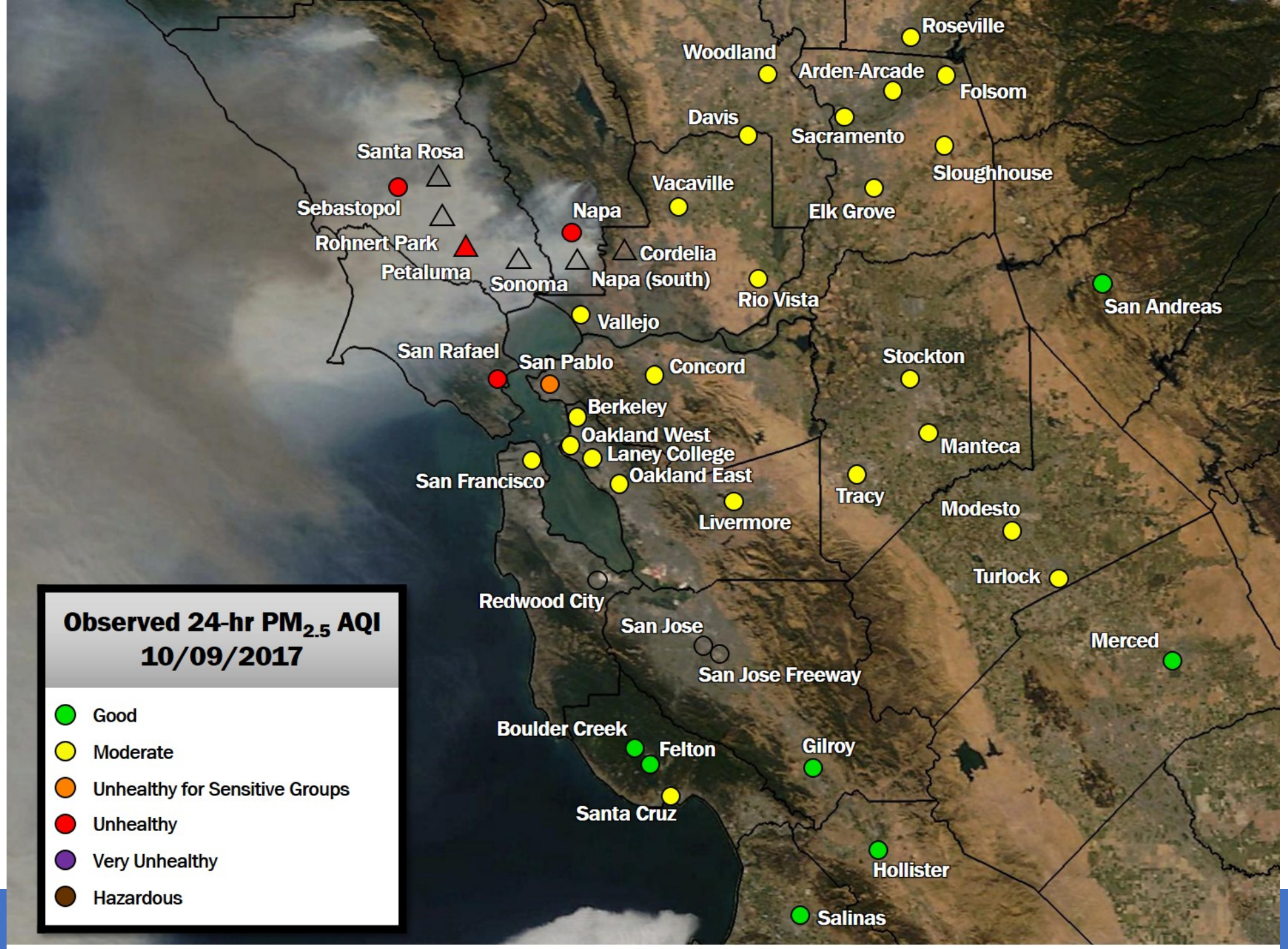
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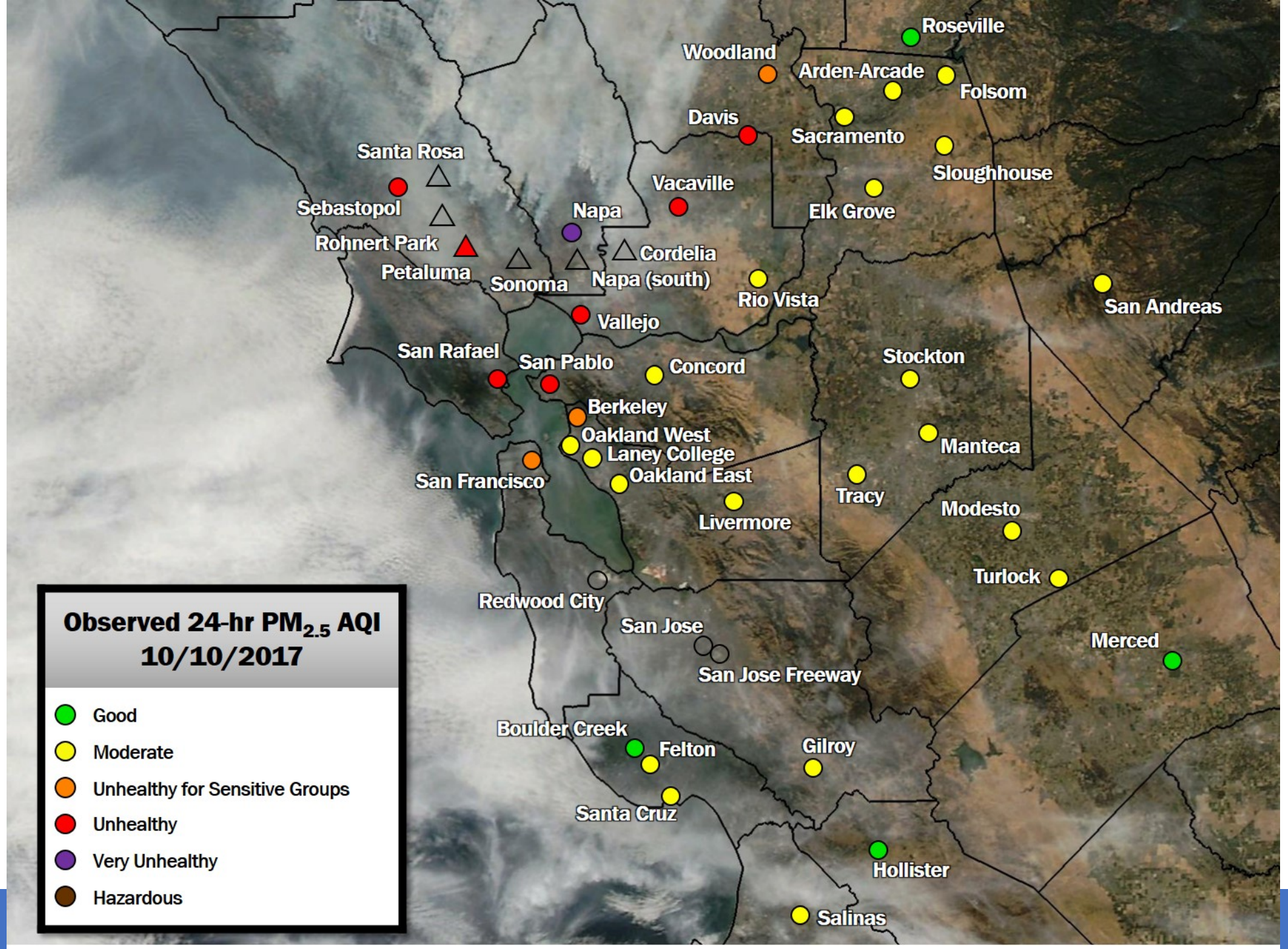
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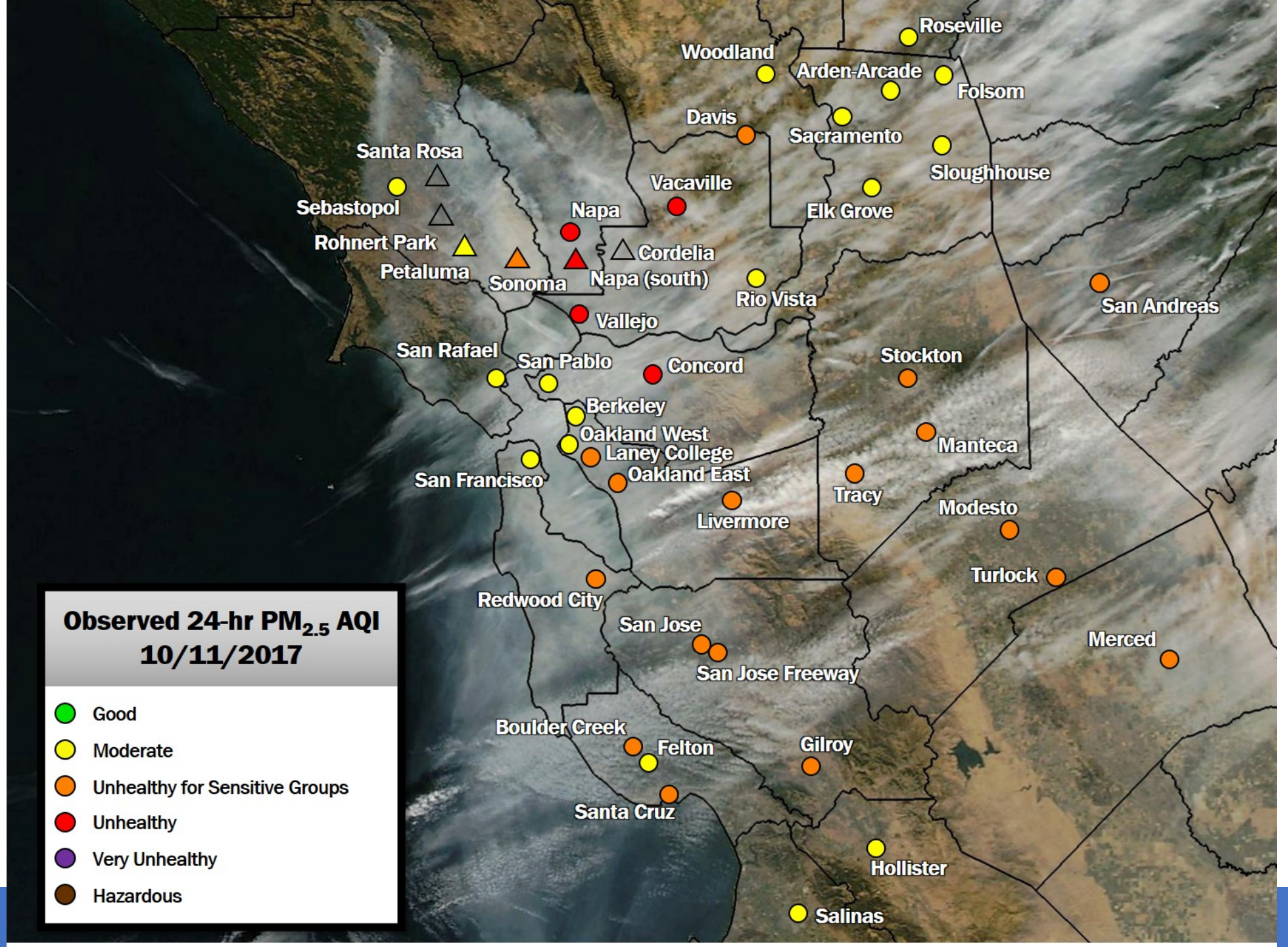
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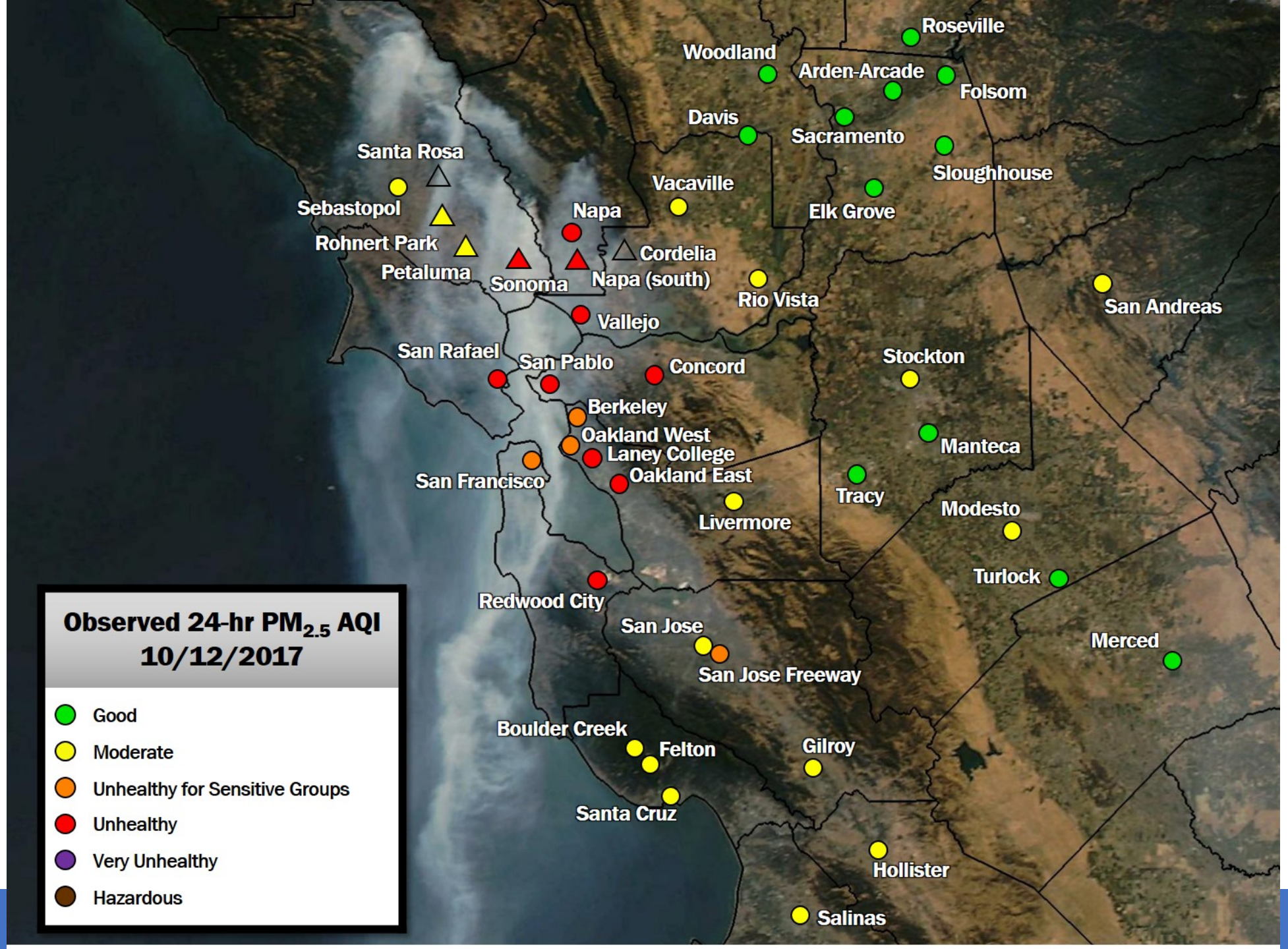
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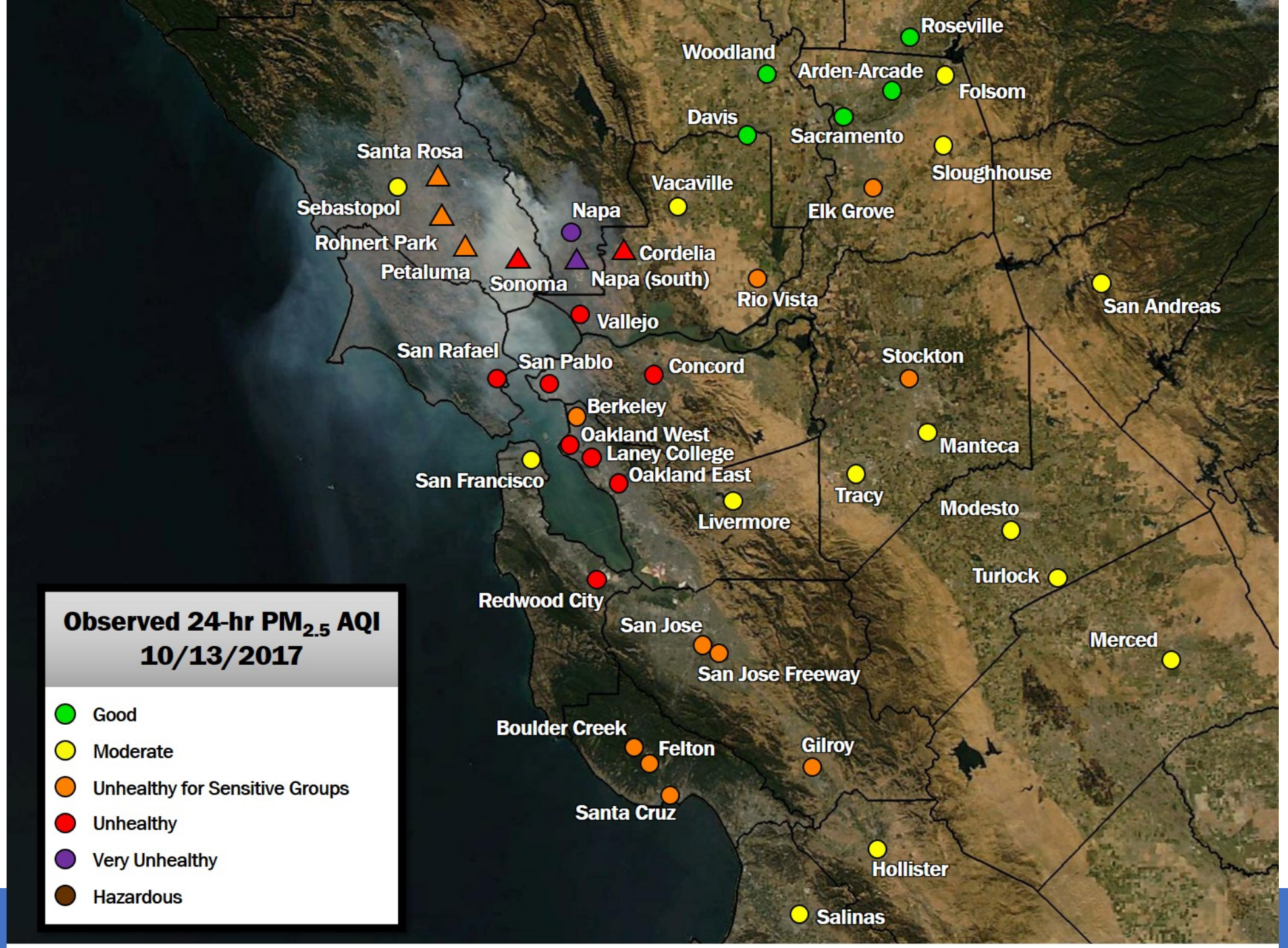
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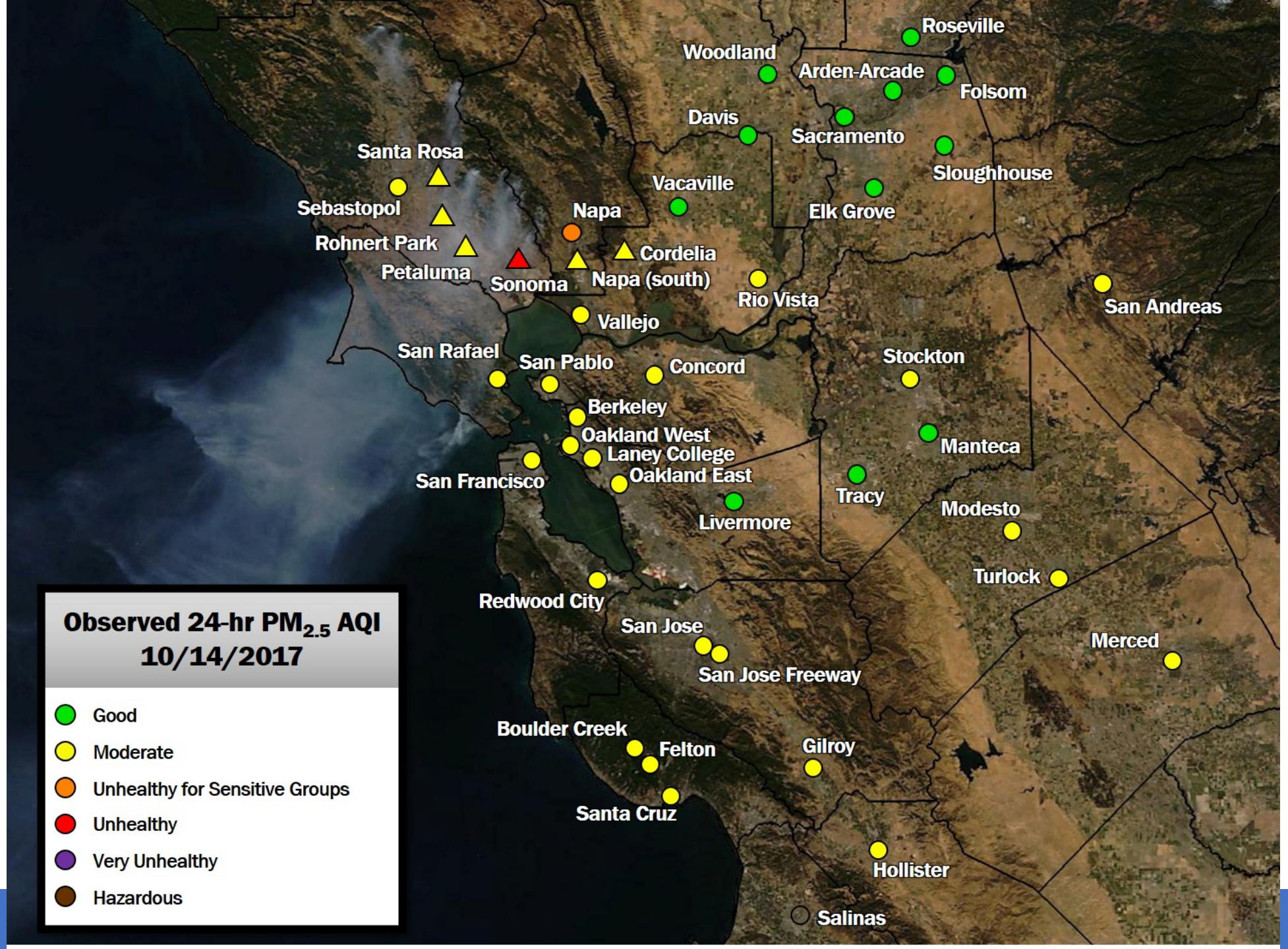
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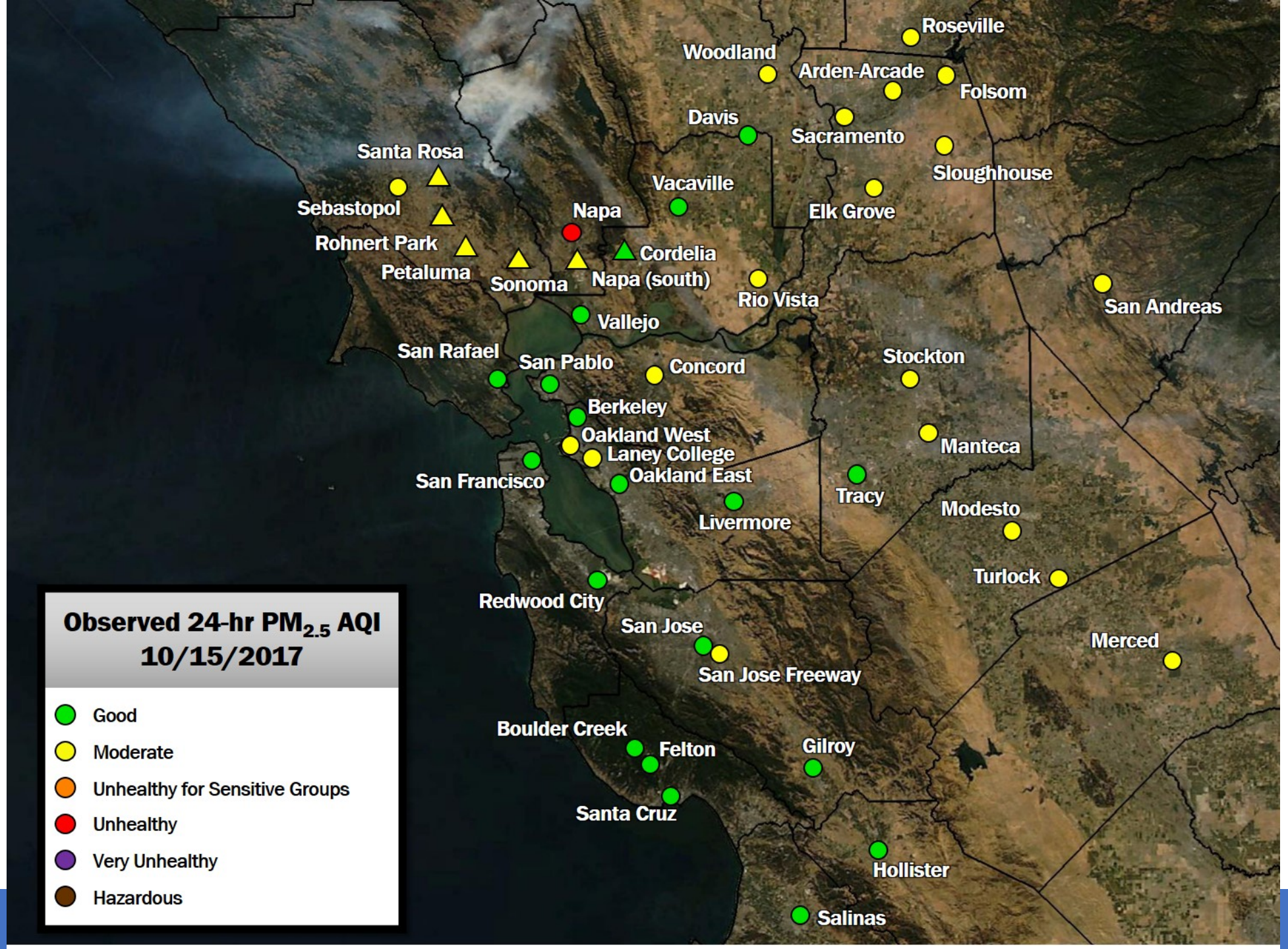
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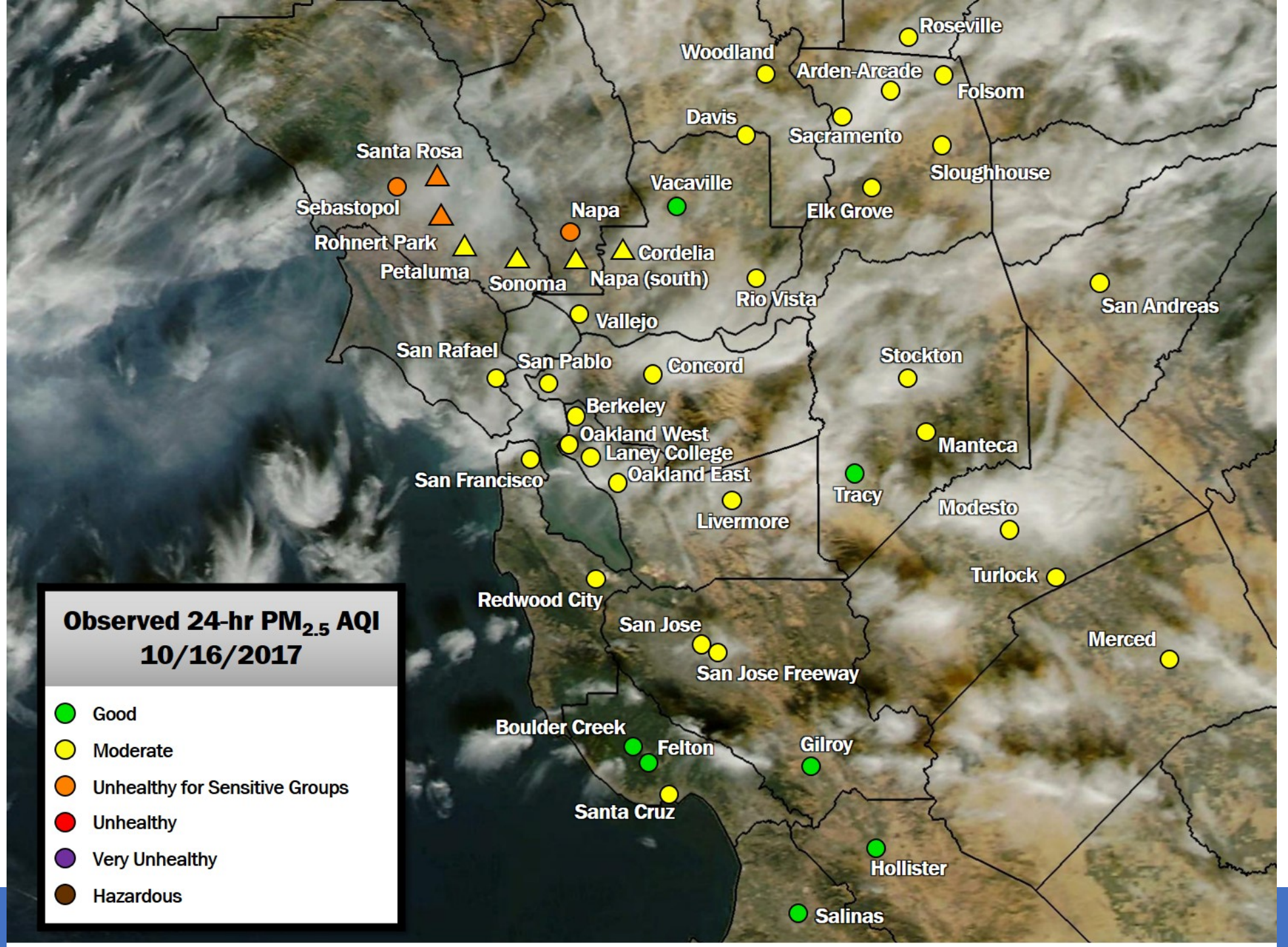
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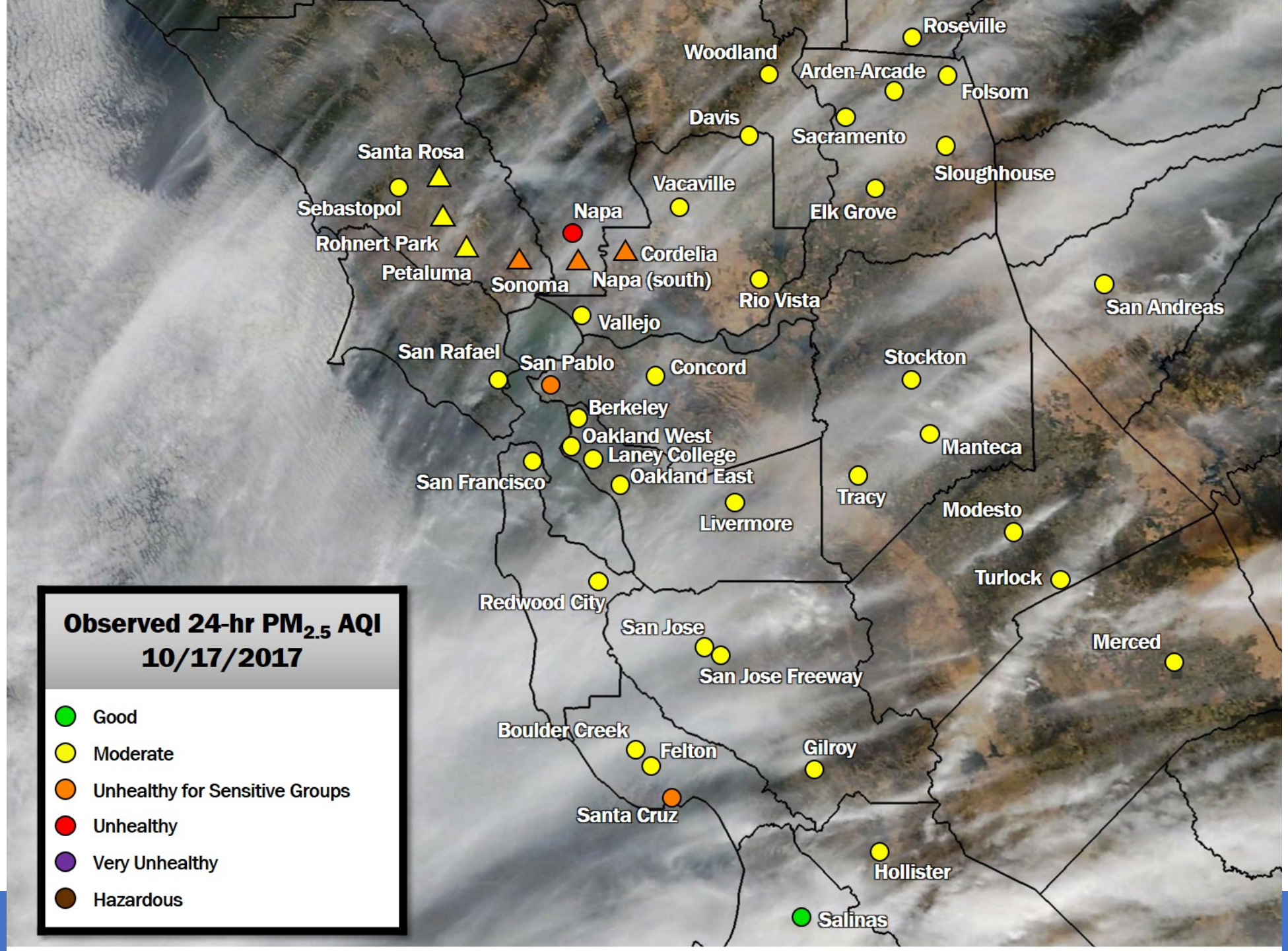
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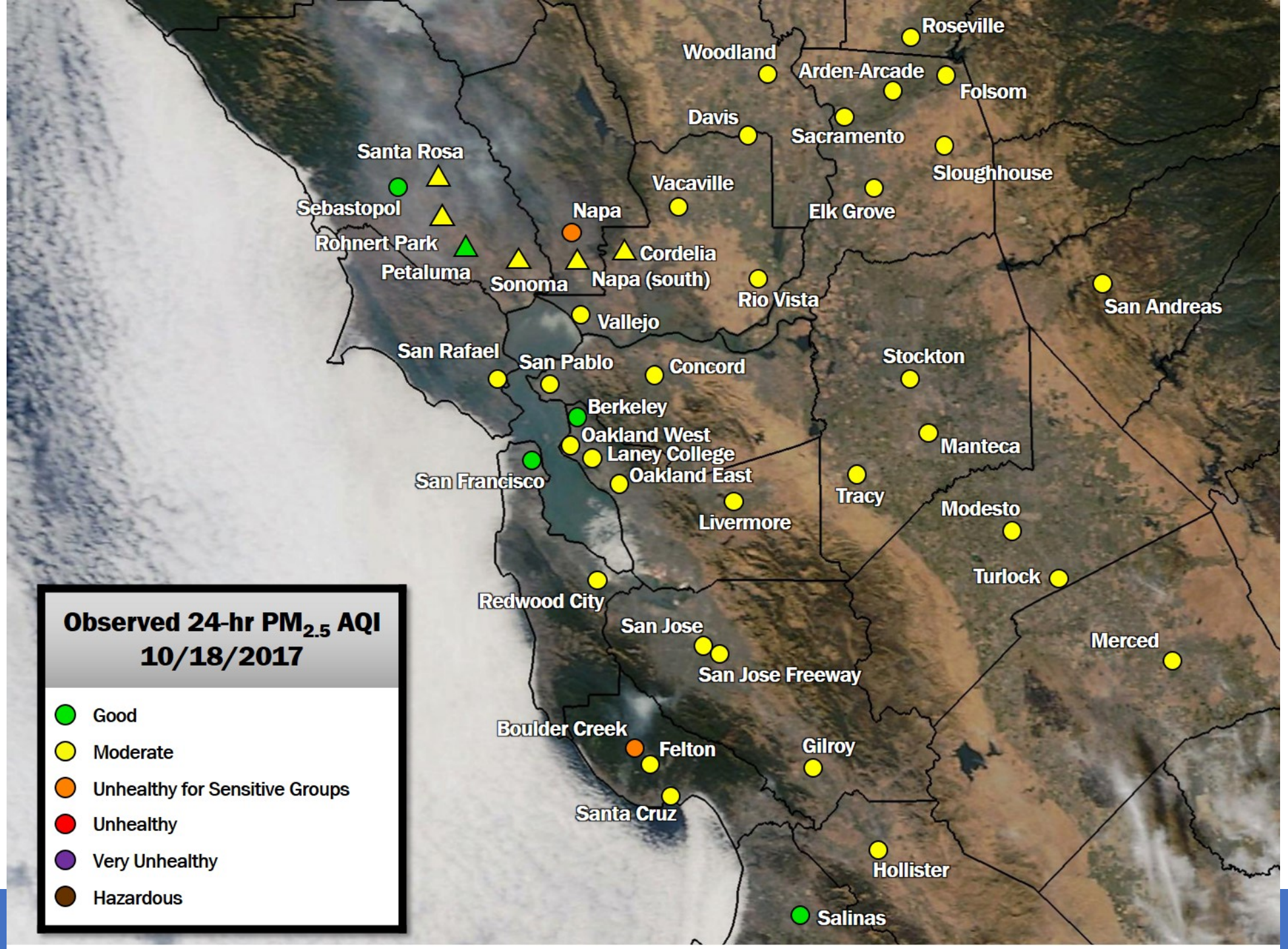
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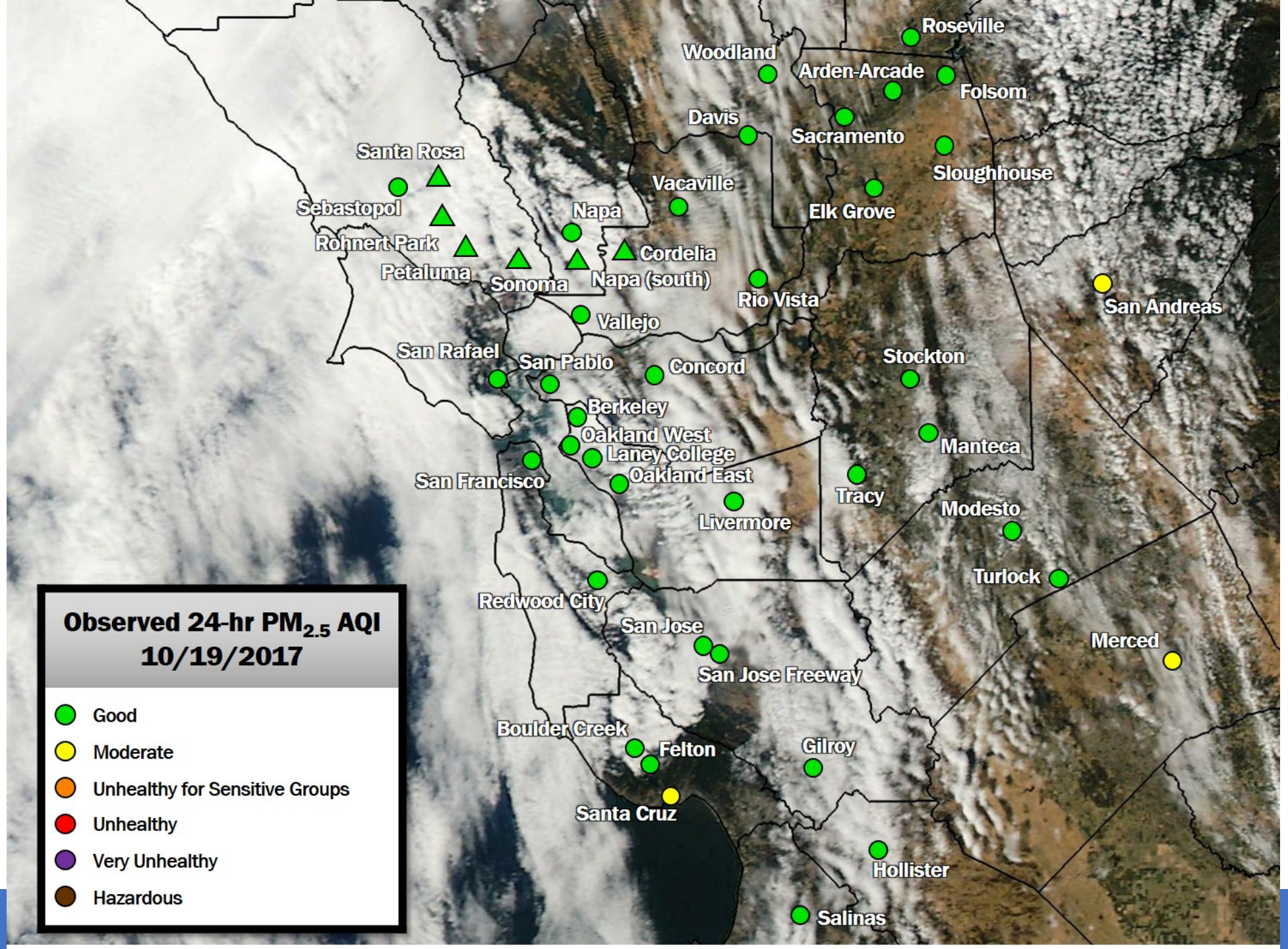
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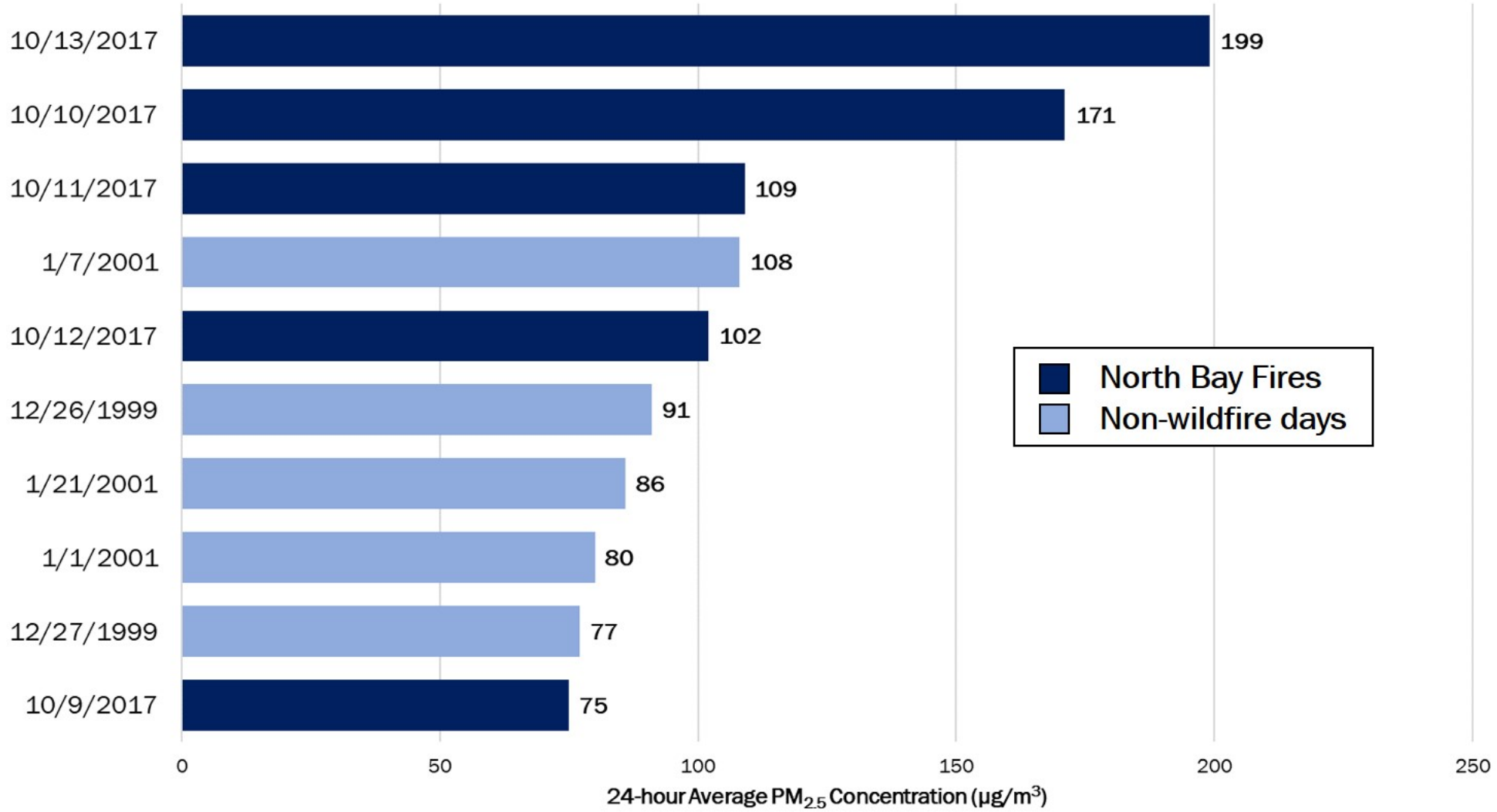
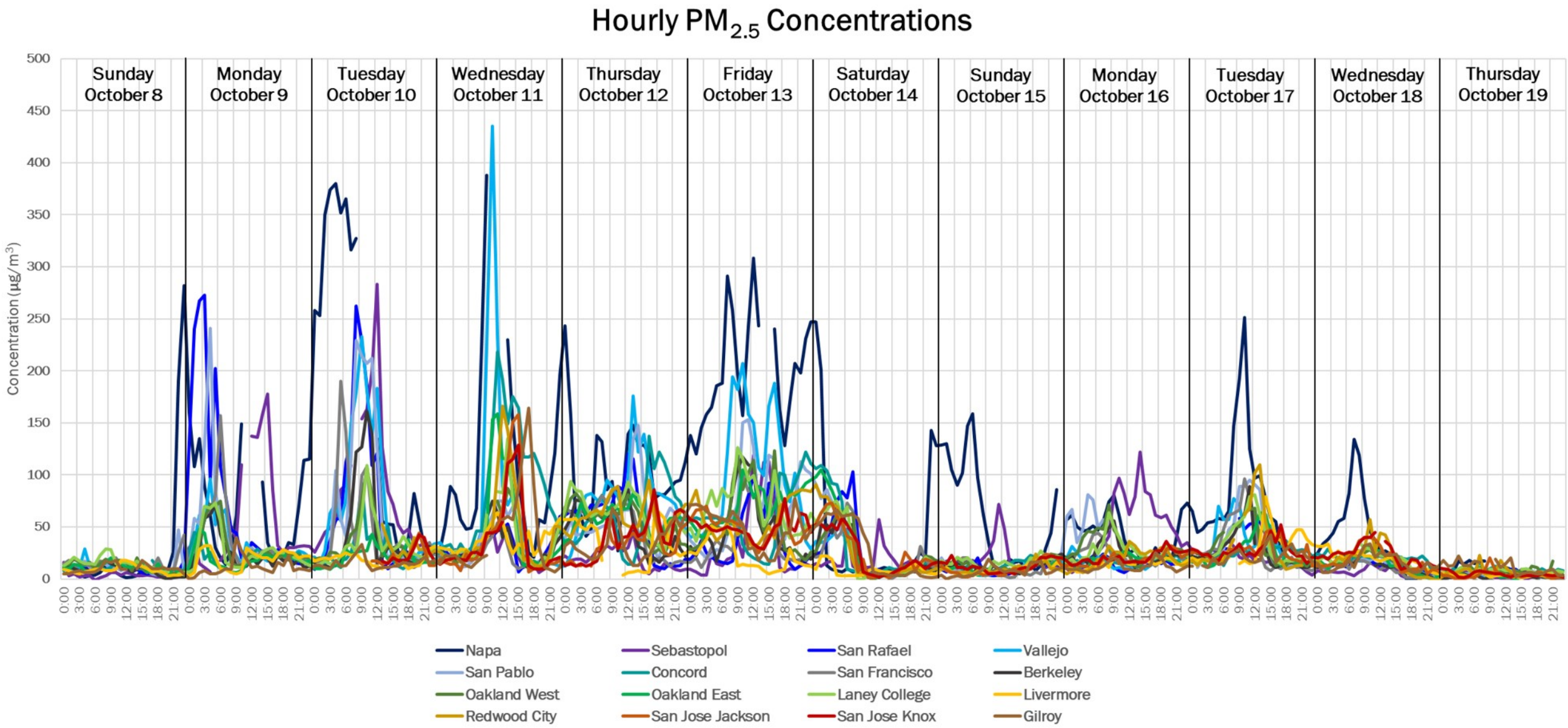
Top Ten $PM_{2.5}$ Days in the Bay Area since 1999



Five of the top ten $PM_{2.5}$ days were related to the North Bay Fires



Substantial variability in hourly concentrations over time and distance (cool colors farther north, warm colors farther south)

Air District Response

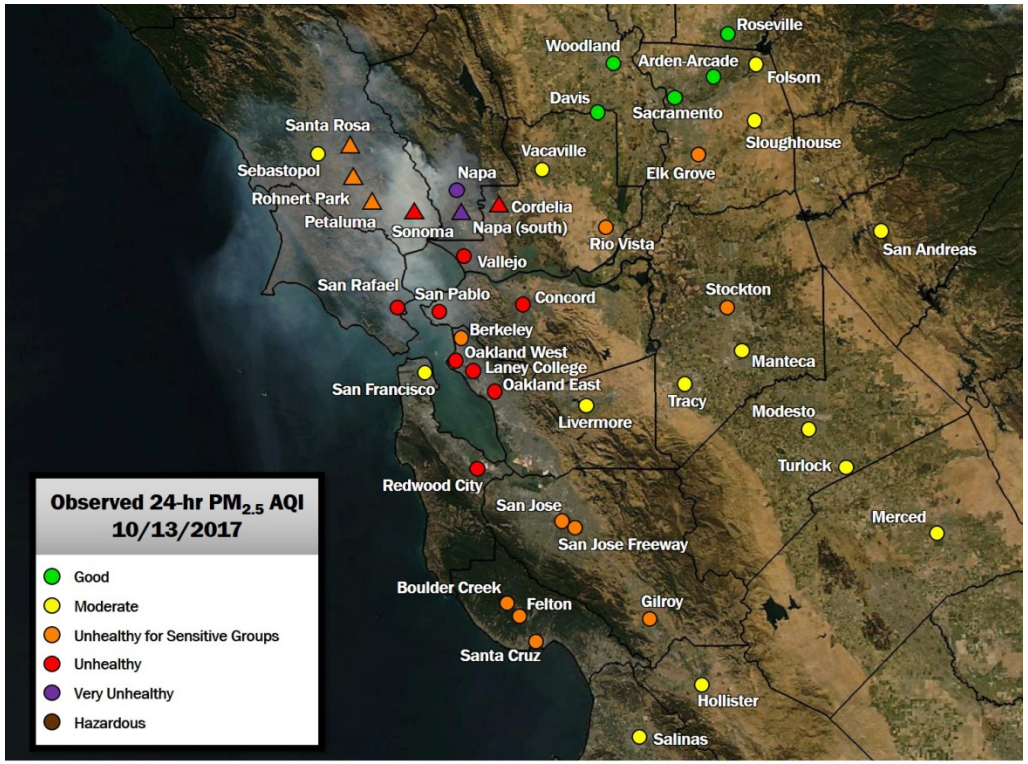
- Focused on Air District expertise
- Developed brief, active talking points
- Responded to hundreds of local/national media & public information requests
- Provided frequent air quality updates for schools with outdoor activities and major sporting events
- Social media helped move messages out to a larger population
- Distributed 40,000 N95 masks to affected communities (masks were sourced from outside the Air District)
- Multiple Air District teams (Meteorology, Monitoring, Communications, Compliance and Enforcement, Health Officer) worked closely together on short deadlines

Air District Response

- With highly-variable smoke conditions, the Air District pointed concerned residents and event organizers to current AQI readings (using the $PM_{2.5}$ NowCast method)
  - Air District website
  - Air District content created for social media
  - AirNow & AirNow wildfire page
- Daily average $PM_{2.5}$ forecasts and AQI values do not reflect the rapidly-changing conditions during wildfire smoke events
- Air District provided as much data as possible to stakeholders but did not make the final call on whether to cancel outdoor events
- Decision was also made to call Spare The Air Days (typically reserved for ozone during the summer) in addition to Smoke/Health Advisories

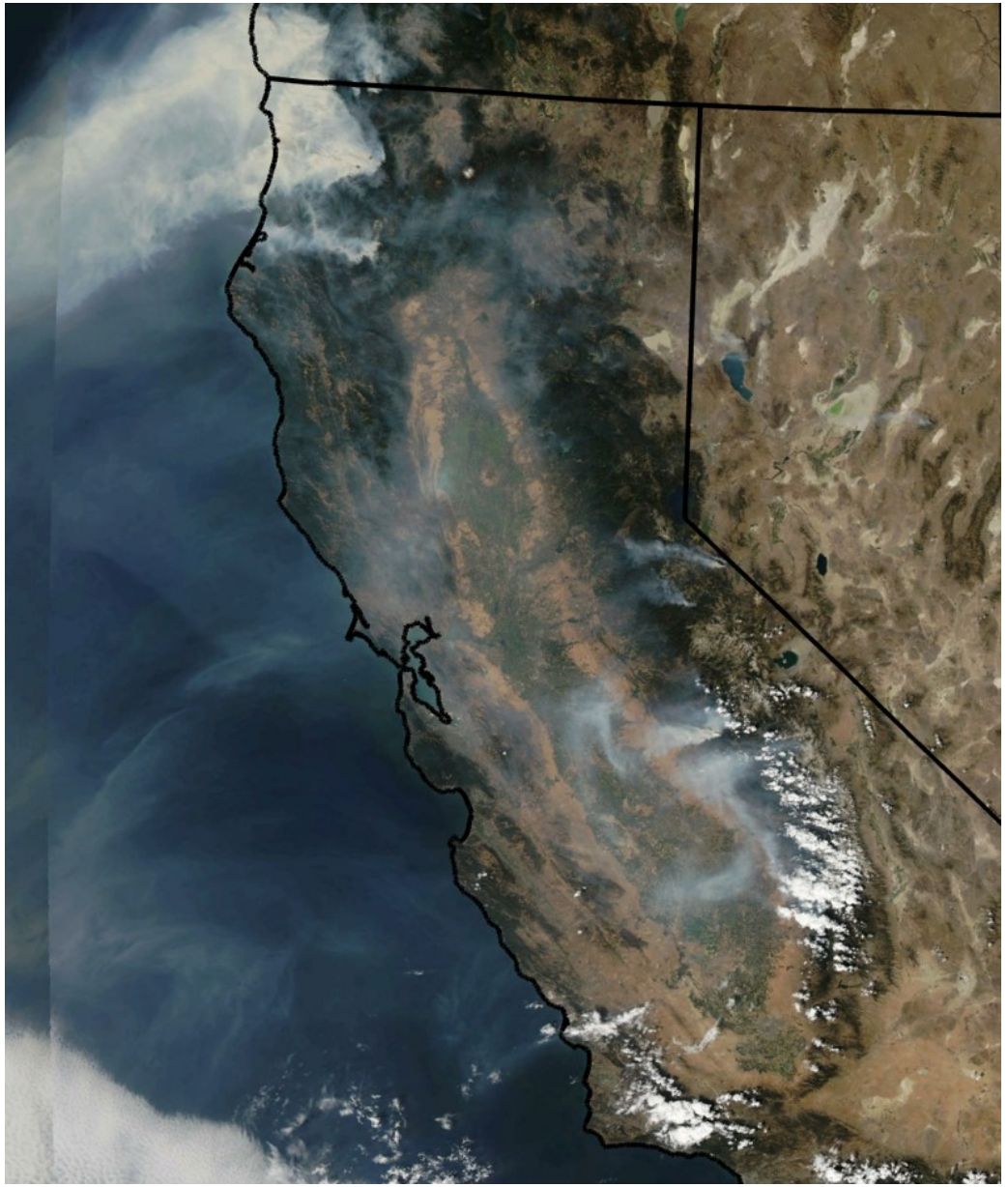
Northern Zone

Stations	Friday, October 13, 2017															
Hourly PST	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Napa	189		193	199	207	222	230	285	296	272	240	266	313	303	386	393
Napa - Napa Valley College	243			234	242	263	256	264	270	260	245	241	234	215	237	274
San Rafael	64		84	81	75	69	64	61	61	84	127	155	164	163	158	164
Sebastopol	38			27	59	58	55	60	65	85	77	128	165	163	171	176
Vallejo	123			125	132	133	150	168	195	212	235	222	211	191	182	195



AQ Episodes in 2017

- In addition to the North Bay fires, other episodes made 2017 a particularly challenging year for air quality in the Bay Area
- Labor Day weekend extreme heat and wildfire smoke
  - Numerous exceedances for $PM_{2.5}$ and ozone
  - Peak 8-hr ozone of 110 ppb
- Four additional $PM_{2.5}$ exceedance days during unusually dry December



MODIS satellite image – September 1, 2017

After the Fires

- Additional air monitoring continued in Santa Rosa as recovery/rebuilding efforts began
  - Concern over health impacts from disturbing ash & debris
  - Some mobile $PM_{2.5}$ monitors moved to school locations near burned debris
  - Asbestos and heavy metals monitoring in cleanup areas being conducted by the Army Corps of Engineers
- Internal and external meetings to recap fire & air quality response and discuss what worked and what should be improved for future incidents
  - Real-time data latency issues & website updates
- Collaborate with other Air Districts (particularly in southern California) where major fires occurred near urban areas

Bay Area Air Quality Management District