

**Exceptional Events Demonstration  
for 2021 PM<sub>2.5</sub> Wildfire Smoke  
Impacts**

***Yuba City-Marysville PM<sub>2.5</sub> Nonattainment Area***

**Feather River Air Quality Management District  
and  
California Air Resources Board**

**January 2023**



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## Acronyms

AMSL	Above Mean Sea Level
AOD	Aerosol Optical Depth
APCD	Air Pollution Control District
AQMD	Air Quality Management District
AQS ID	U.S. EPA Air Quality System Identification
BLM	Bureau of Land Management
CAA	Clean Air Act
CalFire	California Department of Forestry and Fire Protection
CARB	California Air Resources Board
CBSA	Census Core-based Statistical Area
CFR	Code of Federal Regulations
CMAQ	Community Multiscale Air Quality
CMAS	Community Modeling and Analysis System
CO	Carbon Monoxide
DV	Design Value
EER	Exceptional Events Rule
EKA	NWS Eureka Forecast Office
F	Fahrenheit
FCCS	Fuel Characteristic Classification System
FEMA	Federal Emergency Management Agency
FEPS	Fire Emissions Production Simulator
FR	Federal Register
FRAP	Fire <i>and</i> Resource Assessment Program
GIS	Geographic Information System
HMS	(NOAA) Hazard and Mapping System
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory
ISU	Iowa State University

M	meters
MB	millibars
MODIS	Moderate Resolution Imaging Spectroradiometer
MPH	miles per hour
MSA	Metropolitan Statistical Area
NAAPS	Navy Aerosol Analysis and Prediction System
NAAQS	National Ambient Air Quality Standard(s)
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NIFC	National Interagency Fire Center
NO	Nitrogen Oxide
NO <sub>2</sub>	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NO <sub>x</sub>	Oxides of Nitrogen
NPP	National Polar-orbiting Partnership
NPS	National Park Service
NWCC	Northwest Interagency Coordination Center
NWS	National Weather Service
O <sub>3</sub>	Ozone
PM	Particulate Matter
PM <sub>10</sub>	Particulate Matter less than or equal to 10 microns in aerodynamic diameter
PM <sub>2.5</sub>	Particulate Matter less than or equal to 2.5 microns in aerodynamic diameter
POC	Parameter Occurrence Code
ppm	parts per million
PQAO	Primary Quality Assurance Organization
PST	Pacific Standard Time
Q/D	Emissions divided by Distance
ROG	Reactive Organic Gas, used interchangeably with Volatile Organic Compound (VOC) in this report

SF2	SmartFire2
SIP	State Implementation Plan
SMOKE	Sparse Matrix Operator Kernel Emissions
SPECIATE	U.S. EPA repository of organic gas and particulate matter speciation emission source profiles
SSEC	Space Science and Engineering Center
STO	NWS Sacramento Forecast Office
UNC	University of North Carolina
U.S. EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
UTC	Coordinated Universal Time
UWM	University of Wisconsin, Madison
VOC	Volatile Organic Compound
WRCC	Western Regional Climate Center

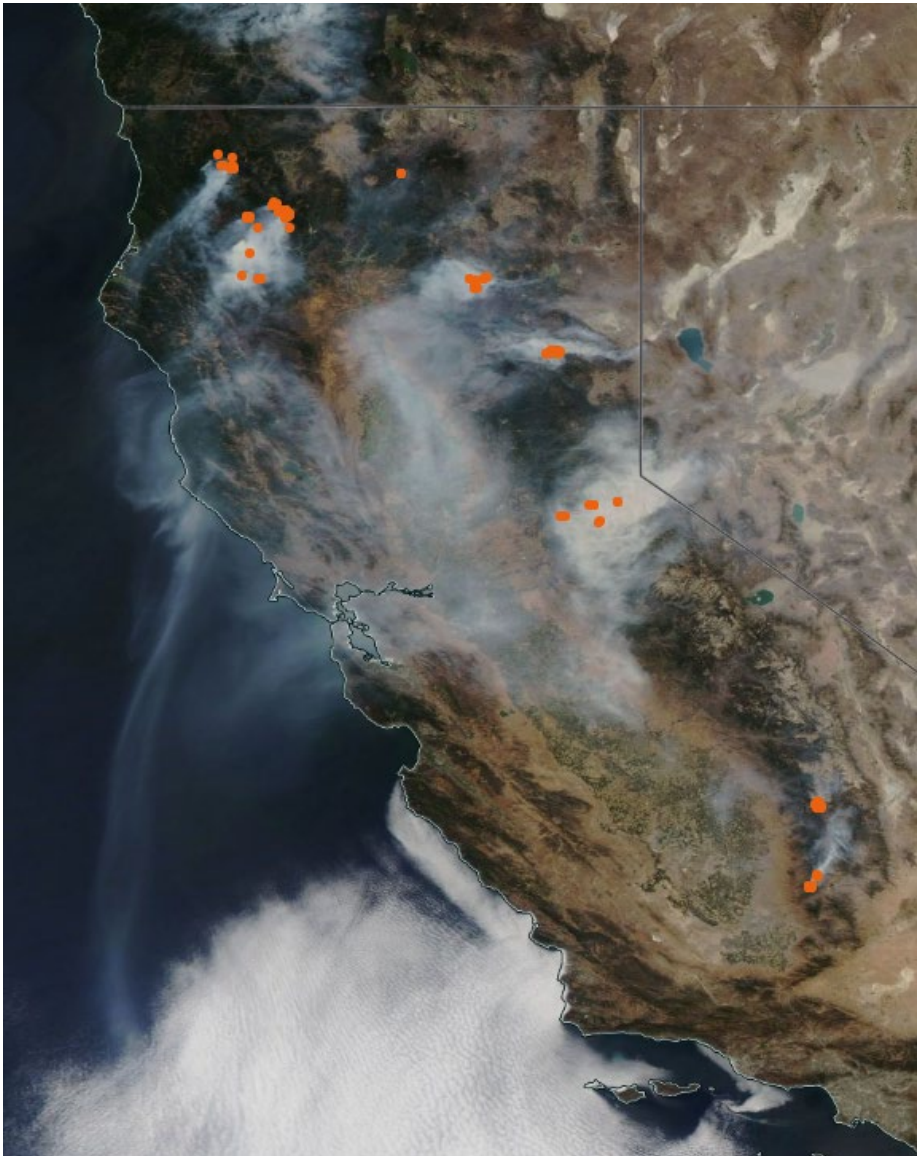




## Overview/Introduction

During the summer of 2021, extreme fuel conditions in California created yet another extreme fire season. Almost all of northern California was affected (Figure 1), with smoke and haze lingering for weeks. As expected, numerous monitoring sites recorded elevated particulate matter (PM) concentration levels, with many days above the National Ambient Air Quality Standards (NAAQS) for both PM<sub>2.5</sub> and PM<sub>10</sub>.

**Figure 1: NASA MODIS Aqua satellite image and fire/thermal anomalies - August 27, 2021<sup>1</sup>**



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<sup>1</sup> NASA EOSDIS Worldview, <https://worldview.earthdata.nasa.gov/>, last accessed 10/28/22

## I. NAAQS and Attainment Status

To protect public health and the environment, the U.S. Environmental Protection Agency (U.S. EPA) has set a NAAQS (or standard) for fine particulate matter (PM<sub>2.5</sub>) that specifies the maximum allowed concentration to be present in outdoor ambient air. The national PM<sub>2.5</sub> standards, first being set in 1997, have been periodically reviewed and revised, resulting in stricter and more health protective standards set at lower and lower concentrations. Areas determined not to meet these standards are considered nonattainment areas. An annual, as well as a 24-hour PM<sub>2.5</sub> standard were initially promulgated in 1997, and further revised as noted in Table 1. Due to its high population, urban density, and unique geography, California is home to a significant number of PM<sub>2.5</sub> nonattainment areas.

**Table 1: Primary PM<sub>2.5</sub> NAAQS**

Final Rule/Decision	Level (µg/m <sup>3</sup> – micrograms per cubic meter)
1997	Annual: 15.0 24-hour: 65
2006	Annual: 15.0 (retained) 24-hour: 35
2012	Annual: 12.0 24-hour: 35 (retained)

The Yuba City-Marysville area, comprising all of Sutter County and a portion of Yuba County, was designated as a nonattainment area for the 2006 PM<sub>2.5</sub> NAAQS. U.S. EPA approved a maintenance plan and request for redesignation to attainment effective January 8, 2015; a second maintenance plan is due January 8, 2023. The impacted site(s) and upcoming regulatory determination(s) are indicated in Table 2.

**Table 2: PM<sub>2.5</sub> nonattainment areas with upcoming regulatory determinations**

Nonattainment Area	PM <sub>2.5</sub> NAAQS	Classification	Regulatory Determination	Impacted Site	Site AQS ID
Yuba City-Marysville	2006	Maintenance	Attainment – 2 <sup>nd</sup> Maintenance Plan	Yuba City-Almond	06-101-0003

## II. Clean Air Act and Exceptional Event Rule Requirements

The Clean Air Act (CAA)<sup>2</sup> defines an exceptional event as:

1. The event affected air quality;
2. The event was not reasonably controllable or preventable;

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<sup>2</sup> CAA Section 319(b)

3. The event was caused by human activity that is unlikely to recur at a particular location or was a natural event; and
4. There exists a clear causal relationship between the specific event and the monitored exceedance.

On October 3, 2016, the EPA finalized revisions to the “Treatment of Data Influenced by Exceptional Events”,<sup>3</sup> also known as the Exceptional Events Rule (EER). These regulations govern exclusion of event-influenced air quality data from certain regulatory determinations of the U.S. EPA Administrator under the CAA Regulatory determinations applicable under the revised EER which are:

- An action to designate or redesignate an area as attainment, unclassifiable/attainment, nonattainment, or unclassifiable for a particular NAAQS;
- The assignment or re-assignment of a classification category to a nonattainment area;
- A determination regarding whether a nonattainment area has attained a NAAQS by its CAA deadline, including a “clean data determination”;
- A determination that an area has data for the specific NAAQS that qualify the area for an attainment date extension under the CAA provisions;
- A finding of SIP inadequacy leading to a SIP call; and
- Other actions on a case-by-case basis.

U.S. EPA regulations<sup>4</sup> state that exceptional events demonstrations must address and include the following elements:

1. A narrative conceptual model;
2. A demonstration that the event was both not reasonably controllable and not reasonably preventable;
3. A demonstration that the event was a human activity unlikely to recur at a particular location or was a natural event; and
4. A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance.

### **III. Actions Requested**

Although a significant number of PM<sub>2.5</sub> nonattainment areas were impacted by the 2021 wildfires, not all areas have upcoming regulatory determinations applicable under the revised EER. The Feather River Air Quality Management District (FRAQMD or District) and California Air Resources Board (CARB) are submitting this Exceptional Event demonstration to U.S. EPA for days in the summer of 2021 that impacted the PM<sub>2.5</sub> nonattainment area of Yuba City-Marysville (Sutter County and a portion of Yuba County). These days, along with impacted days in 2020 that are addressed in a separate demonstration, will affect the upcoming attainment year determination for the area’s 2<sup>nd</sup> PM<sub>2.5</sub> maintenance plan for the 2006 NAAQS

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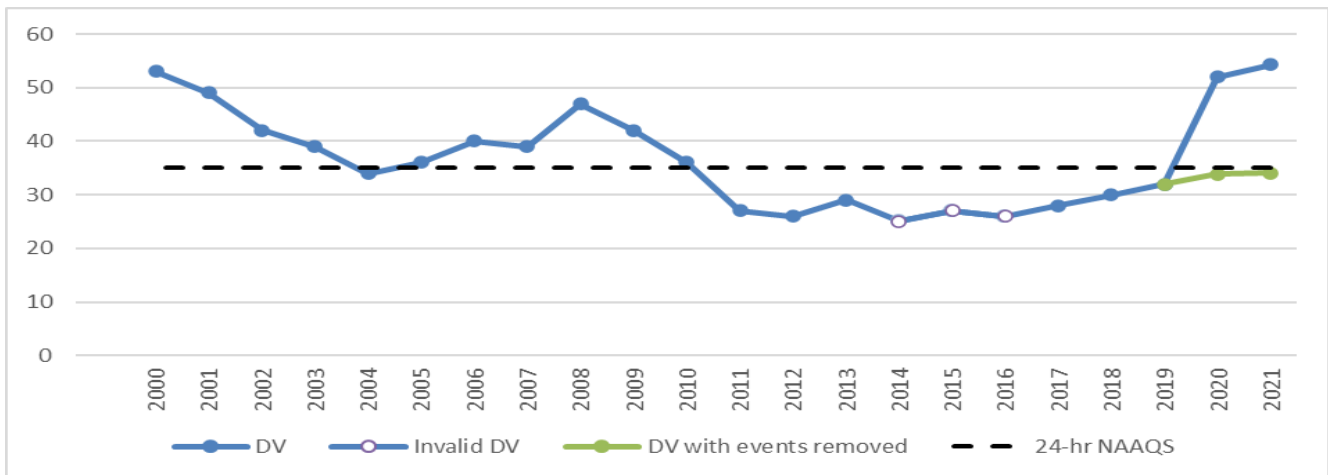
<sup>3</sup> 81 FR 68216

<sup>4</sup> 40 CFR 50.14(c)(3)(iv)

(Figure 2, Table 3). Not all impacted days are being requested for exclusion; only those that will bring the area’s design value below the NAAQS.

Note that design values for 2014 to 2016 are considered invalid due to incomplete 2014 data. U.S. EPA regulations require at least 75 percent data capture in each quarter for a design value to be valid. In 2014, the third quarter (July to September) had 70 percent data capture but since concentrations are typically low during this period, the resulting invalid 24-hour design values are still considered representative and are used here to depict PM<sub>2.5</sub> trends. The specific 2021 exceedances of the standard requested for concurrence at the Yuba City (Sutter County) monitor are listed in Table 4.

**Figure 2: PM<sub>2.5</sub> design values at Yuba City**



**Table 3: PM<sub>2.5</sub> design values with and without U.S. EPA concurrence (2020 and 2021 events)**

a) Design Value Without Concurrence

Site	2019	2020	2021
Yuba City-Almond	32.0	52.0	54.3

b) Design Value With Concurrence

Site	2019	2020	2021
Yuba City-Almond	32.0	33.8	34.1

**Table 4: Summary of Yuba City 2021 PM<sub>2.5</sub> exceedances requested for exclusion**

Date	PM <sub>2.5</sub> Concentration (µg/m³)
8/27/2021	49.22
8/28/2021	82.5
8/29/2021	70.9

# Background

California is divided geographically into air basins to manage the air resources of the State on a regional basis. An air basin generally has similar meteorological and geographic conditions throughout. The State is currently divided into 15 air basins and is further subdivided into 35 local air pollution control districts (APCD(s) or district(s)) or air quality management districts (AQMD(s) or district(s)).

## I. Regional Description

This demonstration covers the Yuba City-Marysville PM<sub>2.5</sub> nonattainment area in the Feather River Air Quality Management District (FRAQMD or District) in the Sacramento Valley Air Basin (SVAB).

The SVAB is bounded on the north and west by the Coastal Mountain Range, on the east by the southern portion of the Cascade Mountain Range, and the northern portion of the Sierra Nevada Mountains. These mountain ranges reach heights in excess of 6,000 feet above mean sea level, with individual peaks rising much higher. The mountains provide a substantial barrier to both locally created pollution and the pollution that has been transported northward on prevailing winds. The air basin is shaped like an elongated bowl.

The FRAQMD includes both Sutter and Yuba counties and is located in the eastern central portion of the SVAB. The FRAQMD is bordered by Butte County to the north, Colusa and Yolo Counties to the west, and Sacramento and a portion of Placer County to the south, all in the SVAB. The FRAQMD is bordered to the east by the Mountain Counties Air Basin, specifically Sierra and Nevada Counties (Figure 3).

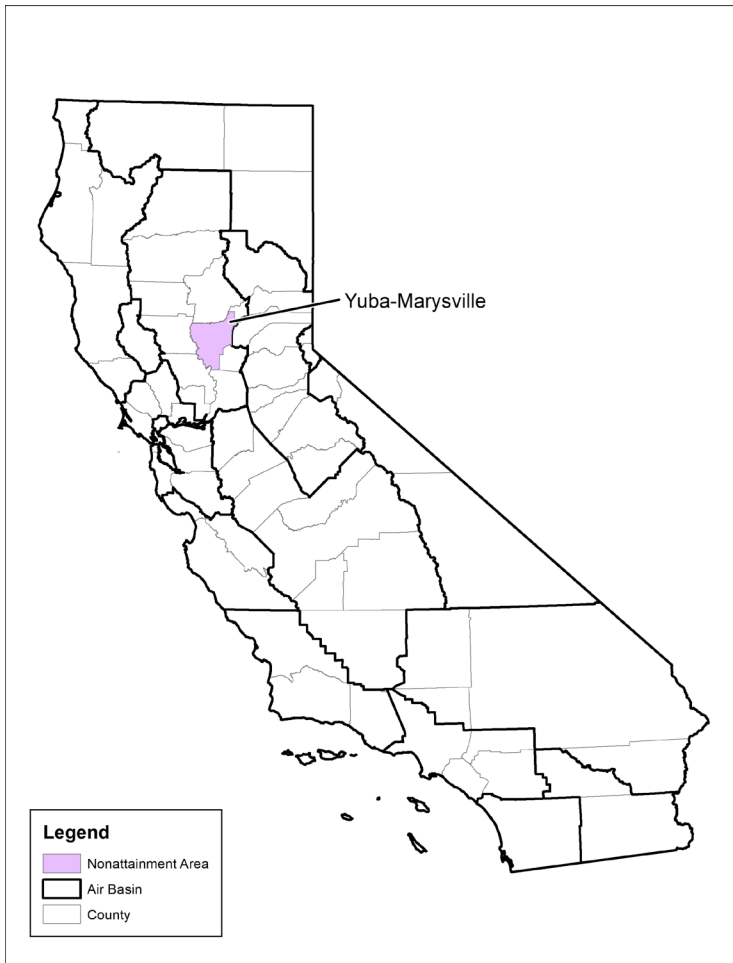
Although part of the FRAQMD is at elevations higher than 1,000 feet above sea level, the vast majority of its populace lives and works below that elevation. The four incorporated cities of Marysville (population just over 12,000), Wheatland (population just above 3,000), Yuba City (population approximately 65,000), and Live Oak (population of about 8,000) are located on the valley floor between 59-92 foot elevations and are located in the nonattainment area.

Summers are typically dry and warm. Most of the precipitation occurs during the winter months from December to March with an average rainfall of 21 inches. Average summer temperatures range from an average high of 93°F to an average low of 60°F. Average winter temperatures range from an average high of 57°F to an average low of 39°F<sup>5</sup>.

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<sup>5</sup> Climate data obtained from <https://wrcc.dri.edu/> covering 1981-2010 measurements from the Marysville station.

**Figure 3: Map of PM<sub>2.5</sub> nonattainment areas with exceptional events addressed in this document**



The Yuba City PM<sub>2.5</sub> monitor was established in December 1998 and is located at 773 Almond Street in Yuba City, in Sutter County. The Yuba City monitor was placed to detect pollutant at neighborhood levels. The filter-based monitor was replaced with a continuous monitor in April 2020 and has served as a collocated FEM/FEM monitoring site since April 2021.

U.S. EPA designated the Yuba City-Marysville area as a nonattainment area for the 2006 24-hour PM<sub>2.5</sub> standard. It was redesignated as attainment effective January 2015.

## **II. Overview of Monitoring Network**

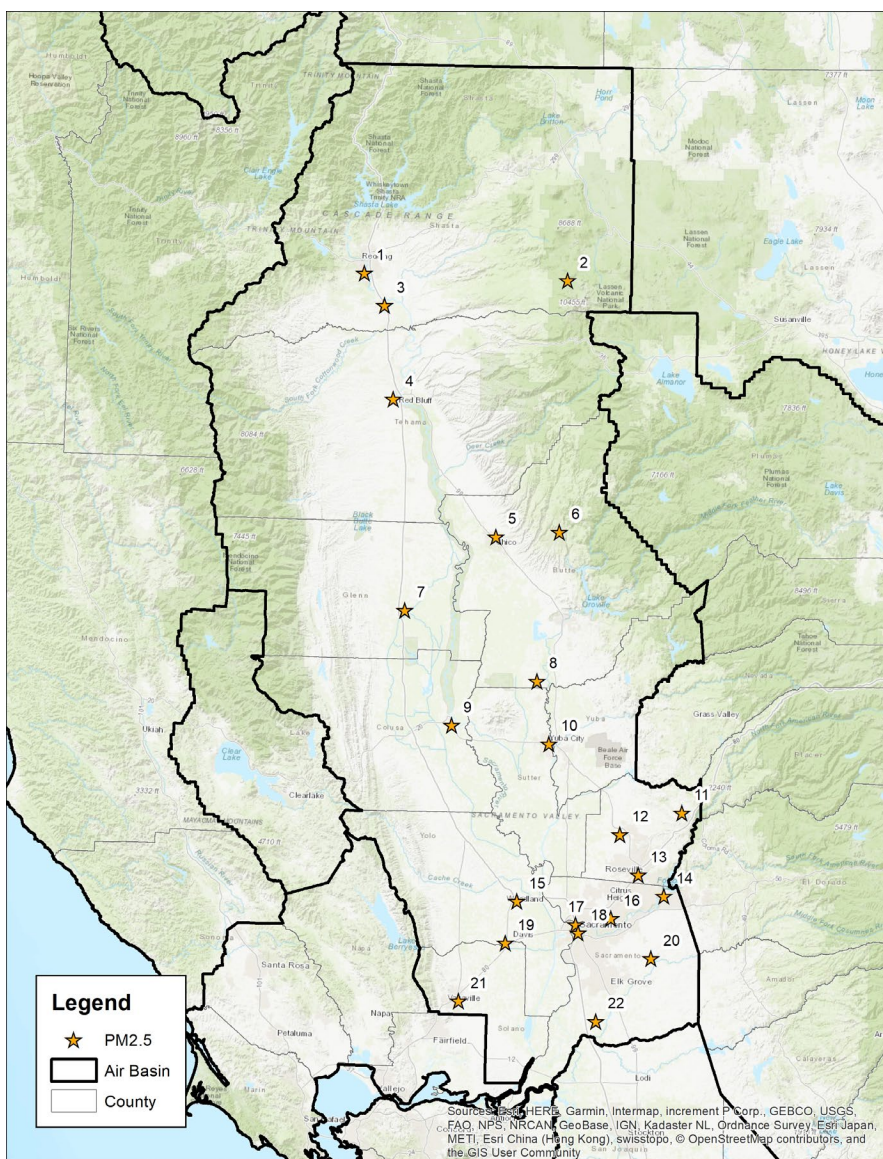
The CARB Primary Quality Assurance Organization (PQAO) is comprised of 32 of the 35 air districts in California. The three remaining districts, the Bay Area Air Quality Management District, San Diego County Air Pollution Control District, and South Coast AQMD, represent their own PQAOs.



California’s ambient air monitoring network includes over 250 sites and more than 700 monitors, making it one of the most extensive in the world. Many regions in California are characterized by complex terrain, variable meteorological conditions, and diverse emission sources. A large monitoring network is critical for assessing the State’s progress in meeting clean air objectives, understanding spatial and temporal variation in air pollutants, and evaluating pollutant exposure. Monitors are operated by CARB, local air districts, and other entities including the National Park Service, private contractors, and tribal authorities.

In the SVAB, there is one nonattainment area covered by this demonstration. The Yuba City-Marysville area in the Feather River AQMD has one PM<sub>2.5</sub> regulatory monitor (Number 10 in Figure 4 and Table 5).

**Figure 4: PM<sub>2.5</sub> monitoring in Sacramento Valley Air Basin**



**Table 5: PM<sub>2.5</sub> Monitoring sites in Sacramento Valley Air Basin**

Number	Monitoring Site	AQS ID
1	Redding-Health Dept	06-089-0004
2	Lassen Volcanic Natl Park-Manzanita Lake	06-089-3003
3	Anderson-North St	06-089-0007
4	Red Bluff-Walnut St	06-103-0006
5	Chico-East Ave	06-007-0008
6	Paradise-Theater	06-007-2002
7	Willows-N Colusa St	06-021-0003
8	Gridley-Cowee Ave	06-007-4001
9	Colusa-Sunrise Blvd	06-011-1002
10	Yuba City-Almond St	06-101-0003
11	Auburn-Atwood Ave	06-061-0003
12	Lincoln-Moore Rd	06-061-2003
13	Roseville-N Sunrise Blvd	06-061-0006
14	Folsom-Natoma St	06-067-0012
15	Woodland-Gibson Rd	06-113-1003
16	Sacramento-Del Paso Manor	06-067-0006
17	Sacramento-Bercut Dr	06-067-0015
18	Sacramento-T St	06-067-0010
19	Davis-UCD Campus	06-113-0004
20	Sloughhouse	06-067-5003
21	Vacaville-Ulatis Dr	06-095-3003
22	Elk Grove-Bruceville Rd	06-067-0011

The ambient air monitoring networks in this area meets the minimum monitoring requirements for all criteria pollutants pursuant to Title 40, Part 58 of the Code of Federal Regulations (CFR), Appendix D. The monitoring network in each area is reviewed annually to fulfill the requirements defined in 40 CFR 58.10 to ensure the networks meet the monitoring objectives defined in 40 CFR 58, Appendix D. Data were collected and quality assured as per 40 CFR 58 and submitted to the Air Quality System (AQS).

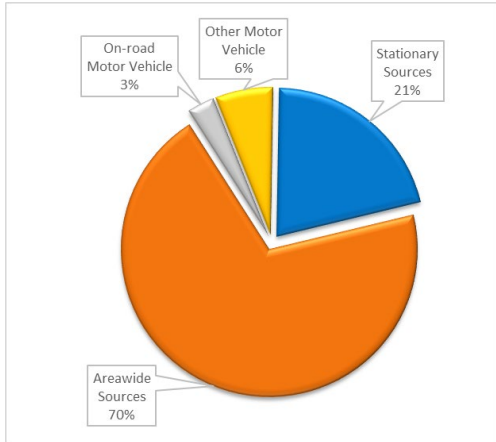
### **III. Characteristics of Non-Event PM<sub>2.5</sub> Formation**

The area-wide and stationary source categories are the largest sources of anthropogenic PM<sub>2.5</sub> emissions in Sutter County and Yuba County, respectively (Figure 5), with food and agricultural industrial processes, farming operations, and managed burning and disposal



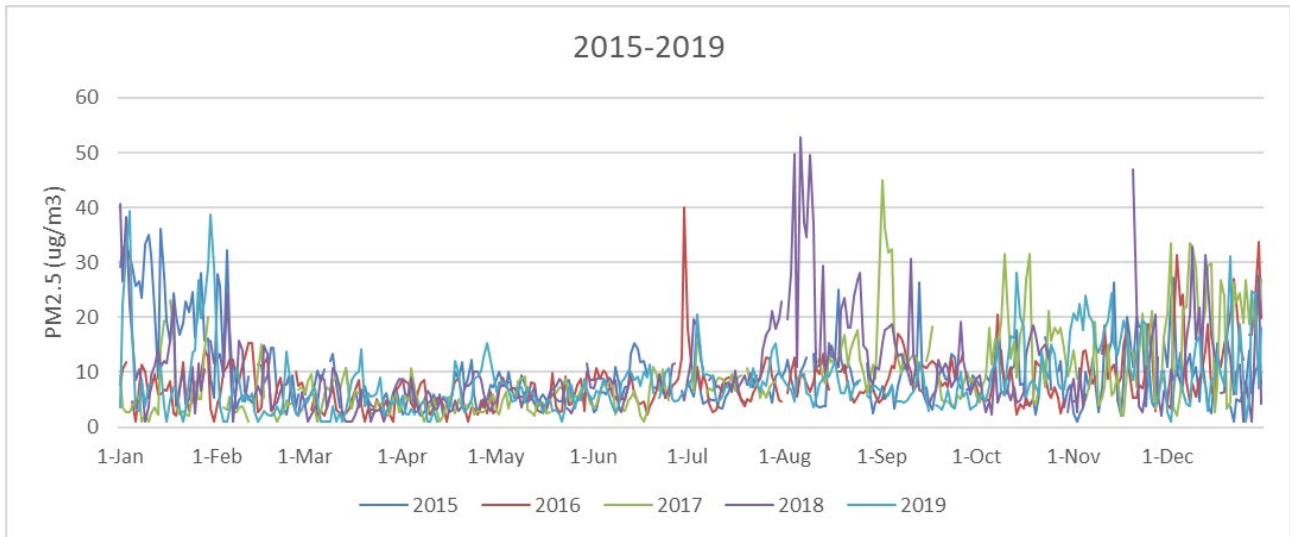
comprising the top three categories in the summer, with residential fuel consumption dominating in the winter months.

**Figure 5: Sutter County and Yuba County anthropogenic daily summer 2021 PM<sub>2.5</sub> emissions estimates.<sup>6</sup>**



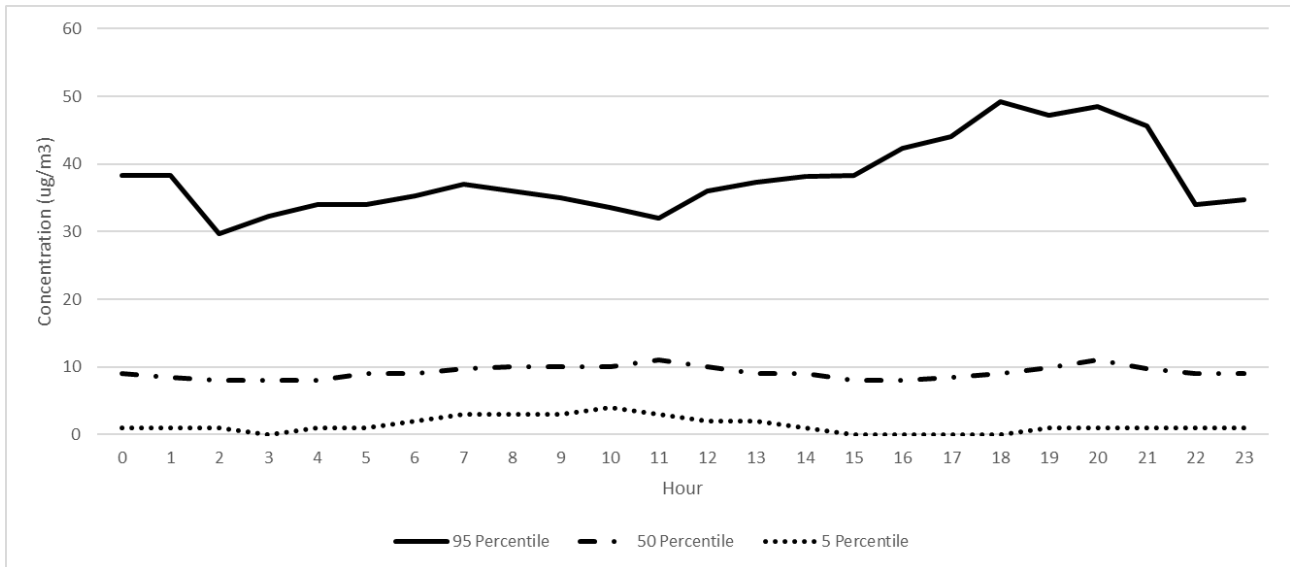
PM<sub>2.5</sub> concentrations are fairly low throughout the year (Figure 6), with the highest PM<sub>2.5</sub> values generally occurring in the winter months from November through February, when residential woodstove use is highest. Exceedances during the remainder of the year are due primarily to wildfire smoke. PM<sub>2.5</sub> concentrations from July to September at the Yuba City monitor typically peak in the late afternoon to early evening (Figure 7) and are lowest in the early morning and the late evening.

**Figure 6: Annual PM<sub>2.5</sub> concentrations at the Yuba City monitor from 2015 through 2019.**



<sup>6</sup> CEPAM: Version 1.03 Planning Inventory Tool.  
[http://outapp.arb.ca.gov/cefs/2019ozsip/fcemssumcat\\_2019sip103.php](http://outapp.arb.ca.gov/cefs/2019ozsip/fcemssumcat_2019sip103.php)

**Figure 7: Typical 3<sup>rd</sup> Quarter (July to September) PM<sub>2.5</sub> diurnal pattern at Yuba City (2015-2019)**



#### IV. Characteristics of Event PM<sub>2.5</sub> Formation

Although wildfires occur in California every year, the number of wildfires and the amount of acreage burned has increased substantially, from an annual average of less than 5,000 fires burning 200,000 acres,<sup>7</sup> to a record 8,648 incidents and 4,304,379 acres burned in 2020<sup>8</sup>, and 8,835 incidents and 2,568,948 acres in 2021.<sup>9</sup> The impact of these wildfires on air quality has been dramatic. Smoke from large fires has caused extreme concentrations of both PM and ozone, especially in the western United States.<sup>10</sup>

Wildfires generate large amounts of directly emitted PM<sub>2.5</sub>, which can contribute to elevated particulate levels in California. However, there are large variations in the amount of emissions (depending on the fuel type and combustion temperature), plume heights, smoke density, and meteorological conditions during different wildfires.

<sup>7</sup> CalFire, *2017 Statistics and Events (5 year average)*, last accessed 8/20/21

<sup>8</sup> California Department of Forestry and Fire Protection (CalFire); <https://www.fire.ca.gov/incidents/2020/>

<sup>9</sup> California Department of Forestry and Fire Protection (CalFire); <https://www.fire.ca.gov/incidents/2021/>

<sup>10</sup> Gong et al., 2017; Laing and Jaffe, 2019; Mass and Ovens, 2019; Jaffe et al., 2020

# Narrative Conceptual Model

The Narrative Conceptual Model describes the events causing the exceedances or violations at the monitor and includes a discussion of how the events led to concentrations above the NAAQS from August 27 to 29, 2021.

## I. Wildfire Information

Although not as extreme a fire season as 2020 in terms of acreage burned, 2021 had a few more incidents, with numerous wildfires active during the time of the exceedances discussed in this demonstration (Figure 8, Table 6), although not all the active wildfires impacted the monitor on any given day.

The flattening of the upper level ridge increased northerly winds and brought smoke from fires in northern California further south, impacting the Yuba City area. The accumulating smoke layers made identification of the impact of just one particular wildfire difficult. The majority of these fires occurred on wildland or in the urban/wildland interface. Although the McFarland, Salt, and Lava Fires are included on the map in Figure 8, they were primarily contained and not considered major sources of smoke during this three day event.

The individual fires that had the most impact on the Yuba City monitor are discussed in more detail in this section. Fire perimeters are overlaid on the Google Earth platform or the ArcMap platform if usable layers were unavailable for Google Earth.

**Table 6: Major wildfires active during 2021 events (in order of ignition)<sup>11</sup>**

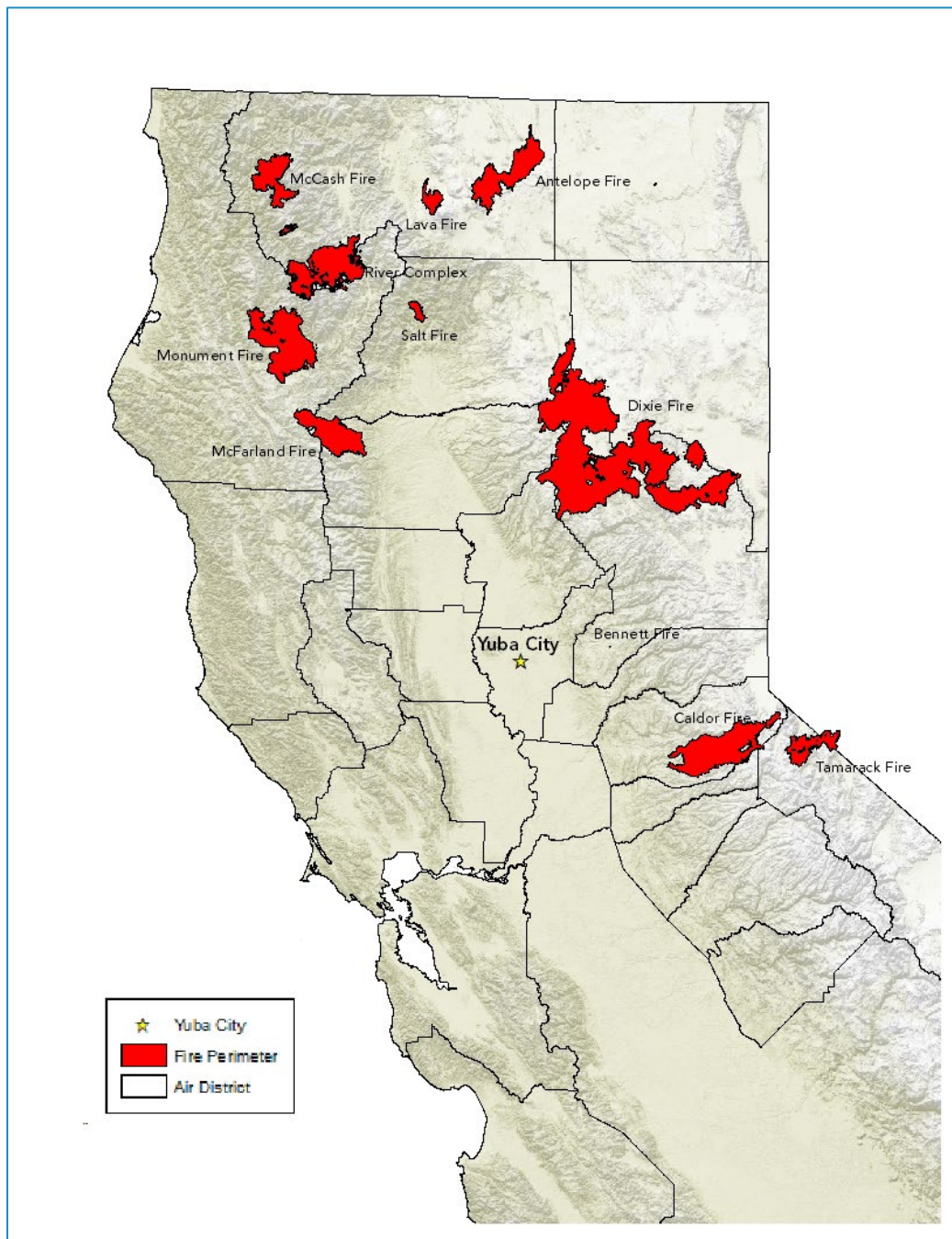
Name	Source	Start	Containment	Lat	Long	Acres
Tamarack Fire	Lightning	7/4/2021	10/26/2021	38.628	-119.859	68,637
Dixie Fire	UI	7/13/2021	10/25/2021	39.871	-121.389	963,309
Monument Fire	Lightning	7/30/2021	10/26/2021	40.752	-123.337	223,124
River Complex	Lightning	7/30/2021	10/26/2021	41.389	-123.057	199,359
Antelope Fire	Lightning	8/1/2021	10/15/2021	41.529	-121.916	145,632
Caldor Fire	UI	8/14/2021	10/21/2021	38.586	-120.538	221,835
McCash Fire	Lightning	8/18/2021	11/2/2021	41.564	-123.404	94,962
Bennett Fire	UI	8/25/2021	9/8/2021	39.217	-121.041	59

UI = Under Investigation

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<sup>11</sup>; CalFire 2021 Incident Archive, <https://www.fire.ca.gov/incidents/2021/>, last accessed 11/30/2022.

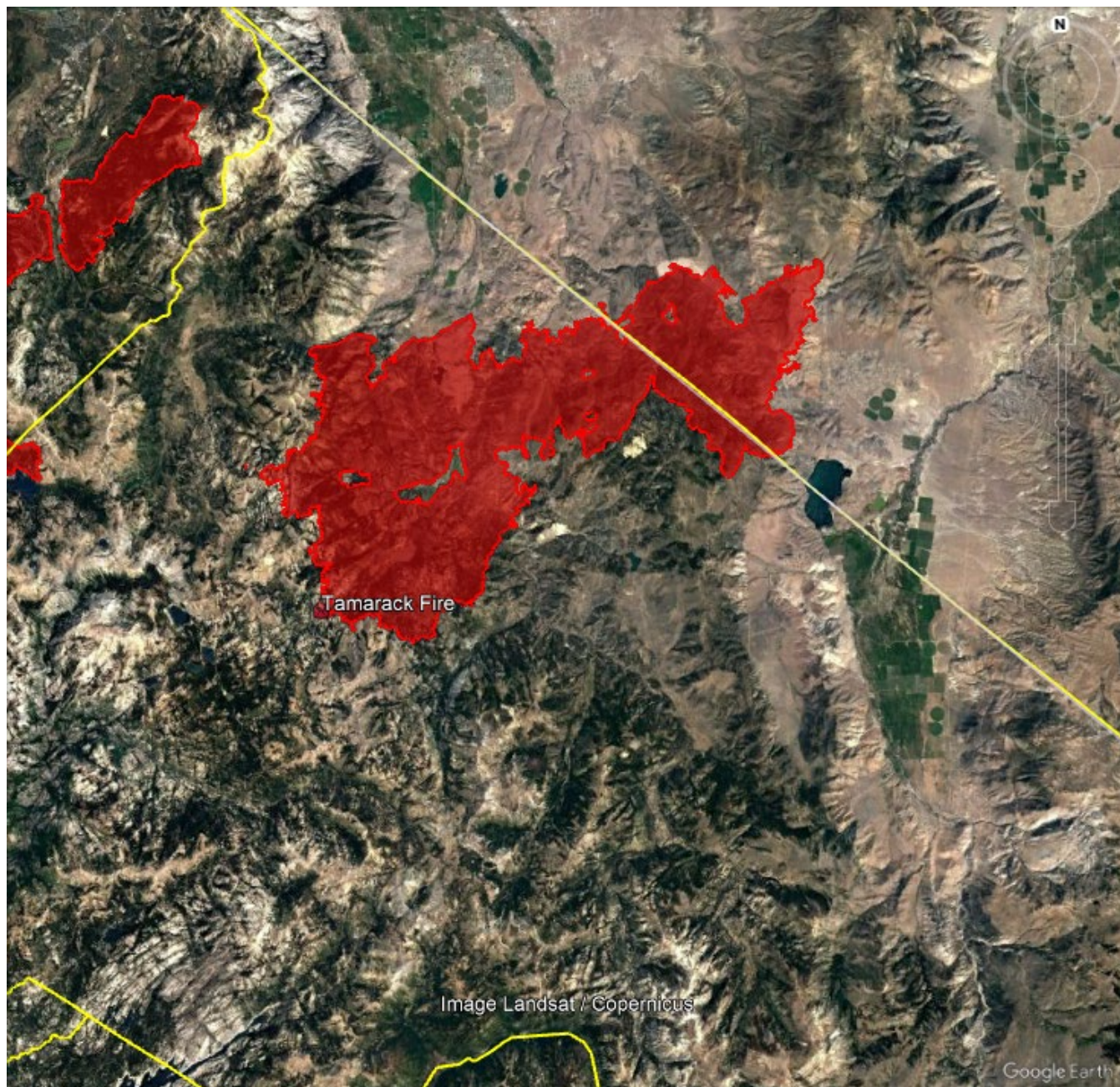
Figure 8: Active major wildfires, July to October 2021





The Tamarack Fire<sup>12</sup> (Figure 9), located 100 miles east-northeast of Yuba City, started with a lightning storm on July 4 in Alpine County in the Humboldt-Toiyabe National Forest. The fire burned 68,637 acres before being officially contained on October 26, 2021.

**Figure 9: Tamarack Fire Perimeter Map**



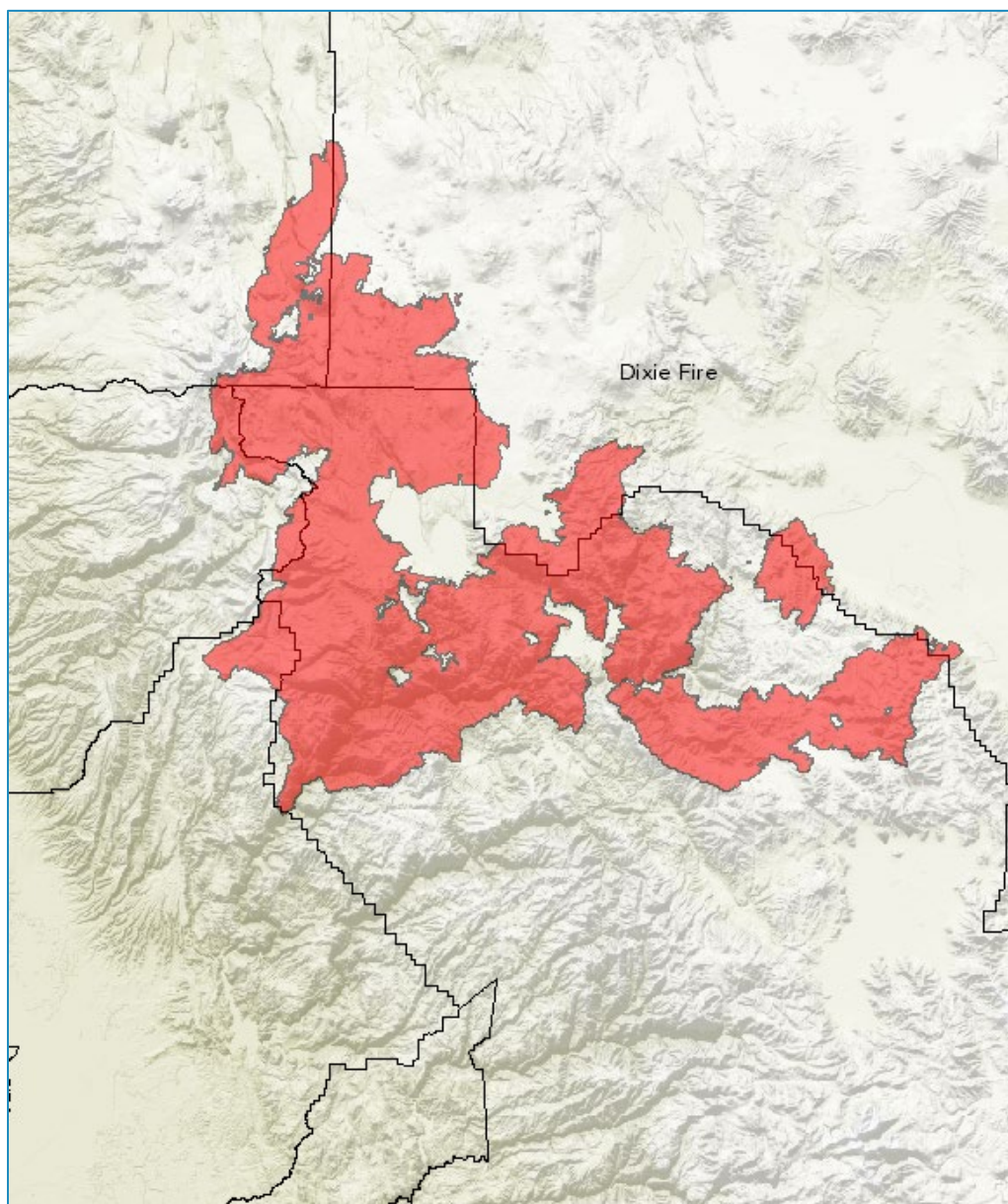
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<sup>12</sup> Tamarack Fire: <https://www.fire.ca.gov/incidents/2021/7/4/tamarack-fire/>



The Dixie Fire<sup>13</sup> (Figure 10), located 50-90 miles northeast of Yuba City, started with a lightning storm on July 11 in the Lassen National Forest. The fire, of undetermined origin, burned in Butte, Lassen, Plumas, Shasta, and Tehama Counties. The fire burned 963,309 acres, destroyed 1,329 structures and damaged 95 others and resulted in one death. The fire was being officially contained on October 25, 2021, and at the time was the second largest in California history.

**Figure 10: Dixie Fire Perimeter Map**

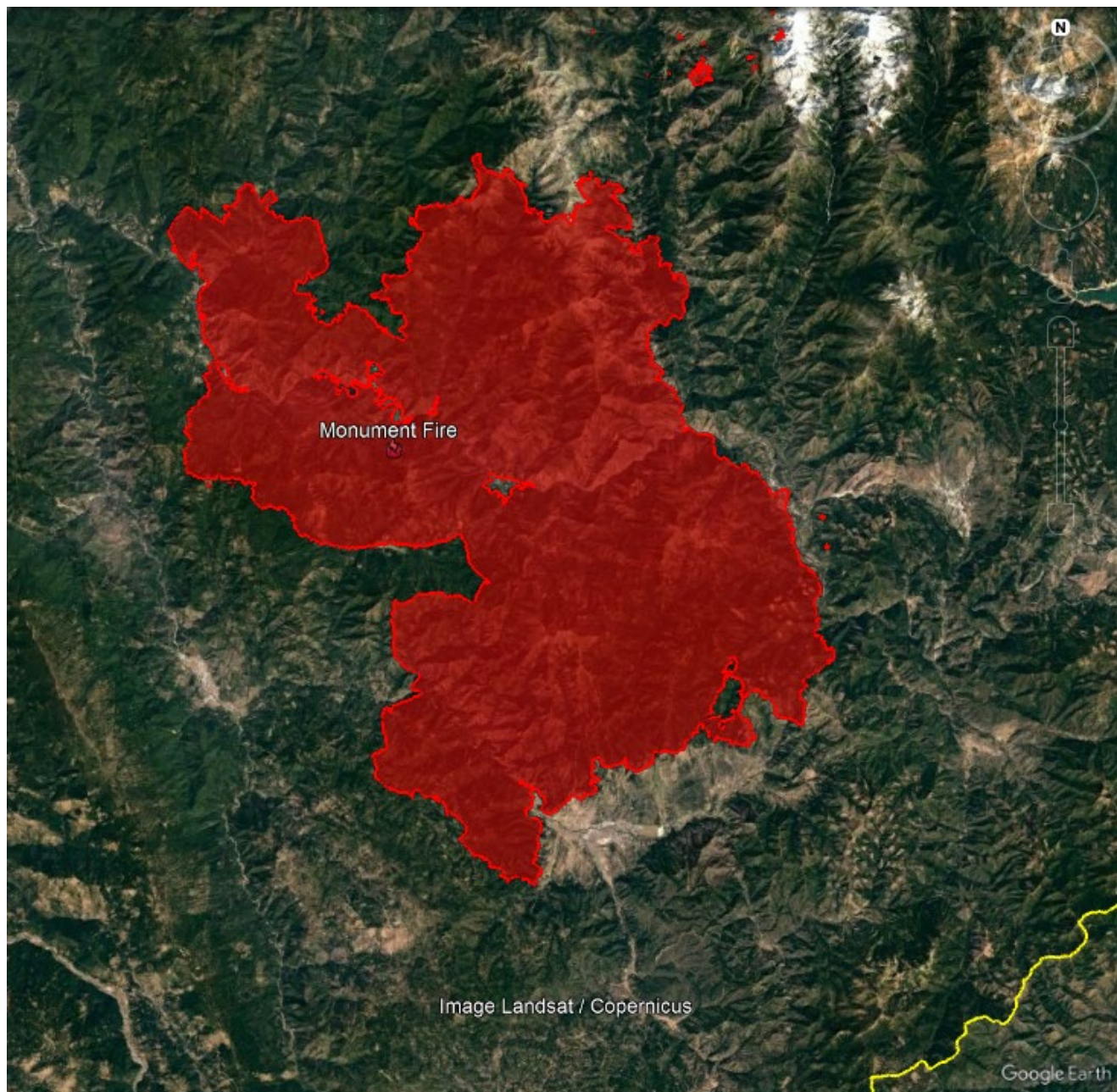


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<sup>13</sup> Dixie Fire: <https://www.fire.ca.gov/incidents/2021/7/13/dixie-fire/>

The Monument Fire<sup>14</sup> (Figure 11), located 150 miles northwest of Yuba City, started with a lightning storm on July 30 in Trinity County in the Shasta-Trinity National Forest. The fire burned 223,124 acres, destroyed 28 structures and damaged 2 others before being officially contained on October 26, 2021.

**Figure 11: Monument Fire Perimeter Map**



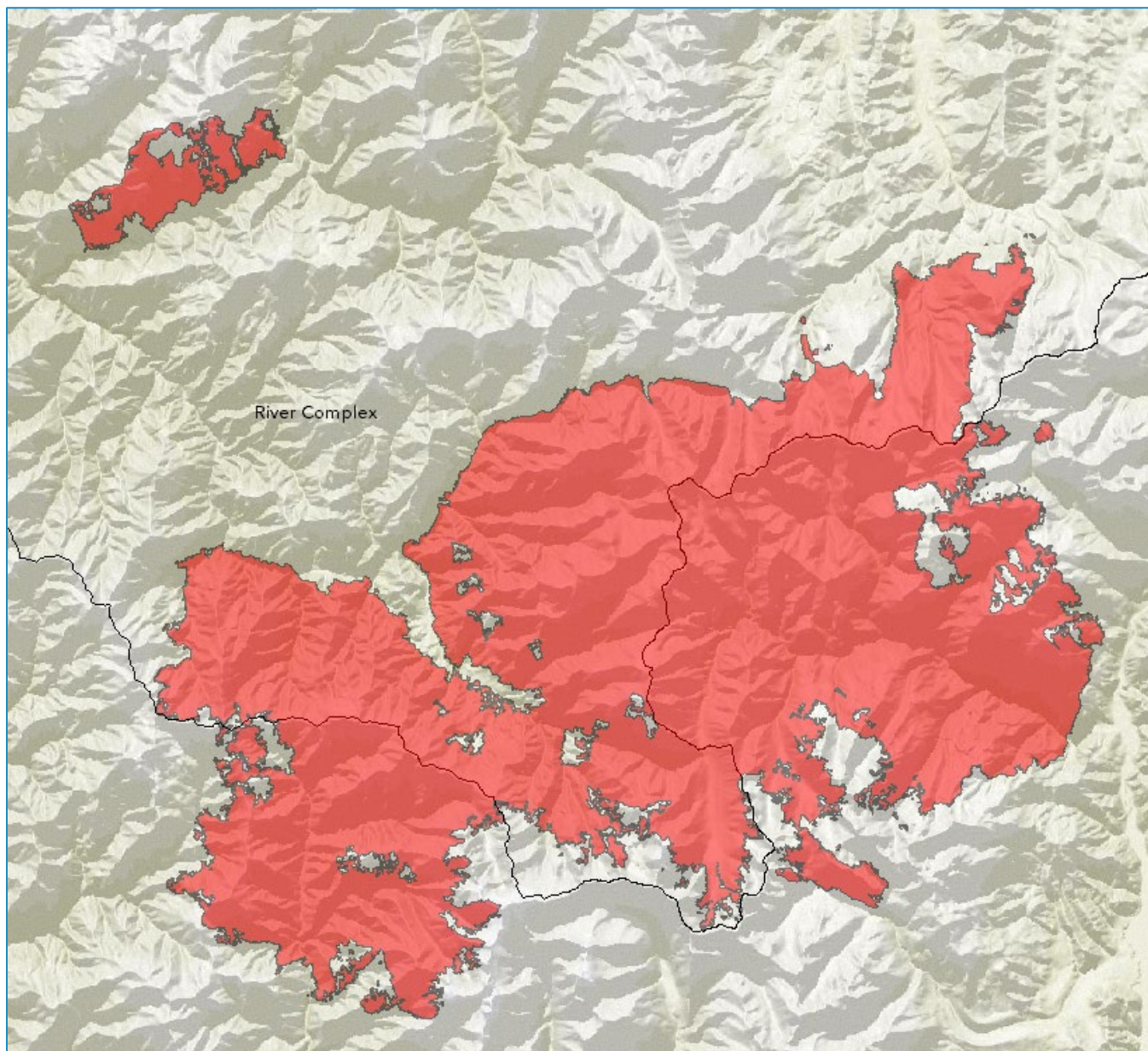
---

<sup>14</sup> Monument Fire: <https://www.fire.ca.gov/incidents/2021/7/30/monument-fire/>



The River Complex<sup>15</sup> (Figure 12Figure 9), located 150 miles north-northwest of Yuba City, started with a lightning storm on July 30 in both the Klamath and Shasta-Trinity National Forests in Siskiyou and Trinity Counties. The Complex was comprised of the Haystack, Summer, and Cornan Fires, burned 199,359 acres, destroyed 122 structures and damaged 2 others before being officially contained on October 26, 2021.

**Figure 12: River Complex Perimeter Map**



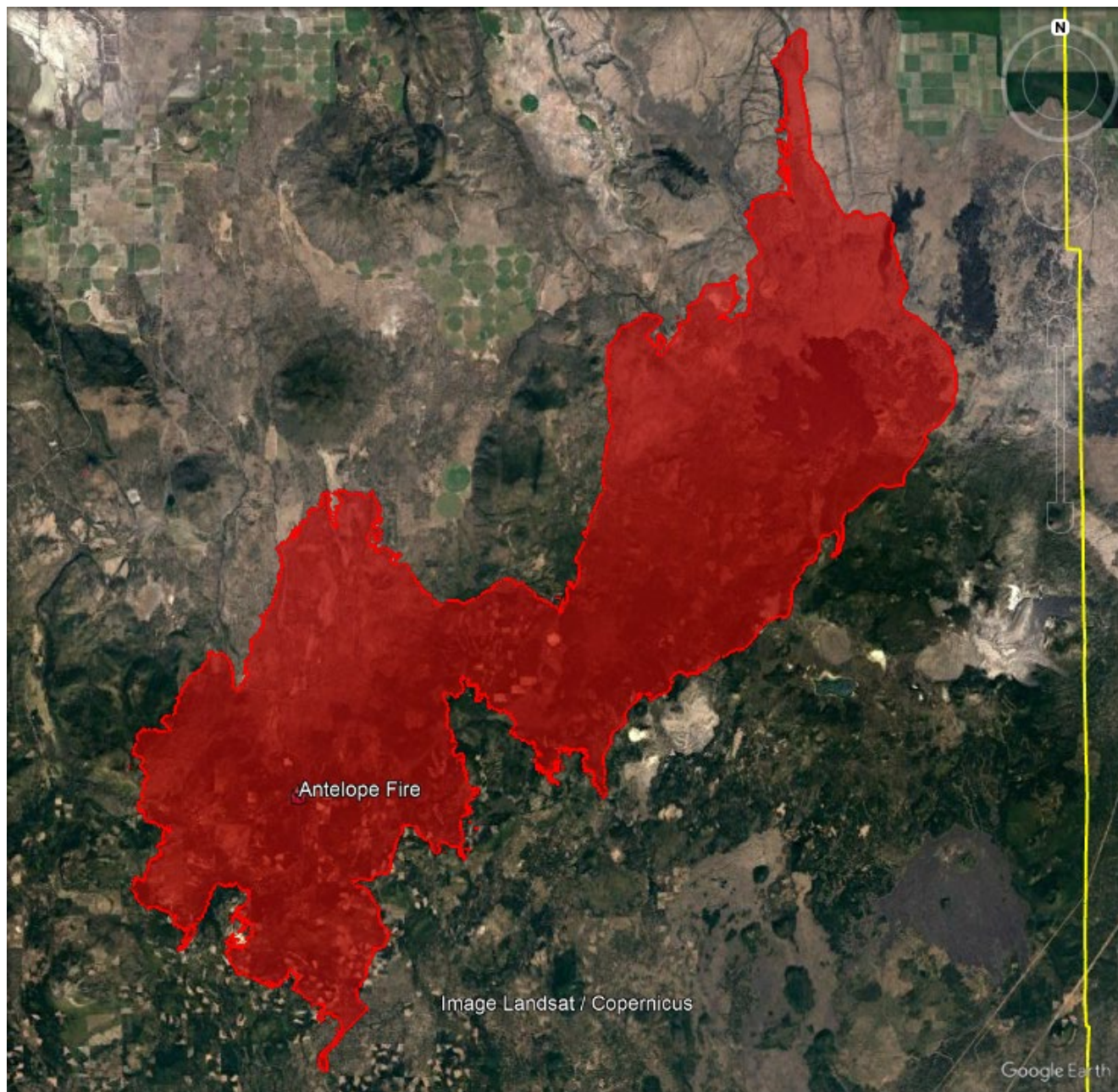
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<sup>15</sup> River Complex: <https://www.fire.ca.gov/incidents/2021/7/30/river-complex/>



The Antelope Fire<sup>16</sup> (Figure 13), located 170 miles north of Yuba City, started with a lightning storm on August 1 in Siskiyou County in the Klamath National Forest. The fire burned 145,632 acres, destroyed 20 structures and damaged 4 others before being officially contained on October 15, 2021.

**Figure 13: Antelope Fire Perimeter Map**



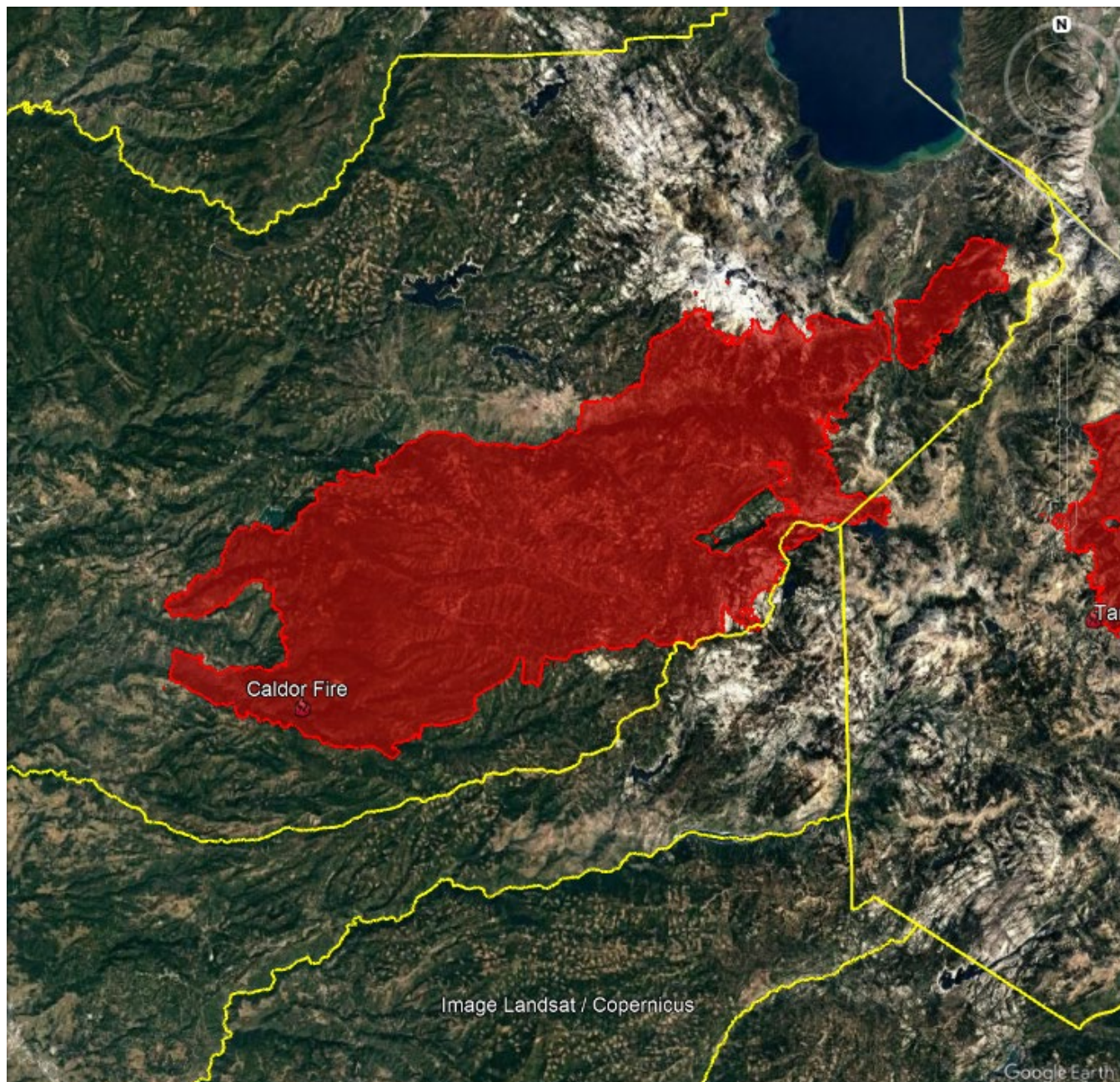
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<sup>16</sup> Antelope Fire: <https://www.fire.ca.gov/incidents/2021/8/1/antelope-fire/>



The Caldor Fire<sup>17</sup> (Figure 14), located 70 miles southeast of Yuba City, started on August 14 in the El Dorado National Forest. The fire, whose cause is still being determined, burned 221,835 acres in Alpine, Amador, and El Dorado Counties, destroyed 1,005 structures, and damaged an additional 81, before being officially contained on October 21, 2021.

**Figure 14: Caldor Fire Perimeter Map**



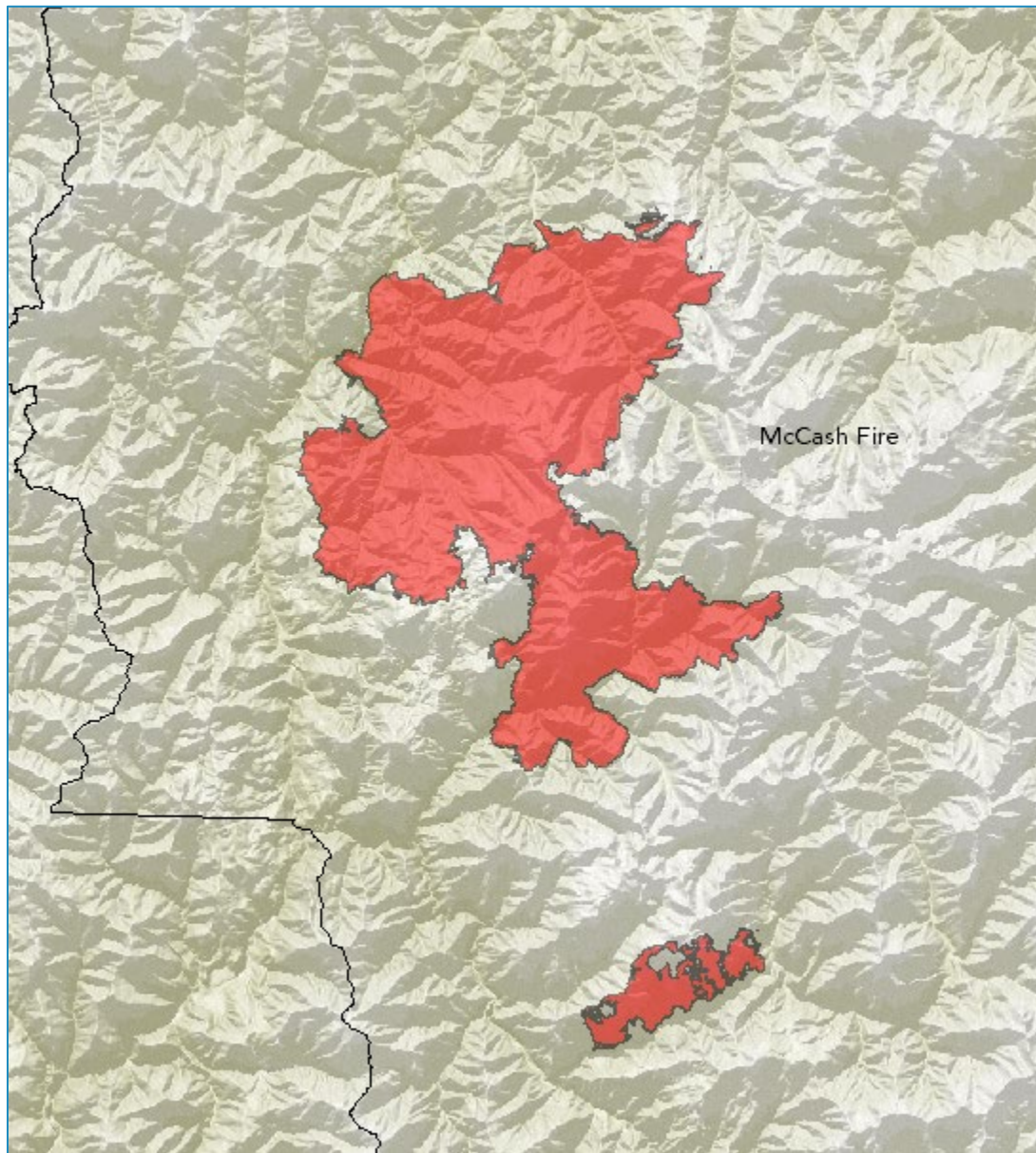
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<sup>17</sup> Caldor Fire: <https://www.fire.ca.gov/incidents/2021/8/14/caldor-fire/>



The McCash Fire<sup>18</sup> (Figure 15), located 190 miles north-northwest of Yuba City, started with a lightning storm on August 18 in Siskiyou County in the Six Rivers National Forest. The fire burned 94,962 acres before being officially contained on November 2, 2021.

**Figure 15: McCash Fire Perimeter Map**



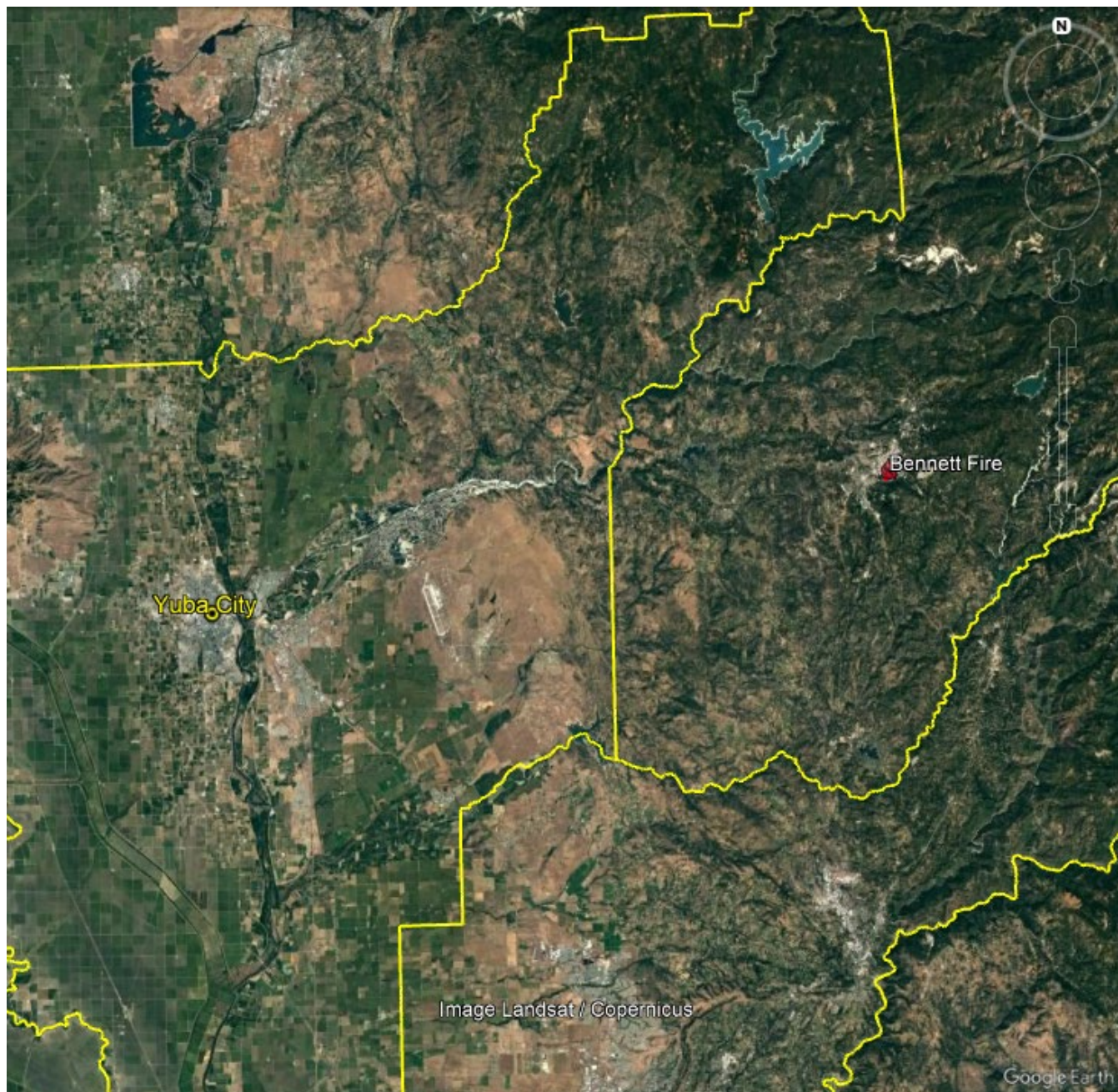
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<sup>18</sup> McCash Fire: <https://www.fire.ca.gov/incidents/2021/8/18/mccash-fire/>



The Bennett Fire<sup>19</sup> (Figure 16), located 30 miles east of Yuba City, started with a lightning storm on August 25 in Nevada County. The fire, of unknown origin, burned only 59 acres before being officially contained on August 28, 2021.

**Figure 16: Bennett Fire Location**



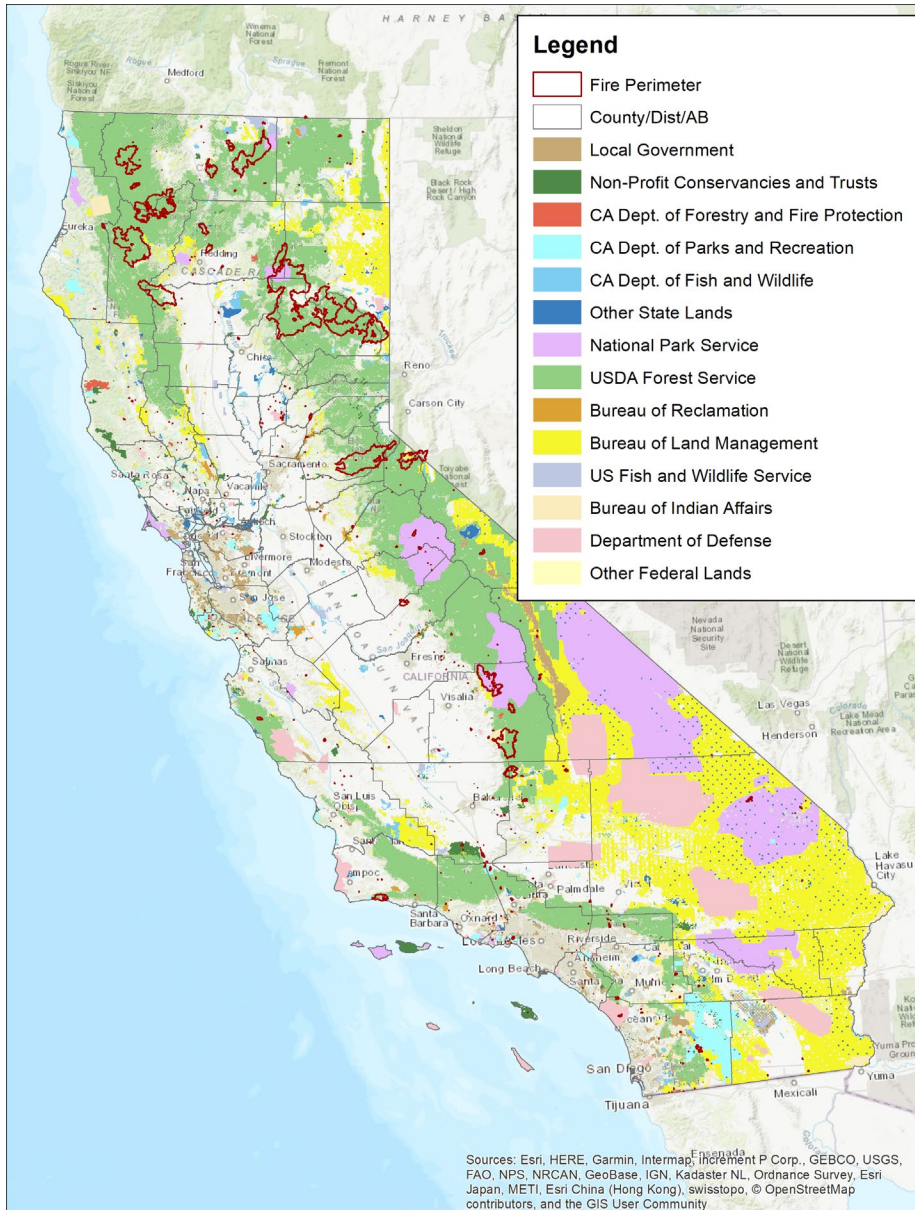
---

<sup>19</sup> Bennett Fire: <https://www.fire.ca.gov/incidents/2021/8/25/bennett-fire/>



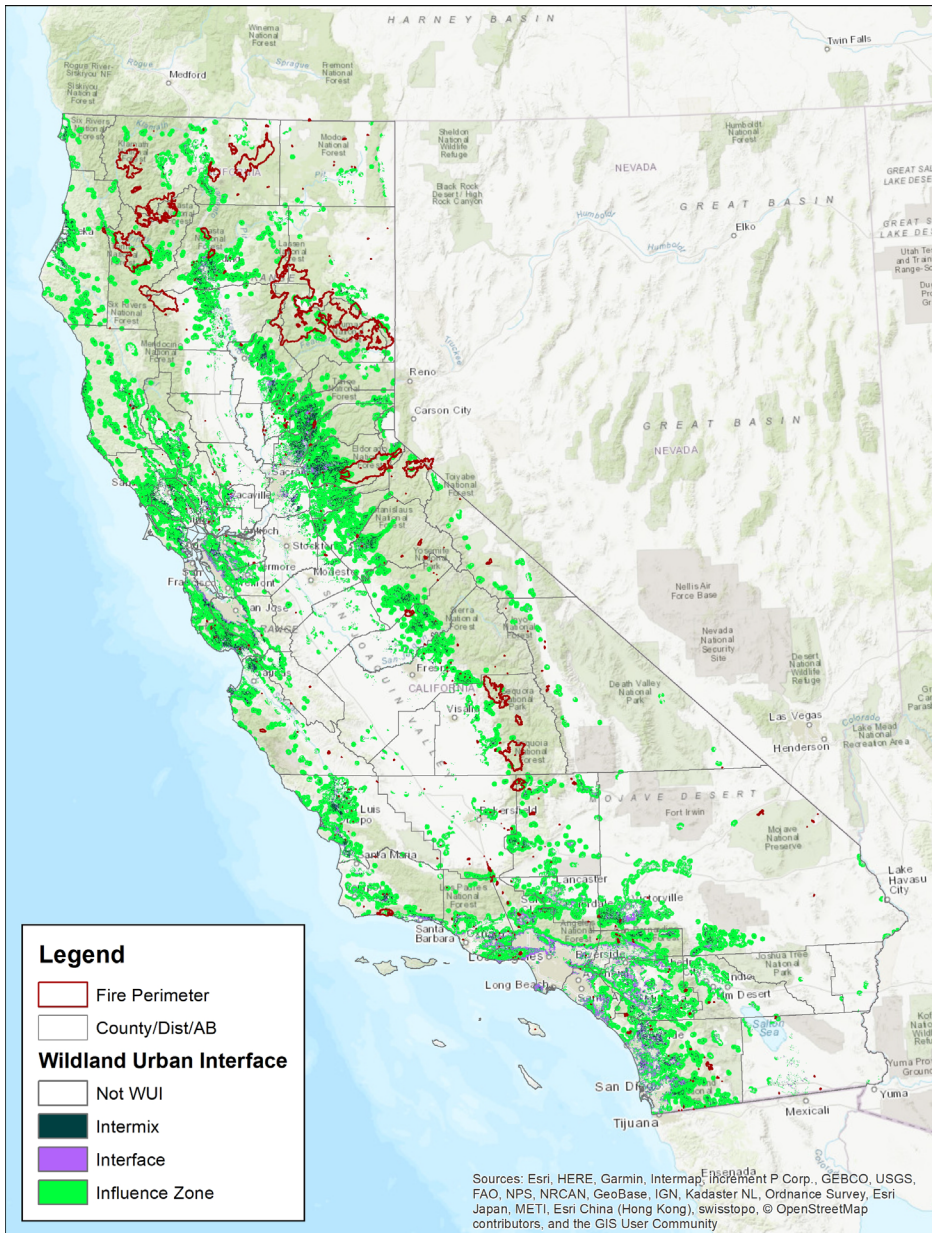
These fires occurred primarily in areas that meet the definition of wildland which is “an area in which human activity and development is essentially non-existent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are widely scattered.” Wildlands can include forestland, shrubland, grassland, and wetlands and includes lands that are predominantly wildland, such as land in the wildland-urban interface, as specified in the preamble of the Exceptional Events Rule.<sup>20</sup> Figure 17 and Figure 18 indicate these areas with the fire perimeters outlined in red.

**Figure 17: California land ownership map with 2021 wildfire boundaries (red)**



<sup>20</sup> 81 FR 68248

Figure 18: Wildland-urban interface map with 2021 wildfire boundaries (red)



## II. Summary of Events

The following section provides evidence of the impact of these exceptional events on the Yuba City PM<sub>2.5</sub> monitor from August 27 to August 29, 2021. Although the Yuba City monitor was affected by smoke from wildfires at other times during the summer of 2021, only these dates are being requested for concurrence under the Exceptional Events Rule at this time.

## A. Tools

NOAA's HYSPLIT<sup>21</sup> model was used to determine simple back-trajectories showing the path that an air parcel took for a specified period of time (here, 36 hours), starting at the monitor at times of peak concentrations on each day. Three height levels (red: 100 meters (m); blue: 500m; green: 1000m) were used to indicate transport near the surface and in the upper atmosphere. Back trajectories from the monitor are included in the following event descriptions as well as in Appendix III.

The HYSPLIT model was also used to indicate how emissions from the wildfires were transported toward the monitor (forward trajectory). Trajectories in this section are shown from the fire(s) estimated to have the highest contribution. The trajectories were initiated from each major fire at both 00z (16PST of the previous day) and 12z (04PST of the same day). These model runs provide insight into the most likely center path a parcel of air (and smoke) from each fire would take in the 36 hours after the start time. This provides a simplified understanding of smoke transport from a fire across the region, connecting these wildfires with smoke seen in satellite imagery, and indicating potential correlations at a site through analysis of parcel transport timing and backwards trajectories when they overlap. These forward trajectories, overlaid in Google Earth with satellite images from the MODIS<sup>22</sup> Aqua or Terra platforms or the Suomi National Polar-orbiting Partnership (Suomi NPP) satellite<sup>23</sup>, provide a visual analysis of the smoke emitting from the fires and impacting the monitors. Forward trajectories are included in the following event descriptions as well as in Appendix III.

Google Earth was used as a platform to combine the HYSPLIT back-trajectories and the NOAA Hazard and Mapping System (HMS) Fire and Smoke Product<sup>24</sup> smoke layers and fire locations. The HYSPLIT trajectory model results, as well as satellite layers and HMS smoke plume analyses, show impacts from multiple California wildfires dispersed throughout the northern and central portions of the State. Although the model results can show potential influence from specific fires, they do not always show the cumulative effect of continuing wildfire emissions that impacted California during August.

NOAA's High-Resolution Rapid Refresh Smoke (HRRR-Smoke),<sup>25</sup> a weather-smoke model that allows for the simulation of smoke dispersion over complex terrain, showed extensive smoke (expressed in  $\mu\text{g}/\text{m}^3$ ) at near surface levels throughout northern California and in the Yuba City area.

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<sup>21</sup> HYbrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT)

<sup>22</sup> UWM, SSEC, [MODIS Today](#), last accessed 7/29/21

<sup>23</sup> NASA EOSDIS Worldview, <https://worldview.earthdata.nasa.gov/>, last accessed 9/19/22

<sup>24</sup> HMS: <https://www.ssd.noaa.gov/PS/FIRE/smoke.html>

<sup>25</sup> NOAA HRRR Smoke Modeling Graphics (older), <https://rapidrefresh.noaa.gov/hrrr/HRRRsmokeold/>, last accessed 11/18/22

## B. Event Description

A series of large wildfires were ignited across California in the summer of 2021. The majority of these fires occurred in the northern portion of the State, including the Dixie Fire, which burned 963,309 acres, the second largest in California history, and the Caldor Fire, which burned 221,835 acres and resulted in the evacuation of the South Lake Tahoe area, and the destruction of most of the small town of Grizzly Flats. A state of emergency was declared by the Governor of California for the Dixie, Fly, and Tamarack Fires as well as the Caldor Fire<sup>26</sup>, with an additional Emergency Order<sup>27</sup> for the Caldor Fire issued by the State of Nevada.

NOAA's National Weather Service noted that a 500mb high pressure ridge began to build, increasing north to south pressure gradients over northern California and resulting in increased gusty winds. As northerly flow developed, increasing surface smoke spread across the Sacramento Valley, including the Yuba City area. Easterly flow in the morning brought smoke into the area, reversing to westerly in the afternoon<sup>28</sup> and bringing smoke from the Dixie fire into the Valley.

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<sup>26</sup> California State of Emergency Proclamations: July 23, 2021: <https://www.gov.ca.gov/wp-content/uploads/2021/07/7.23.21-SOE-Dixie-Fly-Tamarack.pdf>; August 30, 2021: <https://www.gov.ca.gov/wp-content/uploads/2021/08/8.30.21-Caldor-Fire-SOE.pdf>, last accessed 11/18/22

<sup>27</sup> Nevada Declaration of Emergency, August 30, 2021, <https://dem.nv.gov/DEM/Emergency/CaldorFire/>

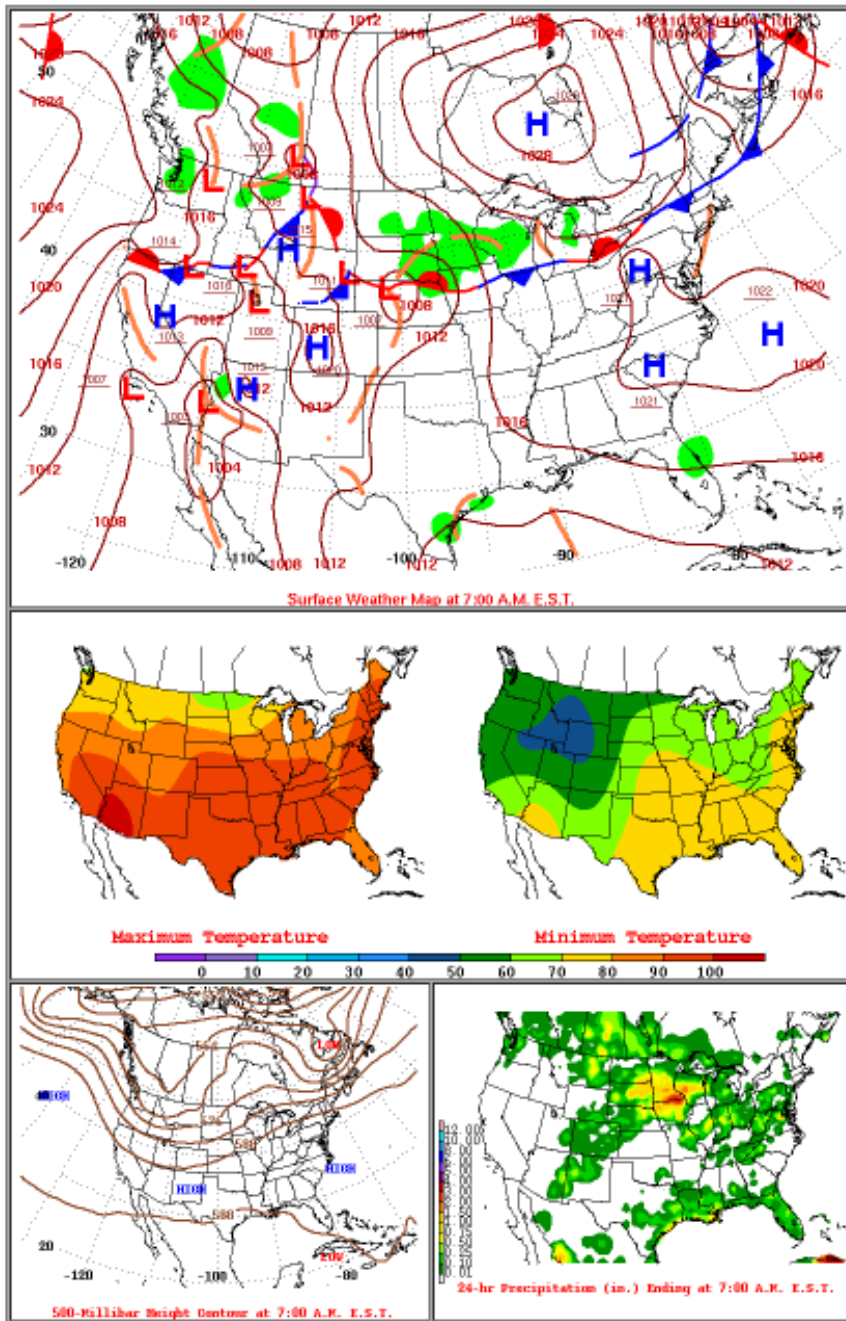
<sup>28</sup> NOAA NWS Area Forecast Discussion, August 27, 2021, 0229PM, <http://mesonet.agron.iastate.edu/wx/afos/p.php?pil=AFDSTO&e=202108272129>, last accessed 11/22/22



Figure 19: Meteorological conditions on August 27, 2021<sup>29</sup>

## Daily Weather Maps

FRIDAY AUGUST 27, 2021

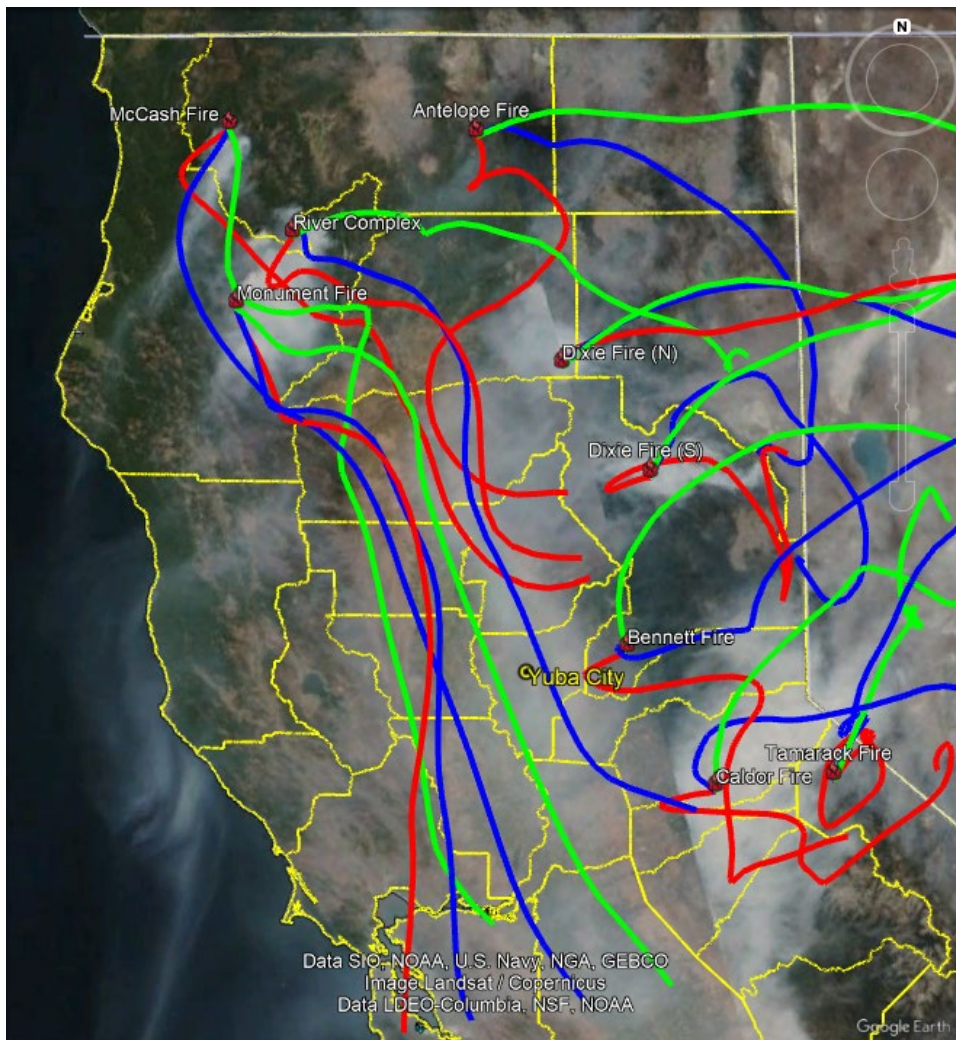


<sup>29</sup> NOAA NCEP Weather Prediction Center Daily Weather Maps:  
<https://www.wpc.ncep.noaa.gov/dailywxmap/index.html>

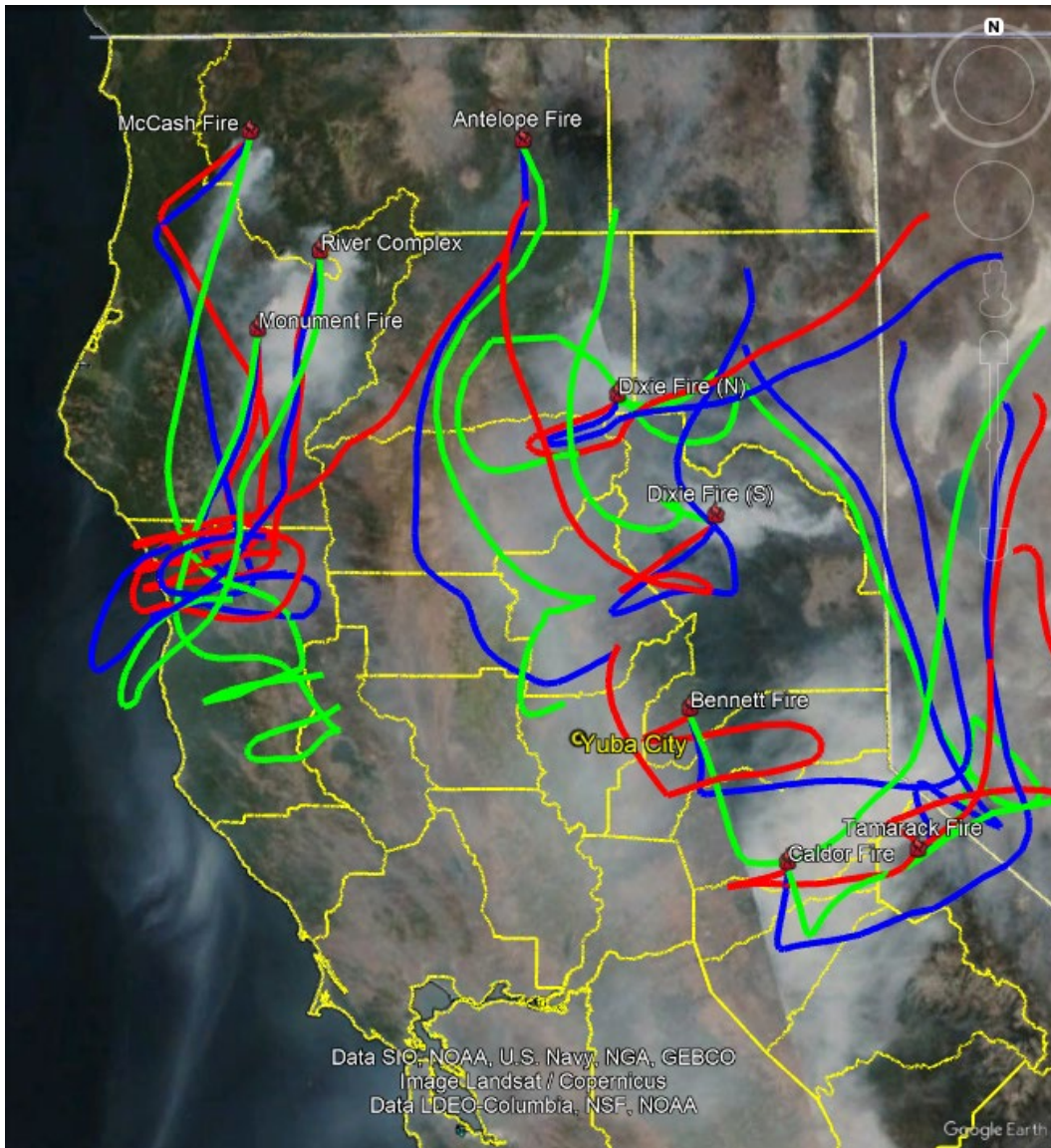
Several fires emitted smoke that impacted the Yuba City monitor on August 27. The following figures show the forward trajectories of the major fires burning in northern and central California. Trajectories starting at 12z (04PST) on August 26 (Figure 20a), and followed for 36 hours, showed potential transport into the western portion of the Sacramento Valley from the River Complex, and the Monument and McCash Fires, and less impacts from the Dixie, Antelope, and Bennett Fires. The next day, August 27 (Figure 20b), showed more impacts from the Dixie, Antelope, and Bennett Fires and less direct influence from fires in the northeast corner of the State or from the fires to the south of the monitor. Lingering smoke from previous days contributed to the layer encompassing the area. The more direct influence of the Dixie Fire and the Bennett Fire can be seen in Figure 20c below, with a small contribution from the Antelope Fire in the north.

**Figure 20: Forward trajectories from fires (Suomi satellite image, August 27, 2021)**

a. Forward trajectories starting 12z (4am PST) on August 26, 2021

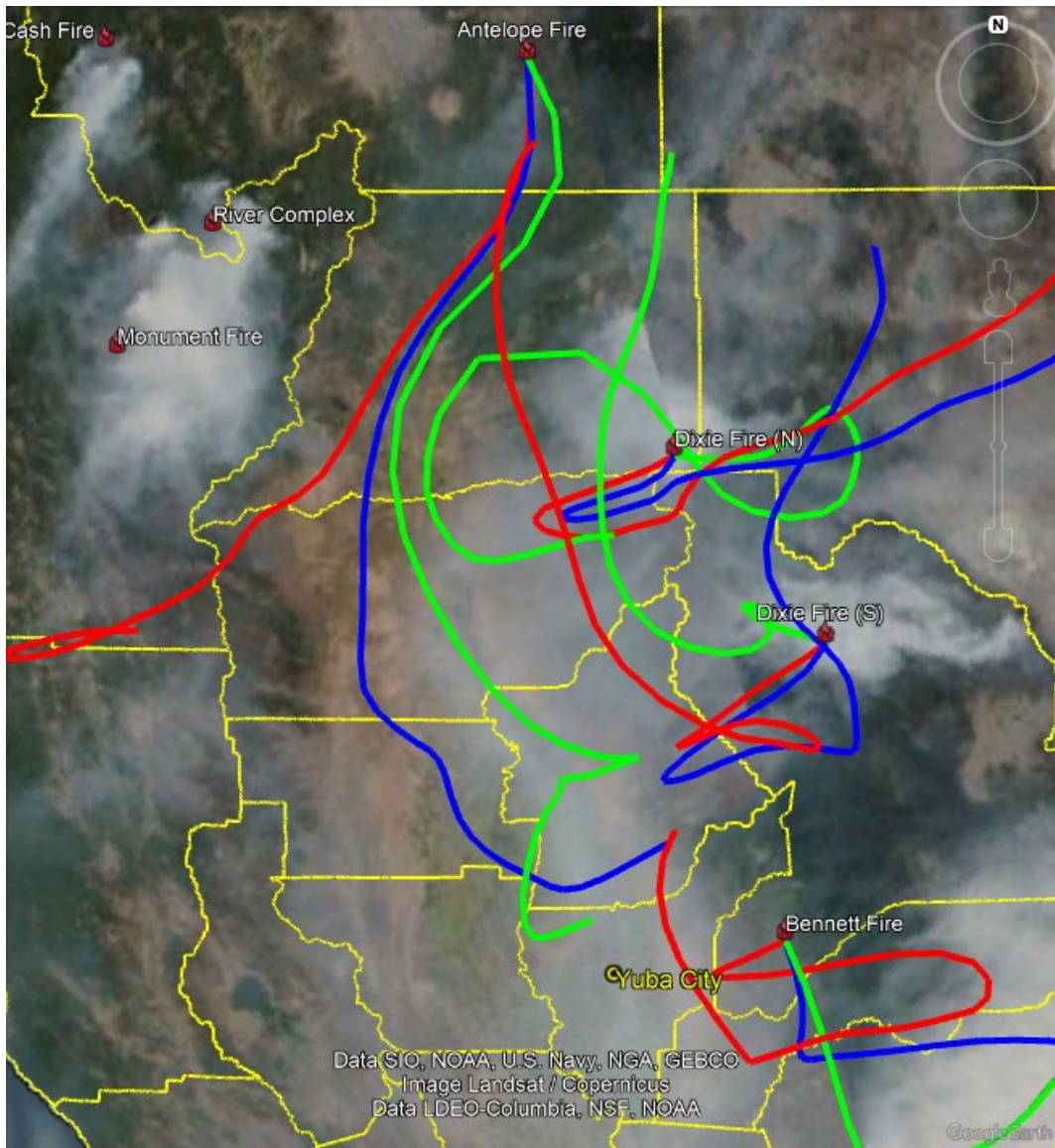


b. Forward trajectories starting 12z (4am PST) on August 27, 2021



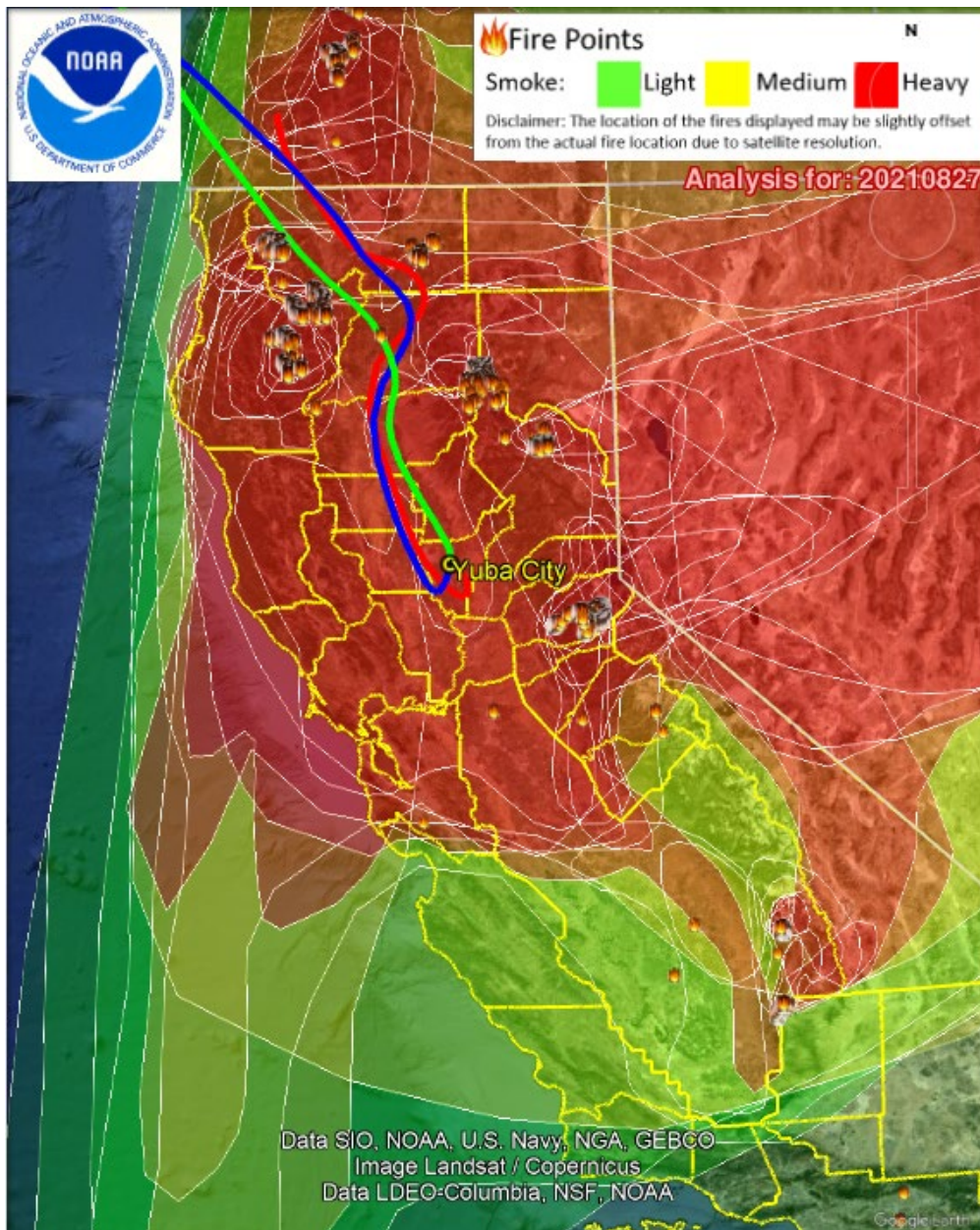


c. Forward trajectories from Antelope, Bennett, and Dixie Fires starting 12z (4am PST) on August 27, 2021



Thick smoke covered most of northern California, as evidenced in the satellite images above as well as the HMS smoke layers in Figure 21. Back-trajectories, beginning at the time of the maximum  $PM_{2.5}$  concentrations at Yuba City on August 27, are overlaid on the HMS smoke and fire layers for the same day. The surface trajectory (red, 100m) indicates a more local smoke influence, while those higher in the atmosphere are more indicative of transport (blue, 500m; green, 1000m). All three trajectories traced a northern path through the heaviest smoke layers.

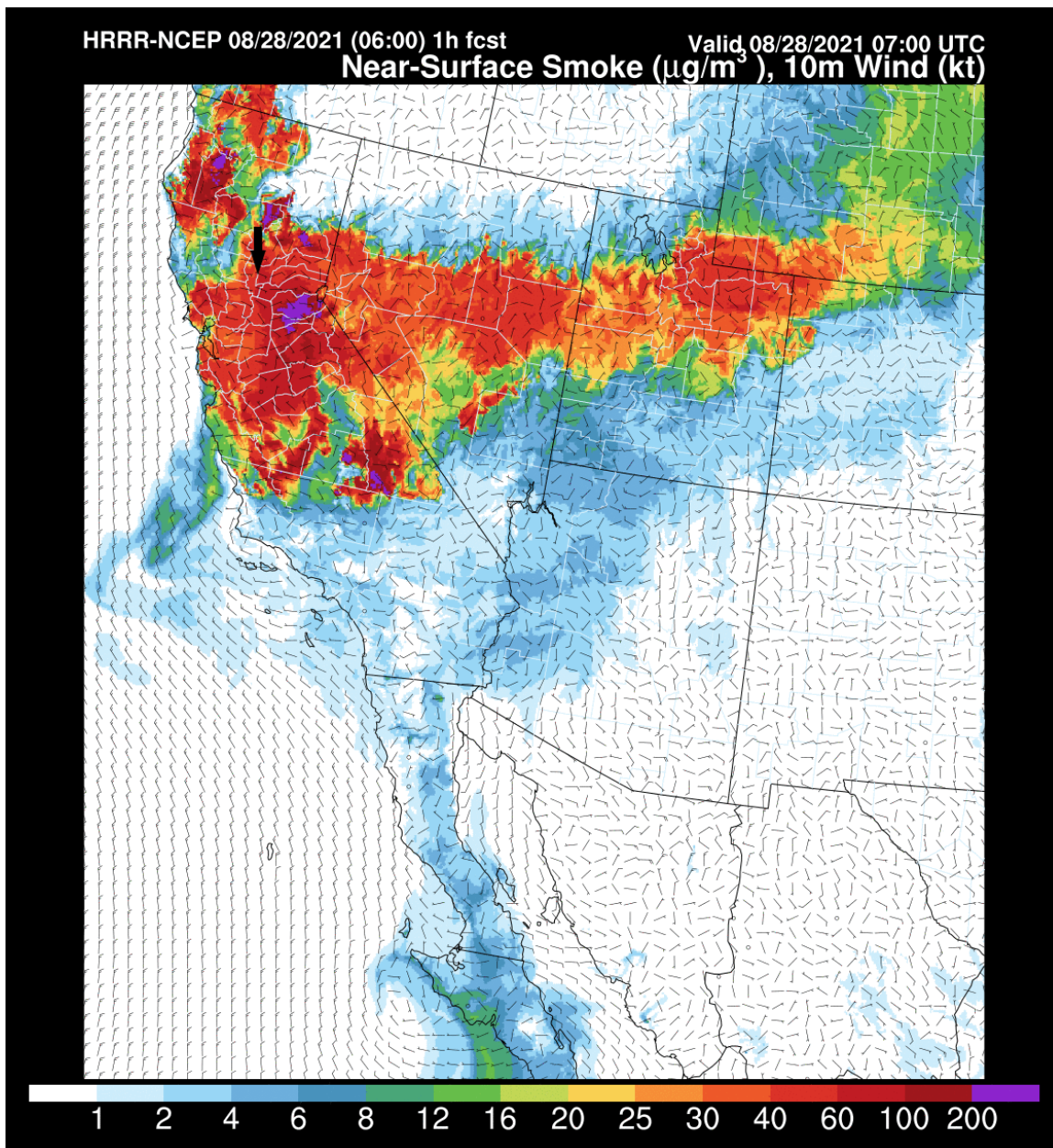
**Figure 21: Back trajectories from Yuba City monitor at time of maximum  $PM_{2.5}$  concentrations on August 27, 2021 (23PST/August 28 07UTC) with HMS smoke and fire layers**





The HRRR-Smoke model results (beginning run at 8/28/2021 06UTC or 8/27/21 22PST and run for one hour) (Figure 22) showed the probability of heavy smoke with PM<sub>2.5</sub> levels between 60 and 100  $\mu\text{g}/\text{m}^3$  at 07UTC (23PST) with the approximate location of the Yuba City monitor marked with a black arrow. This is consistent with the measured concentrations at the monitor of 92  $\mu\text{g}/\text{m}^3$ .

**Figure 22: HRRR-Smoke near-surface model results at time of maximum PM<sub>2.5</sub> concentrations (August 27 23PST/August 28 07UTC)**

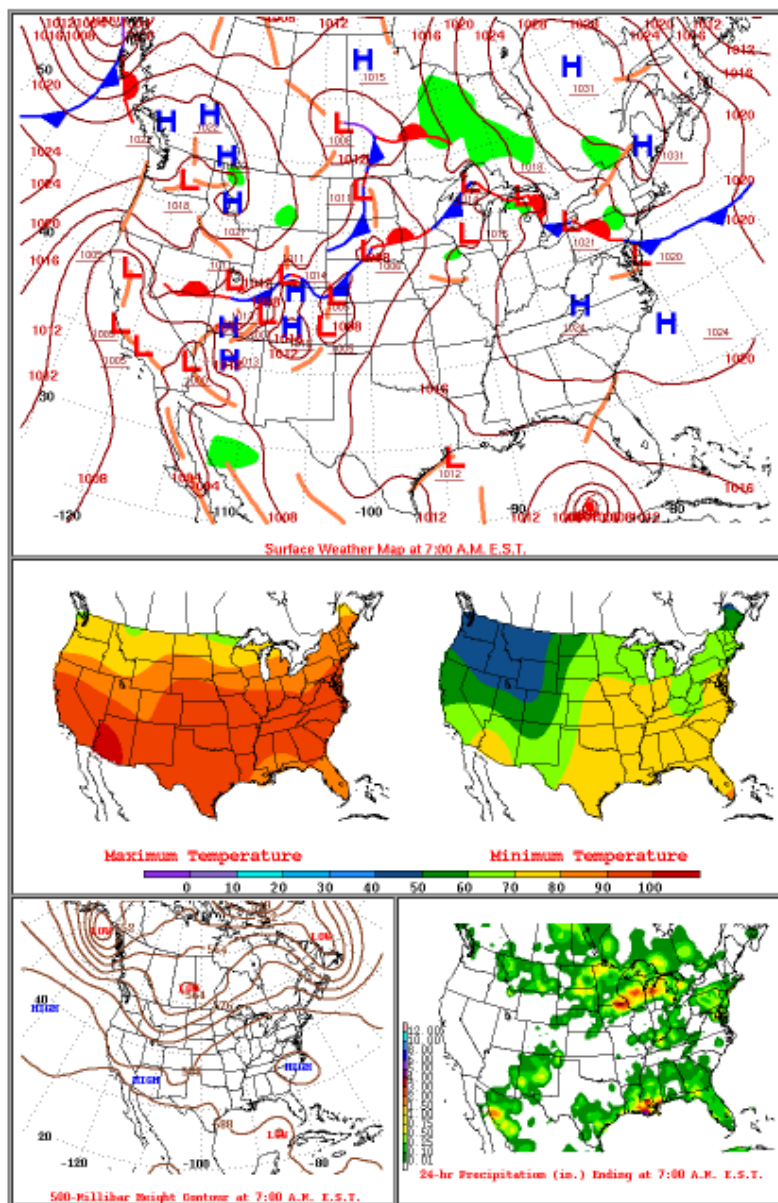


As the 500mb upper level flow pattern began to flatten, a slight tightening of surface pressure gradients resulted that had north winds continuing to send smoke into northern and central California.

Figure 23: Meteorological conditions on August 28, 2021<sup>30</sup>

## Daily Weather Maps

SATURDAY AUGUST 28, 2021

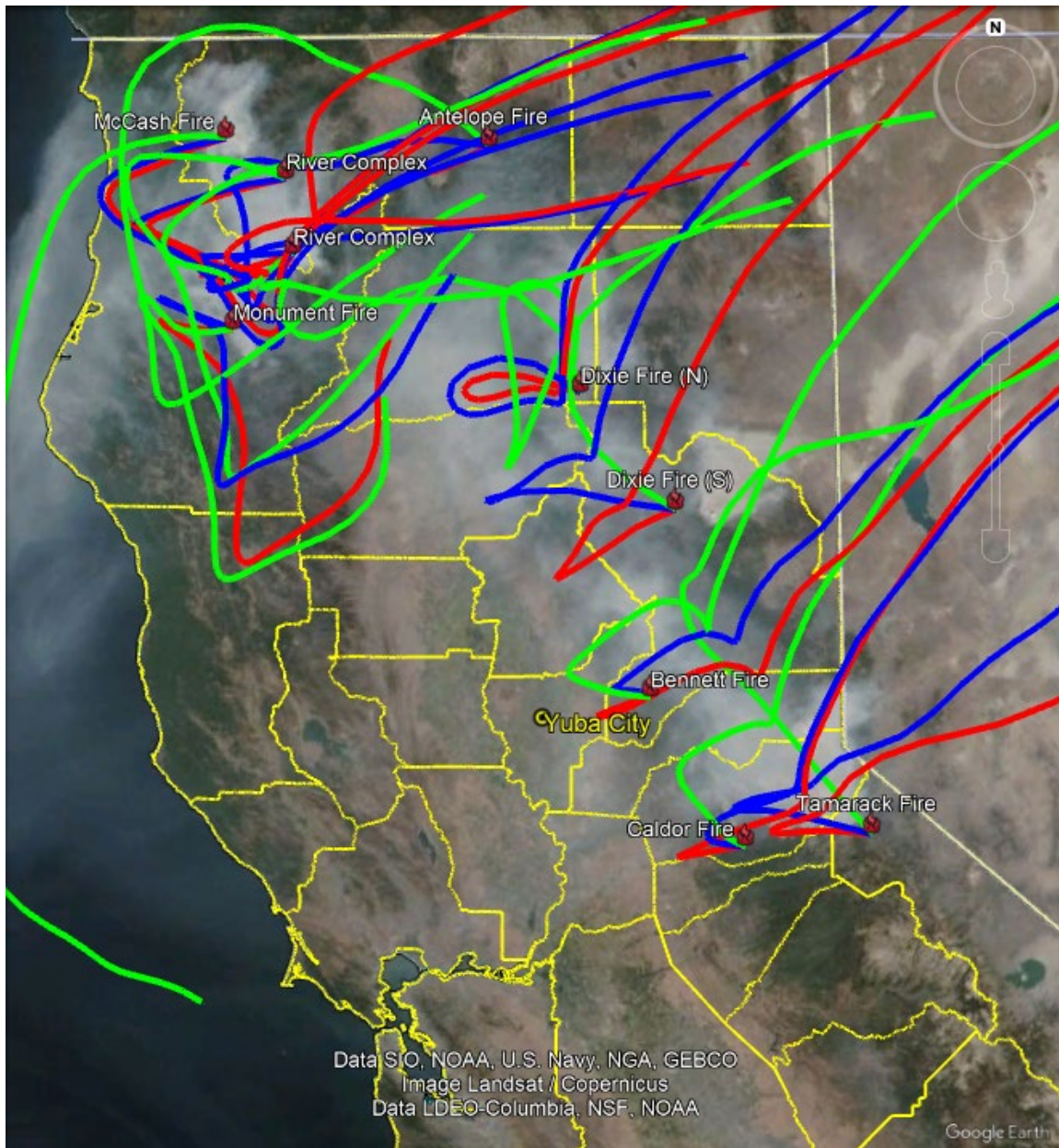


<sup>30</sup> NOAA NCEP Weather Prediction Center Daily Weather Maps: <https://www.wpc.ncep.noaa.gov/dailywxmap/index.html>



Trajectories starting at 12z (04PST) on August 28 (Figure 24), showed some potential transport of smoke from the Monument, Dixie, and Bennett Fires, with the Dixie and Bennett Fires showing the most direct influence. The other fires burning in northern and central California, including the River Complex and the Caldor Fire, contributed to the general smoke layer over the region.

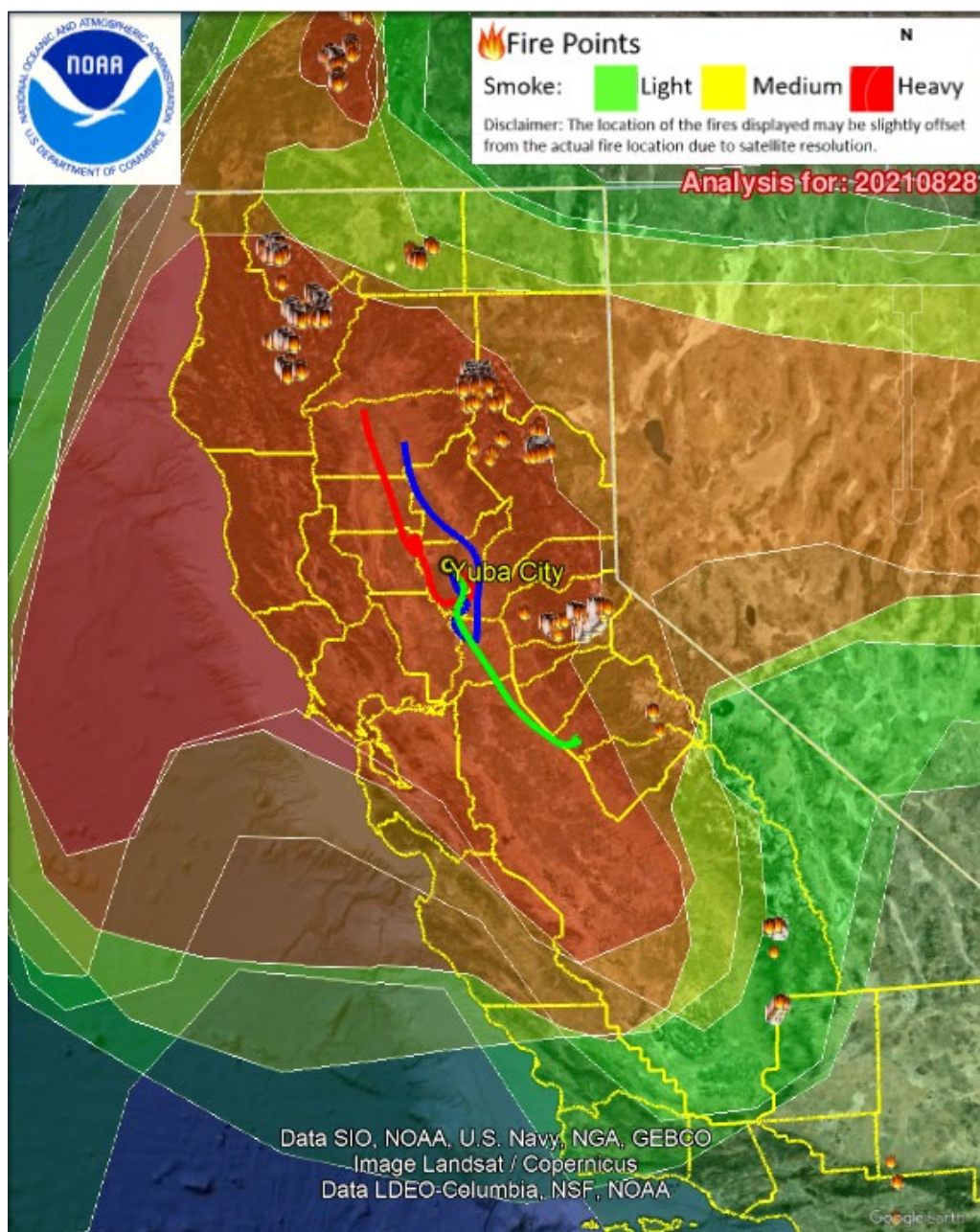
**Figure 24: Forward trajectories 12z (4am) from fires (Suomi satellite image, August 28, 2021)**





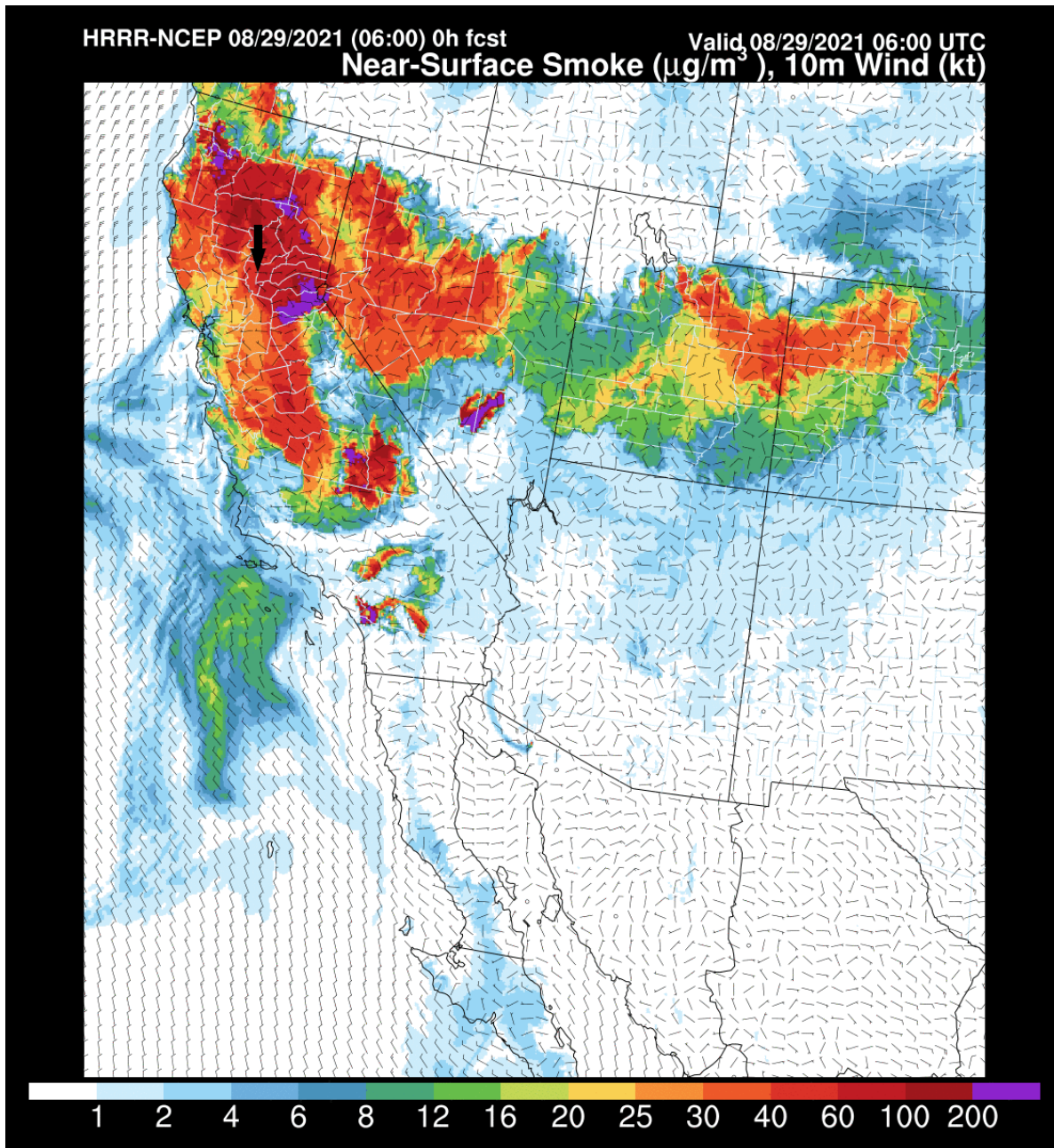
The back-trajectories for August 28, shown in Figure 25, are overlaid on the August 28 HMS smoke and fire layers, and again indicate that the surface trajectories (red, 100m), as well as those indicative of transport (blue, 500m; green, 1000m), were influenced by local wildfire smoke emissions as well as emissions from other fires in northern and central California.

**Figure 25: Back trajectories from Yuba City monitor at time of maximum PM<sub>2.5</sub> concentrations on August 28, 2021 (22PST/August 29 06UTC) with HMS smoke and fire layers**



The HRRR-Smoke model results (beginning run at 8/29/2021 06UTC or 8/28/21 22PST) (Figure 26) showed the probability of heavy smoke with PM<sub>2.5</sub> levels between 60 and 100  $\mu\text{g}/\text{m}^3$  at 06UTC (22PST) with the approximate location of the Yuba City monitor marked with a black arrow. This is consistent with the measured concentrations at the monitor of 105  $\mu\text{g}/\text{m}^3$ .

**Figure 26: HRRR-Smoke near-surface model results at time of maximum PM2.5 concentrations (August 28 22PST/August 29 06UTC)**



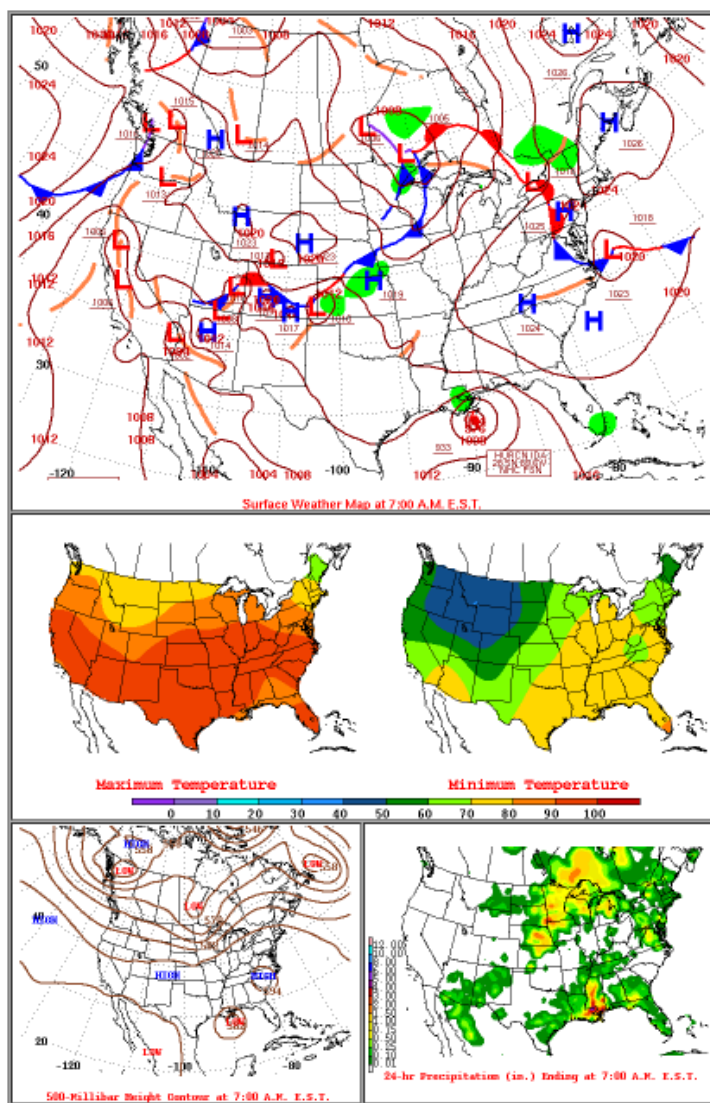


The basic weather pattern evident on August 28 continued into the early hours of August 29 when concentrations at the monitor were high. The flattened ridge pattern evident in the upper level began to fall apart as a trough began to form off the west coast. This allowed onshore winds to develop, pushing smoke toward the east and northeast and thinning out the smoke layers in the Sacramento Valley, causing concentrations at the monitor to slowly decrease.

Figure 27: Meteorological conditions on August 29, 2021<sup>31</sup>

## Daily Weather Maps

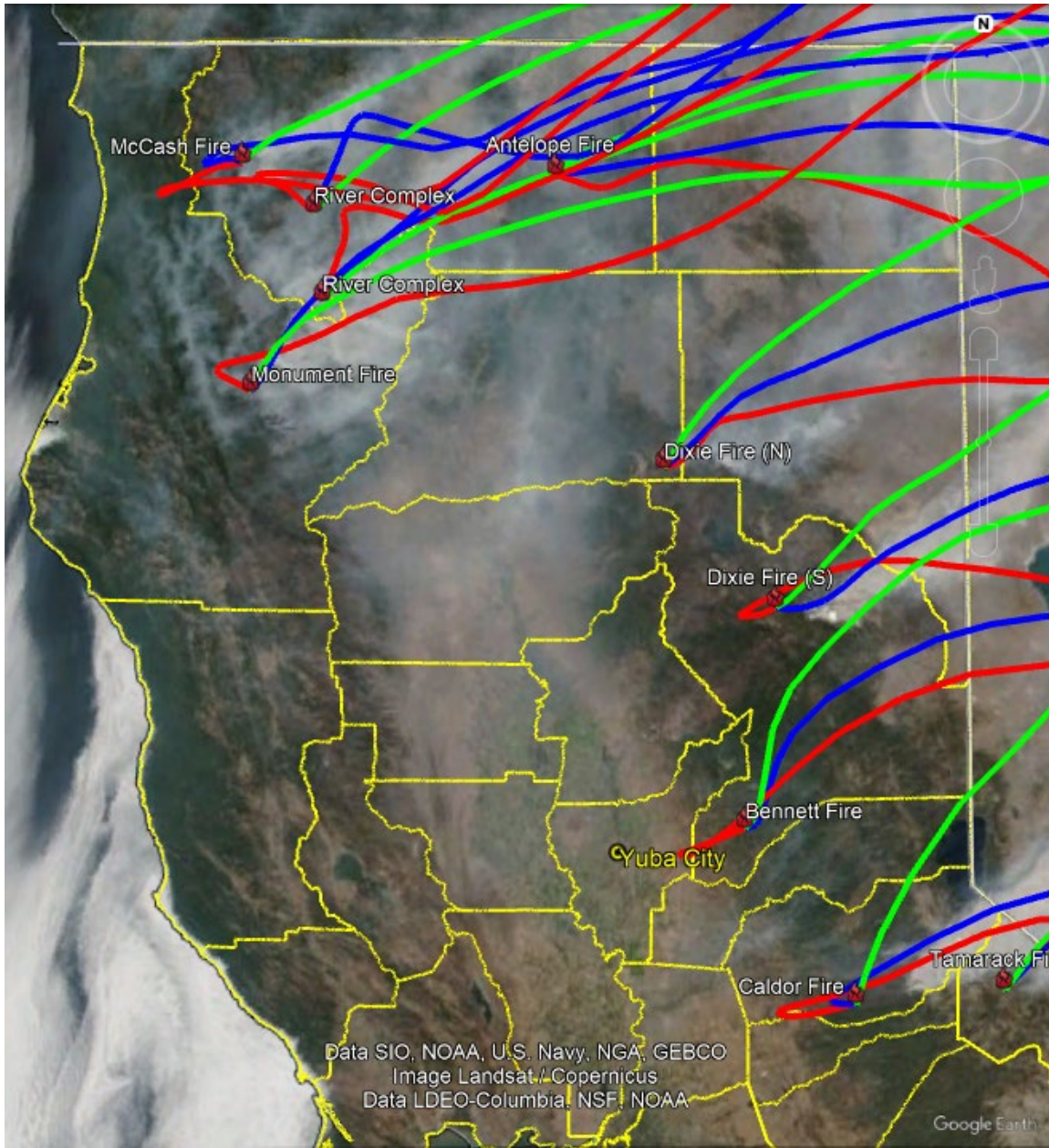
SUNDAY AUGUST 29, 2021



<sup>31</sup> NOAA NCEP Weather Prediction Center Daily Weather Maps: <https://www.wpc.ncep.noaa.gov/dailywxmap/index.html>

Trajectories starting at 12z (04PST) on August 29 (Figure 28), showed the fires burning in northern still contributed to the general smoke layer over the region, but by the time of the satellite pass (approximately 21UTC or 13PST) these layers had begun to thin.

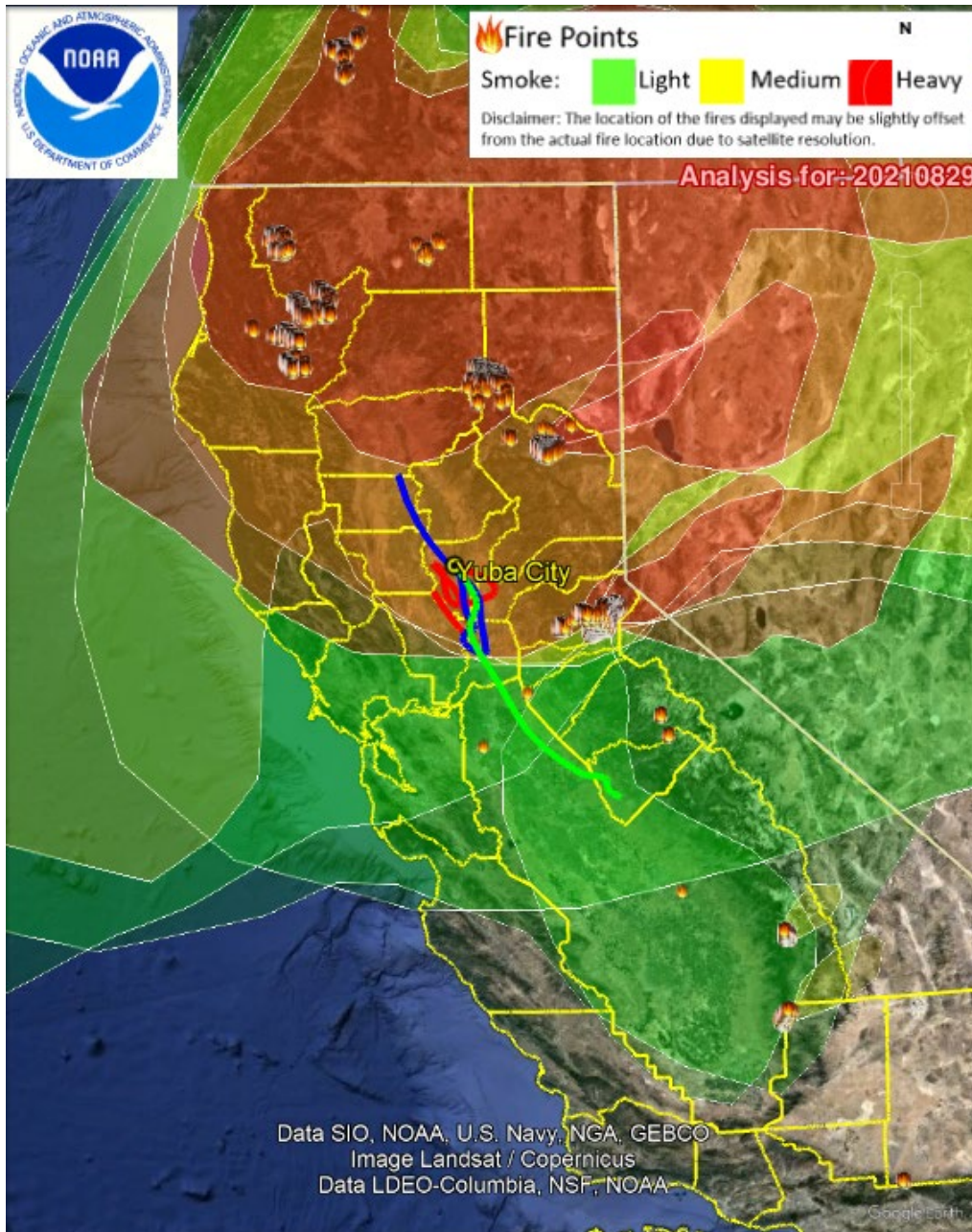
**Figure 28: Forward trajectories 12z (4am) from fires (Suomi satellite image, August 29, 2021)**





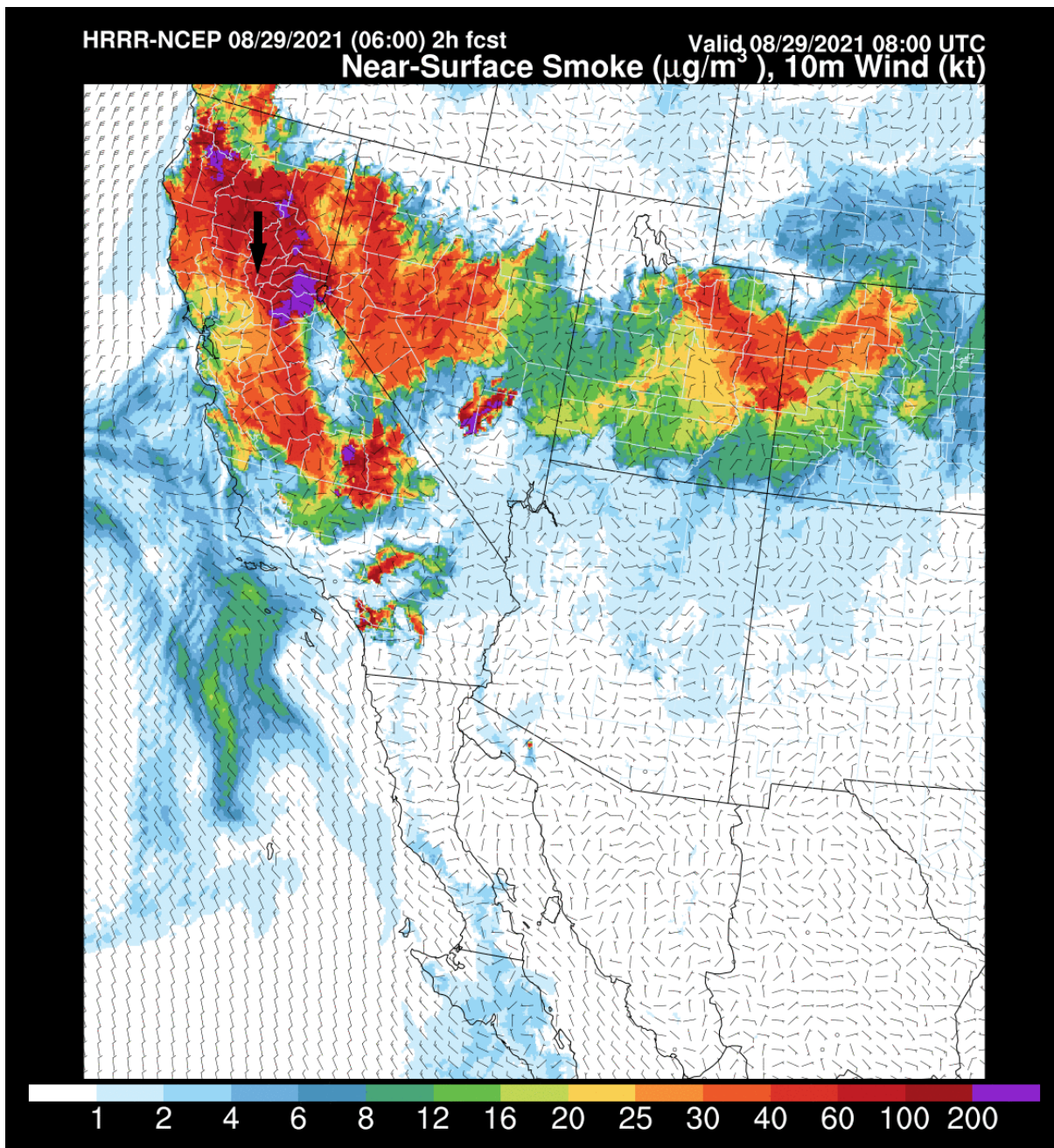
Back trajectories at the hour of peak concentrations at the Yuba City monitor were overlaid on the HMS smoke and fire layers from the same day, August 29, 2021 (Figure 29). These trajectories indicated influence from local wildfire smoke emissions, as well as emissions from fires to the north and somewhat from the southeast, although the smoke layers were beginning to thin.

**Figure 29: Back trajectories from Yuba City monitor at time of maximum PM<sub>2.5</sub> concentrations on August 29, 2021 (00PST/August 29 08UTC) with HMS smoke and fire layers**



The HRRR-Smoke model results (beginning run at 8/29/2021 08UTC or 8/29/21 00PST and run for two hours) (Figure 30) showed the probability of heavy smoke with PM<sub>2.5</sub> levels between 60 and 100 µg/m<sup>3</sup> at 08UTC (00PST) with the approximate location of the Yuba City monitor marked with a black arrow. This is consistent with the measured concentrations at the monitor of 103 µg/m<sup>3</sup>.

**Figure 30: HRRR-Smoke near-surface model results at time of maximum PM<sub>2.5</sub> concentrations (August 29 00PST/August 29 08UTC)**





The evidence presented shows that several wildfires collectively contributed smoke emissions impacting the Yuba City monitoring site in the FRAQMD in the Sacramento Valley Air Basin. These wildfires, as previously noted, primarily occurred on lands that meet the statutory definition of wildlands. Map locations and layers of the fire perimeters were obtained from CalFire, US Forest Service, and the Fire and Resource Assessment Program (FRAP).<sup>32</sup>

### III. Event Related Concentrations and Long-Term Trends

Smoke impacts from the different wildfires on the Yuba City site varied day to day. Variable winds transported wildfire smoke from the fires shown in Figure 8 and listed in Table 6. Elevated PM<sub>2.5</sub> concentrations discussed in this section, along with satellite imagery, media reports, and ceilometer backscatter data and associated timing addressed in the Clear Causal Section support the presence of wildfire smoke at the surface.

Figure 31 shows hourly PM<sub>2.5</sub> concentrations at the Yuba City monitor for the event period (denoted with a gray bar) as well as two days before and after (one hour of missing data on August 27 accounts for the gap seen in the figure). The steady high hourly concentrations resulted in multiple exceedances of the daily PM<sub>2.5</sub> standard as seen in

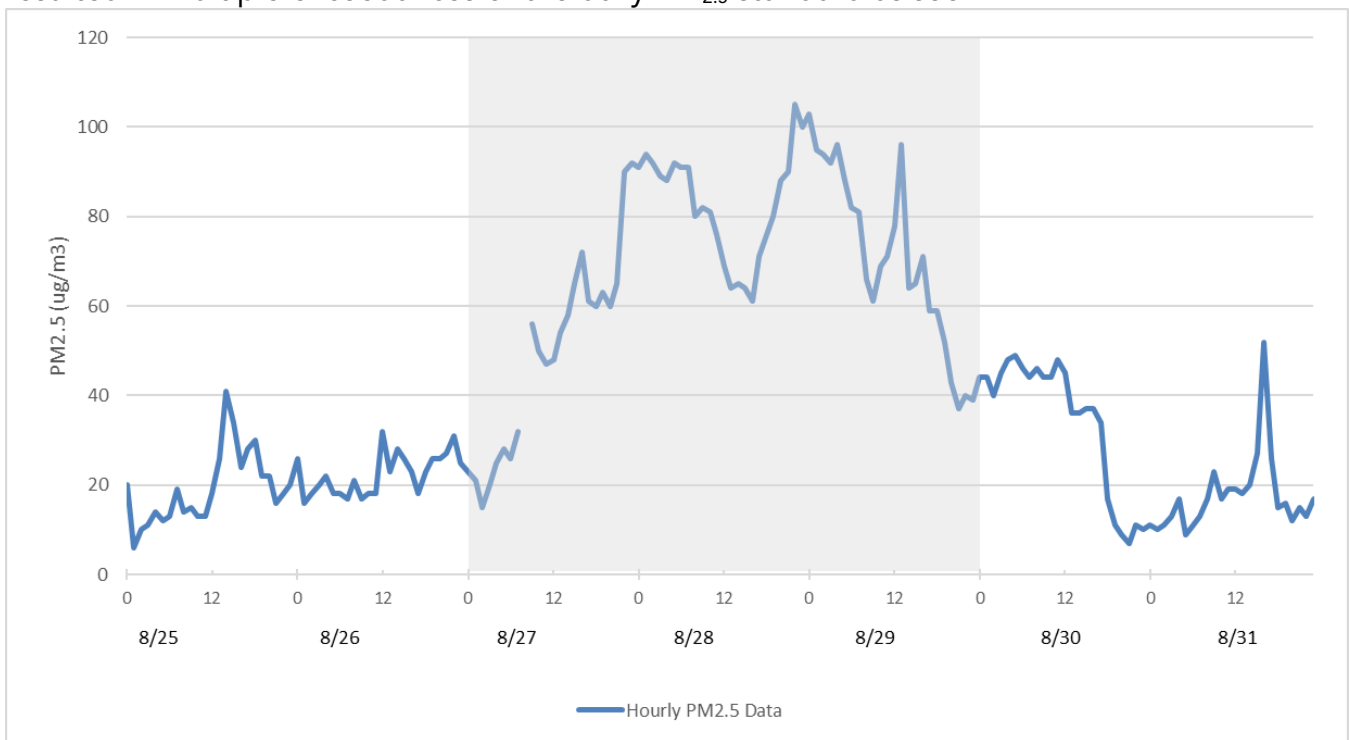
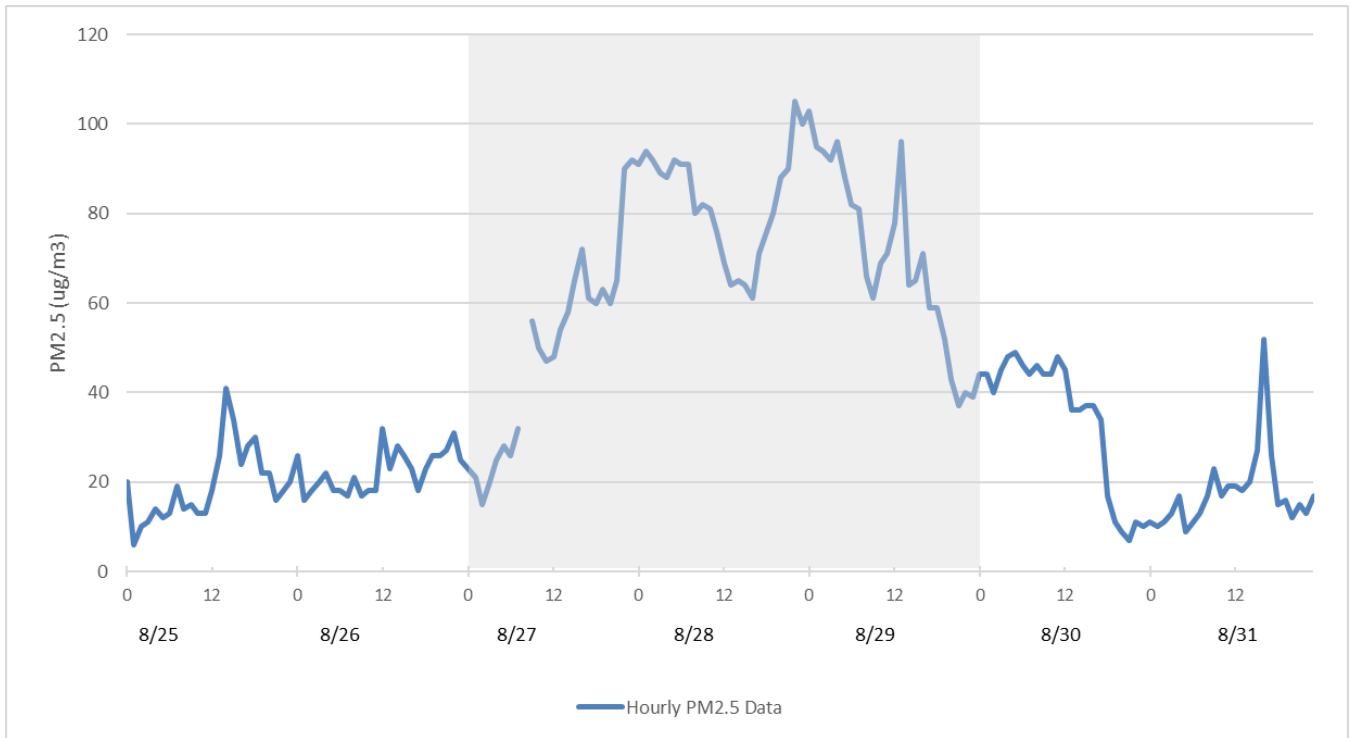


Figure 32.

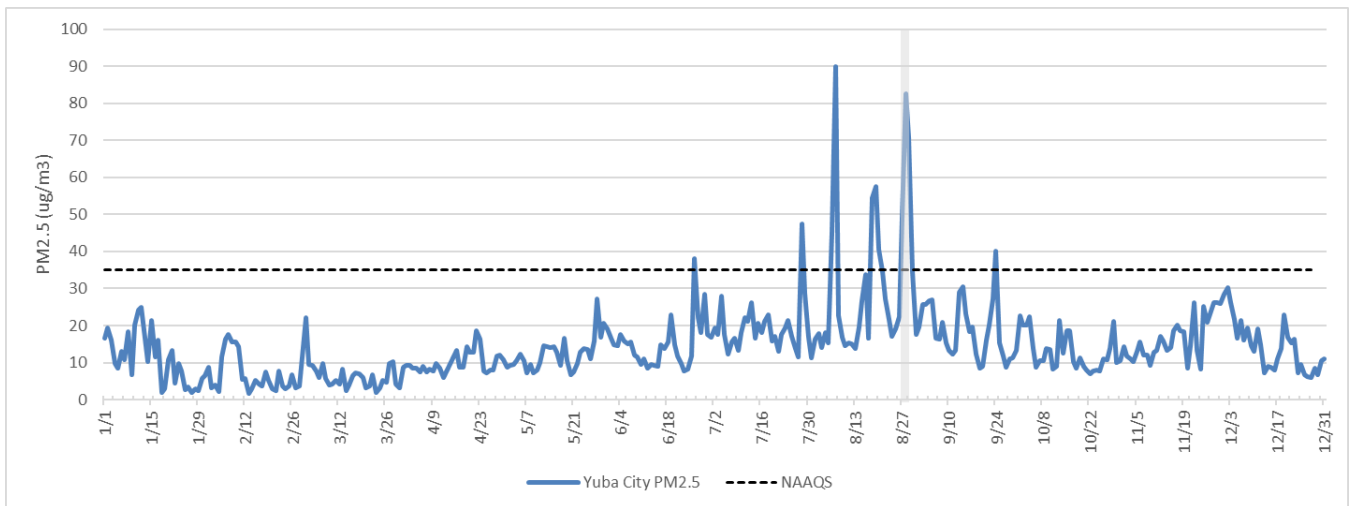
<sup>32</sup> CalEPA/FRAP Fire Perimeters: <https://frap.fire.ca.gov/frap-projects/fire-perimeters/>

**Figure 31: Yuba City 1-hour PM<sub>2.5</sub> Concentrations from August 25 to August 31, 2021**

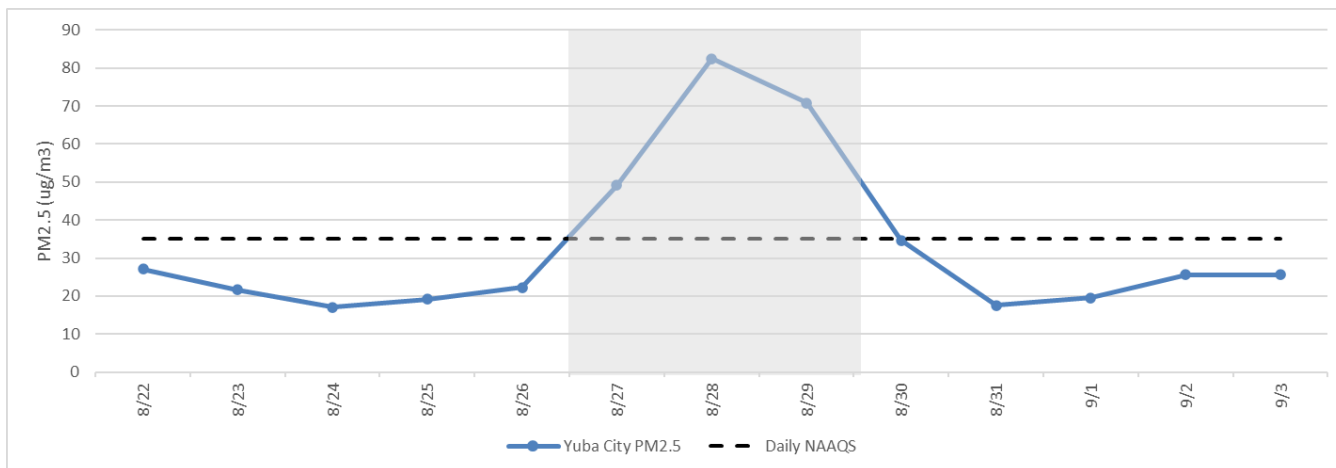


**Figure 32: Daily PM<sub>2.5</sub> Averages at Yuba City in 2021**

a) January 1 to December 31, 2021



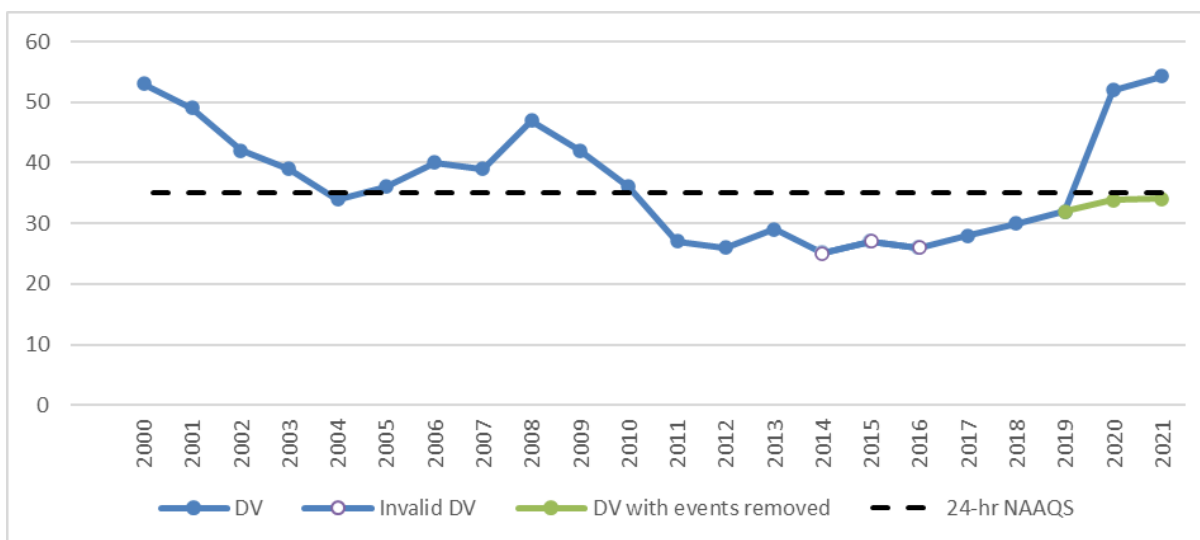
b) August 23 to September 4, 2021



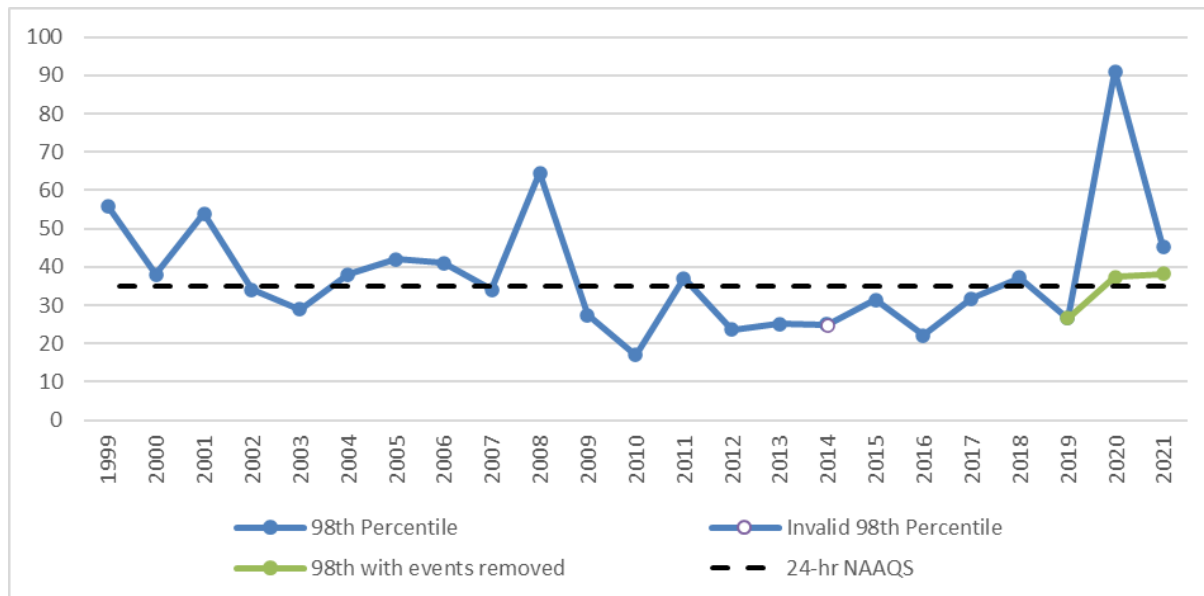
Recent trends show a decrease in PM<sub>2.5</sub> 24-hour design values at the Yuba City monitoring site as shown previously in Figure 2 and again in Figure 33 below. The 2020 and 2021 design values did not follow this trend, rising well above the 24-hour standard. The annual PM<sub>2.5</sub> 98<sup>th</sup> percentiles (Figure 34) have been relatively flat the past ten years, and generally below the standard, with only two years showing an increase, both due to the impacts of wildfire smoke. Exceedances during these two years were not pursued as exceptional events due to a lack of regulatory impact at the time. As previously explained, the 2014 98<sup>th</sup> percentile (shown as a blank marker) is considered invalid due to an incomplete 3<sup>rd</sup> quarter but is still considered representative and used for trend analysis purposes.

Concurrence of the exceptional event dates requested for both the 2020 and 2021 demonstrations will bring the area into attainment of the 2006 PM<sub>2.5</sub> daily standard, aligning with historical trends.

**Figure 33: PM<sub>2.5</sub> design values at Yuba City**



**Figure 34: PM<sub>2.5</sub> 98<sup>th</sup> Percentile Values at Yuba City**



#### IV. Meteorological Conditions

Table 7 lists averages and standard deviations of daily temperatures and resultant wind speeds during the exceptional event periods (as outlined in Table 4: **Summary of Yuba City 2021 PM<sub>2.5</sub> exceedances requested for** ), normal (non-event) days, and all combined days in August 2021 at the Yuba City monitoring site. Although the statistics for only the three requested event days are noted here, there were a total of eight days above the 24-hour standard at the Yuba City monitor in August 2021. Further details of the meteorological conditions on each exceptional event day are included in Table 8. The three event days saw slightly higher average temperatures and slightly lower average wind speeds than the other days in August 2021. The lower average wind speeds on August 28 and August 29 helped keep the area layered with smoke.

**Table 7: Averages and Standard Deviations (SD) of Temperatures (°F) and Resultant Wind Speeds (mph) in 2021**

Exceptional Event Period	Temperature (F)		Wind Speeds (mph)	
	Average	SD	Average	SD
August Event Days	82.33	1.20	1.77	0.17
August Normal Days	78.89	0.87	2.59	0.12
August All	79.23	0.81	2.51	0.12



**Table 8: Maximum Daily Values of PM<sub>2.5</sub>, Temperature, and Resultant Wind Speed on Exceptional Event and Surrounding Days at Yuba City Monitoring Site.<sup>33</sup>**

Date	8/25	8/26	8/27*	8/28*	8/29*	8/30	8/31	9/01
PM <sub>2.5</sub> Hourly Max (µg/m <sup>3</sup> )	41	31	92	105	103	49	52	35
PM <sub>2.5</sub> Daily Average (µg/m <sup>3</sup> )	19.1	22.4	49.2	82.5	70.9	34.7	17.5	19.6
Temperature (°F)	91	98	97	101	103	100	94	83
Wind Speed (mph)	4.6	4.0	5.3	3.7	2.9	5.8	5.2	6.1

\* Denotes Exceptional Event Dates Requested for Data Exclusion

Maximum daily temperatures were in the 90s and low 100s throughout the event. Maximum daily resultant wind speeds generally remained light at 3-6 mph, with the lowest daily maximum wind speeds occurring during the three-day event. Maximum PM<sub>2.5</sub> concentration during the exceedance days ranged from 49.2 µg/m<sup>3</sup> to 82.5 µg/m<sup>3</sup> and hourly maximums ranging from 92 µg/m<sup>3</sup> to 105 µg/m<sup>3</sup>.

The weather data supports that PM<sub>2.5</sub> directly related to wildfire smoke from the wildfires in California affected the Yuba City monitor. Unusual weather, other than the transport of wildfire smoke, was not a factor contributing to the exceptional event.

## V. Air Quality/Health Advisories

The Feather River AQMD maintains a webpage<sup>34</sup> that keeps the public informed of wildfire smoke and air quality impacts as well as utilizing the AirNow Enviroflash Air Quality Notification System through their Air Quality Health Advisory webpage.<sup>35</sup> The District issued several air quality advisories covering all of the event periods. Copies of these are included in Appendix IV. Health Advisories are widely distributed using social media, District website, both County OES social media and websites, faxed to all schools and public agencies in the two counties, and emailed to Enviroflash users. Health Advisories were in effect during all of the days requested for exclusion as exceptional events.

## VI. Media Coverage

Media coverage of the wildfires that occurred throughout the State in 2021 was extensive. Subsequent coverage included the impacts of smoke in communities throughout the districts discussed in this document. An example is given below with other examples found in Appendix V.

<sup>33</sup> CARB Air Quality and Meteorological Information System (AQMIS), <https://www.arb.ca.gov/aqmis2/aqmis2.php>, last accessed 9/13/22

<sup>34</sup> Feather River AQMD, *Wildfire Smoke*, last accessed 8/27/21

<sup>35</sup> Feather River AQMD, *Air Quality Health Advisory*, last accessed 9/30/22

Figure 35: Example of News Media Coverage

## Yuba City home opener called off due to poor air quality from wildfires

By Jeff Larson [jl Larson@appeal democrat.com](mailto:jl Larson@appeal democrat.com)

Aug 27, 2021



Due to air quality ranging in the unhealthy range, Friday's Yuba City-Lincoln varsity and junior varsity football games were canceled.

Photos courtesy of Bill Ollar

## Clear Causal Relationship

This section addresses the “clear causal relationship” criterion as per U.S. EPA’s exceptional events guidance by providing 1) a comparison of the PM<sub>2.5</sub> data requested for exclusion with historical concentrations at the air quality monitor, 2) demonstrating that the wildfire’s emissions were transported to the monitor, 3) show the emissions from the wildfire influenced the monitored concentrations.

This demonstration meets the purpose of U.S. EPA’s published guidance and provides the evidence needed to concur on all requested exceptional event dates in 2021.

The following sections reiterate or provide additional evidence to support the analysis for all requested exceptional event dates.

Evidence that the emissions from the wildfire affected the exceeding monitor.

This requirement is met through evidence shown in the Narrative Conceptual Model section as well as this section, through presentation of increased PM<sub>2.5</sub> concentrations at the monitor and in the surrounding area. Additional news and social media accounts of smoke in the vicinity of the monitor can also be found in Appendix V.

Evidence that the emissions were transported to the monitor.

This requirement is met through evidence given in the Narrative Conceptual Model section as well as Appendices II and III, using both backward trajectory analysis from the monitor at the hour of peak concentrations in each exceedance day as well as forward trajectories from individual wildfires. Satellite imagery, and HMS satellite-derived smoke layers, ceilometer data, and meteorological analyses, are also presented in this section as well as Appendices II and III.

Additional evidence that the emissions caused the exceedance by reaching the ground and affecting the monitors.

This requirement is met through the PM<sub>2.5</sub> concentration and black carbon analyses as well as ceilometer data at the Yuba City airport that show wildfire smoke both aloft and at the surface, corroborating media reports of smoke at ground level.

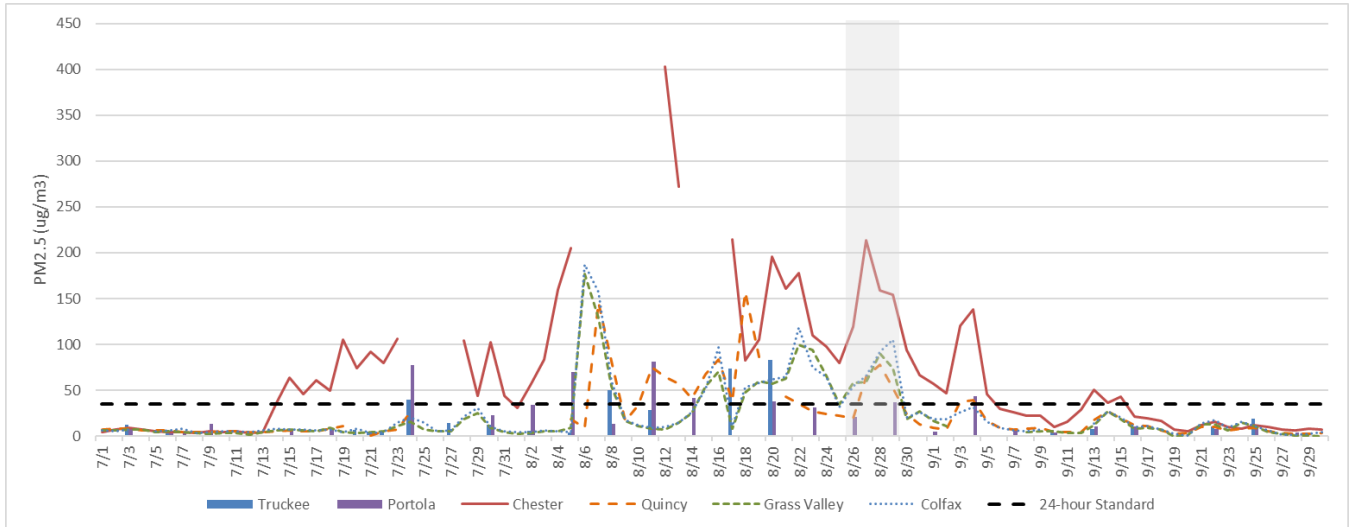
### I. PM<sub>2.5</sub>

#### A. PM<sub>2.5</sub> Regional Concentrations

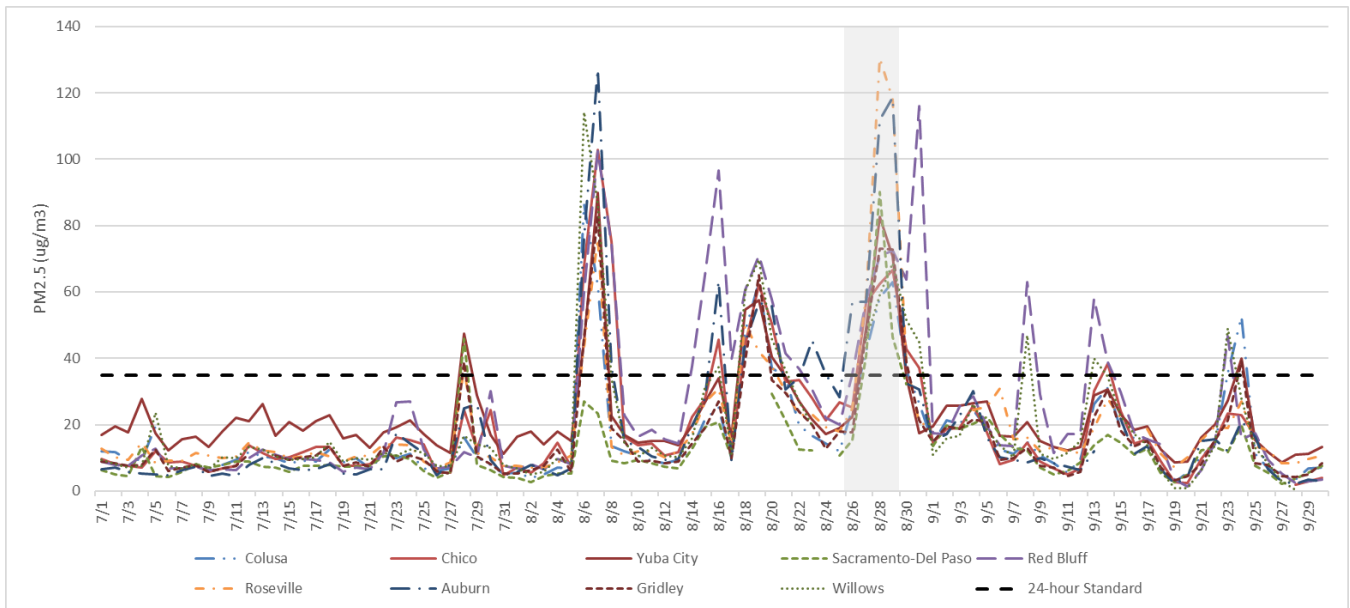
The following figures show elevated PM<sub>2.5</sub> concentrations at multiple sites in the Mountain Counties Air Basin to the east of Yuba City (Figure 36) and throughout the Sacramento Valley Air Basin (Figure 37) during the summer of 2021 and the time of the exceptional events requested for exclusion in this document (grey box). These increased concentrations were a direct result of smoke and emissions from the wildfires in northern California. This supports

that the wildfire smoke and emissions were widespread across the region and directly impacted monitors at the surface during the event period of August 27 to August 29.

**Figure 36: Daily PM<sub>2.5</sub> at selected sites in the Mountain Counties Air Basin**



**Figure 37: Daily PM<sub>2.5</sub> at selected sites in the Sacramento Valley Air Basin**

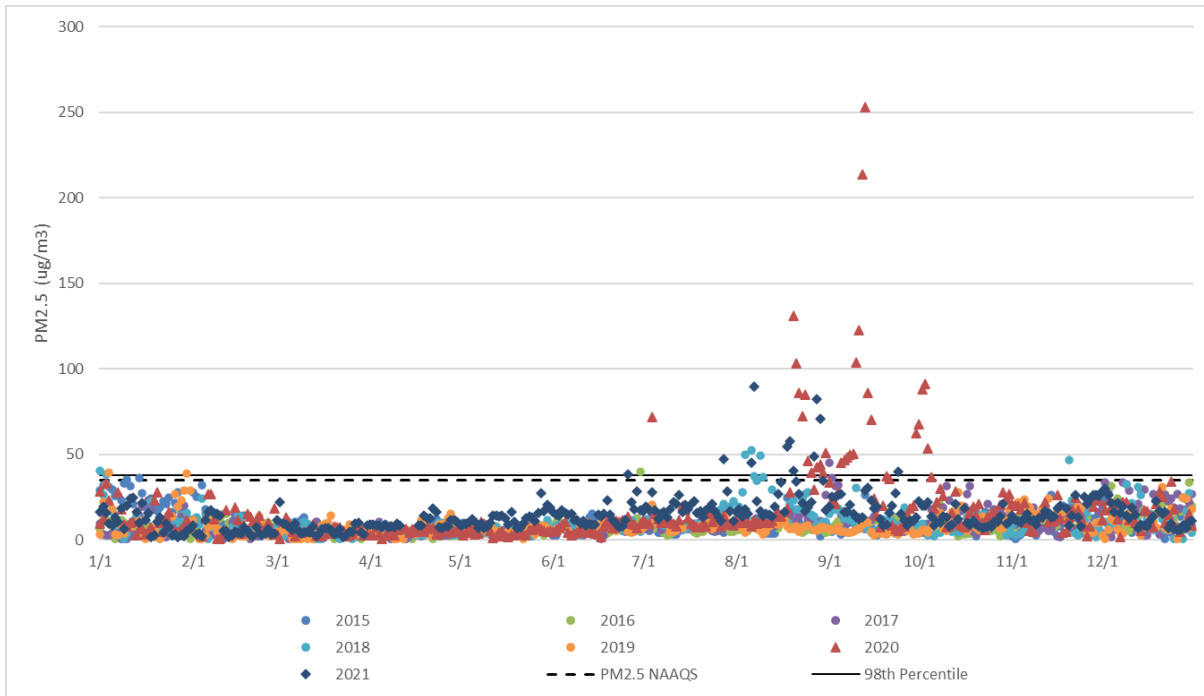


## B. Historical PM<sub>2.5</sub> Concentrations

Historically, PM<sub>2.5</sub> concentrations at the Yuba City monitor fall well below the PM<sub>2.5</sub> daily NAAQS (Figure 38). Concentrations above the standard and above the 98<sup>th</sup> percentile ranking (including the days requested for exclusion), particularly during the 2<sup>nd</sup> and 3<sup>rd</sup> quarters, were the result of smoke from numerous wildfires, mostly in 2018, 2020, and 2021 (the 2020 exceedance not attributable to wildfire smoke in this period was on July 4).

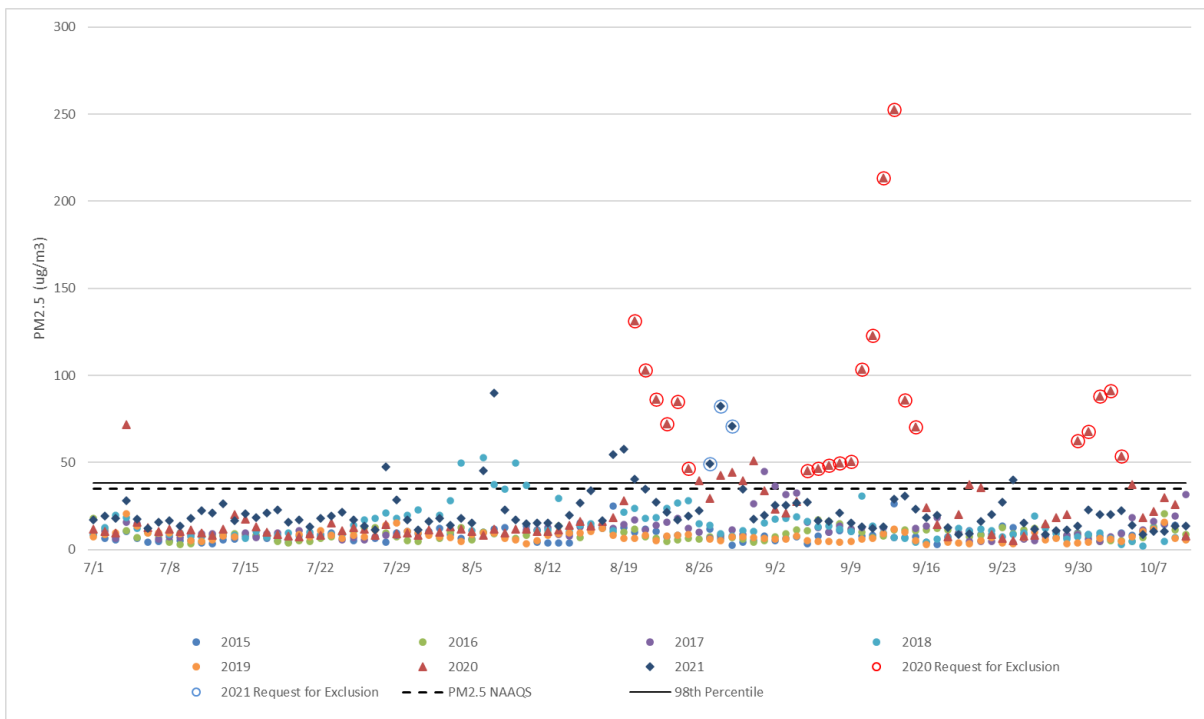


**Figure 38: Yuba City PM2.5 daily averages by day of year for 2015-2021**



A closer look at third quarter data from 2015 to 2021 shows that all days requested for exclusion in 2020 and in 2021 (circled), and some requested but not needed for this regulatory determination, are above the 98<sup>th</sup> percentile (Figure 39).

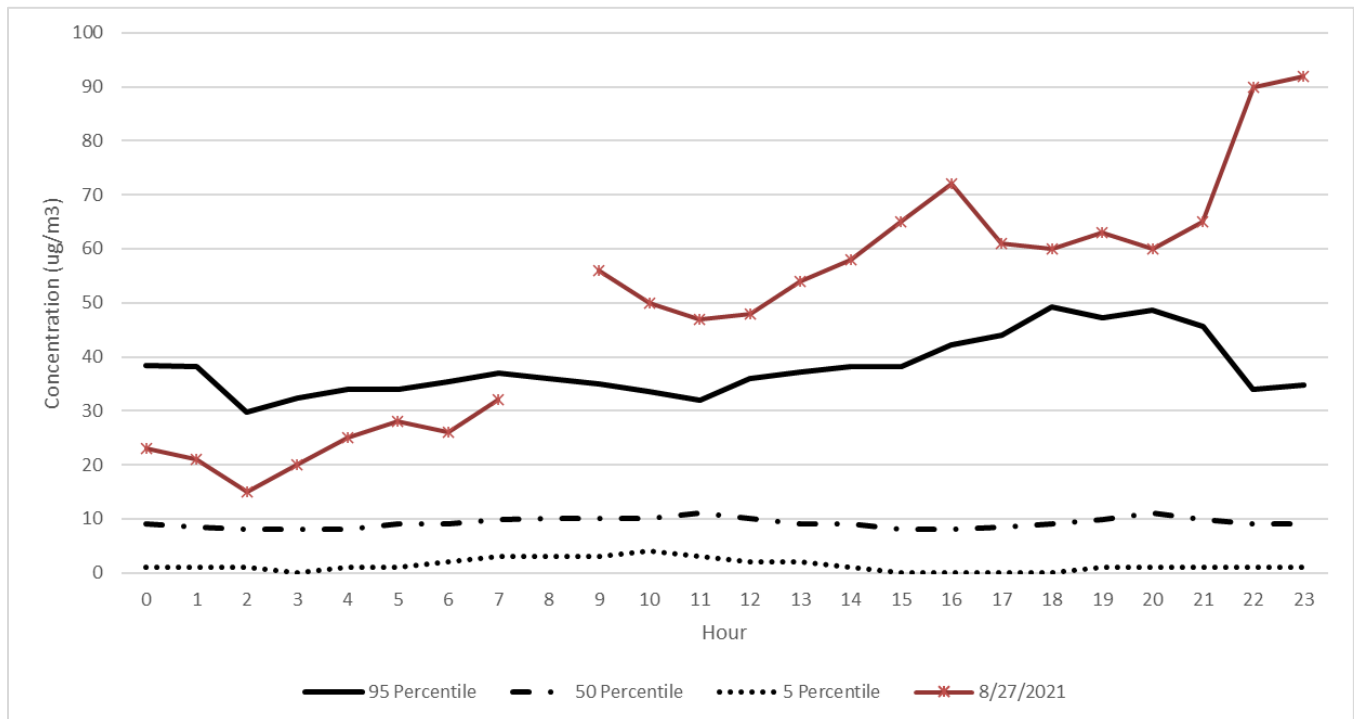
**Figure 39: Yuba City PM2.5 daily averages from July 1 to October 10, 2015-2021**



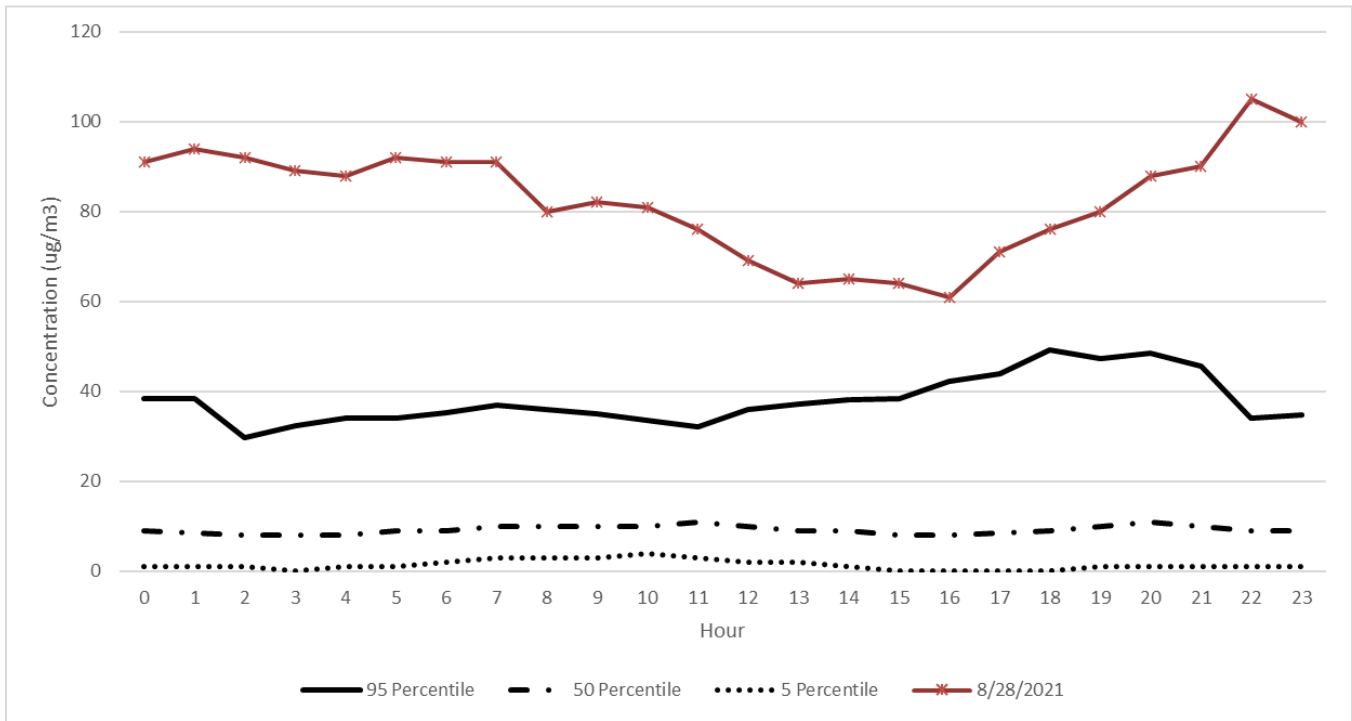
### C. Diurnal Comparison

The following figures compare the daily diurnal pattern for each of the three exceedance days in the event period with the hourly diurnal percentiles for PM<sub>2.5</sub> for the third quarter (July to September) from 2015 to 2019. These figures show that during these three days the pattern was unusual compared to the percentiles of each site’s typical diurnal pattern with unusually timed peaks or spikes. As previously noted, one hour on August 27 was not recorded, resulting in a break in the diurnal pattern. The rise in concentrations on the 27<sup>th</sup>, the fairly steady high concentrations on the 28<sup>th</sup>, and the decrease throughout the day on the 29<sup>th</sup>, show the ongoing presence of wildfire smoke emissions and are consistent with the meteorological analyses presented earlier. These diurnal figures support that the exceedance days were unusual compared to historical patterns and act as supporting evidence that wildfire emissions directly impacted PM<sub>2.5</sub> concentrations at each site.

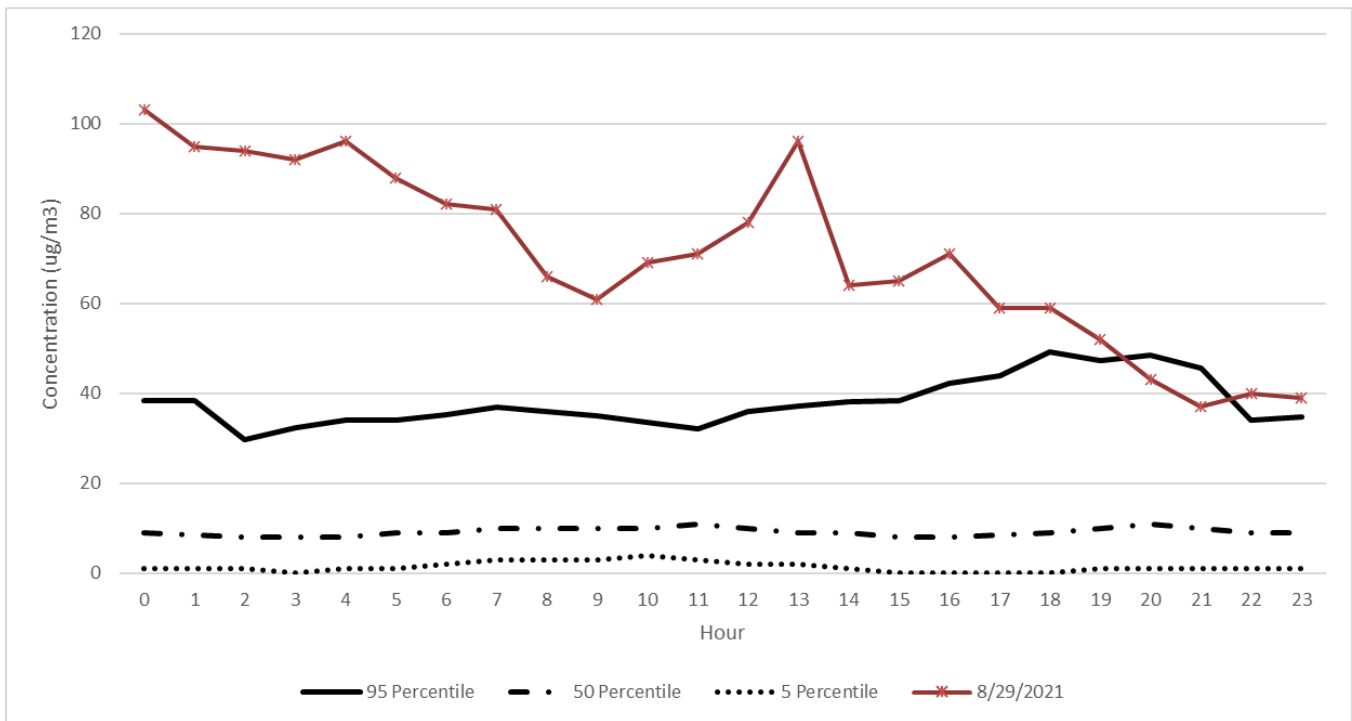
**Figure 40: Percentiles for 3<sup>rd</sup> quarter PM<sub>2.5</sub> for 2015-2019 compared with August 27, 2021**



**Figure 41: Percentiles for 3<sup>rd</sup> quarter PM2.5 for 2015-2019 compared with August 28, 2021**



**Figure 42: Percentiles for 3<sup>rd</sup> quarter PM2.5 for 2015-2019 compared with August 29, 2021**

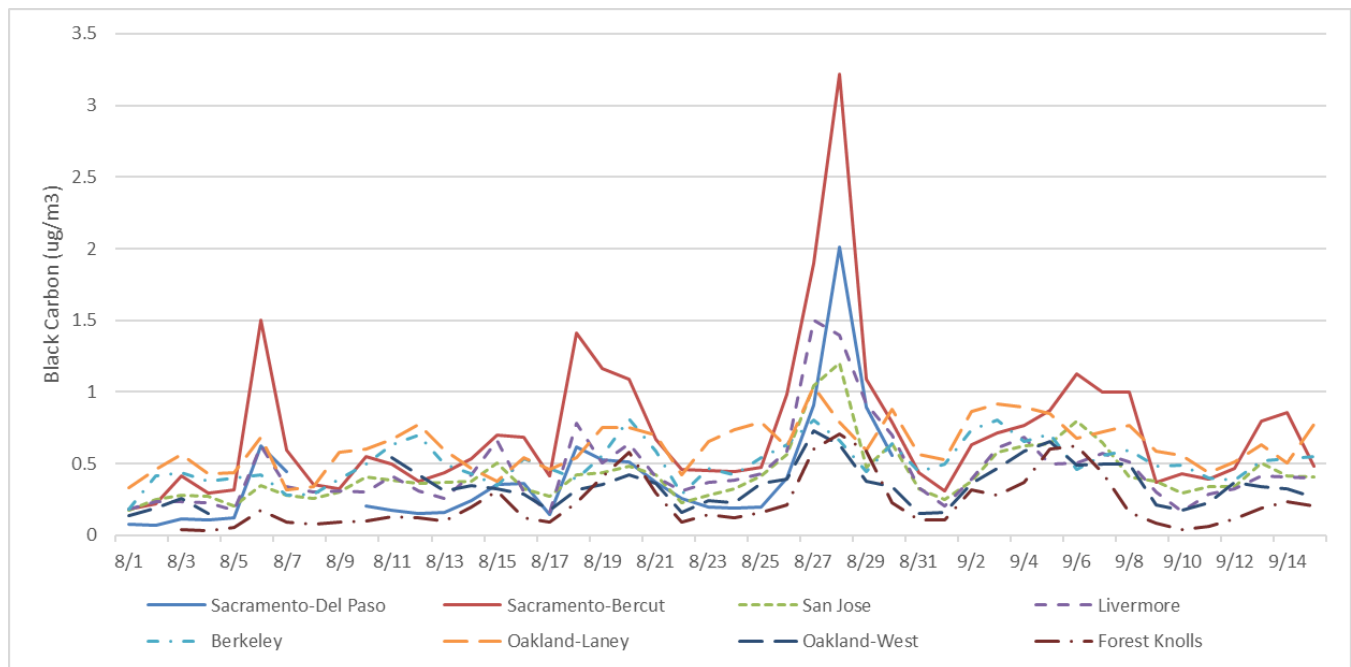


## II. Biomass Burning Indicators

Levoglucosan, Mannosan, and Galactosan, organic compounds produced during biomass combustion, are commonly used as woodsmoke tracers. Sites with monitors that measure these compounds were placed at Portola in Plumas County in the MCAB and in Chico and Sacramento-T Street in the SVAB, to aid in the analysis of woodstove use. Unfortunately, these sites were established to track smoke from woodburning heating devices and do not consistently monitor during the summer months.

Fires that burn at relatively low temperatures and smolder in moist fuels are the most likely to produce black carbon (BC) and other toxic pollutants because they tend to burn less completely than hotter fires burning through dry fuels. Wildfires are a major source of black carbon emissions in California, far surpassing vehicle emissions, wood stoves, industrial emissions, agricultural fires, and other sources of the pollutant.<sup>36</sup> BC is measured as a form of PM, with an increase in BC contributing to an increase in PM measurements. BC is monitored at several sites in northern California, with the closest two in Sacramento. All sites showed an increase in BC at the time of the three-day event from August 27 to August 29.

**Figure 43: Daily average black carbon, August 1 to September 14**

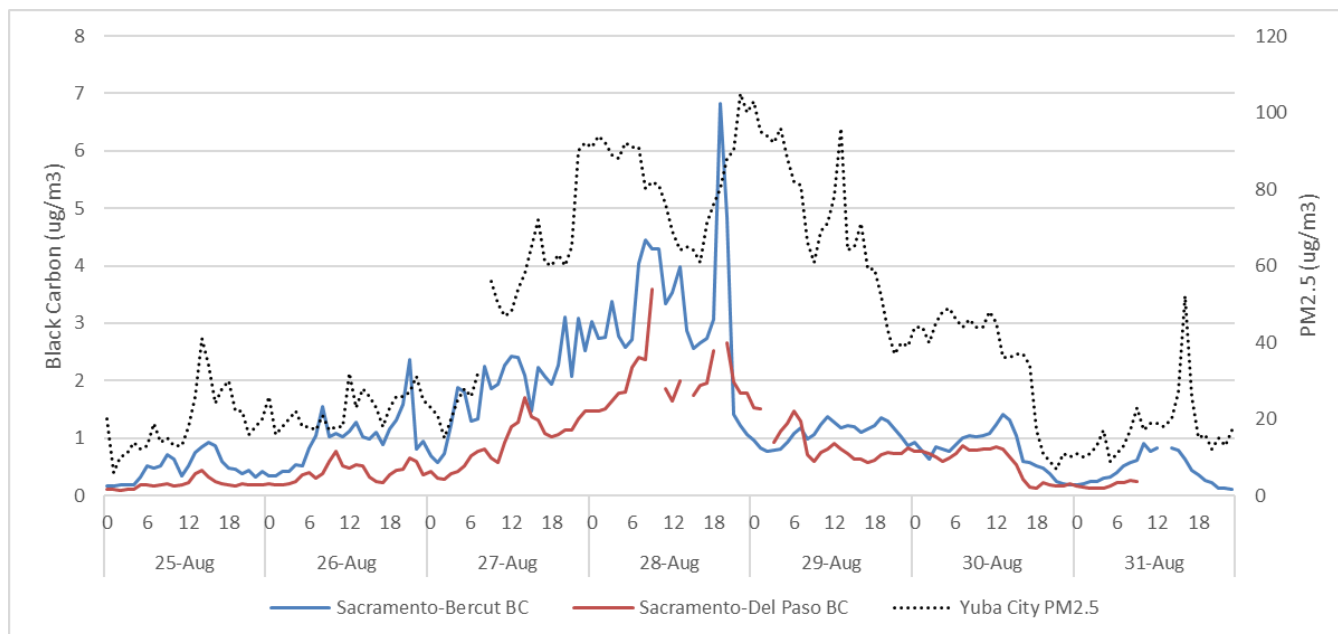


A comparison of hourly BC at the two Sacramento sites, the closest to the Yuba City monitor, and hourly PM<sub>2.5</sub> at the Yuba City monitor showed a good correlation, considering the 40 mile distance between Sacramento and Yuba City.

<sup>36</sup> Proposed Short-Lived Climate Pollutant Reduction Strategy (April 2016, page 49)  
<https://ww2.arb.ca.gov/sites/default/files/2021-01/ProposedStrategy-April2016.pdf>



Figure 44: Hourly black carbon and PM2.5, August 25 to 31



### III. Additional Supporting Ground-Level Evidence

#### A. Area Forecast Discussions

In the days prior to the first of the wildfire smoke event addressed in this document, Area Forecast Discussions issued by the National Weather Service (NWS) Sacramento Office (STO) were focused on a trough that pushed inland, setting up the building of an upper level ridge over the Pacific. As previously stated, this increased the north to south pressure gradients, resulting in increased windy conditions which spread smoke across northern California. When the upper level flow pattern began to flatten, north winds continued to facilitate the transport of smoke into the Sacramento Valley. This pattern changed on the last day of the event period, when the ridge moved eastward and an upper level trough began to form off the west coast, allowing for the development of onshore winds that pushed the smoke toward the east and northeast and away from the Yuba City monitor. A sampling of Area Forecast Discussions from the NWS Sacramento forecast office are included in Appendix II, with Figure 45 shown as an example.

Figure 45: NWS Area Forecast Discussion – August 27, 2021, 02:29 PM PDT

446

FXUS66 KSTO 272129

AFDSTO

Area Forecast Discussion

National Weather Service Sacramento CA

229 PM PDT Fri Aug 27 2021

.SYNOPSIS...

Hot and very dry through the weekend. Locally breezy north winds will lead to areas of critical fire weather conditions over the northern Sacramento Valley into Saturday morning, with a Red Flag Warning in effect. Cooler weather returns next week. Breezy southwest winds early next week over Sierra ridges.

&&

.DISCUSSION...

Satellite shows smoky skies across much of the area. Northerly flow has brought wildfire smoke down through the Valley. Easterly flow in the morning brought dense smoke into the Motherlode and eastern Sacramento suburbs. The diurnal flow has reversed, with westerly winds shifting some of the denser smoke in those areas further to the east. The HRRR smoke model shows this pattern reversing overnight, with dense smoke bake into the Motherlode and eastern Sacramento suburbs by early Saturday. Smoke continues to be an issue across the area through the weekend. For air quality forecasts check with your local air quality district or [AirNow.gov](https://airnow.gov).

Northerly winds and low humidity have brought Red Flag conditions to the northern and central Sacramento Valley and surrounding areas today. Redding currently has a humidity down to 9% with winds gusting to 25 mph. Gusts of 25-30 mph are likely over the northern half of the valley, and locally further south along the western edge. Winds should gradually decrease overnight, but overnight recoveries should be poor to moderate (25-40%) and winds should pick up again early Saturday. The Red Flag Warning continues until 11 am Saturday.

## B. Smoke Indications

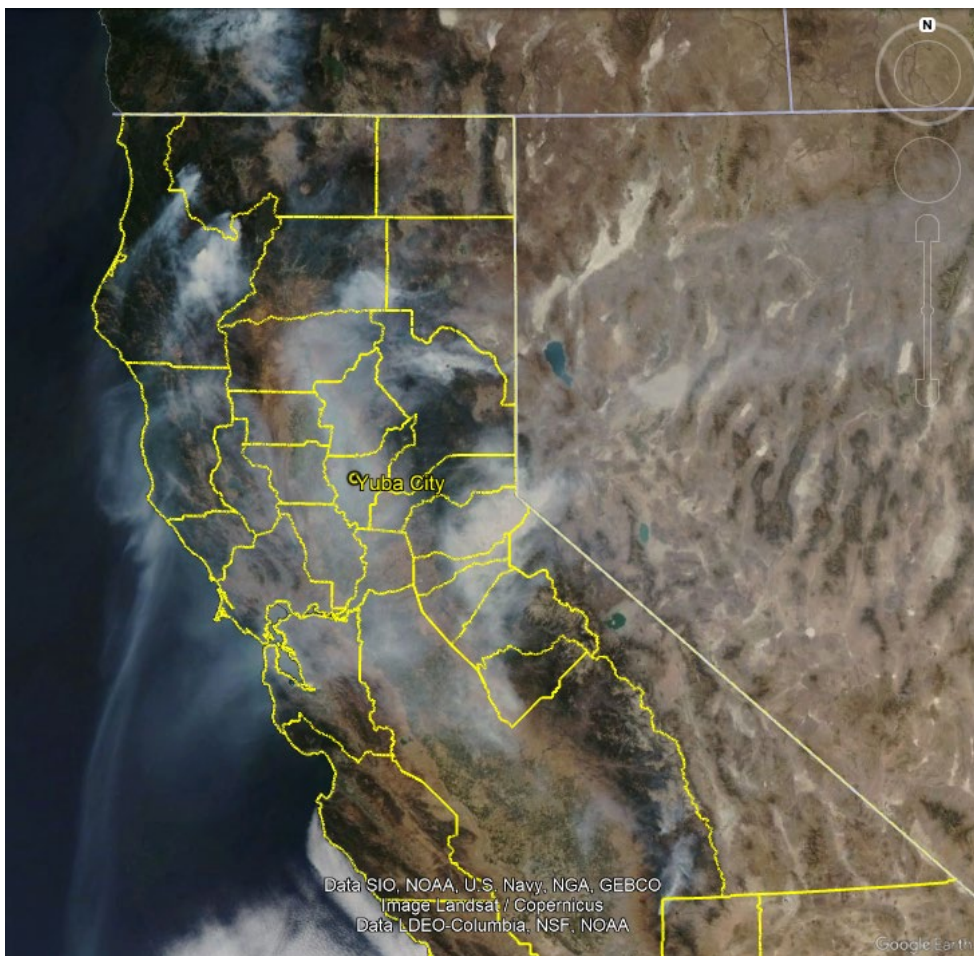
The smoke reaching the Yuba City monitor in late-August was primarily from wildfires that occurred on either side the Sacramento Valley. Smoke from these fires blanketed northern portions of California and several tools are available to look for this smoke that impacted the monitor.

### a) Satellite Imagery

Google Earth was used as a platform to overlay locations of active wildfires with th NOAA Aqua MODIS satellite<sup>37</sup> imagery (Figure 46). Other satellite images in this document may use those obtained from the Suomi National Polar-orbiting Partnership (Suomi NPP).

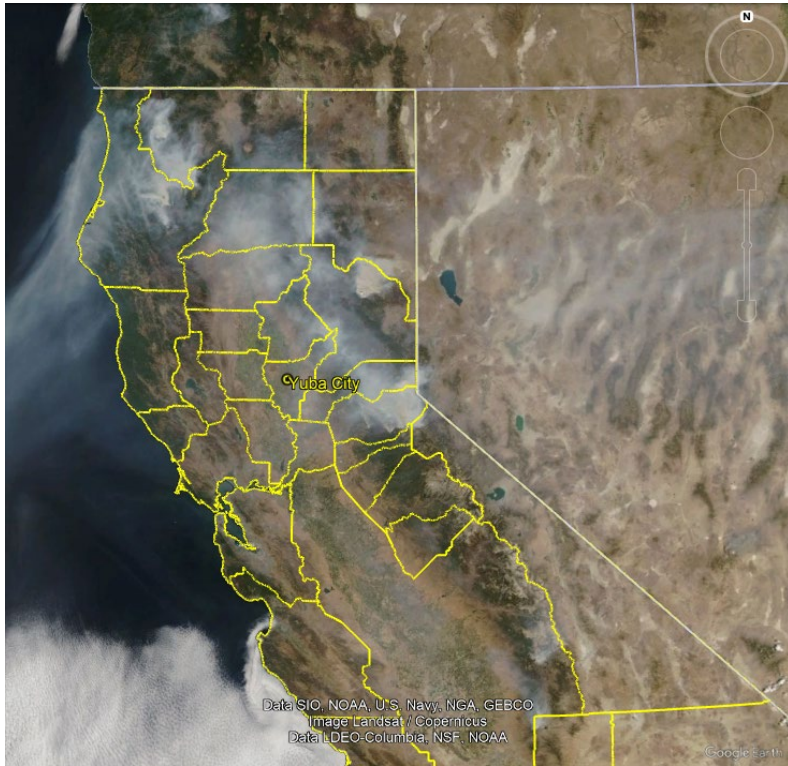
**Figure 46: Aqua MODIS Satellite imagery for the event period**

a) August 27, 2021

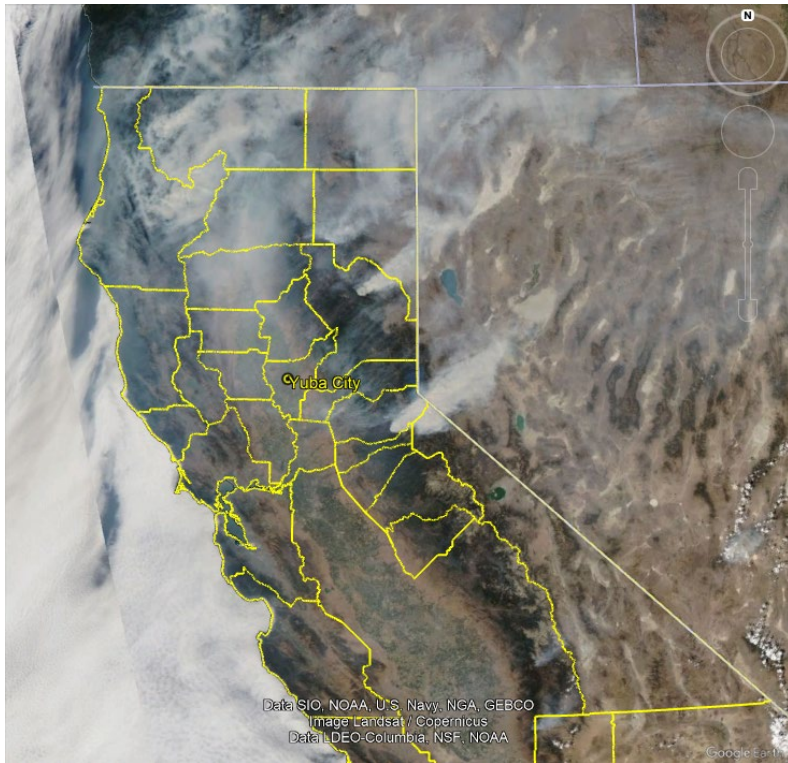


<sup>37</sup> NASA EOSDIS Worldview, <https://worldview.earthdata.nasa.gov/>, last accessed 9/19/22

b) August 28, 2021



c) August 29, 2021

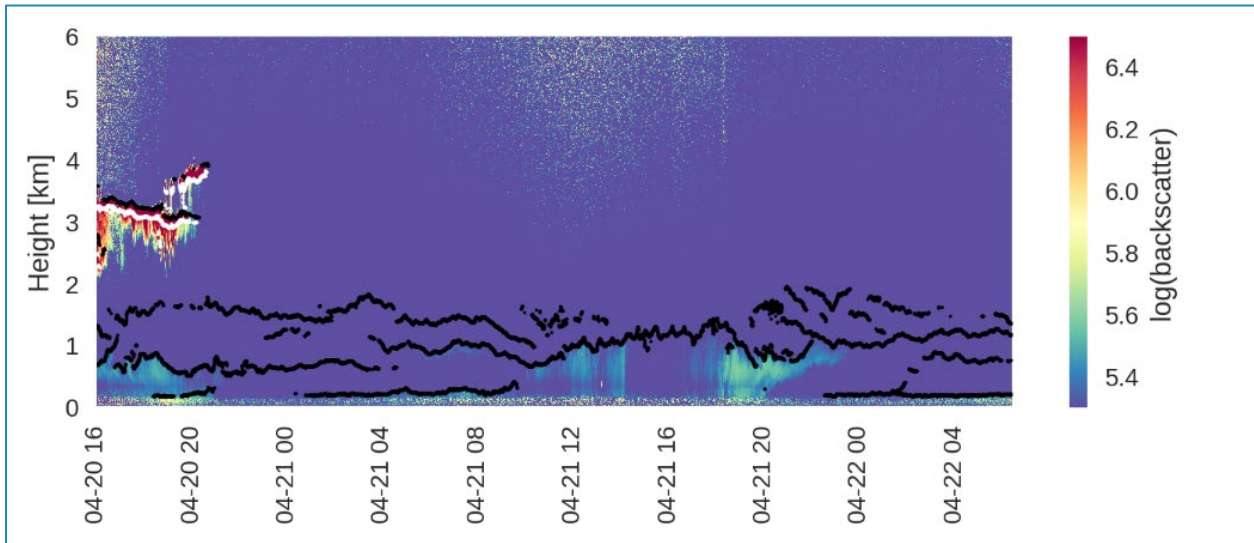




## b) Ceilometer Data

A ceilometer is an automatic, active, remote-sensing instrument primarily for detecting the presence of clouds overhead and measuring the height of their bases.<sup>38</sup> LiDAR ceilometers are also able to detect aerosols such as wildfire smoke aloft, with the density of aerosols being relative to the measured backscatter values. The example in Figure 47 shows a typical ceilometer backscatter plot with clouds between 2-4km and otherwise clean air for the rest of the period shown.

**Figure 47: Example of ceilometer data for a clean period, April 20, 2020, 4pm through April 22, 2020, 4am at Yuba City.**

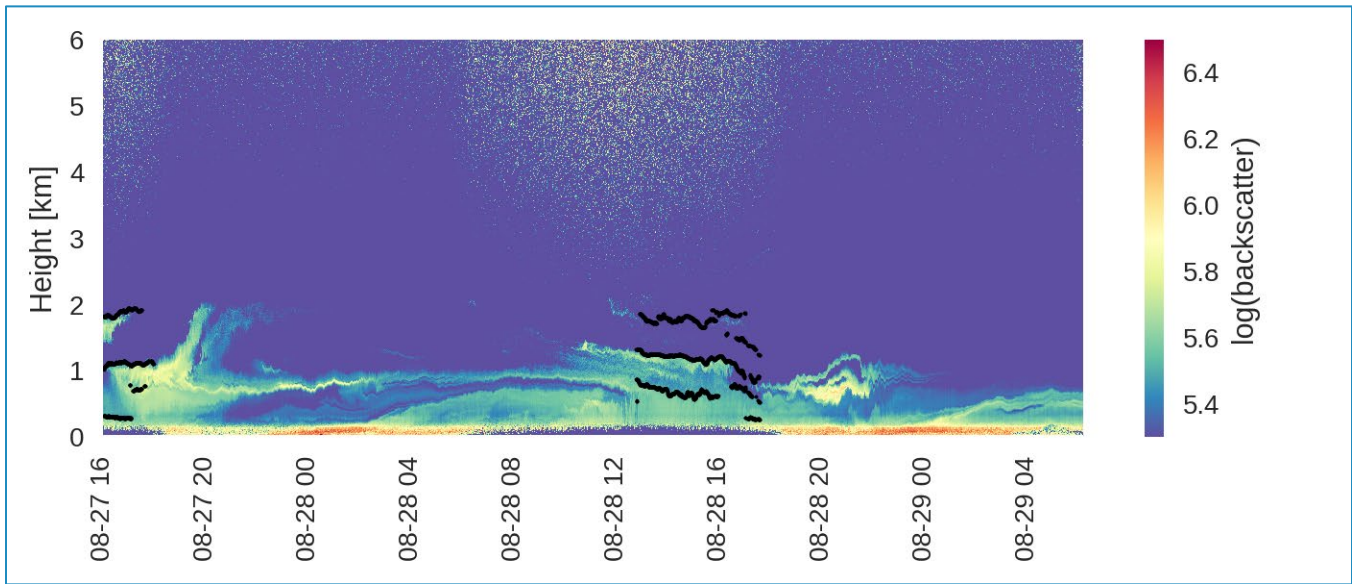


During the fires from August 27 through 29, ceilometer data shows high density aerosol backscatter close to the ground and aloft within the atmosphere, mixing up to 1 km. The data (Figure 48) shows high density aerosol backscatter hugging the surface from late in the day on August 27 through early morning on August 28 and then again late on August 28 into the early morning of August 29. This correlates well with the hourly  $PM_{2.5}$  concentrations seen earlier, with concentrations rising late on the 27<sup>th</sup>, peaking in the late hours of the 27<sup>th</sup> and early hours of the 28<sup>th</sup>, decreasing in the morning of the 28<sup>th</sup>, and increasing again in the late hours of the 28<sup>th</sup> and early morning of the 29<sup>th</sup> before decreasing to more normal conditions (Figure 31 and Figure 49).

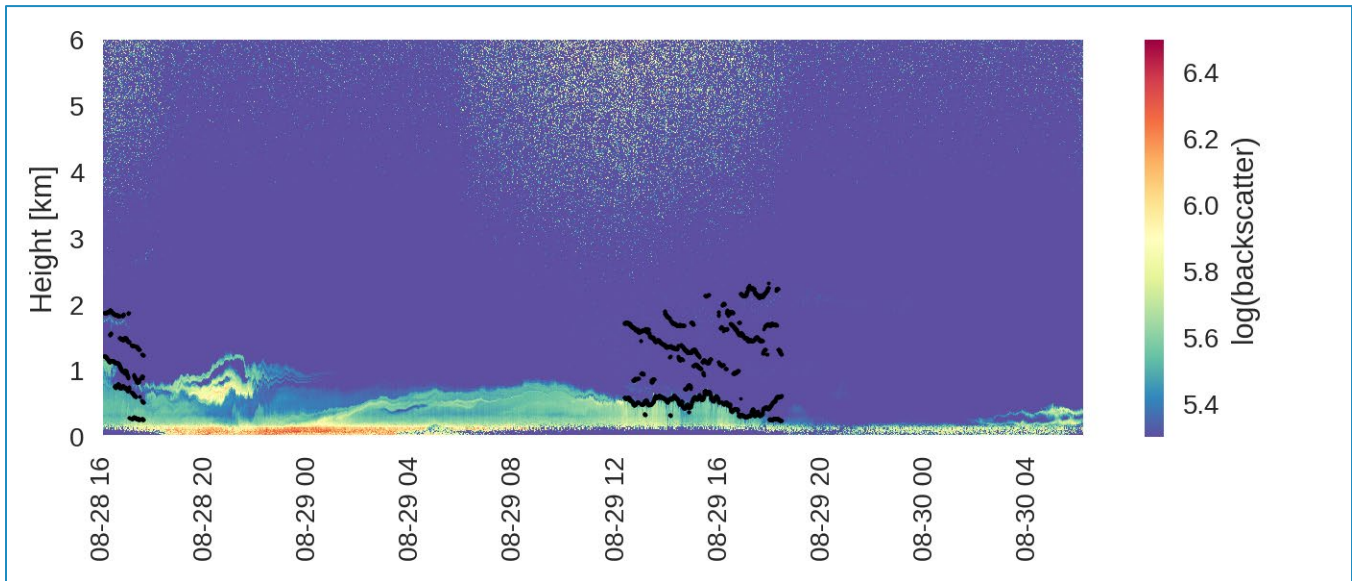
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<sup>38</sup> <https://glossary.ametsoc.org/wiki/Ceilometer>, accessed 10/19/21

**Figure 48: Ceilometer data for August 27 4pm through August 29 4am at Yuba City.**



**Figure 49: Ceilometer data for August 28 4pm to August 30 4am at Yuba City.**

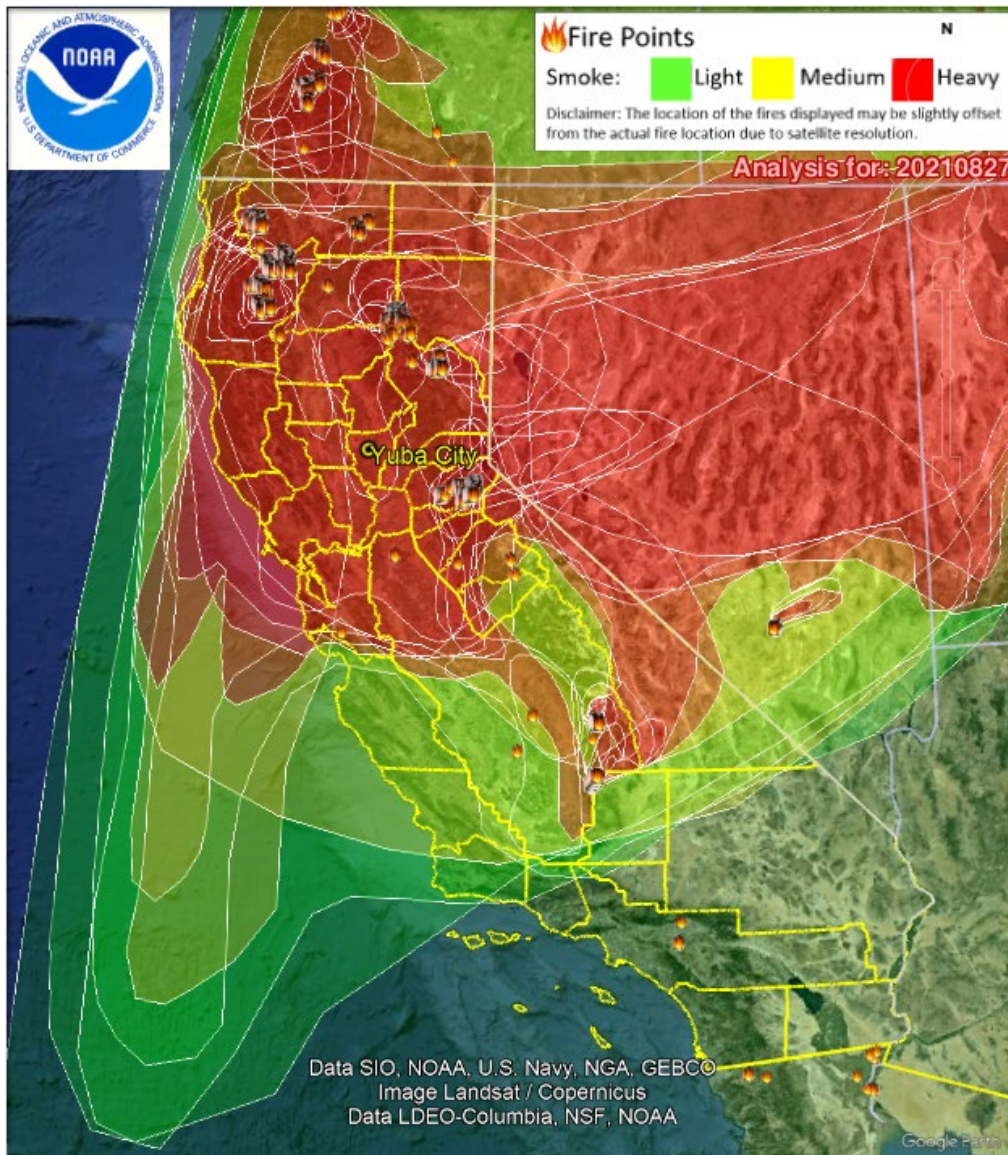


### **c) Hazard and Mapping System Smoke Layers**

The NOAA Hazard and Mapping System (HMS) Fire and Smoke Product is an analysis of various satellite imagery to map out the scope and even to some extent thickness of smoke layers as well as fire locations. These products were extensively utilized in the Narrative Conceptual Model and Clear Causal Relationship sections of this document. The HMS smoke layers for the three days of this event period are shown in Figure 50. The images show the heavy smoke over northern California on August 27 and 28, along with the decreasing smoke on August 29, correlating to both the hourly  $PM_{2.5}$  and ceilometer data discussed previously.

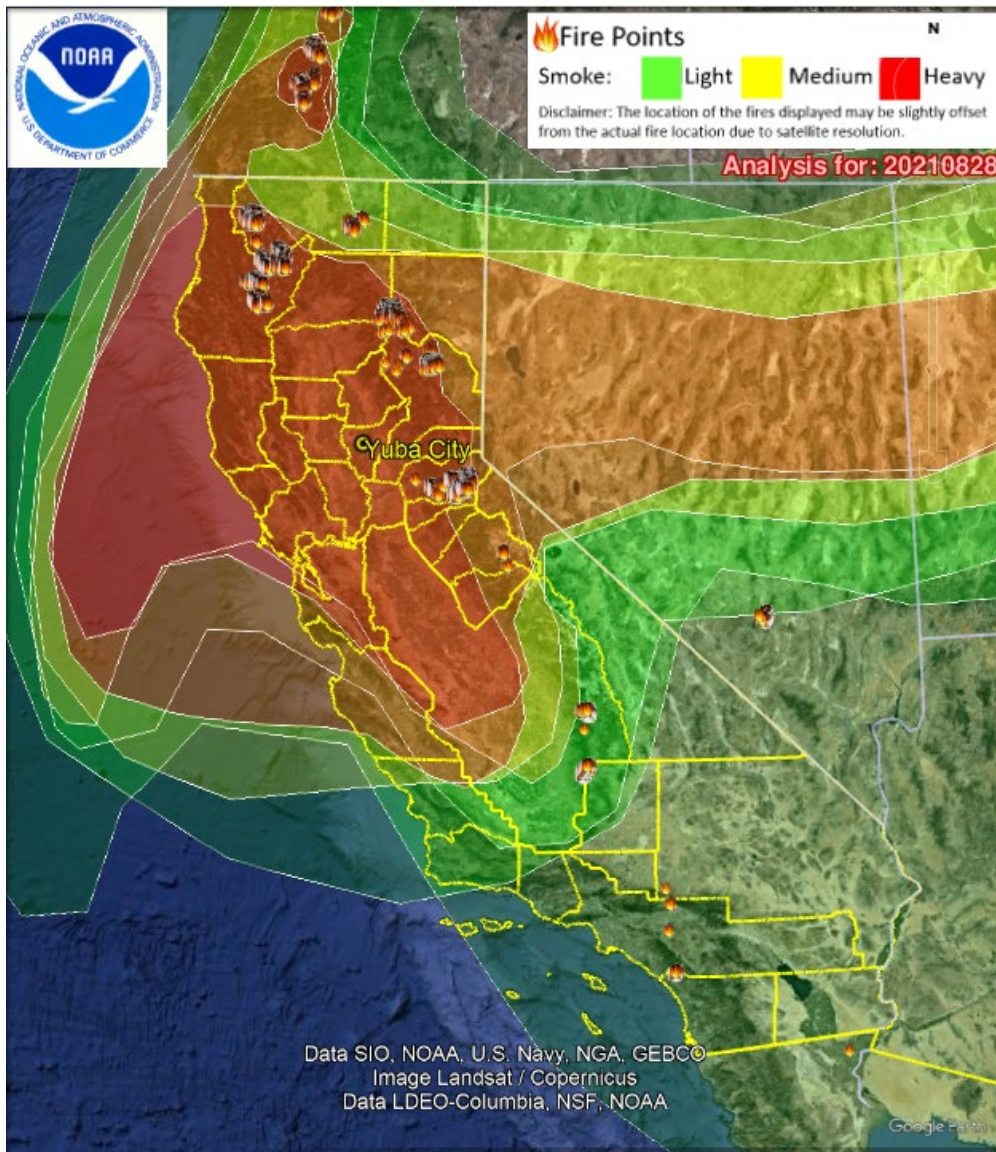
Figure 50: HMS Smoke Layers for the event period

a) August 27, 2021



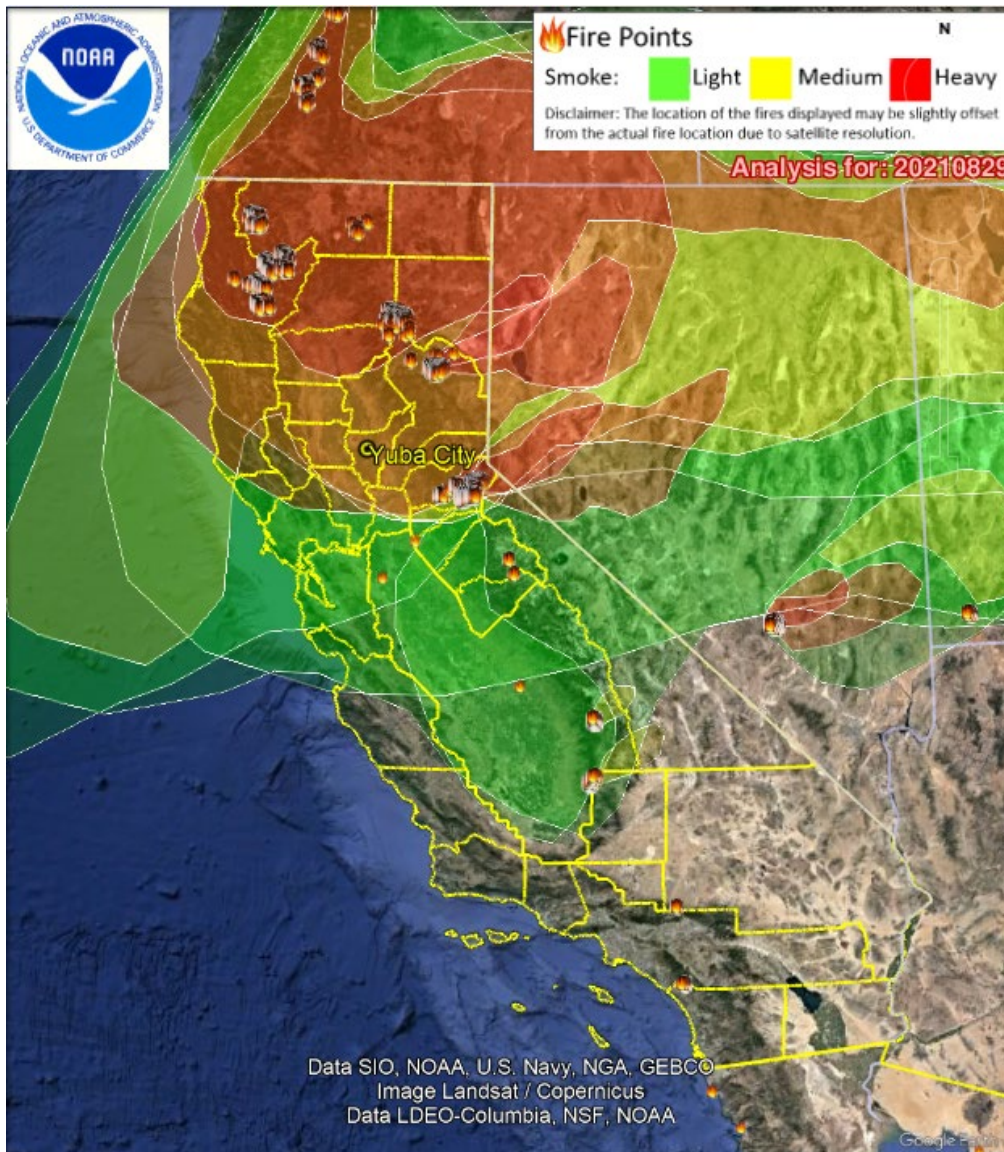


b) August 28, 2021





c) August 29, 2021



### d) NOAA Smoke Text Product

NOAA Smoke Text Product<sup>39</sup> is a text-based analysis of satellite imagery. These products are used to give an overall view of smoke origins, current locations, and potential transport. Unfortunately, the Smoke Text Product was not available for all of 2021.

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<sup>39</sup> NOAA Hazard and Mapping System (HMS), *Fire and Smoke Text Product*, last accessed 7/29/21

## e) NOAA HRRR-Smoke Model

Finally, the NOAA's High-Resolution Rapid Refresh Smoke (HRRR-Smoke),<sup>40</sup> a weather-smoke model that allows for the simulation of smoke dispersion over complex terrain, showed extensive smoke (expressed in  $\mu\text{g}/\text{m}^3$ ) at near surface levels throughout northern California and in the Yuba City area. The modeling results corresponding to the hours of high concentrations at the Yuba City monitor can be seen in previously presented Figures Figure 22, Figure 26, and Figure 30.

### IV. Summary

Smoke from several large wildfires in northern California generated emissions that directly resulted in elevated  $\text{PM}_{2.5}$  concentrations at the Yuba City Monitor in the Feather River AQMD. Inspection of  $\text{PM}_{2.5}$  concentrations, satellite-derived smoke layers, and modeled trajectories indicate pathways for the transport of smoke from the wildfires in northern and central California.

The three requested dates for exclusion were in the 95<sup>th</sup> percentile or higher of the prior 5-year distribution of daily  $\text{PM}_{2.5}$  data.  $\text{PM}_{2.5}$  concentration data, area forecast discussions, satellite smoke products, and ceilometer data all indicated periods of wildfire smoke aloft and at the surface during the requested event dates. Daily diurnal comparison graphs show the days exhibited abnormal patterns and unusually timed peaks due to the impacts of wildfire emissions.

The comparisons and analyses provided in the Narrative Conceptual Model and Clear Causal Relationship sections of this demonstration support our conclusion that the numerous wildfire events affected air quality in such a way that there exists a clear causal relationship between the monitoring exceedances or violations as listed in Table 4: Summary of Yuba City 2021  $\text{PM}_{2.5}$  exceedances requested for and thus satisfies the clear causal relationship criteria.

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<sup>40</sup> NOAA HRRR Smoke Modeling Graphics (older), <https://rapidrefresh.noaa.gov/hrrr/HRRRsmokeold/>, last accessed 11/18/22

## Natural Event/Human Activity Unlikely to Recur

The Background and Narrative Conceptual Model chapters of this document provide evidence that the event qualifies as a "Natural Event" as defined in 40 CFR 50.1(k). The fires that impacted the exceeding monitor at Yuba City occurred on wildlands that meet the definition in 40 CFR 50.1(n) and (o). When considering fire cause, "wildfires on wildland initiated by accident or arson are considered natural events, and on a case-by-case basis this treatment for wildfires may bear on the appropriate treatment of accidental and arson-set structural fires."<sup>41</sup>

U.S. EPA generally considers the PM emissions from wildfires on wildland to meet the regulatory definition of a natural event at 40 CFR 50.1(k), and accordingly, FRAQMD and CARB have shown that this event is a natural event and may be considered for treatment as an exceptional event.

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<sup>41</sup> 81 FR 68233, Footnote 35

## Not Reasonably Controllable and/or Not Reasonably Preventable

The Background and Narrative Conceptual Model sections of this document provide evidence the wildfires impacting the PM<sub>2.5</sub> monitor Yuba City in the Feather River AQMD were natural events predominantly occurring on wildland. Feather River AQMD and CARB are not aware of any evidence clearly demonstrating that prevention or control efforts beyond those actually made would have been reasonable. Therefore, emissions from the wildfires were not reasonably controllable nor reasonably preventable.

Further, all open burning from agricultural and residential sources was prohibited during the dates requested for exclusion at elevations above 3000 feet and limited on the Valley floor.<sup>42</sup>

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<sup>42</sup> California Air Resources Board, Agricultural and Prescribed Burn Monthly Decisions, <https://ww2.arb.ca.gov/ag-rx-burn-monthly-decisions>, last accessed 1/4/23.



## **Public Notification**

As presented in the Narrative Conceptual Model chapter, the Feather River AQMD maintains a public alert system as well as publicly available information via their website to keep residents informed of potential wildfire smoke impacts. Examples of the information released to the public is included in Appendix IV and V.

Feather River AQMD will hold a 30-day public comment period to solicit public input regarding this demonstration. Notification of the public comment period will be posted on the Feather River AQMD website and emailed to interested stakeholders. Any comments received, and the District's responses, will be submitted to CARB and U.S. EPA at the end of the 30-day public comment period.

## Summary/Conclusion

The wildfires in Table 9 below were discussed as part of the retroactive analyses as potentially direct, significant contributors to the exceptional events being requested in this demonstration. These fires ultimately consumed almost two million acres of wildlands in California and were all active producers of vast amounts of wildfire smoke and emissions.

**Table 9: Total Acreage Consumed by Wildfires**

Fire Name	Acreage
Antelope Fire	145,632
Bennett Fire	59
Caldor Fire	221,835
Dixie Fire	963,309
McCash Fire	94,962
Monument Fire	223,124
River Complex	199,359
Tamarack Fire	68,637

During the event periods of August 27 to August 29, wildfire smoke blanketed vast portions of central and northern California, often settling into valleys and foothills when conditions allowed. Air quality monitors across the region showed elevated PM<sub>2.5</sub> throughout the Sacramento Valley and Mountain Counties Air Basins, indicating smoke impacts at the surface. Ceilometer data detected wildfire smoke transported aloft and at the surface. National Weather Service Area Forecast Discussions, satellite imagery, HMS smoke and fire layers, and HRRR-Smoke models advised of widespread smoke across California impacting surface locations.

This 2021 Feather River PM<sub>2.5</sub> Exceptional Events Demonstration supports the criteria for an exceptional event as detailed in the 2016 Exceptional Events Rule.<sup>43</sup> This documentation used the following evidence to demonstrate the exceptional event:

- Ambient air monitoring data
- HYSPLIT forward and backward trajectory analyses
- Satellite imagery and narratives
- Statistical historical concentration comparisons
- Meteorological conditions
- Air Quality District alerts and advisories
- Ceilometer data
- NOAA and HMS smoke products, including HRRR-Smoke model results

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<sup>43</sup> 81 FR 68216

This Exceptional Events Demonstration clearly demonstrates justification for exclusion of data as listed in Table 4: Summary of Yuba City 2021 PM<sub>2.5</sub> exceedances requested for due to an exceptional event under 40 CFR 50.14(c)(3)(iv). The 2021 Feather River PM<sub>2.5</sub> Exceptional Events Demonstration has provided evidence that:

- Describes the events causing the exceedance and a discussion of how emissions from the event led to the exceedance at each monitor;
- Demonstrates a clear causal relationship between the wildfire emissions and the PM exceedances at the Yuba City monitor for the requested dates;
- Shows that event-influenced concentrations were unusual and above normal historical concentrations;
- Demonstrates the event was neither reasonably controllable nor reasonably preventable; and
- Verifies the event was multiple wildfires, all natural events or human activity that is unlikely to recur at a particular location, all occurring predominantly on wildlands.

**Table 10: Summary of Demonstration Criteria based on EER Requirements**

Demonstration Requirement	Reference	Page
Narrative conceptual model	40 CFR 5.014(c)(3)(iv)(A)	11-44, Appendices I, II
Clear causal relationship	40 CFR 50.14(c)(3)(iv)(B)	45-60, Appendices II, III, IV
Historical analysis	40 CFR 50.14(c)(3)(iv)(C)	4, 9-10, 39-42, 46-47
Human Activity Unlikely to Recur or Natural Event	40 CFR 50.14(c)(3)(iv)(E)	10-22, 61
Not Reasonably Controllable and Not Reasonably Preventable	40 CFR 50.14(c)(3)(iv)(D)	8-22, 62

**Table 11: Summary of Procedural Criteria Based on EER Requirements**

Procedural Requirement	Reference	Page/Section
Prompt Public Notification	40 CFR 50.14(c)(1)(i)	43-44, 63, Appendices IV, V
Initial Notification of Potential Exceptional Event Process	40 CFR 50.14(c)(2)(i)	Appendix I
Public opportunity to review and comment on demonstration	40 CFR 50.14(c)(3)(v)]	63

The Feather River AQMD recommends that CARB and U.S. EPA Region 9 concur with the 2021 Feather River PM<sub>2.5</sub> Exceptional Events Demonstration and, pending the additional 2020 Feather River PM<sub>2.5</sub> Exceptional Event Demonstration submission, exclude the requested data from comparison to the NAAQS.

## References

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# Appendices

## I. Initial Notification and Air Quality Data

### A. Initial Notification Information (INI) Form

INI form submitted to U.S. EPA Exceptional Event Tracking System (EETS) on April 25, 2022 (EETID 1779). U.S. EPA response received 6/27/22.<sup>44</sup>

<u>EE Initial Notification Summary Information</u>						
Submitting Agency: Feather River Air Quality Management District						
Agency Contact: Sondra Spaethe, <a href="mailto:sspaethe@fraqmd.org">sspaethe@fraqmd.org</a>						
Date Submitted: April 22, 2022						
Applicable NAAQS: 2006 PM2.5 NAAQS						
Affected Regulatory Decision <sup>1</sup> : Attainment determination <i>(for classification decisions, specify level of the classification with/without EE concurrence)</i>						
Area Name/Designation Status: Yuba City-Marysville, Maintenance Area						
Design Value Period (list three year period): 2019, 2020, 2021 <i>(where there are multiple relevant design value periods, summarize separately)</i>						
<b>A) Information specific to each flagged site day that may be submitted to EPA in support of the affected regulatory decision listed above</b>						
Date of Event	Type of Event (high wind, volcano, wildfires/prescribed fire, other <sup>2</sup> )	AQS Flag	Site AQS ID	Site Name	Exceedance Concentration (with units)	Notes (e.g. event name, links to other events)
7/4/2020	Wildfire	RH	061010003	Yuba City-Almond	71.8 ug/m3	Fireworks
8/20/2020	Wildfire	RT	061010003	Yuba City-Almond	131.3 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
8/21/2020	Wildfire	RT	061010003	Yuba City-Almond	103.3 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
8/22/2020	Wildfire	RT	061010003	Yuba City-Almond	86.3 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
8/23/2020	Wildfire	RT	061010003	Yuba City-Almond	72.4 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
8/24/2020	Wildfire	RT	061010003	Yuba City-Almond	84.8 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
8/25/2020	Wildfire	RT	061010003	Yuba City-Almond	46.5 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
8/26/2020	Wildfire	RT	061010003	Yuba City-Almond	39.5 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
8/28/2020	Wildfire	RT	061010003	Yuba City-Almond	42.8 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
8/29/2020	Wildfire	RT	061010003	Yuba City-Almond	44.3 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
8/30/2020	Wildfire	RT	061010003	Yuba City-Almond	39.6 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
8/31/2020	Wildfire	RT	061010003	Yuba City-Almond	51.1 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
9/5/2020	Wildfire	RT	061010003	Yuba City-Almond	45.2 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
9/6/2020	Wildfire	RT	061010003	Yuba City-Almond	46.8 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
9/7/2020	Wildfire	RT	061010003	Yuba City-Almond	48.5 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires

<sup>44</sup> Email from G.Yoshimura, U.S. EPA, to S.Vanderspek, CARB. June 27, 2022.

9/8/2020	Wildfire	RT	061010003	Yuba City-Almond	49.7 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
9/9/2020	Wildfire	RT	061010003	Yuba City-Almond	50.5 ug/m3	Wildfire smoke from August Complex, LNU, and other regional wildfires
9/10/2020	Wildfire	RT	061010003	Yuba City-Almond	103.6 ug/m3	Wildfire smoke from the North Complex, August Complex, and other regional wildfires.
9/11/2020	Wildfire	RT	061010003	Yuba City-Almond	122.8 ug/m3	Wildfire smoke from the North Complex, August Complex, and other regional wildfires.
9/12/2020	Wildfire	RT	061010003	Yuba City-Almond	213.5 ug/m3	Wildfire smoke from the North Complex, August Complex, and other regional wildfires.
9/13/2020	Wildfire	RT	061010003	Yuba City-Almond	253 ug/m3	North Complex, August Complex, and other regional wildfires
9/14/2020	Wildfire	RT	061010003	Yuba City-Almond	86 ug/m3	Wildfire smoke from the North Complex, August Complex, and other regional wildfires.
9/15/2020	Wildfire	RT	061010003	Yuba City-Almond	70.4 ug/m3	Wildfire smoke from the North Complex, August Complex, and other regional wildfires.
9/20/2020	Wildfire	RT	061010003	Yuba City-Almond	37.4 ug/m3	Wildfire smoke from the North Complex, August Complex, and other regional wildfires.
9/30/2020	Wildfire	RT	061010003	Yuba City-Almond	62.3 ug/m3	Wildfire smoke from the August Complex, Zogg Fire, and North Complex.
10/1/2020	Wildfire	RT	061010003	Yuba City-Almond	67.8 ug/m3	Wildfire smoke from the August Complex, Zogg Fire, and North Complex.
10/2/2020	Wildfire	RT	061010003	Yuba City-Almond	87.9 ug/m3	Wildfire smoke from the August Complex, Zogg Fire, and North Complex.
10/3/2020	Wildfire	RT	061010003	Yuba City-Almond	91.2 ug/m3	Wildfire smoke from the August Complex, Zogg Fire, and North Complex.
10/4/2020	Wildfire	RT	061010003	Yuba City-Almond	53.8 ug/m3	Wildfire smoke from the August Complex, Zogg Fire, and North Complex.
10/5/2020	Wildfire	RT	061010003	Yuba City-Almond	37.2 ug/m3	Wildfire smoke from the August Complex, Zogg Fire, and North Complex.
7/28/2021	Wildfire	RT	061010003	Yuba City-Almond	47.5 ug/m3	Dixie, Monument, McFarland, and other regional fires
8/6/2021	Wildfire	RT	061010003	Yuba City-Almond	45.1 ug/m3	Dixie, McFarland, and other regional fires
8/7/2021	Wildfire	RT	061010003	Yuba City-Almond	89.9 ug/m3	Dixie, McFarland, and other regional fires
8/18/2021	Wildfire	RT	061010003	Yuba City-Almond	54.6 ug/m3	Dixie, McFarland, and other regional fires
8/19/2021	Wildfire	RT	061010003	Yuba City-Almond	57.6 ug/m3	Dixie, McFarland, and other regional fires
8/20/2021	Wildfire	RT	061010003	Yuba City-Almond	40.5 ug/m3	Fawn Fire, Shasta County
8/27/2021	Wildfire	RT	061010003	Yuba City-Almond	49.1 ug/m3	Dixie Fire in Plumas/Butte Counties
8/28/2021	Wildfire	RT	061010003	Yuba City-Almond	82.5 ug/m3	Dixie, McFarland, and other regional fires
8/29/2021	Wildfire	RT	061010003	Yuba City-Almond	70.8 ug/m3	Dixie, McFarland, and other regional fires
9/24/2021	Wildfire	RT	061010003	Yuba City-Almond	40 ug/m3	Dixie, Monument, McFarland, and other regional fires

#### B) Violating Sites Information

(listing of all violating sites in the planning area, regardless of operating agency, and regardless of whether or not they are impacted by EEs)

Site/monitor (AQS ID and POC)	Design Value (without EPA concurrence on any of the events listed in table A above)	Design Value (with EPA concurrence on all events listed in table A above)
Yuba City – Almond/061010003, 3	54 ug/m3	28 ug/m3

<sup>1</sup> designation, classification, attainment determination, attainment date extension, or finding of SIP inadequacy leading to SIP call

<sup>2</sup> Provide additional information for types of event described as "other"

#### C) Summary of Maximum Design Value (DV) Site Information (Effect of EPA Concurrence on Maximum Design Value Site Determination)

(Two highest values from Table B)

Maximum DV site (AQS ID) <u>without</u> EPA concurrence on any of the events listed in table A above	Design Value	Design Value Site	Comment
Maximum DV site (AQS ID) <u>with</u> EPA concurrence on all events listed in table A above	54 ug/m3	Yuba City - Almond	
	28 ug/m3	Yuba City - Almond	

#### D) List of any sites (AQS ID) within planning area with invalid design values (e.g., due to data incompleteness)

N/A

# B. Yuba City AQS AMP350 Raw Data Report

PM<sub>2.5</sub> Data is currently flagged with the REQEXC Code "rt-Wildfire-U.S."

(88101) PM2.5 - Local Conditions SITE ID: 06-101-0003 POC: 3 COUNTY: (101) Sutter CITY: (86972) Yuba City SITE ADDRESS: 773 ALMOND ST, YUBA CITY SITE COMMENTS: RELOCATED ABOUT 1 MILE NW OF THE YUBA CITY-AG BUILDING SITE. ARB SITE NAME (#) IS MONITOR COMMENTS: SUPPORT AGENCY: (0145) California Air Resources Board MONITOR TYPE: SIAMS COLLECTION AND ANALYSIS METHOD: (170) Met One BAM-1020 Mass Monitor w/VIS FQAO: (0145) California Air Resources Board STATE: (06) California AQCR: (028) SACRAMENTO VALLEY URBANIZED AREA: (9340) YUBA CITY, CA LAND USE: COMMERCIAL LOCATION SETTING: SUBURBAN CAS NUMBER: LATITUDE: 39.1387725442 LONGITUDE: -121.61854899 UTM ZONE: UTM NORTHING: UTM EASTING: ELEVATION-MSL: 20 PROBE HEIGHT:																												
REPORT FOR: AUGUST 2021															DURATION: 1 HOUR													
UNITS: Micrograms/cubic meter (LC)																												
MIN DETECTABLE: 2																												
DAY	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	OBS	MEAN		
1	10.0	11.0	11.0	9.0	5.0	11.0	9.0	9.0	10.0	10.0	14.0	13.0	13.0	13.0	15.0	16.0	11.0	52.0	48.0	11.0	46.0	16.0	14.0	16.0	24	16.38		
2	14.0	10.0	7.0	23.0	5.0	7.0	9.0	24.0	30.0	21.0	27.0	19.0	13.0	12.0	23.0	21.0	35.0	29.0	22.0	25.0	12.0	14.0	17.0	24	17.96			
3	32.0	5.0	4.0	5.0	10.0	10.0	14.0	14.0	14.0	24.0	28.0	17.0	14.0	13.0	10.0	10.0	8.0	10.0	10.0	14.0	17.0	13.0	13.0	30.0	24	14.13		
4	19.0	12.0	10.0	9.0	10.0	12.0	15.0	35.0	24.0	21.0	15.0	32.0	19.0	28.0	24.0	28.0	11.0	10.0	21.0	17.0	12.0	26.0	12.0	12.0	24	18.08		
5	13.0	11.0	9.0	11.0	11.0	10.0	12.0	12.0	11.0	15.0	23.0	19.0	39.0	19.0	21.0	15.0	16.0	12.0	14.0	16.0	14.0	16.0	14.0	13.0	24	15.25		
6	18.0rt	12.0rt	10.0rt	9.0rt	19.0rt	14.0rt	17.0rt	17.0rt	31.0rt	30.0rt	24.0rt	34.0rt	45.0rt	55.0rt	47.0rt	54.0rt	47.0rt	50.0rt	52.0rt	64.0rt	72.0rt	116.0rt	122.0rt	125.0rt	24	45.17		
7	129.0rt	127.0rt	127.0rt	123.0rt	116.0rt	115.0rt	96.0rt	98.0rt	113.0rt	115.0rt	156.0rt	147.0rt	150.0rt	98.0rt	71.0rt	38.0rt	47.0rt	55.0rt	52.0rt	48.0rt	42.0rt	33.0rt	35.0rt	27.0rt	24	89.92		
8	22.0	15.0	13.0	12.0	10.0	10.0	11.0	12.0	14.0	23.0	24.0	25.0	35.0	39.0	26.0	27.0	26.0	24.0	33.0	27.0	37.0	27.0	28.0	15.0	24	22.71		
9	17.0	16.0	12.0	12.0	13.0	11.0	12.0	11.0	25.0	26.0	AX	23.0	21.0	25.0	18.0	22.0	17.0	19.0	27.0	17.0	11.0	10.0	11.0	14.0	23	16.96		
10	22.0	8.0	10.0	15.0	16.0	15.0	14.0	12.0	12.0	16.0	18.0	17.0	15.0	13.0	14.0	14.0	12.0	15.0	15.0	18.0	17.0	14.0	16.0	14.0	24	14.67		
11	19.0	14.0	14.0	12.0	14.0	14.0	19.0	23.0	17.0	18.0	21.0	15.0	19.0	19.0	16.0	18.0	15.0	14.0	11.0	13.0	10.0	12.0	10.0	8.0	24	15.21		
12	44.0	10.0	6.0	11.0	14.0	14.0	14.0	11.0	14.0	14.0	13.0	9.0	12.0	12.0	14.0	37.0	20.0	21.0	15.0	12.0	13.0	10.0	12.0	11.0	24	15.13		
13	11.0	11.0	10.0	10.0	11.0	12.0	12.0	12.0	11.0	9.0	16.0	14.0	18.0	19.0	21.0	16.0	15.0	17.0	15.0	20.0	14.0	14.0	11.0	10.0	24	13.71		
14	26.0	6.0	16.0	13.0	10.0	11.0	11.0	12.0	13.0	16.0	21.0	19.0	17.0	20.0	23.0	33.0	31.0	22.0	21.0	30.0	25.0	26.0	24.0	27.0	24	19.71		
15	23.0	19.0	17.0	19.0	20.0	22.0	25.0	21.0	20.0	21.0	24.0	24.0	29.0	23.0	28.0	25.0	32.0	30.0	34.0	31.0	36.0	45.0	50.0	24	26.75			
16	46.0IT	36.0IT	34.0IT	33.0IT	28.0IT	28.0IT	30.0IT	29.0IT	35.0IT	38.0IT	37.0IT	37.0IT	38.0IT	38.0IT	44.0IT	54.0IT	61.0IT	60.0IT	55.0IT	26.0IT	13.0IT	13.0IT	12.0IT	13.0IT	13.0IT	24	33.92	
17	12.0	12.0	11.0	13.0	13.0	13.0	17.0	16.0	13.0	6.0	14.0	18.0	15.0	16.0	22.0	21.0	19.0	22.0	19.0	24.0	27.0	20.0	19.0	15.0	24	16.54		
18	20.0rt	22.0rt	15.0rt	34.0rt	58.0rt	84.0rt	87.0rt	103.0rt	67.0rt	35.0rt	36.0rt	36.0rt	57.0rt	63.0rt	62.0rt	56.0rt	32.0rt	27.0rt	74.0rt	76.0rt	72.0rt	66.0rt	65.0rt	65.0rt	24	54.67		
19	61.0rt	58.0rt	54.0rt	60.0rt	61.0rt	61.0rt	44.0rt	41.0rt	32.0rt	36.0rt	44.0rt	51.0rt	60.0rt	71.0rt	79.0rt	123.0rt	116.0rt	87.0rt	72.0rt	57.0rt	36.0rt	26.0rt	28.0rt	25.0rt	24	57.63		
20	33.0rt	30.0rt	33.0rt	34.0rt	41.0rt	33.0rt	32.0rt	40.0rt	36.0rt	41.0rt	45.0rt	44.0rt	49.0rt	52.0rt	53.0rt	55.0rt	51.0rt	51.0rt	58.0rt	55.0rt	41.0rt	27.0rt	24.0rt	26.0rt	24	40.58		
21	46.0IT	43.0IT	38.0IT	45.0IT	44.0IT	43.0IT	45.0IT	41.0IT	44.0IT	44.0IT	38.0IT	38.0IT	32.0IT	33.0IT	32.0IT	25.0IT	29.0IT	26.0IT	41.0IT	32.0IT	24.0IT	20.0IT	16.0IT	19.0IT	24	34.50		
22	17.0	13.0	19.0	19.0	14.0	17.0	19.0	17.0	17.0	23.0	23.0	29.0	39.0	33.0	47.0	54.0	47.0	36.0	31.0	31.0	30.0	29.0	29.0	HK	23	27.13		
23	17.0	14.0	18.0	HK	9.0	12.0	25.0	18.0	20.0	23.0	21.0	25.0	24.0	24.0	29.0	20.0	28.0	31.0	43.0	25.0	22.0	16.0	17.0	18.0	23	21.70		
24	14.0	16.0	16.0	16.0	15.0	18.0	19.0	17.0	HL	18.0	HL	20.0	15.0	20.0	14.0	21.0	22.0	21.0	21.0	11.0	10.0	18.0	14.0	22	17.18			
25	20.0	6.0	10.0	11.0	14.0	12.0	13.0	19.0	14.0	15.0	13.0	13.0	18.0	26.0	41.0	34.0	24.0	28.0	30.0	22.0	22.0	16.0	18.0	20.0	24	19.13		
26	26.0	16.0	18.0	20.0	22.0	18.0	18.0	17.0	21.0	17.0	18.0	18.0	32.0	23.0	28.0	26.0	23.0	18.0	23.0	26.0	27.0	21.0	25.0	24	22.38			
27	23.0rt	21.0rt	15.0rt	20.0rt	25.0rt	28.0rt	26.0rt	32.0rt	AX	56.0rt	59.0rt	47.0rt	48.0rt	54.0rt	59.0rt	65.0rt	72.0rt	61.0rt	60.0rt	63.0rt	60.0rt	65.0rt	90.0rt	92.0rt	23	49.37		
28	91.0rt	94.0rt	92.0rt	89.0rt	88.0rt	92.0rt	91.0rt	91.0rt	80.0rt	82.0rt	81.0rt	76.0rt	69.0rt	64.0rt	65.0rt	64.0rt	61.0rt	71.0rt	76.0rt	80.0rt	88.0rt	90.0rt	105.0rt	100.0rt	24	82.50		
29	163.0rt	95.0rt	94.0rt	92.0rt	96.0rt	88.0rt	82.0rt	81.0rt	66.0rt	61.0rt	69.0rt	71.0rt	78.0rt	96.0rt	64.0rt	65.0rt	71.0rt	59.0rt	59.0rt	52.0rt	43.0rt	37.0rt	40.0rt	39.0rt	24	70.88		
30	44.0IT	44.0IT	40.0IT	45.0IT	48.0IT	49.0IT	46.0IT	44.0IT	46.0IT	44.0IT	46.0IT	44.0IT	44.0IT	48.0IT	45.0IT	36.0IT	36.0IT	37.0IT	37.0IT	34.0IT	17.0IT	11.0IT	9.0IT	7.0IT	11.0IT	10.0IT	24	34.67
31	11.0	10.0	11.0	13.0	17.0	9.0	11.0	13.0	17.0	23.0	17.0	19.0	19.0	18.0	20.0	27.0	52.0	26.0	15.0	16.0	12.0	15.0	13.0	17.0	24	17.54		
NO.:	31	31	31	30	31	31	31	31	29	31	29	31	31	31	31	31	31	31	31	31	31	31	31	31	30			
MAX:	129.0	127.0	127.0	123.0	116.0	115.0	96.0	103.0	113.0	115.0	156.0	147.0	150.0	98.0	79.0	123.0	116.0	87.0	76.0	80.0	88.0	116.0	122.0	125.0				
AVG:	32.03	26.35	25.61	27.90	28.29	28.81	28.87	30.39	29.90	30.03	33.59	32.84	34.94	35.06	34.16	36.55	34.39	33.61	34.13	31.19	29.74	28.19	29.61	29.57				
MONTHLY OBSERVATIONS:	738				MONTHLY MEAN:	31.08				MONTHLY MAX:	156.0																	
Note:	Qualifier codes with regional concurrence are shown in upper case, and those without regional review are shown in lower case. An asterisk (***) indicates that the region has reviewed the value and does not concur with the qualifier.																											

## II. NWS Area Forecast Discussions

Excerpts from pertinent NWS Sacramento Area Forecast Discussions (AFDs) are presented below, with discussions of the flattening and eventual movement of the upper level ridge, subsequent wind patterns and smoke impacts, and pertinent meteorological discussions highlighted. The complete AFDs can be found on the Iowa State University Mesonet site.<sup>45</sup> Air Quality Alerts were not issued by the NWS Sacramento Forecast Office, although the Eureka Forecast Office issued several for their forecast area.

037

FXUS66 KSTO 262138

AFDSTO

Area Forecast Discussion

National Weather Service Sacramento CA

**238 PM PDT Thu Aug 26 2021**

.SYNOPSIS...

Winds shift to the north today, and will become locally breezy Friday and Saturday. This along with low humidity and dry fuels will bring critical fire weather, so a Red Flag Warning has been issued. **Smoke and haze from the wildfires will continue to impact portions of the area.** Temperatures will warm to above normal levels by late week, though the smoke may keep it from getting as hot as it otherwise could be.

&&

.DISCUSSION...

A building high pressure ridge will increase the north to south pressure gradient late tonight into Friday. **The HRRR smoke model shows near surface smoke levels increasing across the Valley and Delta as northerly winds increase with this gradient.** Air quality will likely worsen. For more details on this, go to [AirNow.gov](https://airnow.gov) or check with your local air quality district.

There north winds over the northern and central Sacramento Valley will increase further early Friday morning and become gusty. Winds could gust to 35 mph during the strongest winds mid day and afternoon. Relative humidity recovery will be moderate to poor in the morning, with afternoon humidity dropping to single digits to teens from around Chico northward. The Fire Weather Watch in that area has been upgraded to a Red Flag Warning from 5 am Friday morning to 11 am Saturday morning. The earlier start is due to winds picking sooner than previously expected.

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<sup>45</sup> Iowa State University, Mesonet, [NWS Text Products](#), last accessed 11/30/22



The ridge strengthening offshore will also lead to warming over the next several days. Triple digit high temperatures are forecast for northern Sacramento Valley on Friday, with chances expanding south down the Valley for Saturday and continuing Sunday. Wildfire smoke may reduce solar heating, so have reduced forecast high temperatures by a few degrees, with highs projected to peak around 100-101, bringing moderate heat risk.

Monday Valley highs cool down into the low to mid 90s as an upper trough approaches, bringing cooler onshore flow. This should act to shift the smoke eastward, bringing clearer air. Gusty southwest winds over Sierra ridges could enhance fire weather concerns there. EK

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446

FXUS66 KSTO 272129

AFDSTO

Area Forecast Discussion

National Weather Service Sacramento CA

**229 PM PDT Fri Aug 27 2021**

.SYNOPSIS...

Hot and very dry through the weekend. Locally breezy north winds will lead to areas of critical fire weather conditions over the northern Sacramento Valley into Saturday morning, with a Red Flag Warning in effect. Cooler weather returns next week. Breezy southwest winds early next week over Sierra ridges.

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.DISCUSSION...

Satellite shows smoky skies across much of the area. Northerly flow has brought wildfire smoke down through the Valley. Easterly flow in the morning brought dense smoke into the Motherlode and eastern Sacramento suburbs. The diurnal flow has reversed, with westerly winds shifting some of the denser smoke in those areas further to the east. The HRRR smoke model shows this pattern reversing overnight, with dense smoke bake into the Motherlode and eastern Sacramento suburbs by early Saturday. Smoke continues to be an issue across the area through the weekend. For air quality forecasts check with your local air quality district or [AirNow.gov](https://www.airnow.gov).

Northerly winds and low humidity have brought Red Flag conditions to the northern and central Sacramento Valley and surrounding areas today. Redding currently has a humidity down to 9% with winds gusting to 25 mph. Gusts of 25-30 mph are likely over the northern half of the valley, and locally further south along the western edge. Winds should gradually decrease overnight, but overnight recoveries should be poor to moderate (25-40%) and winds should pick up again early Saturday. The Red Flag Warning continues until 11 am Saturday.

High pressure rebounds a bit over the weekend in the wake of the short-wave. 850 mb temps climb to the upper 20s to around 30C over the weekend. Given the amount of wildfire smoke, surface temperatures will probably not realize their full potential. Nevertheless, it will be hot with most Valley high temperatures forecast to range from 100 to 105 (about 10 degrees above average). Widespread moderate heat risk is expected.

The next upstream trough moves in early next week bringing cooler temperatures and a return of onshore flow.

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.EXTENDED DISCUSSION (Tuesday THROUGH Friday)...

Upper troughing remains along the West Coast through the extended forecast period. This will result in below normal high temperatures Tuesday into Friday. Locally breezy wind possible at times through the Delta and over higher terrain, mainly afternoons into evenings. This will likely clear some of the smoke out of the Valley. Southwest ridge winds over the mountains could bring fire weather concerns.

&&

.AVIATION...

VFR with MVFR to locally IFR at times next 24 hrs due to area wildfire smoke. **Generally elevated smoke layers 040 and 100 AGL**. Gusty northerly flow through the Sacramento Valley today. Gusts 20 to 30 kts possible through around 03 UTC.

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484

FXUS66 KSTO 282127

AFDSTO

Area Forecast Discussion

National Weather Service Sacramento CA

**227 PM PDT Sat Aug 28 2021**

.SYNOPSIS...

Hot and very dry through the weekend. Gusty southwest to west winds early next week could bring critical fire weather concerns to the northern Sierra and southern Cascades. Cooler weather returns next week.

&&

.DISCUSSION...

GOES-West satellite imagery reveals smoky skies blanketing portions of interior NorCal this afternoon as wildfires continue to burn. Winds have subsided as surface pressure gradients are weaker than yesterday. Hot and dry conditions persist across the region this afternoon under flat ridging. Afternoon temperatures are generally running 2 to 6 degrees warmer across most of the area compared to 24 hours ago. Thick wildfire smoke may inhibit additional warming at some locations this afternoon. Forecast highs on Sunday will range from the upper 90s to around 103 resulting in moderate heat risk.

Ensembles and cluster analysis indicate that an upper trough will start to take shape off the West Coast Sunday afternoon and gradually deepen into mid-week. This will promote increased onshore flow/southwest winds and cooler temperatures. However, these gusty winds will bring increasing fire weather concerns to the northern Sierra and southern Cascades Sunday into Wednesday. At this point, the strongest winds are expected Monday and Tuesday with gusts ranging from 20-35 mph. The strongest winds area expected in the afternoon and evening hours. A Fire Weather Watch has been issued for the higher elevations of the northern Sierra and southern Cascades from 11 AM Monday through 11 PM Tuesday given the potential for rapid spread of new or existing wildfires.

The onshore flow will likely help with some smoke dispersal in the Valley. The HRRR smoke model shows improvement near the Delta influenced areas Sunday afternoon. A stronger onshore flow/southwest winds will get going Monday, which should push the smoke eastward out of the Valley and much of the foothills.

A gradual cooling trend is expected during the Monday-Wednesday timeframe with mid 80s to low 90s returning by mid-week.

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.EXTENDED DISCUSSION (Wednesday THROUGH Saturday)...

Ensemble guidance is in good agreement large scale troughing will likely persist over the West Coast through the extended forecast period. This pattern will support a Delta breeze and slightly below average temperatures. Gusty southwest to west winds over the higher elevations of the mountains are possible in the afternoon into evening hours.

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.AVIATION...

Areas of MVFR to IFR due to area wildfire smoke. Gusts 15 to 20 kts vicinity Delta. Elsewhere, winds generally under 12 kts. Breezy conditions develop after around 21 UTC Sunday.

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274

FXUS66 KSTO 291034

AFDSTO

Area Forecast Discussion

National Weather Service Sacramento CA

**334 AM PDT Sun Aug 29 2021**

.SYNOPSIS...

Hot and very dry today and Monday turning cooler through the rest of the week. Gusty southwest to west winds early this week could bring critical fire weather concerns to the northern Sierra and southern Cascades.

&&

.DISCUSSION...

Flat ridge pattern over Northern California will begin to erode as upper trough starts to form off the West Coast this afternoon. Ensembles and clusters indicate that the trough will gradually deepen into mid-week. This will switch the wind pattern to more onshore, which will thin out the smoke today, especially for the Delta/Srn Sacramento Valley. A stronger onshore flow/southwest winds will get going Monday, which should push the smoke eastward out of the Valley and much of the foothills. However, the deepening trough will enhance southwest ridgetop winds and could bring critical fire weather conditions to ongoing wildfires. West to southwest wind gusts of 20 to 35 mph, strongest over the higher elevations with minimum humidity of 8 to 25 percent and moderate to poor overnight recoveries are expected. A Fire Weather Watch has been issued for the higher elevations of the northern Sierra and southern Cascades from 11 AM Monday through 11 PM Tuesday, given the potential for rapid spread of new or existing wildfires. A brief period of critical fire weather conditions may also occur late this afternoon over ridgetops, as trough forms off the Coast.

Despite the developing trough higher heights will remain over the area keeping temperatures on the hot side today, with widespread readings from 100 to 105 at Valley locations. These readings are 10 to 15 degrees above normal and will likely result in moderate heat risk, especially for sensitive individuals. Temperatures will cool back into the mid 80's/mid 90's during the Tuesday-Wednesday timeframe.

&&

595

FXUS66 KSTO 292114

AFDSTO

Area Forecast Discussion

National Weather Service Sacramento CA

214 PM PDT Sun Aug 29 2021



.SYNOPSIS...

Hot and very dry today and Monday turning cooler through the rest of the week. Gusty southwest to west winds early this week will bring critical fire weather conditions to the northern Sierra and southern Cascades.

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.DISCUSSION...

GOES-West fire temperature product is showing intense heat signatures associated with the Caldor Fire this afternoon. A brief period of critical fire weather conditions is expected late this afternoon over ridgetops, as trough forms off the Coast. Wind gusts up to 20 mph has been observed so far across the high Sierra and southern Cascades this afternoon. Valley afternoon highs will range from the upper 90s to around 103, resulting in moderate heat risk.

Ensembles and cluster analysis indicate that an upper trough will gradually deepen into mid-week. This will switch the wind pattern to more onshore, which will gradually thin out the smoke the rest of today, especially for the Delta/Southern Sacramento Valley per latest HRRR smoke model. A stronger onshore flow/southwest winds will get going Monday, which should push the smoke eastward out of the Valley and much of the foothills.

The deepening trough will bring increasing fire weather concerns to the northern Sierra and southern Cascades early to mid-week. The strongest winds are expected in the afternoon and evening hours. Southwest to west wind gusts of 20 to 35 mph are possible. These winds combined with very low humidity and extremely dry fuels will lead to critical fire weather conditions. A Red Flag Warning has been issued for the northern Sierra and southern Cascades as well as portions of the eastern foothills from 11 AM Monday through 11 PM Tuesday, given the potential for rapid spread of new or existing wildfires. Elevated fire weather conditions may continue into Wednesday due to locally gusty winds and low humidity. Practice fire safety.

Highs will remain above seasonal normals through Monday. Then, temperatures will cool back into the mid 80s to mid 90s during the Tuesday-Wednesday timeframe.

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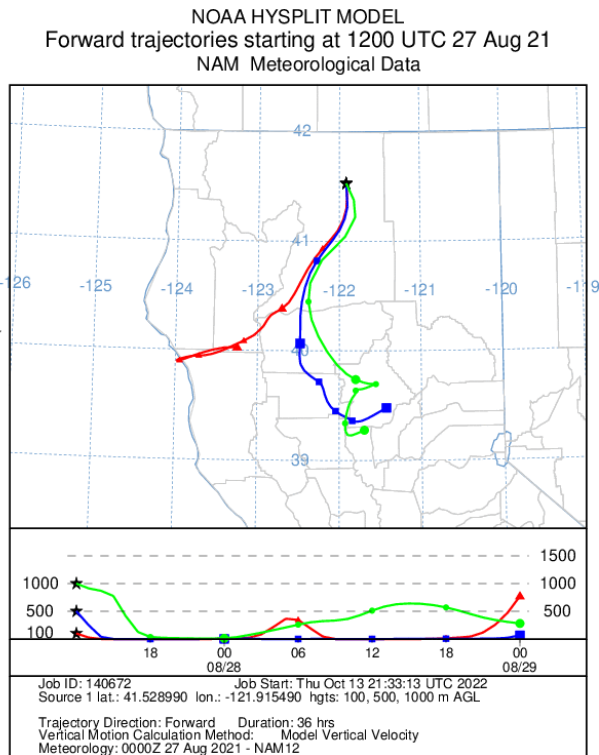
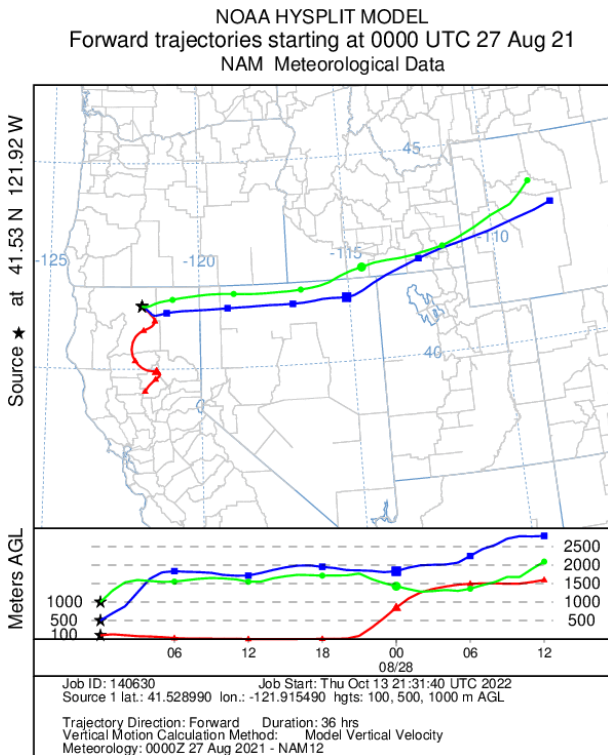
### III. Transport

#### A. HYSPLIT Forward Trajectory (from Fires)

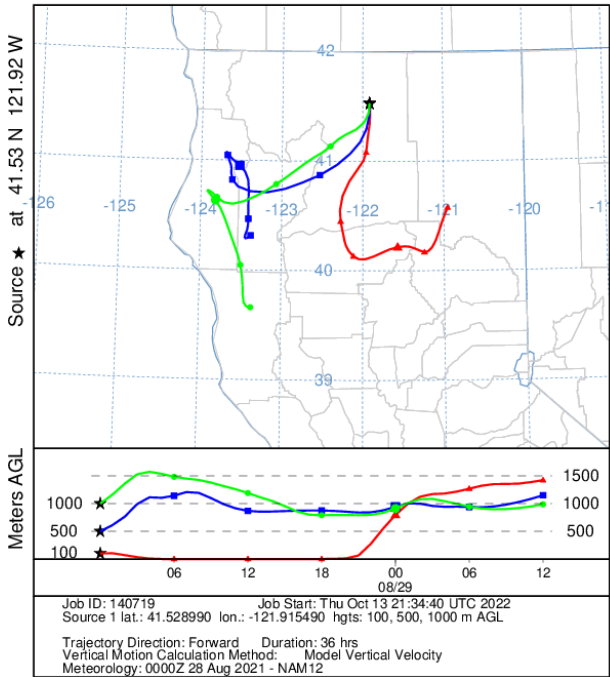
The forward trajectory tool of the HYSPLIT model was used to indicate how emissions from the wildfires were transported toward the monitors, although some of these fires had a more indirect impact. The model was run from each major fire for 36 hours during the days of potential impact of the exceeding monitors starting at both 00UTC (16PST of the previous day) and 12UTC (04PST of the same day). These model runs offer insight into the path a hypothetical parcel of air (or potential smoke) would take from each fire. This provides for a generalized understanding of smoke transport from a single fire across a region, connecting a specific wildfire with smoke in satellite imagery, and finding potential correlations at a site through analysis of the intersection of forward and backward trajectories.

#### a) Antelope Fire

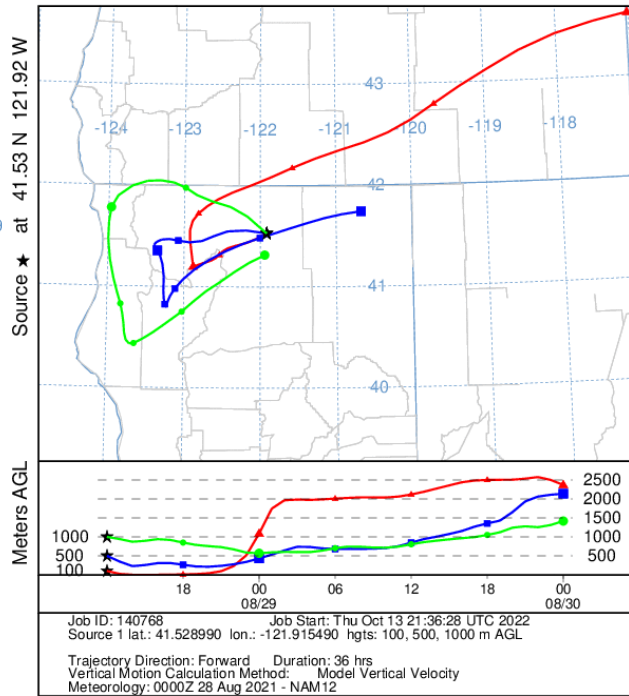
Name	Start	Containment	Latitude	Longitude	Total Acres
Antelope	8/1/2021	10/15/2021	41.5290	-121.9155	145,632



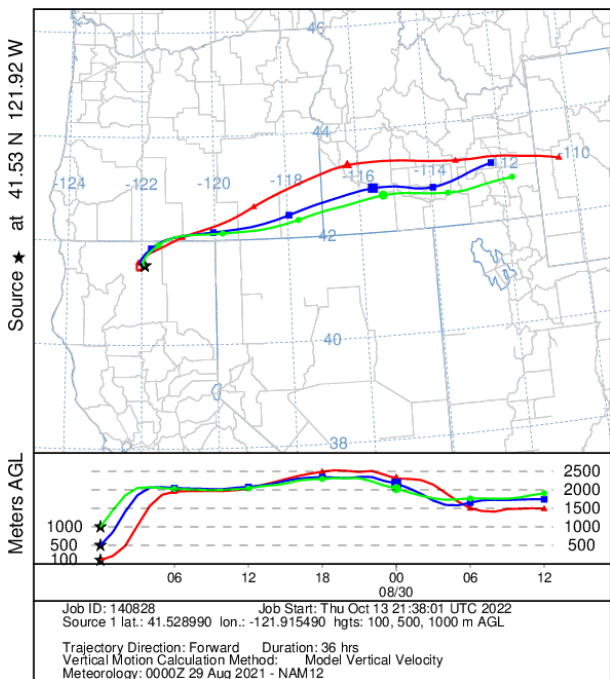
NOAA HYSPLIT MODEL  
Forward trajectories starting at 0000 UTC 28 Aug 21  
NAM Meteorological Data



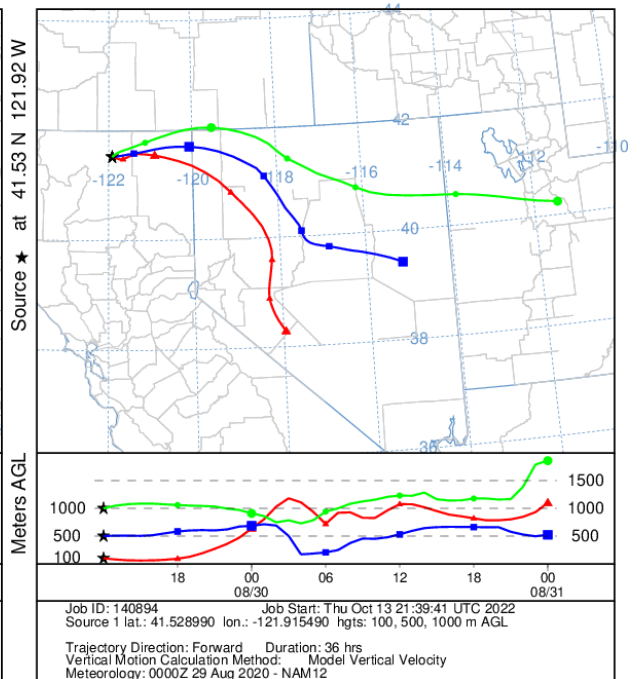
NOAA HYSPLIT MODEL  
Forward trajectories starting at 1200 UTC 28 Aug 21  
NAM Meteorological Data



NOAA HYSPLIT MODEL  
Forward trajectories starting at 0000 UTC 29 Aug 21  
NAM Meteorological Data



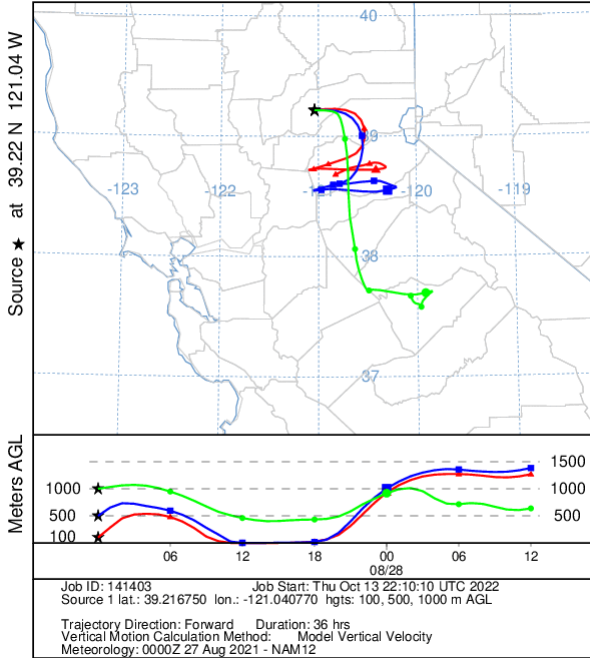
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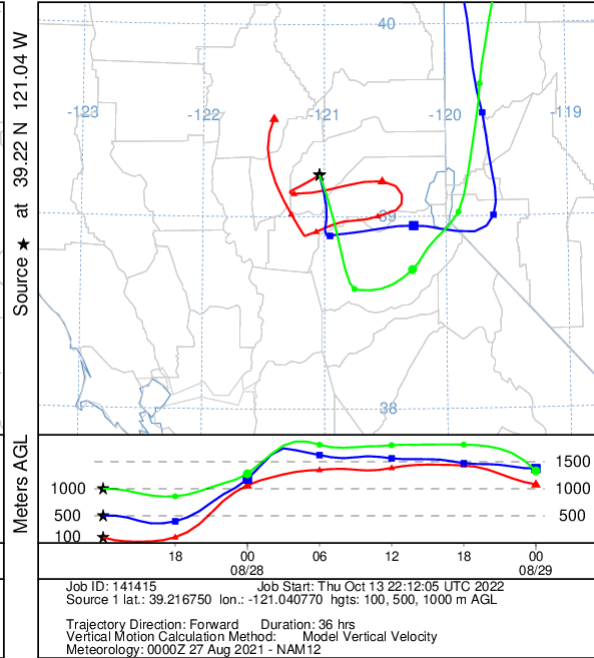
## b) Bennett Fire

Name	Start	Containment	Latitude	Longitude	Total Acres
Bennett	8/25/2021	9/3/2021	39.2168	-121.0408	59

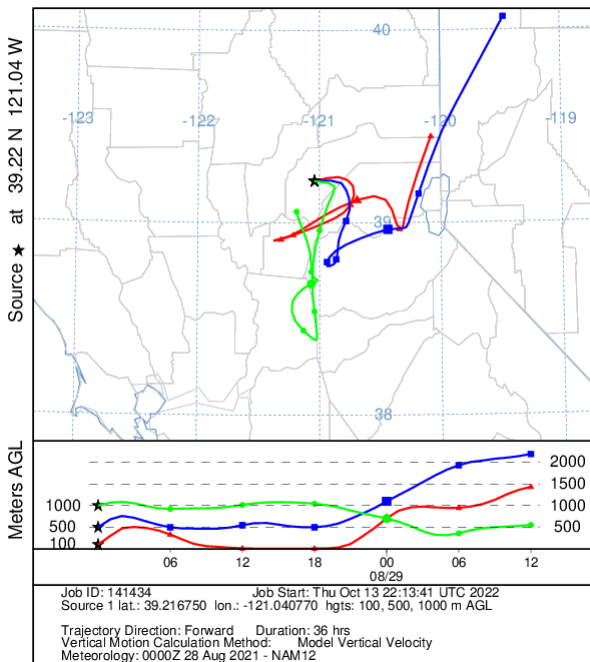
NOAA HYSPLIT MODEL  
Forward trajectories starting at 0000 UTC 27 Aug 21  
NAM Meteorological Data



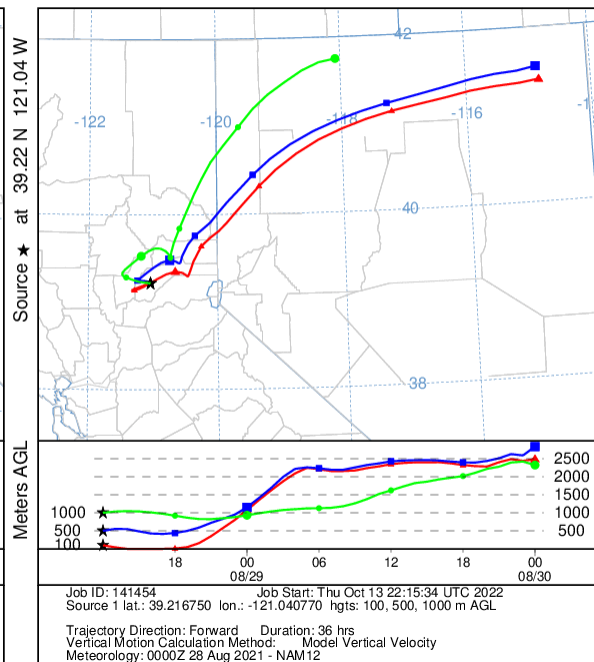
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NAM Meteorological Data



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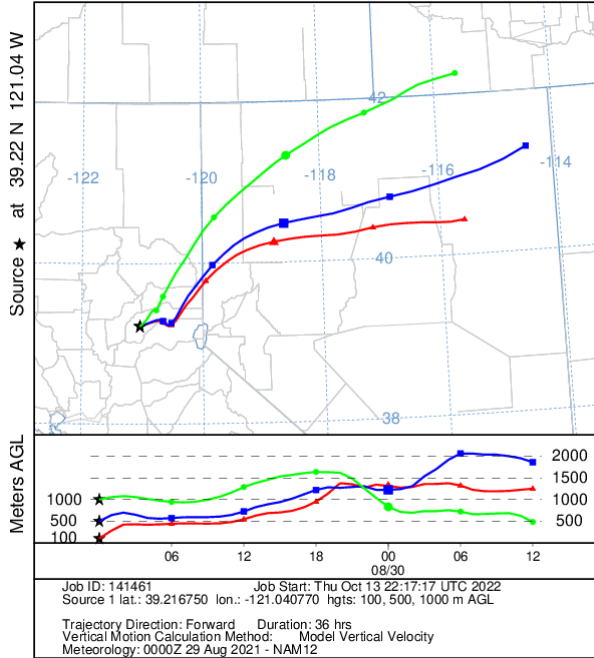


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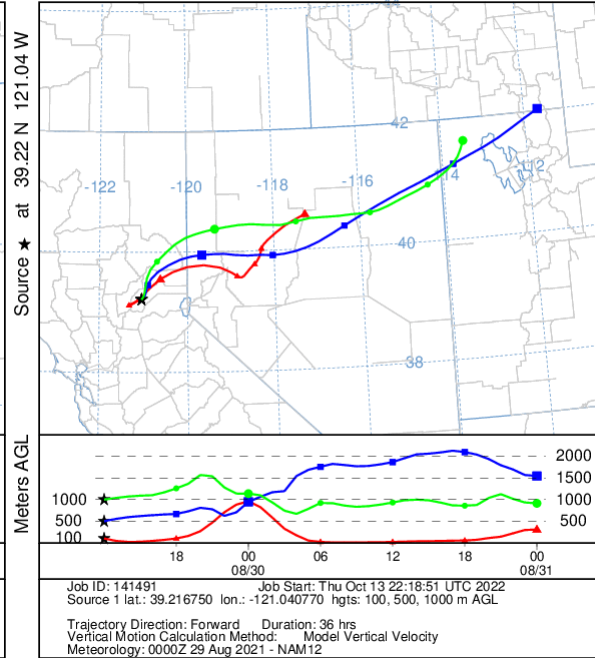




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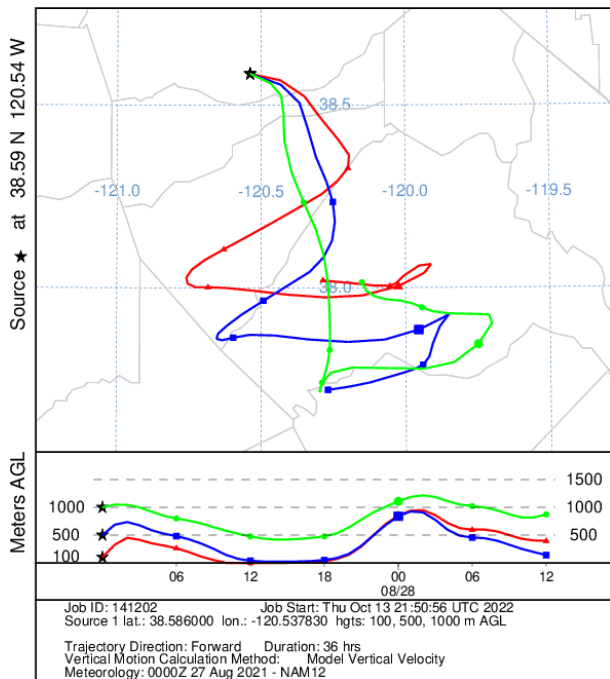
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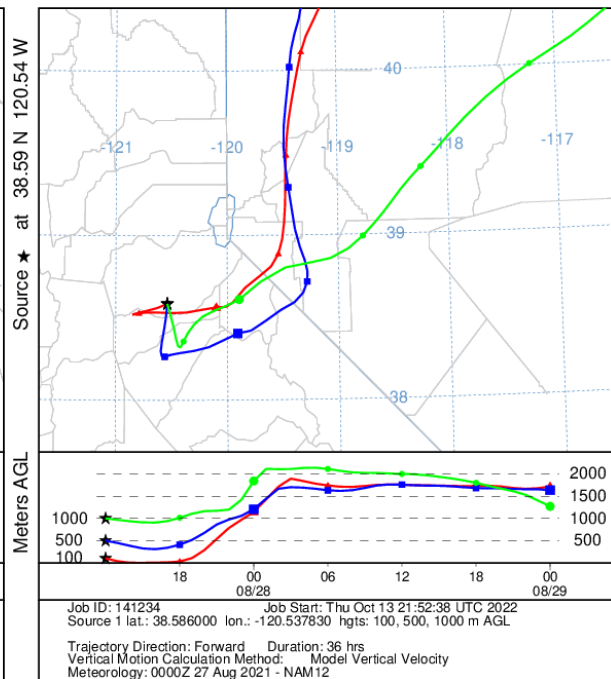
### c) Caldor Fire

Name	Start	Containment	Latitude	Longitude	Total Acres
Caldor	8/14/2021	10/21/2021	38.5860	-120.5378	221,835

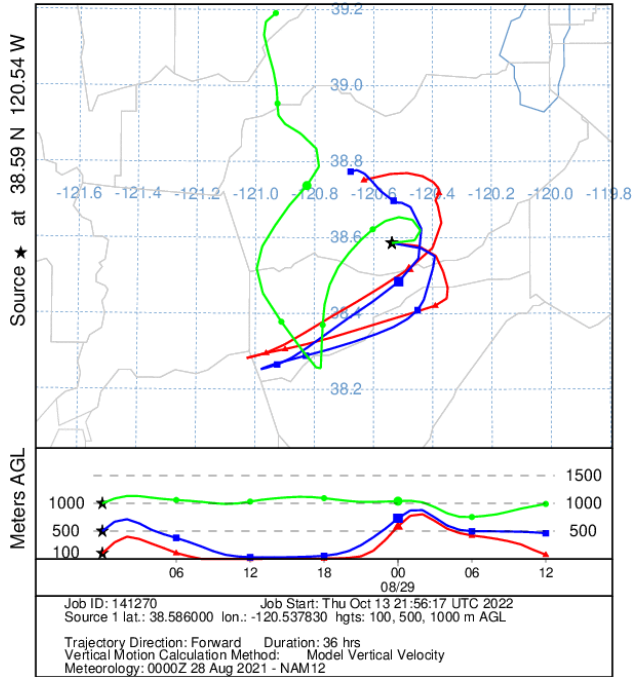
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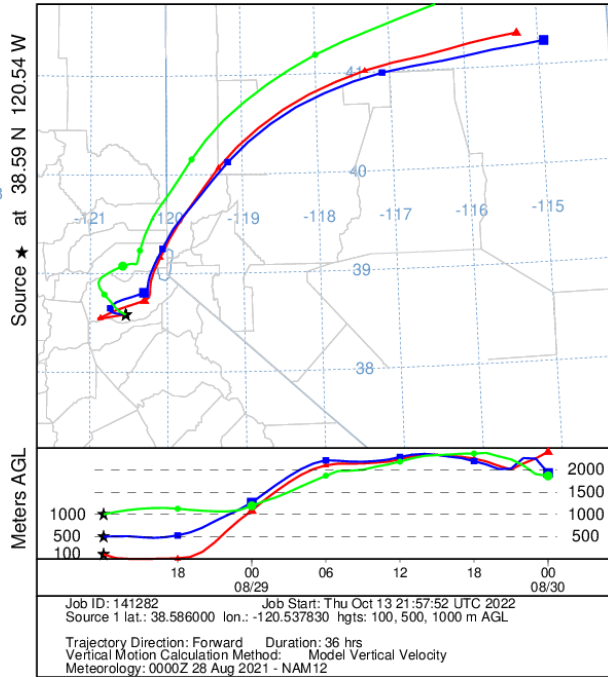
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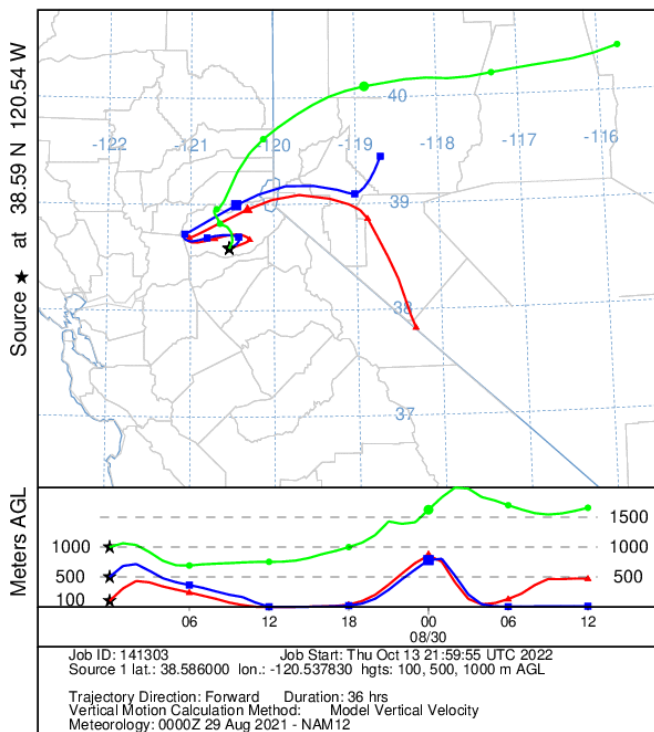
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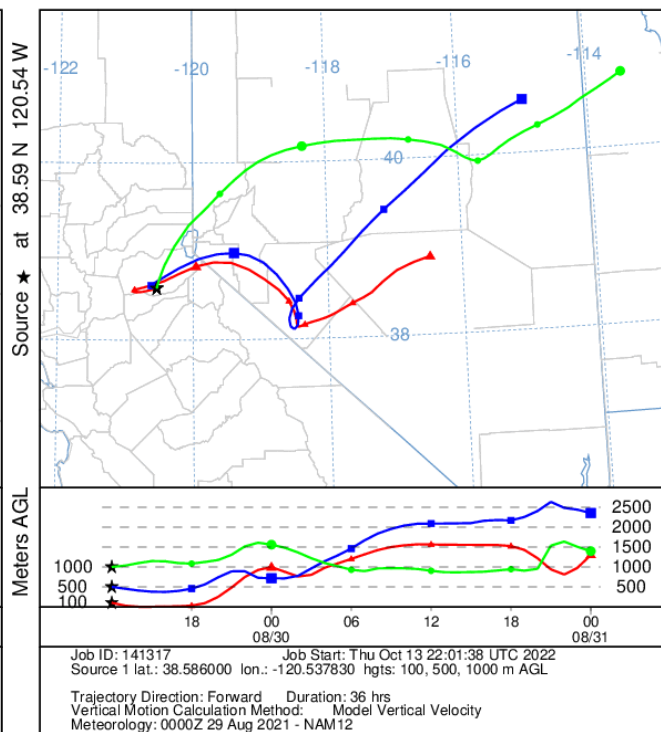
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Forward trajectories starting at 1200 UTC 28 Aug 21  
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NOAA HYSPLIT MODEL  
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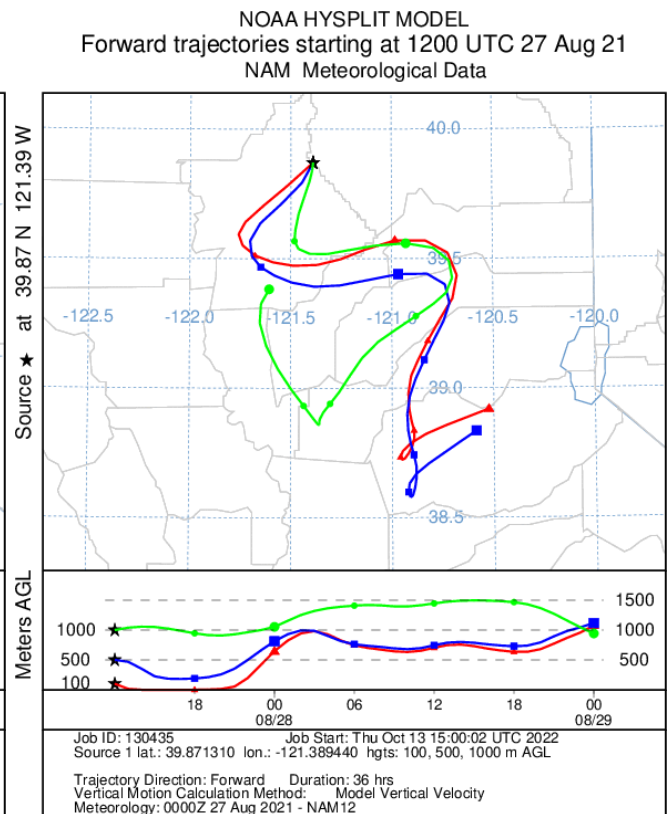
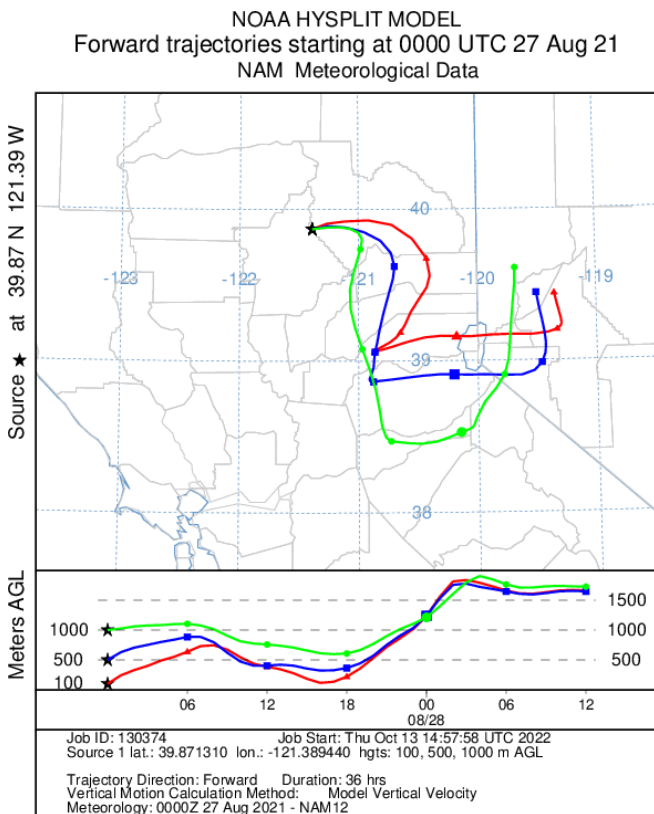


## d) Dixie Fire

Forward trajectories from were calculated from three different points, the original location as defined by CalFire<sup>46</sup>, a more northern point, and a southern point, both selected using satellite imagery.

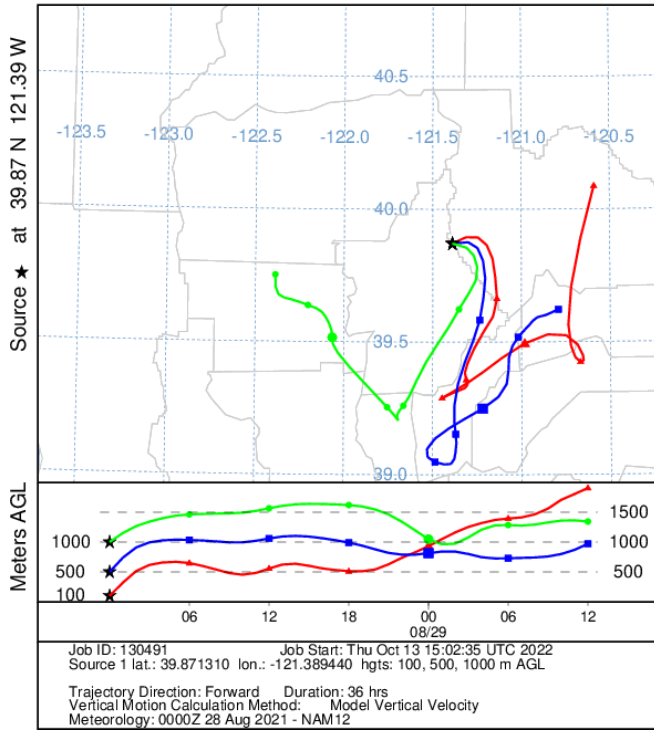
Name	Start	Containment	Latitude	Longitude	Total Acres
Dixie	7/13/2021	10/25/2021	39.8713	-121.3894	963,309
<i>Dixie (Northern portion)</i>			40.4876	-121.4112	
<i>Dixie (Southern portion)</i>			39.9969	-120.8973	

### Original Location

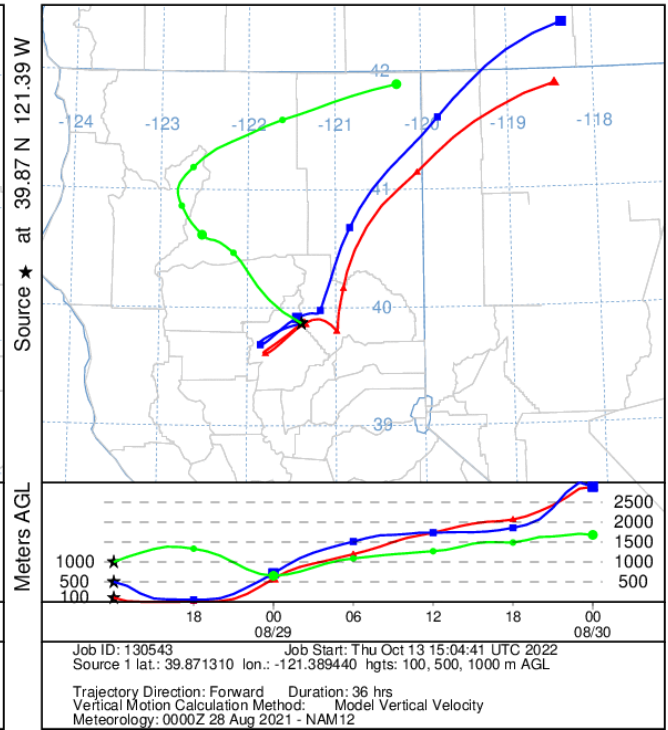


<sup>46</sup> CalFire Incidents, <https://www.fire.ca.gov/incidents/2021/7/13/dixie-fire/>, last accessed 11/30/22

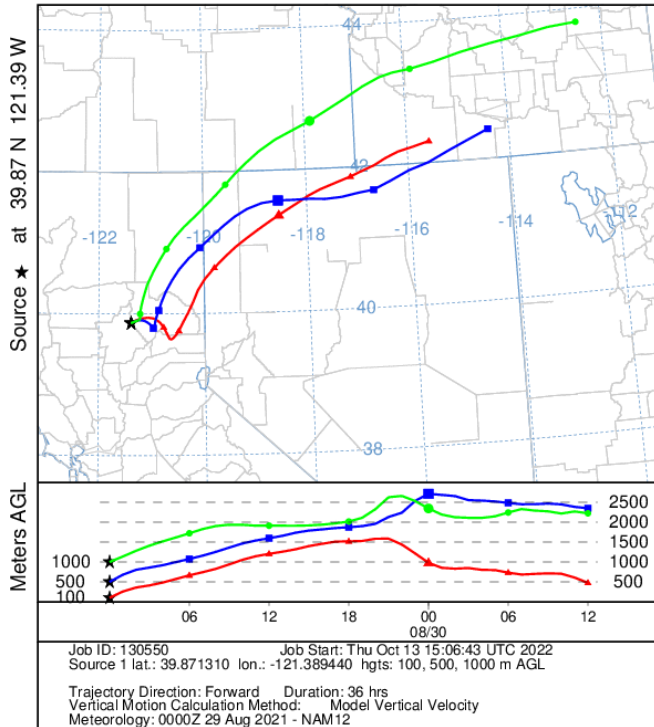
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NAM Meteorological Data



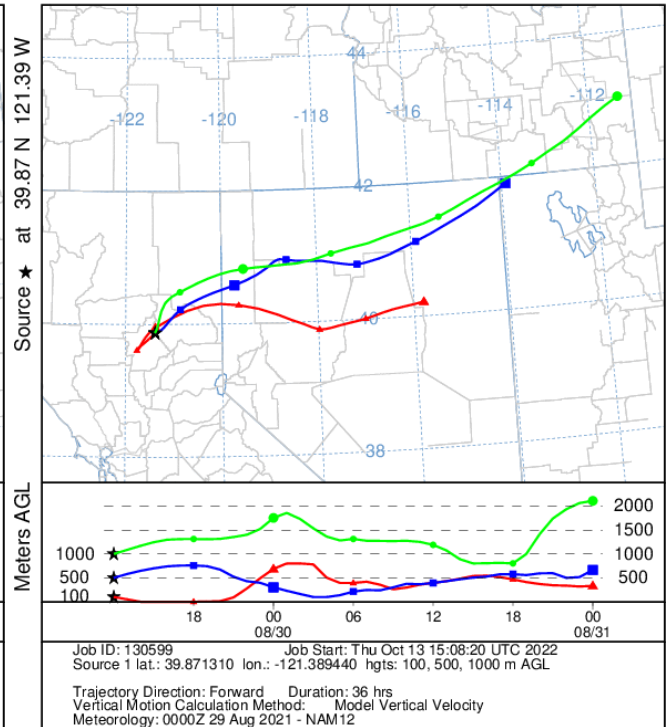
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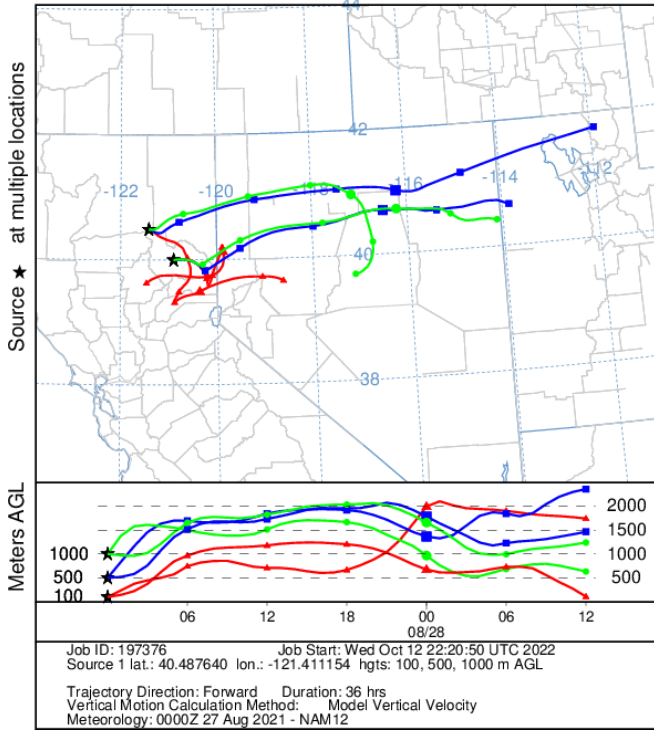
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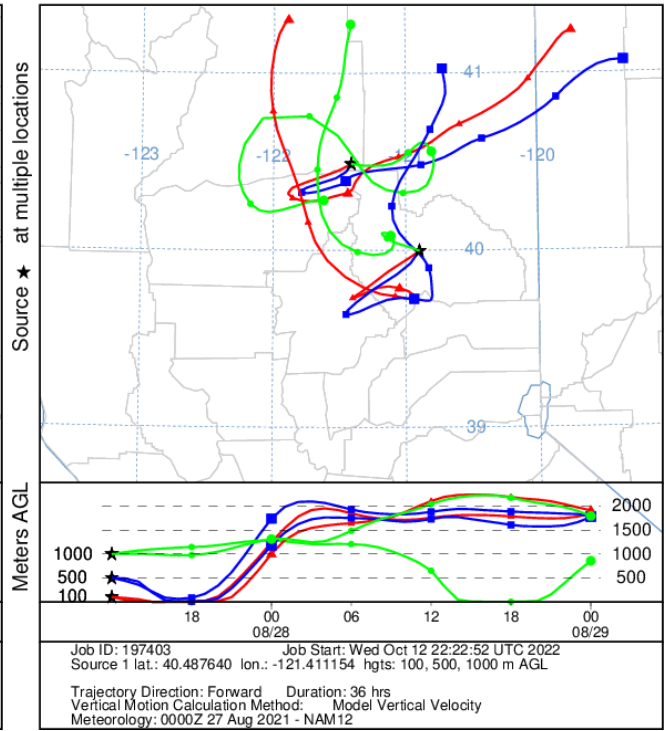


# Northern and Southern portions

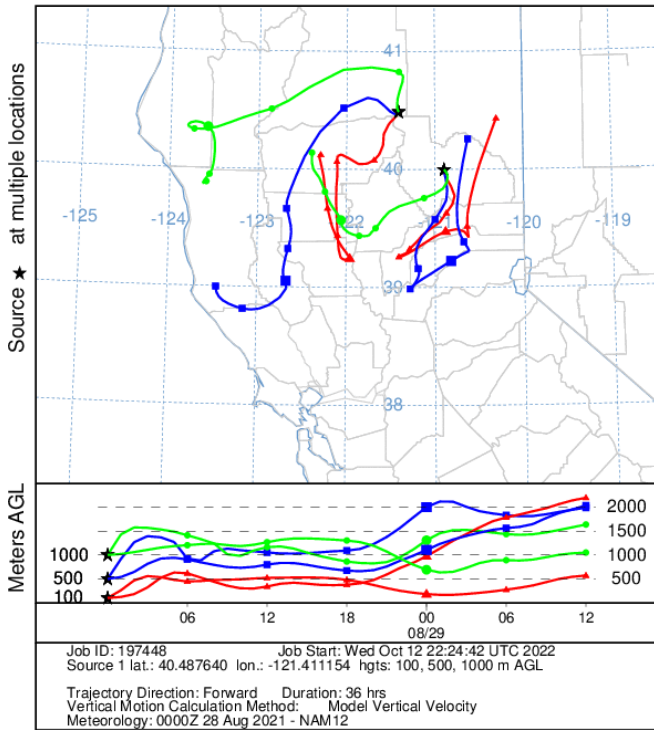
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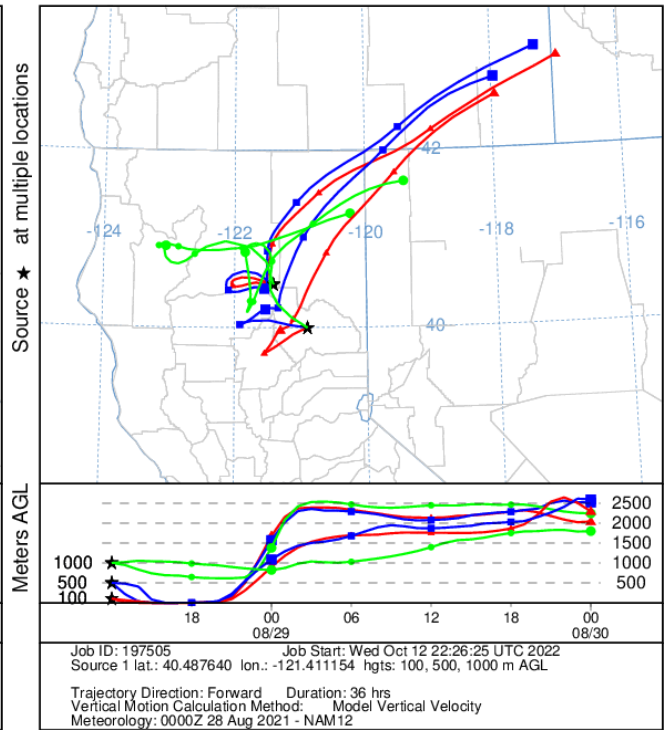
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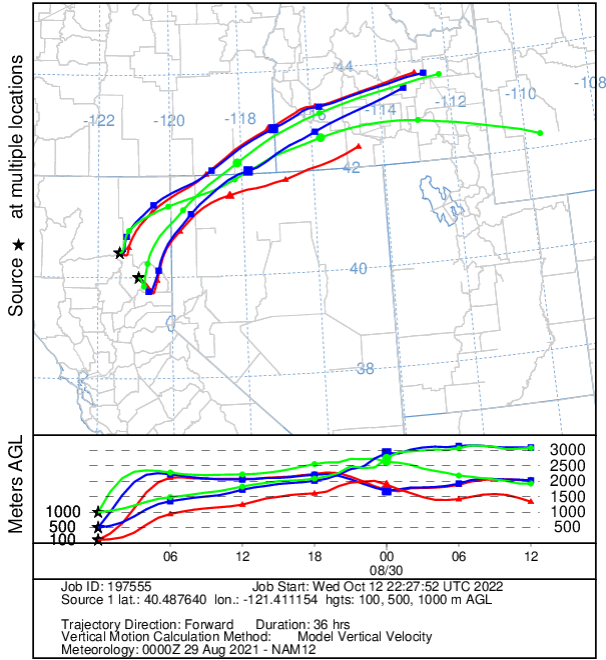
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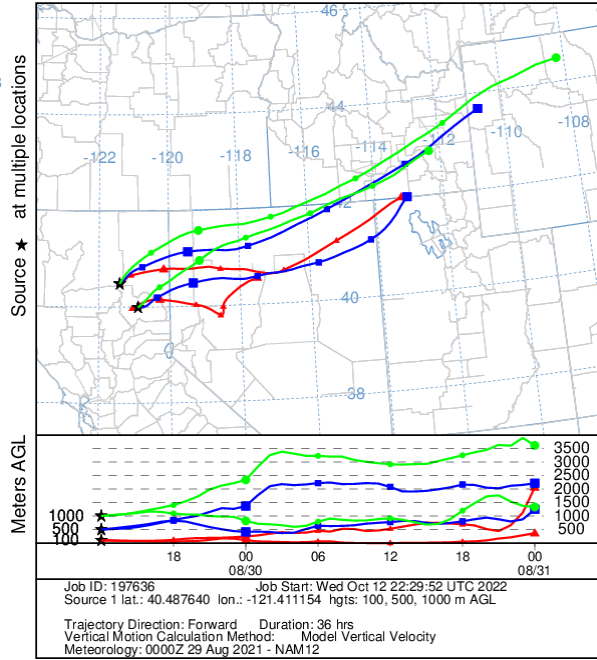
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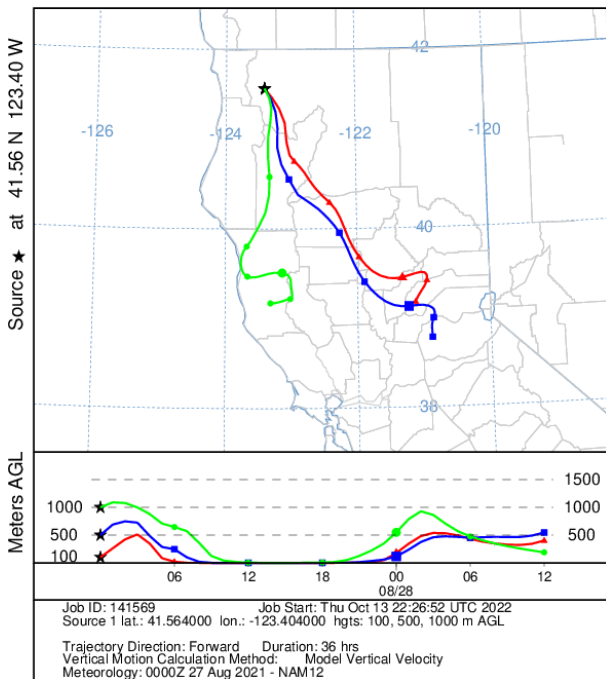
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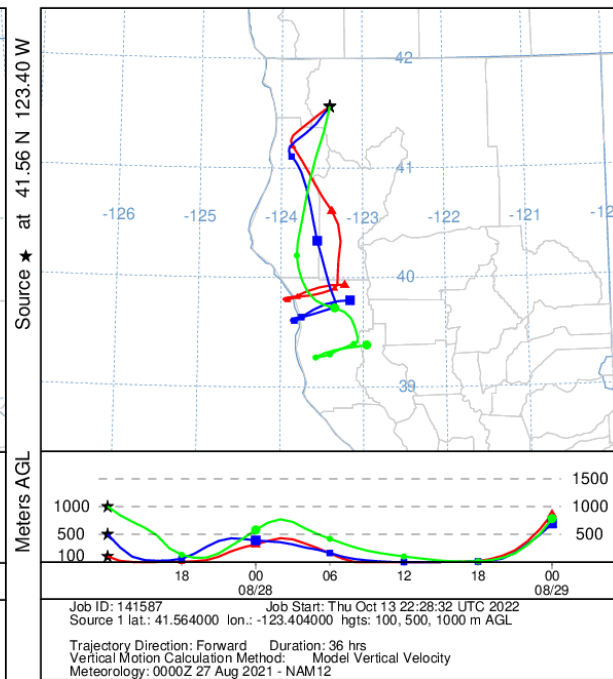
### e) McCash Fire

Name	Start	Containment	Latitude	Longitude	Total Acres
McCash	8/18/2021	11/2/2021	41.5640	-123.4040	94,962

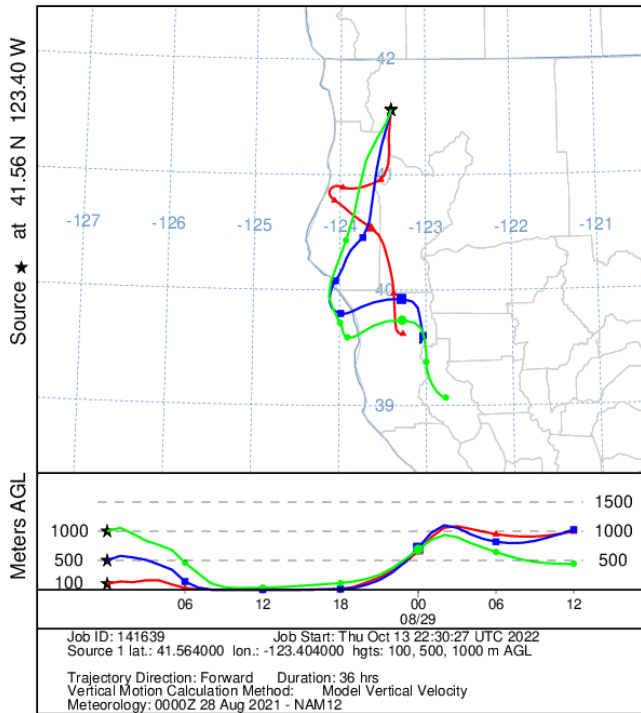
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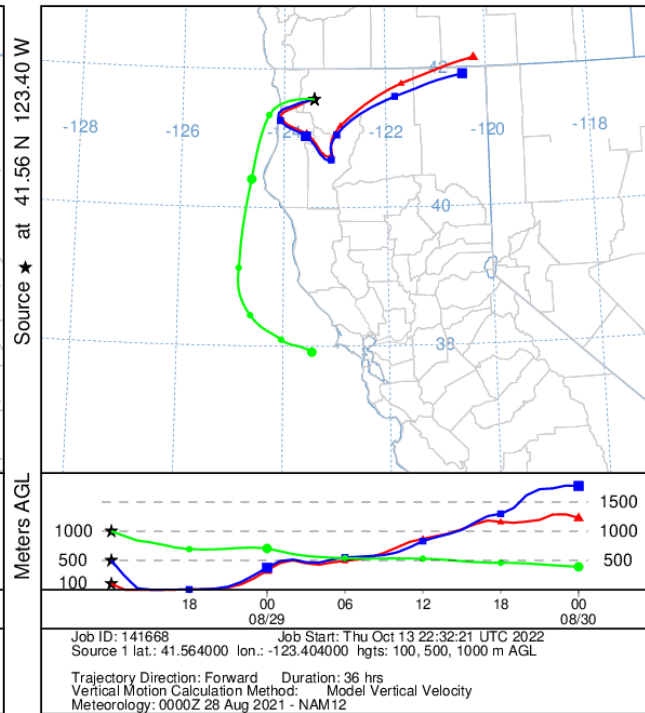
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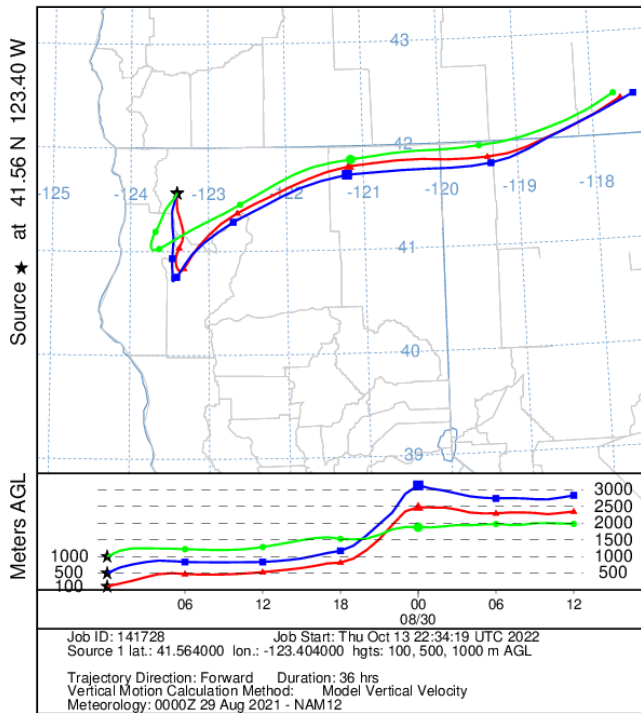
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NAM Meteorological Data



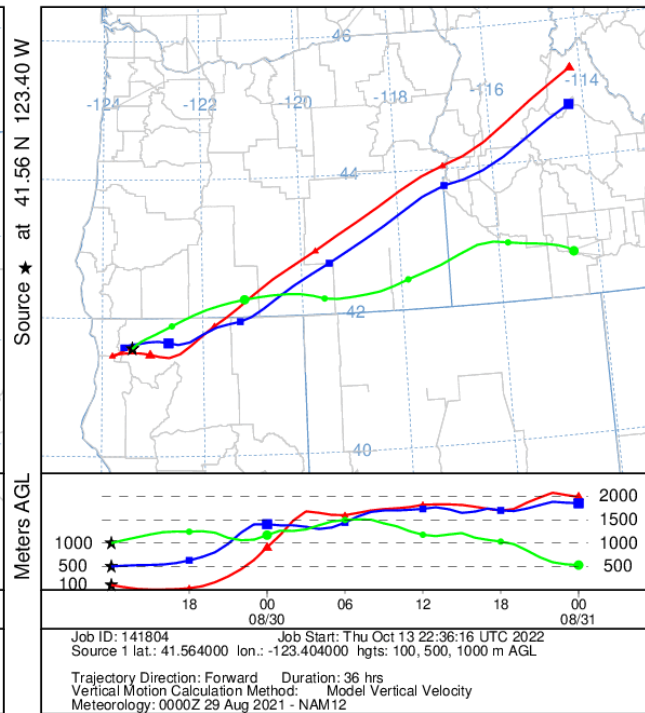
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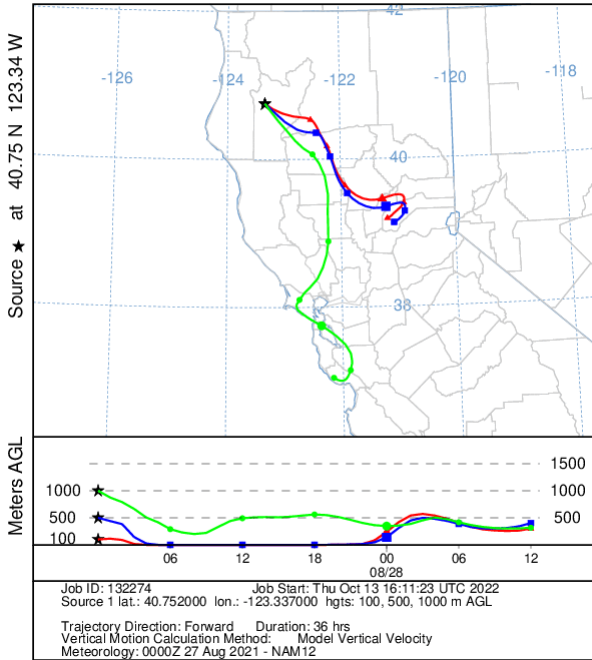
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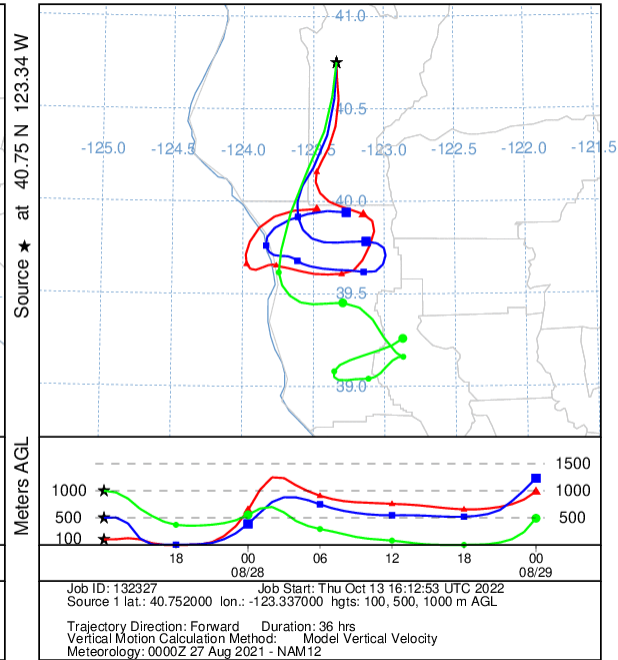
## f) Monument Fire

Name	Start	Containment	Latitude	Longitude	Total Acres
Monument	7/30/2021	10/26/2021	40.7520	-123.3370	223,124

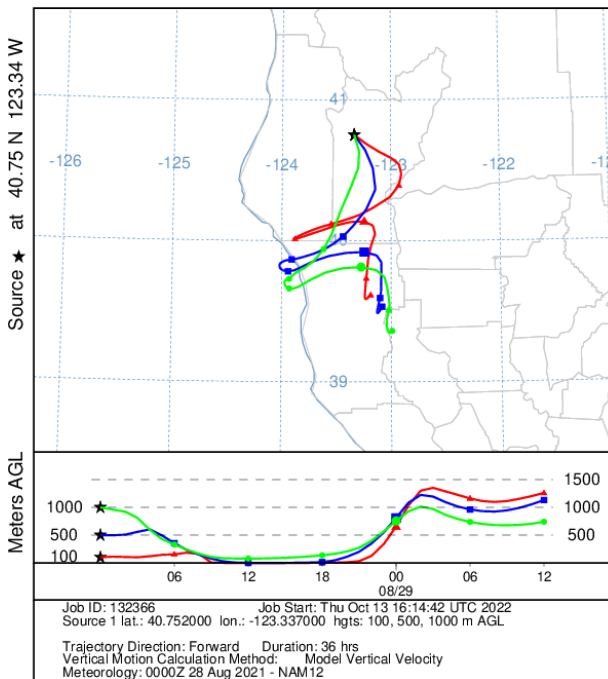
NOAA HYSPLIT MODEL  
Forward trajectories starting at 0000 UTC 27 Aug 21  
NAM Meteorological Data



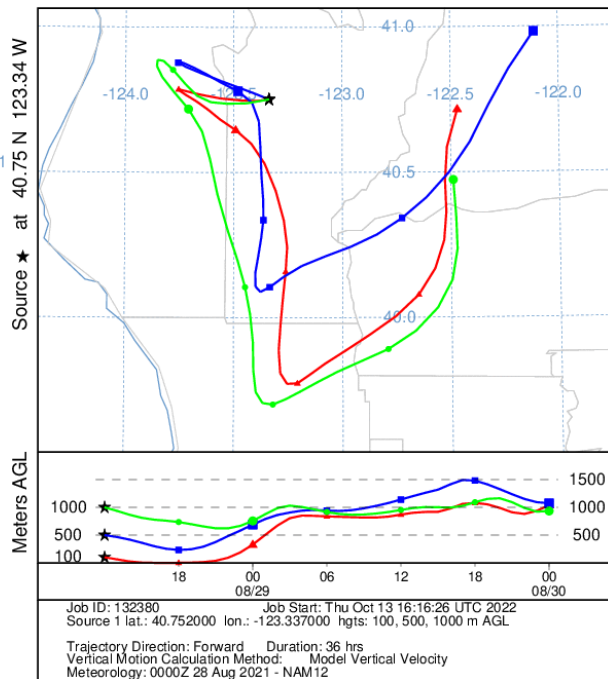
NOAA HYSPLIT MODEL  
Forward trajectories starting at 1200 UTC 27 Aug 21  
NAM Meteorological Data



NOAA HYSPLIT MODEL  
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NAM Meteorological Data

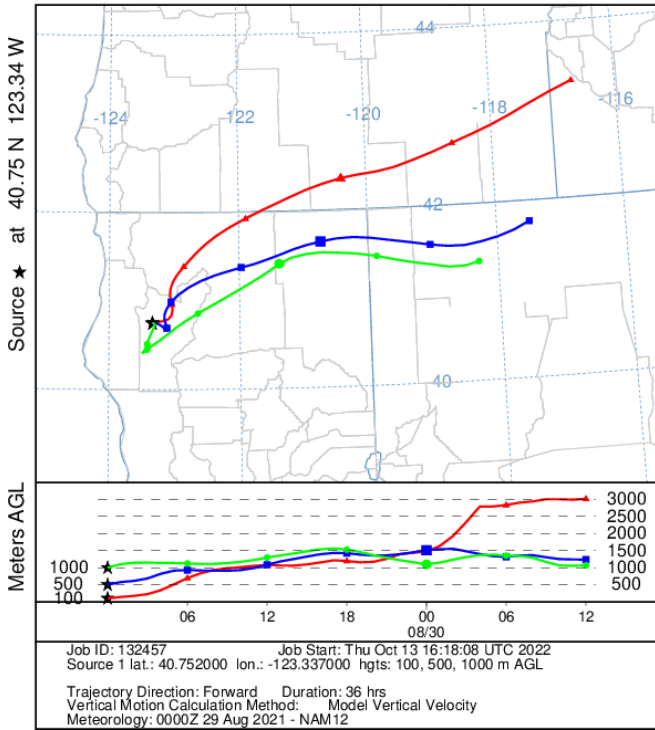


NOAA HYSPLIT MODEL  
Forward trajectories starting at 1200 UTC 28 Aug 21  
NAM Meteorological Data

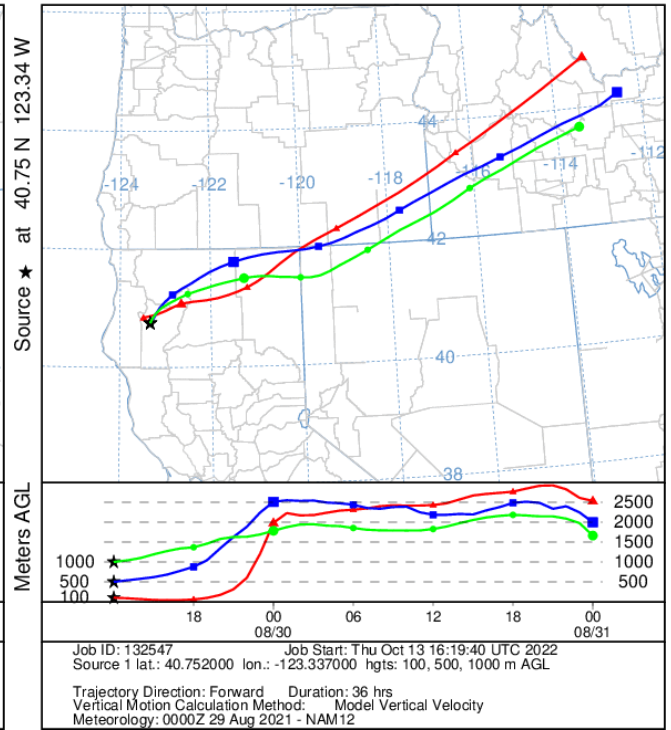




NOAA HYSPLIT MODEL  
 Forward trajectories starting at 0000 UTC 29 Aug 21  
 NAM Meteorological Data



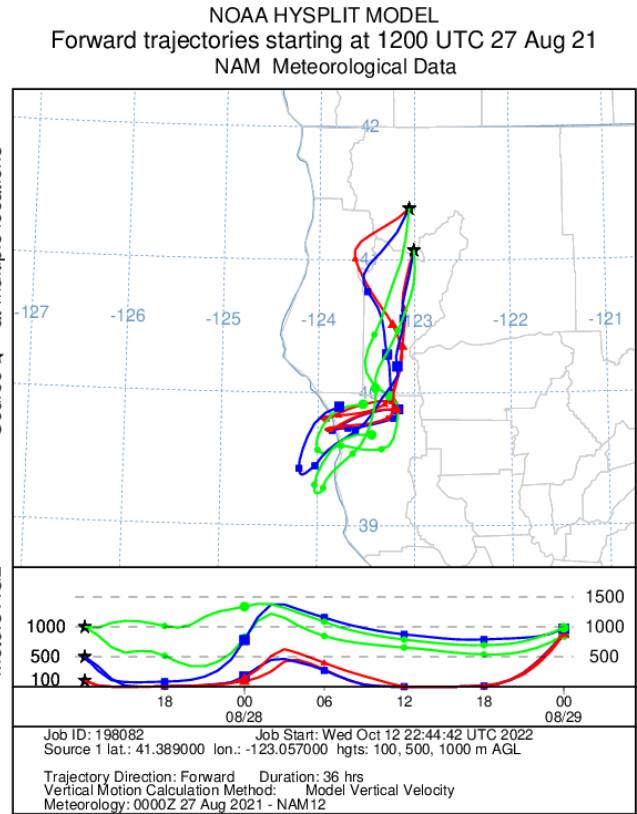
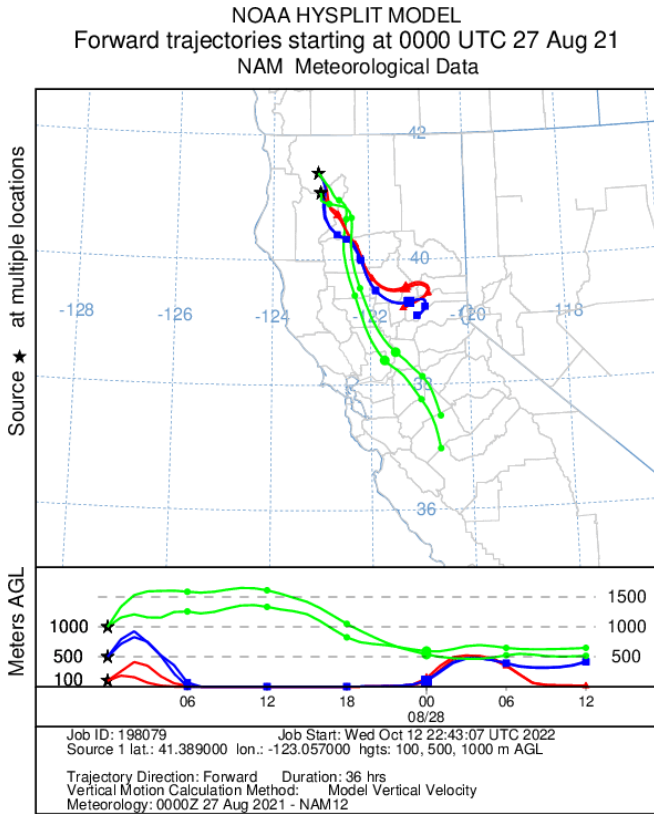
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 Forward trajectories starting at 1200 UTC 29 Aug 21  
 NAM Meteorological Data



## g) River Complex

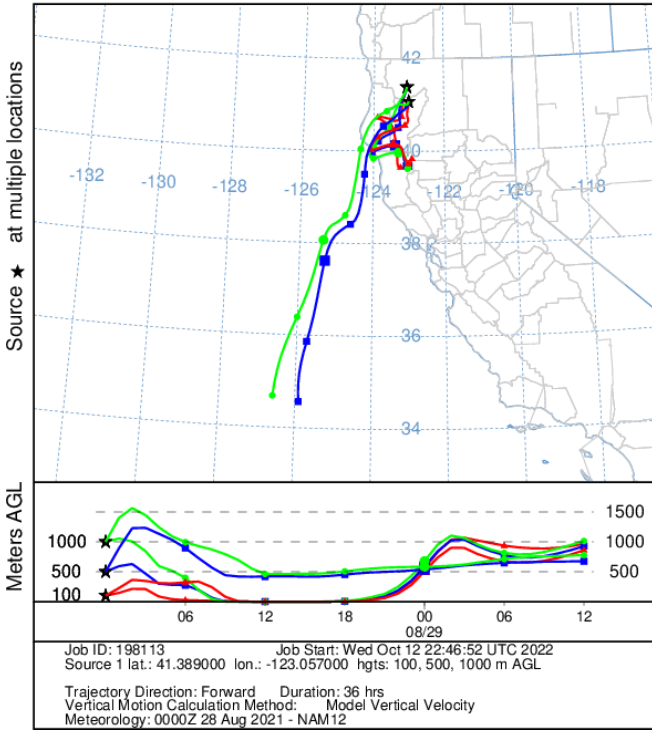
Forward trajectories were calculated from two different points, the original location as defined by CalFire<sup>47</sup>, and a point to the south selected using satellite imagery. These two points are combined in one figure.

Name	Start	Containment	Latitude	Longitude	Total Acres
River	7/30/2021	10/26/2021	41.3890	-123.0570	199,359
<i>River (Southern portion)</i>			41.0723	-123.0078	

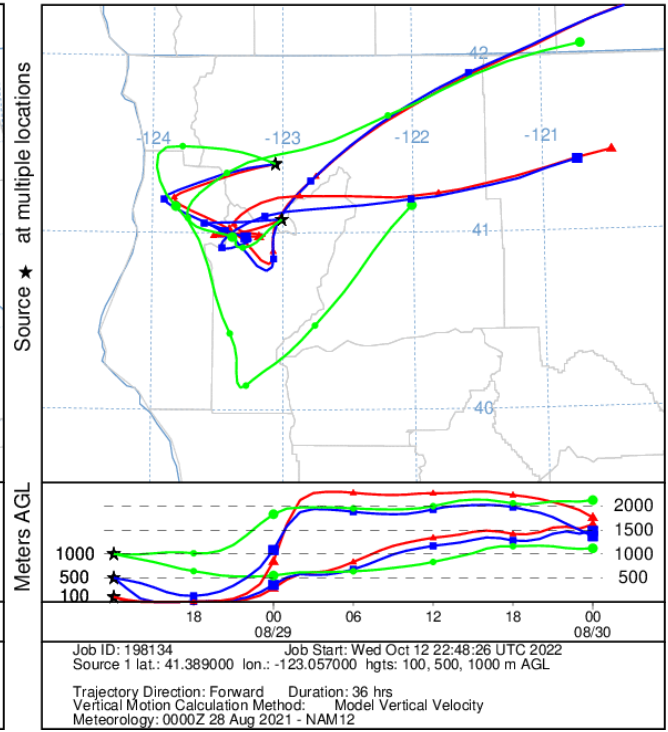


<sup>47</sup> CalFire Incidents, <https://www.fire.ca.gov/incidents/2021/7/13/dixie-fire/>, last accessed 11/30/22

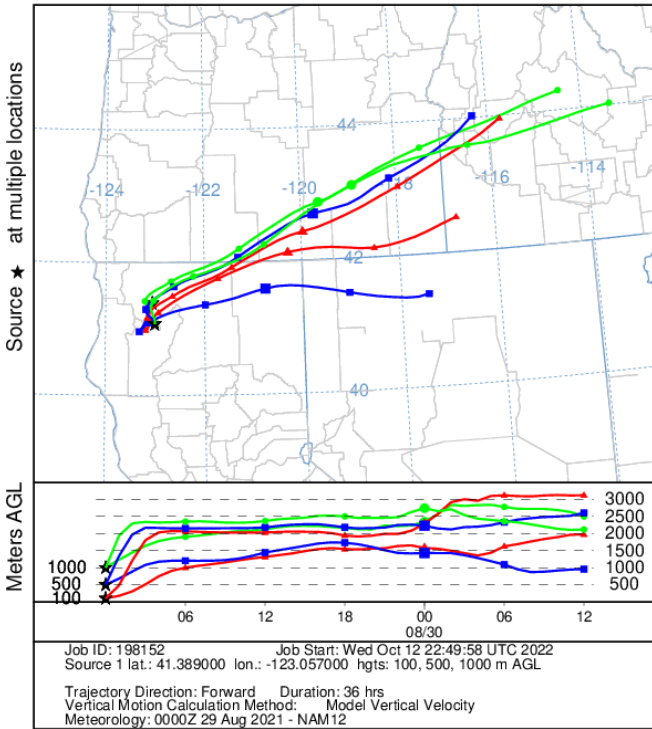
NOAA HYSPLIT MODEL  
 Forward trajectories starting at 0000 UTC 28 Aug 21  
 NAM Meteorological Data



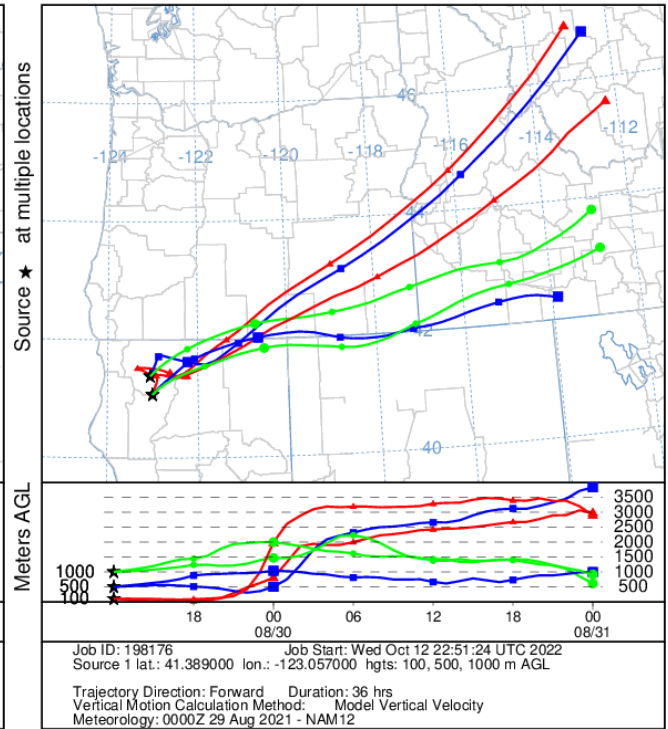
NOAA HYSPLIT MODEL  
 Forward trajectories starting at 1200 UTC 28 Aug 21  
 NAM Meteorological Data



NOAA HYSPLIT MODEL  
 Forward trajectories starting at 0000 UTC 29 Aug 21  
 NAM Meteorological Data



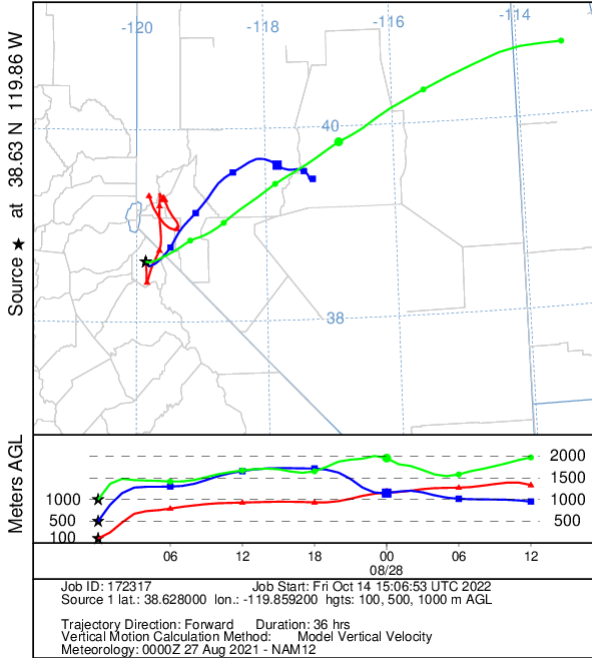
NOAA HYSPLIT MODEL  
 Forward trajectories starting at 1200 UTC 29 Aug 21  
 NAM Meteorological Data



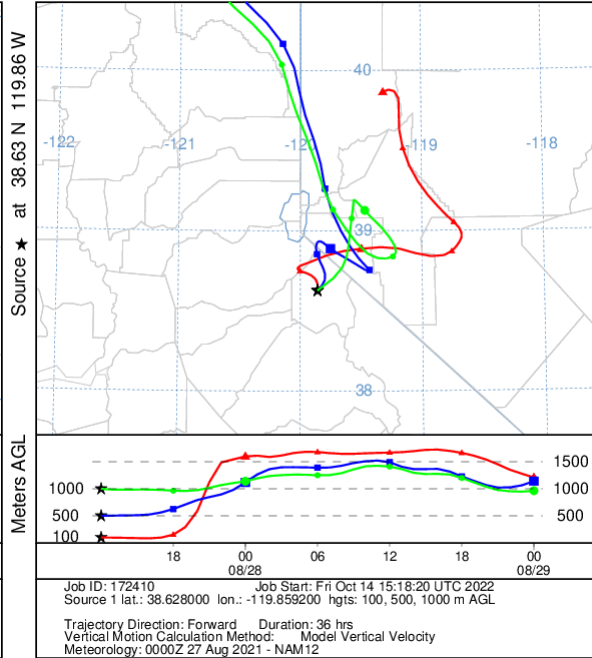
## h) Tamarack Fire

Name	Start	Containment	Latitude	Longitude	Total Acres
Tamarack	7/4/2021	10/26/2021	38.6280	-119.8592	68,637

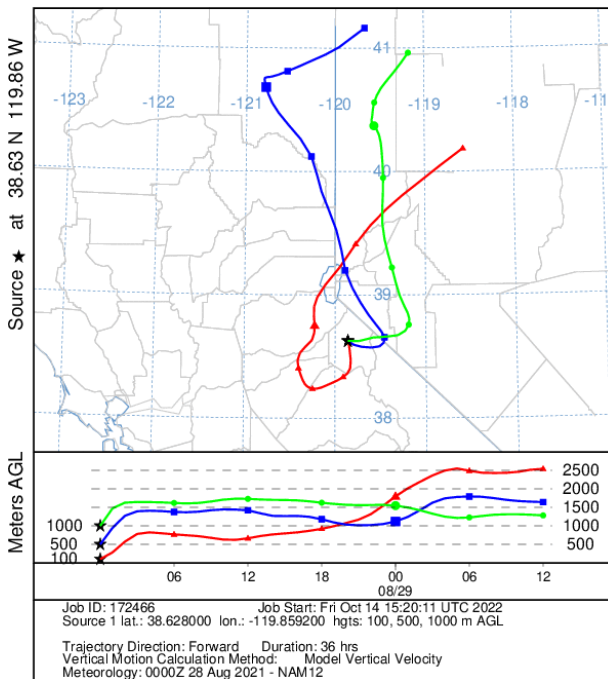
NOAA HYSPLIT MODEL  
Forward trajectories starting at 0000 UTC 27 Aug 21  
NAM Meteorological Data



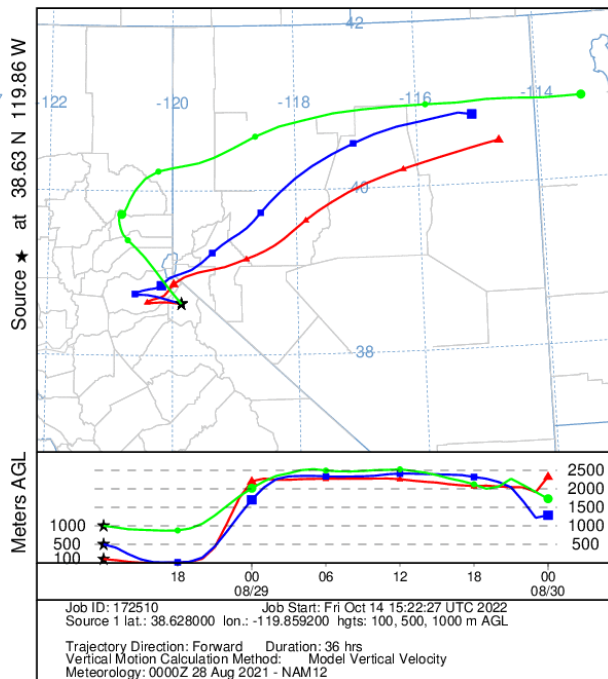
NOAA HYSPLIT MODEL  
Forward trajectories starting at 1200 UTC 27 Aug 21  
NAM Meteorological Data



NOAA HYSPLIT MODEL  
Forward trajectories starting at 0000 UTC 28 Aug 21  
NAM Meteorological Data

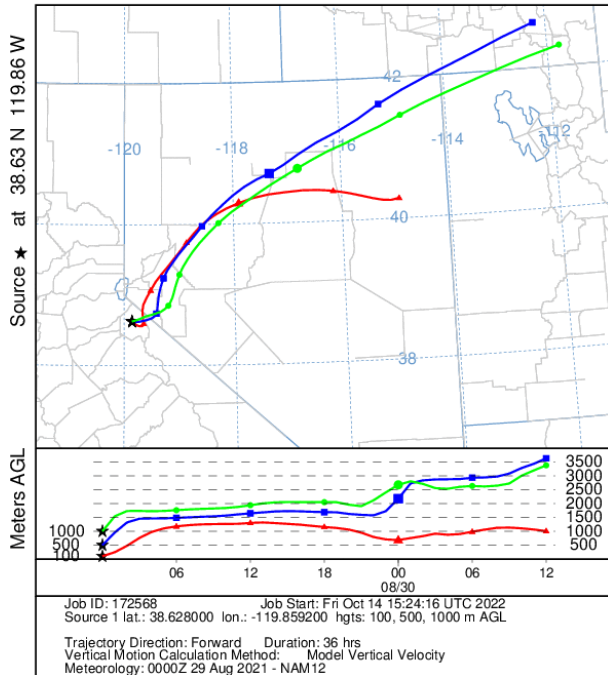


NOAA HYSPLIT MODEL  
Forward trajectories starting at 1200 UTC 28 Aug 21  
NAM Meteorological Data

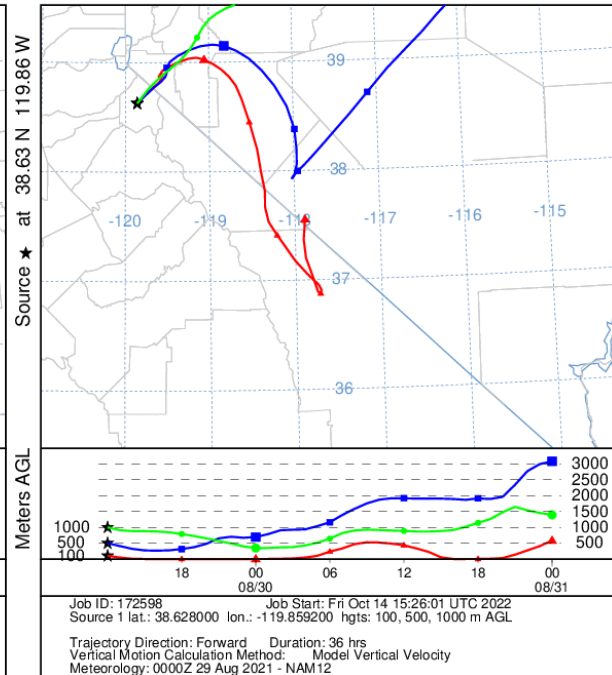




NOAA HYSPLIT MODEL  
Forward trajectories starting at 0000 UTC 29 Aug 21  
NAM Meteorological Data



NOAA HYSPLIT MODEL  
Forward trajectories starting at 1200 UTC 29 Aug 21  
NAM Meteorological Data



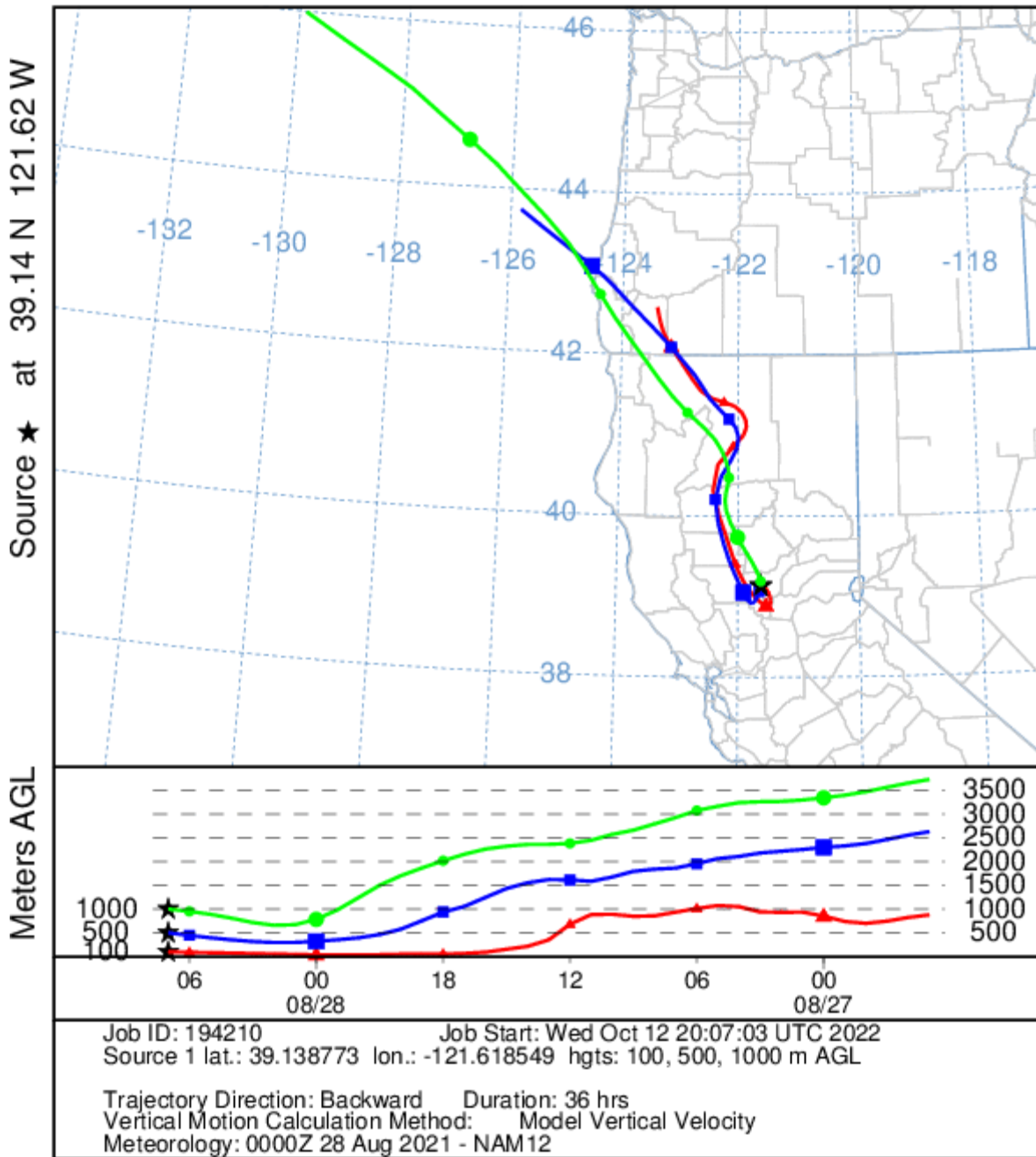
## B. HYSPLIT Backward Trajectory (from Monitor)

NOAA's HYSPLIT<sup>48</sup> model was used to determine simple back-trajectories showing the path that an air parcel took for a specified period of time (here, 36 hours) before reaching the exceeding monitor at Yuba City at the hour of maximum concentration on the exceeding day. Three height levels (red: 100 meters (m), blue: 500m; green: 1000m) were used to indicate transport near the surface and in the mid to upper levels of the atmosphere. Tables indicate the maximum hour of the exceeding day. Both PST (Pacific Standard Time) and UTC (Universal Coordinated Time) are noted. Unlike the previous figures that show these back trajectories, these figures include the distance above ground level that the individual paths took during the 36 hours, with every six hours marked.

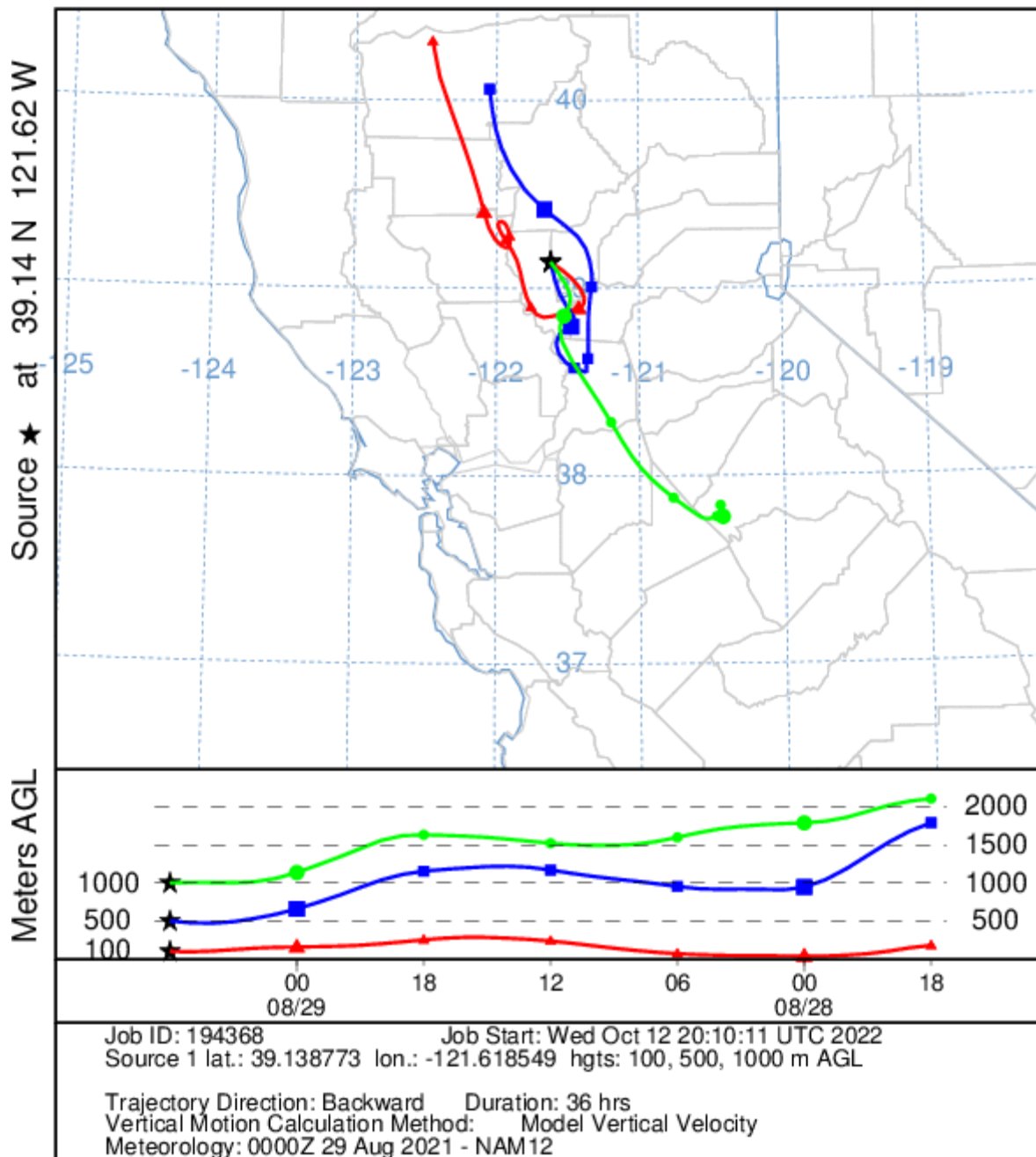
Date (PST)	Daily Concentration ( $\mu\text{g}/\text{m}^3$ )	Max Hourly Concentration ( $\mu\text{g}/\text{m}^3$ )	Max Hour (PST)	Date (UTC)	Max Hour (UTC)
8/27/2021	49.2	92	23	8/28/2021	07
8/28/2021	82.5	105	22	8/29/2021	06
8/29/2021	70.9	103	00	8/29/2021	08

<sup>48</sup> Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT)

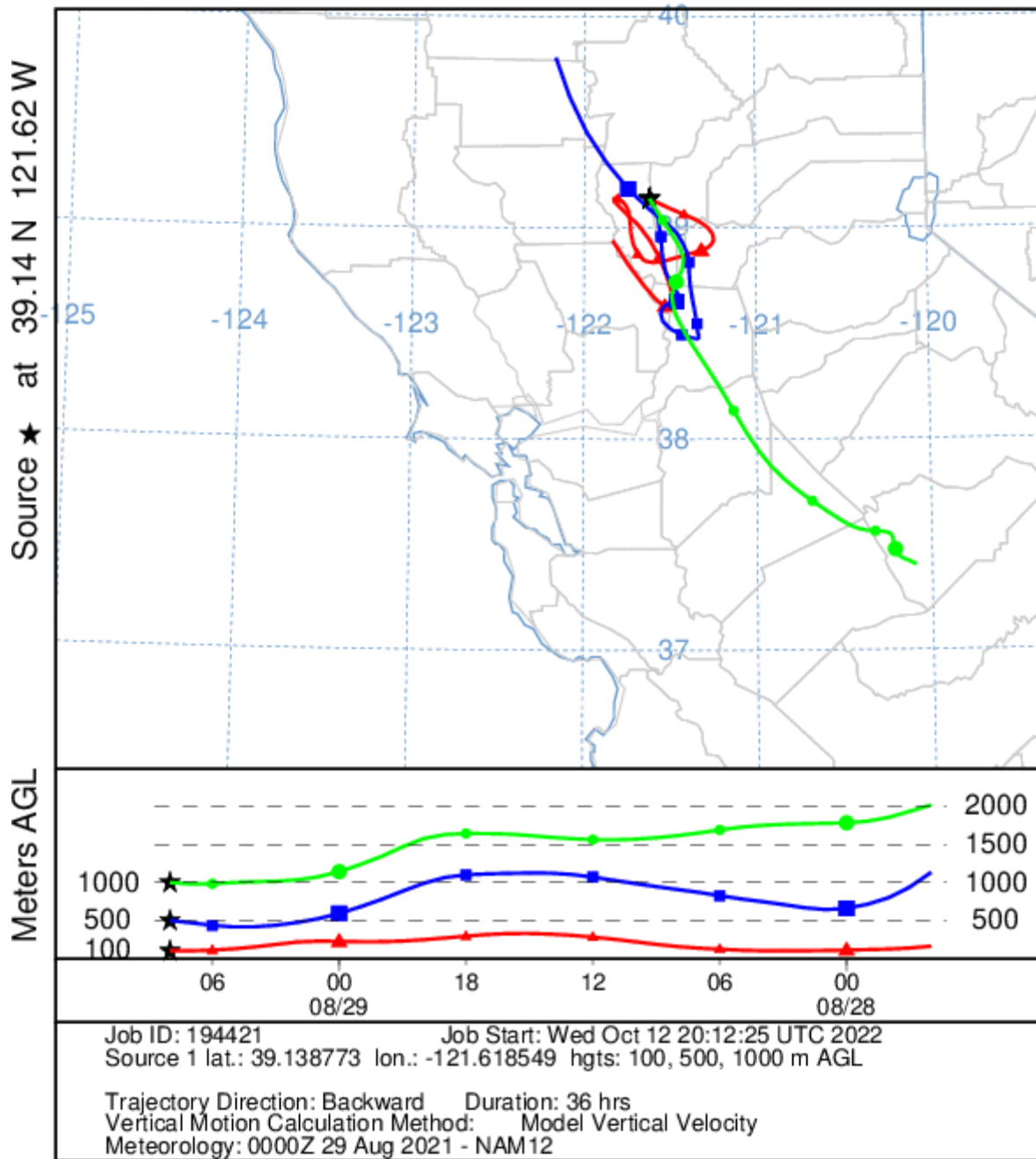
NOAA HYSPLIT MODEL  
 Backward trajectories ending at 0700 UTC 28 Aug 21  
 NAM Meteorological Data



NOAA HYSPLIT MODEL  
 Backward trajectories ending at 0600 UTC 29 Aug 21  
 NAM Meteorological Data






NOAA HYSPLIT MODEL  
 Backward trajectories ending at 0800 UTC 29 Aug 21  
 NAM Meteorological Data





## IV. District Alerts/Advisories

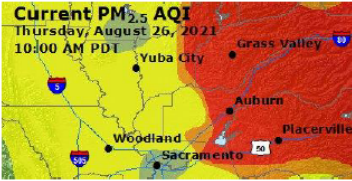
The Feather River AQMD maintains a webpage<sup>49</sup> that keeps the public informed of wildfire smoke and air quality impacts as well as utilizing the AirNow Enviroflash Air Quality Notification System through their Air Quality Health Advisory webpage.<sup>50</sup> The District issued one air quality advisory covering the three-day event and kept the public informed of the daily air quality via the district website as well as social media.

**Air Quality Health Advisory**  
EFFECTIVE AUGUST 26 THROUGH AUGUST 30, 2021

The Public Health Departments for Yuba and Sutter counties and the Feather River Air Quality Management District are issuing an air quality health advisory due to poor air quality conditions from smoke from regional wildfires.

Air Quality Index (AQI) levels are currently Moderate in the valley and Unhealthy for Sensitive Groups to Unhealthy in the Yuba County foothills. Due to an expected shift to northerly winds, smoke levels will increase starting Thursday afternoon. In addition, high pressure Friday and Saturday may result in Unhealthy to Unhealthy for Sensitive Groups AQI in the Yuba-Sutter area. Moderate to Unhealthy for Sensitive Groups AQI is expected Sunday, with higher concentrations of smoke likely in the Yuba County foothills than in the valley.



The Sutter County and Yuba County Public Health Departments advise residents with lung or heart disease, and the elderly to leave areas where levels of particulate matter are high. For everyone else, when you smell smoke, or see smoke around you, you should consider staying indoors and avoiding heavy exertion.

Smoke density can vary widely over short distances and due to changes in metrological conditions. "Because smoke generation and weather are ever changing accurate predictions of smoke impacts are difficult, residents are encouraged to be aware of local conditions." warns Christopher D. Brown, Air Pollution Control Officer.

You can check current conditions online at <https://fire.airnow.gov> [www.sparetheair.com](http://www.sparetheair.com). Residents can also sign up for air quality forecasts and alerts at [www.fraqmd.org](http://www.fraqmd.org) that can be sent by email or text message. Residents that do not have internet access may also check particulate matter levels by listening to reports from local radio stations, local news, checking the local newspaper such as the Appeal-Democrat (during extended wildfire smoke impacts), or by using the distance/visibility table at the bottom of this advisory.

Residents who see or smell smoke should consider these precautionary measures:

- Healthy people should delay strenuous exercise, particularly when they can smell smoke.
- Children and elderly people should consider avoiding outdoor activities, particularly prolonged outdoor exertion. Parents of children involved in youth sports programs should consider whether their children be allowed to participate when smoke is in the air.
- People with health-related illnesses, particularly breathing problems, should remain indoors.
- Keep windows and doors closed as much as possible. Use the recycle or recirculate mode on the air conditioner in your home or car.
- Masks, such as cloth masks worn to prevent the spread of the novel coronavirus, are not capable of filtering extra fine particles found in wildfire smoke.
- Do not rely on N-95 respirators to do unnecessary outdoor activities.
- Keep airways moist by drinking lots of water. Breathing through a warm, wet washcloth can also help relieve dryness, but does not filter out the hazardous smoke particles.
- Avoid the fire areas and watch for emergency equipment.

Wildfire smoke may contain particulate matter, ozone, carbon monoxide, and toxic air contaminants. While all persons may experience varying degrees of symptoms, more sensitive individuals, such as the young, aged and those with respiratory conditions are at greatest risk of experiencing more aggravated symptoms. Symptoms may include, but are not limited to, coughing, watery and itchy eyes, and difficulty breathing. Persons experiencing questionable or severe symptoms should seek professional medical advice and treatment.

The following index may also assist in assessing the air quality based on the visibility in your area. To assess visibility:

- Face away from the sun. Determine visibility range by looking for targets that are at known distances (miles). You can use an electronic device map app or a map of the local area that has a mile scale.
- The visible range is the point where even high-contrast objects disappear.

Distance you can see	Recommended action if you are a healthy adult, teenager, or other child	Recommended action if you are age 65 and over, pregnant, a young child or have asthma, respiratory illness, or lung or heart disease
10 + miles	Watch for changing conditions and moderate outdoor activity based on personal sensitivity	Moderate outdoor activity
5 – 10 miles	Moderate outdoor activity	Minimize or avoid outdoor activity
Less than 5 miles	Minimize or avoid outdoor activity	Stay inside or in a location with good air quality

Some examples of local distances: From the junction of Hwy 99 and Hwy 20 to the South Butte in the Sutter Buttes is about 11 miles; from the 10<sup>th</sup> Street bridge to Township Road is about 5 miles; from the intersection of Hwy 20 and Acacia Avenue to the South Butte is about 5.5 miles; and the distance between the 5<sup>th</sup> Street and 10<sup>th</sup> Street bridges is about 0.5 mile.

<sup>49</sup> Feather River AQMD, *Wildfire Smoke*, last accessed 9/30/22

<sup>50</sup> Feather River AQMD, *Air Quality Health Advisory*, last accessed 9/30/22

County officials will continue to monitor air quality in Sutter and Yuba County and provide updates on this advisory as needed. For current information, or to sign up for air quality alerts and forecasts, go to the Feather River Air Quality Management District website <http://www.fraqmd.org/> or check the Sutter County and Sutter County Public Health Facebook pages or Yuba County website.

Air Quality Index		
AQI Category and Color	Index Value	Description of Air Quality
Good Green	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Moderate Yellow	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups Orange	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Unhealthy Red	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy Purple	201 to 300	Health alert: The risk of health effects is increased for everyone.
Hazardous Maroon	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

## V. Media Reports

Examples of traditional news and social media accounts of wildfires and smoke impacts, arranged by type of media and date. Due to the amount of information available, not all available articles are provided.

### A. News Media and Other Information Sources

Appeal-Democrat, Air quality advisory issued for Yuba-Sutter, [https://www.appeal-democrat.com/news/air-quality-advisory-issued-for-yuba-sutter/article\\_b37117ca-06d7-11ec-ac4e-678442117d08.html](https://www.appeal-democrat.com/news/air-quality-advisory-issued-for-yuba-sutter/article_b37117ca-06d7-11ec-ac4e-678442117d08.html), August 26, 2021, last accessed 11/20/22

Air quality advisory issued for Yuba-Sutter

Appeal Staff Report  
Aug 26, 2021

An air quality health advisory was issued Thursday in response to poor air quality conditions from smoke and regional wildfires.

The public health departments for Yuba and Sutter counties and the Feather River Air Quality Management District said a high pressure weather system today and Saturday "may result in Unhealthy to Unhealthy for Sensitive Groups AQI (Air Quality Index) in the Yuba-Sutter area," according to a news release.

Sunday could see improvements with higher concentrations of smoke likely in the Yuba County foothills.

The health departments advised anyone with lung or heart disease and the elderly to leave areas where levels of particulate matter are high. Others are advised to stay indoors if smoke is present. Wildfire smoke may contain particulate matter, ozone, carbon monoxide or toxic air contaminants, the release said.

The public can check current conditions at <https://fire.aimow.gov> or [www.sparetheair.com](http://www.sparetheair.com).

Residents also can sign up for air quality forecasts and alerts at [www.fraqmd.org](http://www.fraqmd.org).

ABC10 News, Terrain-driven winds over the weekend threaten to supercharge the Caldor Fire, <https://www.abc10.com/article/news/local/wildfire/south-lake-tahoe-caldor-fire-evacuations-and-road-closures/103-21d275d6-3a29-4b6f-9df5-e2a7a8bb0282>, August 27, 2021, last accessed 11/30/22

**10** ABC10

**Terrain-driven winds over the weekend threaten to supercharge the Caldor Fire | Evacuations, maps, updates**

Saturday's updates are at [/article/news/local/wildfire/caldor-fire-latest-evacuations- ...](#) taking Highway 89 to Interstate 80 to her family in Yuba City.

Aug 27, 2021



Sacramento Bee, Air quality expected to worsen in Sacramento Area, improve in Lake Tahoe as wind shifts, <https://www.sacbee.com/news/local/article253769028.html>, August 27, 2021, last accessed 11/30/22

**B** The Sacramento Bee

## Air quality expected to worsen in Sacramento area, improve in Lake Tahoe as wind shifts

Enhanced wildfire smoke is expected to return to the valley starting ... Colusa, Yuba, Sutter and Butte counties, as well as Shasta-Trinity National Forest.

Aug 27, 2021



Sacramento Bee, Hazardous air from wildfires blankets Sacramento region again, <https://www.sacbee.com/news/local/article253790093.html>, August 27, 2021, last accessed 11/30/22

**B** The Sacramento Bee

## Hazardous air from wildfires blankets Sacramento region again — Red Hawk casino among closures

Wildfire smoke continues to drive up levels of particulate matter 2.5 as the Caldor ... Rio Vista, Roseville, Yuba City and Elk Grove in the moderate range.

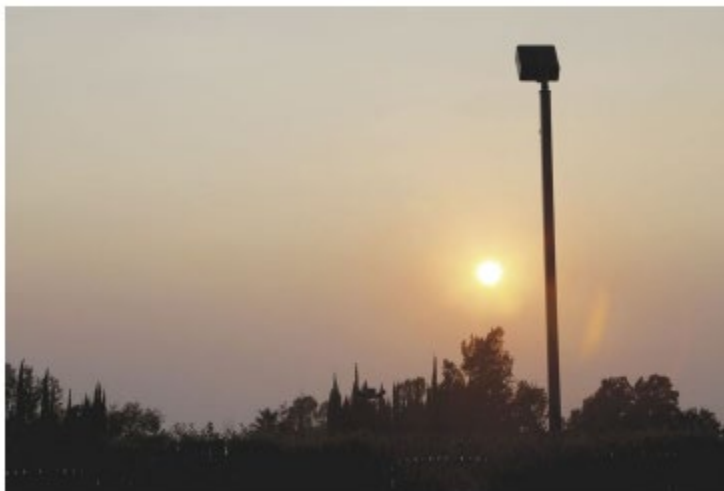
Aug 27, 2021



Appeal-Democrat, Yuba City home opener called off due to poor air quality from wildfires, [https://www.appeal-democrat.com/sports/yuba-city-home-opener-called-off-due-to-poor-air-quality-from-wildfi%20res/article\\_8fda9600-07c8-11ec-a926-c3438a92f722.html](https://www.appeal-democrat.com/sports/yuba-city-home-opener-called-off-due-to-poor-air-quality-from-wildfi%20res/article_8fda9600-07c8-11ec-a926-c3438a92f722.html), August 27, 2021, last accessed 11/20/22

### Yuba City home opener called off due to poor air quality from wildfires

By Jeff Larson [jlanson@appealdemocrat.com](mailto:jlanson@appealdemocrat.com)  
Aug 27, 2021




Due to air quality ranging in the unhealthy range, Friday's Yuba City-Lincoln varsity and junior varsity football games were canceled.

Photos courtesy of Bill Clark



## B. Social Media



**Feather River AQMD**  
@FeatherRiverAir

A(n) Air Quality Advisory has been declared for Yuba City and Marysville, CA on Aug 26

3:10 PM · Aug 25, 2021 · EnviroFlash

<https://twitter.com/FeatherRiverAir/status/1430653713463525381>



**Feather River AQMD**  
@FeatherRiverAir


Air Quality Health Advisory issued for Yuba and Sutter counties for Thursday August 26 through Monday August 30th: [fraqmd.org/air-quality-he...](https://fraqmd.org/air-quality-health-advisory)



fraqmd.org  
Air Quality Health Advisory

10:58 AM · Aug 26, 2021 · Twitter Web App

<https://twitter.com/FeatherRiverAir/status/1430952807108988928>



**Feather River AQMD**  
@FeatherRiverAir

A(n) Air Quality Advisory has been declared for Yuba City and Marysville, CA on Aug 27

3:10 PM · Aug 26, 2021 · EnviroFlash

<https://twitter.com/FeatherRiverAir/status/1431016101450854405>



Feather River AQMD  
@FeatherRiverAir

...

A(n) Air Quality Advisory has been declared for Yuba City and Marysville, CA on Aug 28

3:10 PM · Aug 27, 2021 · EnviroFlash

<https://twitter.com/FeatherRiverAir/status/1431378489530269703>



Feather River AQMD  
@FeatherRiverAir

...

A(n) Air Quality Advisory has been declared for Yuba City and Marysville, CA on Aug 29

3:10 PM · Aug 28, 2021 · EnviroFlash

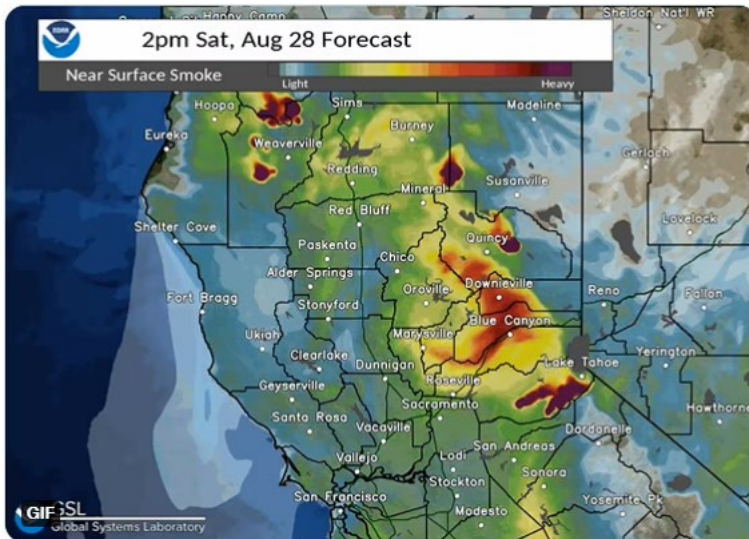
<https://twitter.com/FeatherRiverAir/status/1431740876963864582>



NWS Sacramento  
@NWSSacramento

...

Don't leave your windows open tonight! Latest smoke forecast has significant amount of smoke moving over the foothills, mountains, and Sacramento region overnight and Saturday morning. A more favorable wind pattern Sunday afternoon will bring improving conditions. #CAwx



9:01 PM · Aug 27, 2021 · TweetDeck

<https://twitter.com/NWSSacramento/status/1431466955593027584>

 **kcranews** ✓  
@kcranews  
Official

Here's a live look at the smoke that has settled in the Sacramento region on Saturday



 **kcranews** ✓ @kcranews  
pscp.tv  
Here's a live look at the smoke that has settled in the Sacramento region on Saturday

12:05 PM · Aug 28, 2021 · Periscope

<https://twitter.com/kcranews/status/1431694437470511104>