

2023 Revision to the California State Implementation Plan for Carbon Monoxide

*Updated Maintenance Plan for Three Federal Planning
Areas*

February 9, 2024

California Air Resources Board

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Executive Summary

Carbon monoxide (CO) levels have been decreasing across California due to the effectiveness of state and local control programs. In 1991, 11 areas were designated as nonattainment for the federal 8-hour CO standard¹ of 9 parts per million (ppm). All the areas designated as nonattainment, including the Los Angeles urbanized area, now attain the federal 8-hour CO standard.

In April 1996, the California Air Resources Board (CARB) adopted California's CO Maintenance Plan, and the U.S. Environmental Protection Agency (U.S. EPA) approved it in 1998.² This 1996 CO Maintenance plan showed that California's CO maintenance areas would continue to attain the CO standard through 2010. In July 2004, CARB adopted the 2004 CO Maintenance Plan, and the U.S. EPA approved it in November 2005.³ The 2004 CO State Implementation Plan (SIP) Update showed how 10 of the 11 California CO maintenance areas would continue to maintain the CO standard through 2018. The 10 original CO maintenance areas are: Bakersfield Metropolitan Area, Chico Urbanized Area, Fresno Urbanized Area, Lake Tahoe North Shore Area, Lake Tahoe South Shore Area, Modesto Urbanized Area, Sacramento Urbanized Area, San Diego Area, San Francisco-Oakland-San Jose Area, and Stockton Urbanized Area. To date, California has completed the 20-year maintenance requirement for the CO standard for the 10 areas.

The 2023 Revision to the California State Implementation Plan for Carbon Monoxide (2023 CO SIP revision) is updating the maintenance plan to remove the contingency measures and monitoring requirement for 3 of the 10 maintenance areas included in the 2004 CO Maintenance Plan:

Chico Urbanized Area

Stockton Urbanized Area

Modesto Urbanized Area

By 2022, these three maintenance areas were monitoring CO levels 81% to 86% below the federal 8-hour CO standard of 9 ppm (Table 1). These levels, together with declining emissions due to an ever-cleaner vehicle fleet and local air district rules for stationary sources, provide assurance that the three maintenance areas will continue to attain the federal 8-hour CO standard.

¹ The federal CO standard is 9 parts per million (ppm) averaged over 8 hours. To determine attainment, the greater of the second high levels measured at a site in each of two consecutive years (known as the design value) is compared to the standard.

² Federal Register, *Volume 63*, Number 61, 15305, March 31, 1998.

³ Federal Register, *Volume 70*, Number 61, 71776, November 30, 2005.

Table 1: 2021-2022 design value and their percent below the federal 8-hour standard

CO Maintenance Area	Federal 8-hour CO Standard (ppm)	2021-2022 Design Value (ppm)	Percent Below Federal 8-hour CO standard (as of the 2021-2022 design value)
Chico	9	1.3	86%
Modesto	9	1.4	84%
Stockton	9	1.7	81%

In addition to the ambient CO data, the CO emission estimates and forecasts demonstrate that:

- CO emissions have reduced significantly from 2000 through 2023; and
- Forecasted CO emissions demonstrate the three areas will remain in attainment for the next 27 years (through 2050).

Air quality will continue to improve through emission reductions from adopted CARB and local air district measures. These will generate progressively more benefits over time, effectively decreasing CO emissions well below the levels that resulted in attainment.

The 2023 CO SIP revision complies with the Clean Air Act (Act) section 110(l) by demonstrating that the removal of the contingency measures, and the monitoring requirements, will not interfere with maintenance of the federal 8-hour CO standard or any other Act requirements related to this standard. This revision demonstrates that ambient monitoring in the three maintenance areas is no longer needed, and U.S. EPA can approve a monitoring discontinuation request in the three maintenance areas listed above.

CARB staff recommends that Executive Officer approve and submit this 2023 CO SIP revision, to remove the contingency measures and the monitoring requirements for three (Chico Urbanized Area, Modesto Urbanized Area, and Stockton Urbanized Area) federal CO planning areas, to the U.S. EPA for approval in the California State Implementation Plan. The 2023 CO SIP revision is necessary to update CO monitor siting in these three areas pursuant to 40 Code of Federal Regulations (CFR) section 58.14(c)(1).

Background

CO is a colorless and odorless gas that is directly emitted as a product of combustion. The highest concentrations are generally associated with cold stagnant weather conditions that occur during winter. In contrast to ozone, which tends to be a regional pollutant, CO problems tend to be localized.

High CO levels are a health concern because the pollutant is readily absorbed through the lungs into the blood, where it binds with hemoglobin and reduces the ability of the blood to carry oxygen. As a result, insufficient oxygen reaches the heart, brain, and other tissues. The harm caused by CO can be critical for people with heart disease, chronic lung disease, or anemia. Even healthy people exposed to sustained CO levels above 70ppm can experience headaches, fatigue, slow reflexes, and dizziness and can be fatal at sustained concentrations above 150 to 200ppm.⁴

Both CARB and U.S. EPA have established health-based air quality standards for CO, measured over one hour and eight hours. Prior to the 1990s, many urban areas in California routinely violated the State and federal 8-hour standards for CO. Ambient CO levels have dropped statewide in response to continued emission reductions. This proposed State Implementation Plan (SIP) revision focuses solely on the federal 8-hour CO standard.

In 1991, U.S. EPA designated 11 areas in California (the 10 areas listed below, and the Los Angeles urbanized area) as nonattainment of the federal 8-hour CO standard of 9 ppm. By 1995, CO levels in the 10 areas⁵ met the air quality test for attainment. In 1996, CARB adopted and submitted a CO Maintenance Plan⁶ and requested that 10 of the areas be redesignated to attainment for the federal 8-hour CO standard. U.S. EPA found that the State satisfied all 5 criteria based on the 1996 CO Maintenance Plan and prior SIP submittals for other elements of the Act. U.S. EPA approved the 1996 CO Maintenance Plan as part of the California SIP and redesignated the 10 areas to attainment effective June 1, 1998.⁷ For the second 10-year maintenance period, CARB developed the 2004 CO Maintenance Plan revision⁸ which U.S. EPA approved on November 30, 2005.⁹ The combination of these two Plans showed how the 10 areas (listed below) would maintain the CO standard through 2018. The 10 original CO maintenance areas are: Bakersfield Metropolitan Area, Chico Urbanized Area, Fresno Urbanized Area, Lake Tahoe North Shore Area¹⁰, Lake Tahoe South Shore Area¹¹, Modesto

⁴ United States Consumer Product Safety Commission, [Carbon Monoxide Questions and Answers](#)

⁵ The eleventh nonattainment area – Los Angeles urbanized area – attained the federal 8-hour CO standard (9 ppm) by 2002. The local air district prepared a [separate maintenance plan and request for redesignation](#) which was approved by the EPA in 2005

⁶ CARB, the [1996 CO Maintenance Plan](#) was adopted on April 26, 1996

⁷ Federal Register, [Volume 63](#), Number 61, 15305, March 31, 1998.

⁸ CARB, the [2004 CO Maintenance Plan](#) was adopted on July 22, 2004.

⁹ Federal Register, [Volume 70](#), Number 61, 71776, November 30, 2005.

¹⁰ Placer County part of Lake Tahoe Air Basin.

¹¹ El Dorado County part of Lake Tahoe Air Basin.

Urbanized Area, Sacramento Urbanized Area¹², San Diego Area¹³, San Francisco-Oakland-San Jose Area¹⁴, and Stockton Urbanized Area. To date, California has completed the 20-year maintenance requirement for CO for the 10 areas.

In 2022, CARB submitted a request to the U.S. EPA to discontinue CO monitoring at four locations, including the three maintenance areas listed below. The 2023 CO SIP revision is updating the 2004 CO Maintenance Plan revision to remove the contingency and monitoring requirement for the following 3 of the 10 maintenance areas on Section E on page 11 of the 2004 CO Maintenance Plan revision¹⁵ (these three areas will be collectively referred to as the CO maintenance areas) so that U.S. EPA can approve the monitoring discontinuation request:

Chico Urbanized Area

Stockton Urbanized Area

Modesto Urbanized Area

Using a combination of monitored air quality data and CO emissions, the 2023 CO SIP revision shows that CO levels in the CO maintenance areas are well below the federal 8-hour CO standard and will remain below the standard. Thus, the 2023 CO SIP revision complies with the Act section 110(l) by demonstrating that the removal of the contingency measures, and the monitoring requirements, will not interfere with maintenance or any other Act requirements. This revision is necessary for U.S. EPA to approve a monitoring discontinuation request, in the three maintenance areas, under 40 CFR 58.14(c)(1).¹⁶ In summary, this 2023 CO SIP revision demonstrates that ambient monitoring in the three maintenance areas is no longer necessary, by including:

- Air quality data that demonstrate the three areas (Chico Urbanized Area, Modesto Urbanized Area, and Stockton Urbanized Area) continue to be in attainment and air quality trends show a decline in CO levels between 1990 and 2022;
- Emission estimates show significant reductions in CO emissions projected from 2000 through 2023;
- Emissions estimate forecasts that demonstrate the three areas will remain in attainment for the next 27 years through 2050; and
- CARB's adopted mobile source control strategy generates progressively more emission reduction benefits over time, effectively decreasing CO emissions well below the levels that resulted in attainment.

¹² Urbanized parts of Sacramento, Placer, and Yolo Counties

¹³ Western part of County only

¹⁴ Urbanized parts of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties.

¹⁵ CARB, the [2004 CO Maintenance Plan](#) was adopted on July 22, 2004.

¹⁶ Code of Federal Regulations: [40 CFR 58.14\(c\)\(1\)](#)

Air Quality Monitoring Data Demonstrates Maintenance

I. Carbon Monoxide Design Value

Table 2 and Figure 1 shows the 8-hour CO design values - the higher of each year's annual second maximum, non-overlapping 8-hour average over a two-year period for the CO maintenance areas. The CO design values, in the three maintenance areas, have declined by about 76% to 79% overall between the attainment period (1993-1995) and 2021-2022, resulting in them being well below the federal 8-hour CO standard of 9 ppm.

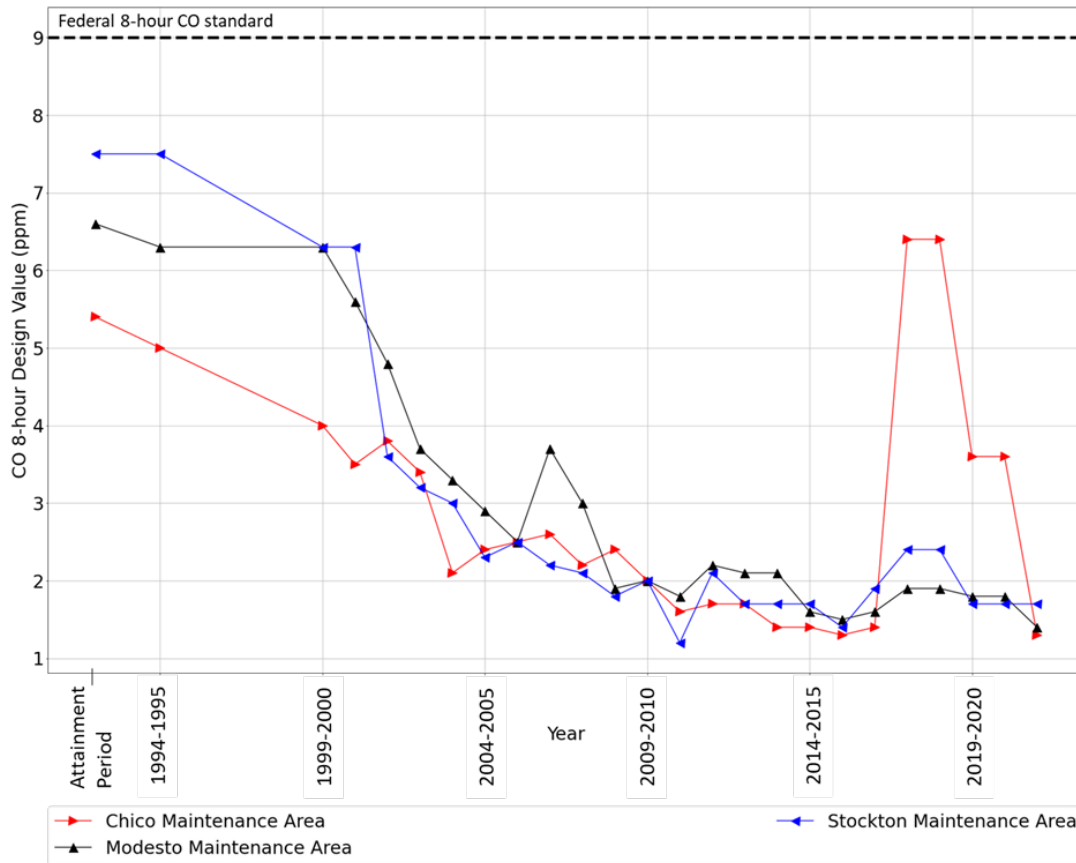
Table 2: Design values for the federal 8-hour CO standard (ppm)

Site Name	Attainment Period*	Attainment Period*	1999-2000	2004-2005	2009-2010	2014-2015	2019-2020	2021-2022
Chico	1993-1995	5.4	3.5	2.5	1.6	1.4	3.6	1.3
Modesto	1993-1994	6.6	5.6	2.5	1.8	1.6	1.8	1.4
Stockton	1993-1994	7.5	6.3	2.5	1.2	1.7	1.7	1.7

* Attainment period and attainment design value were obtained from the 2004 CO Maintenance Plan¹⁷

¹⁷ CARB, the [2004 CO Maintenance Plan](#) was adopted on July 22, 2004.

Figure 1: Design values for the federal 8-hour CO standard (ppm)

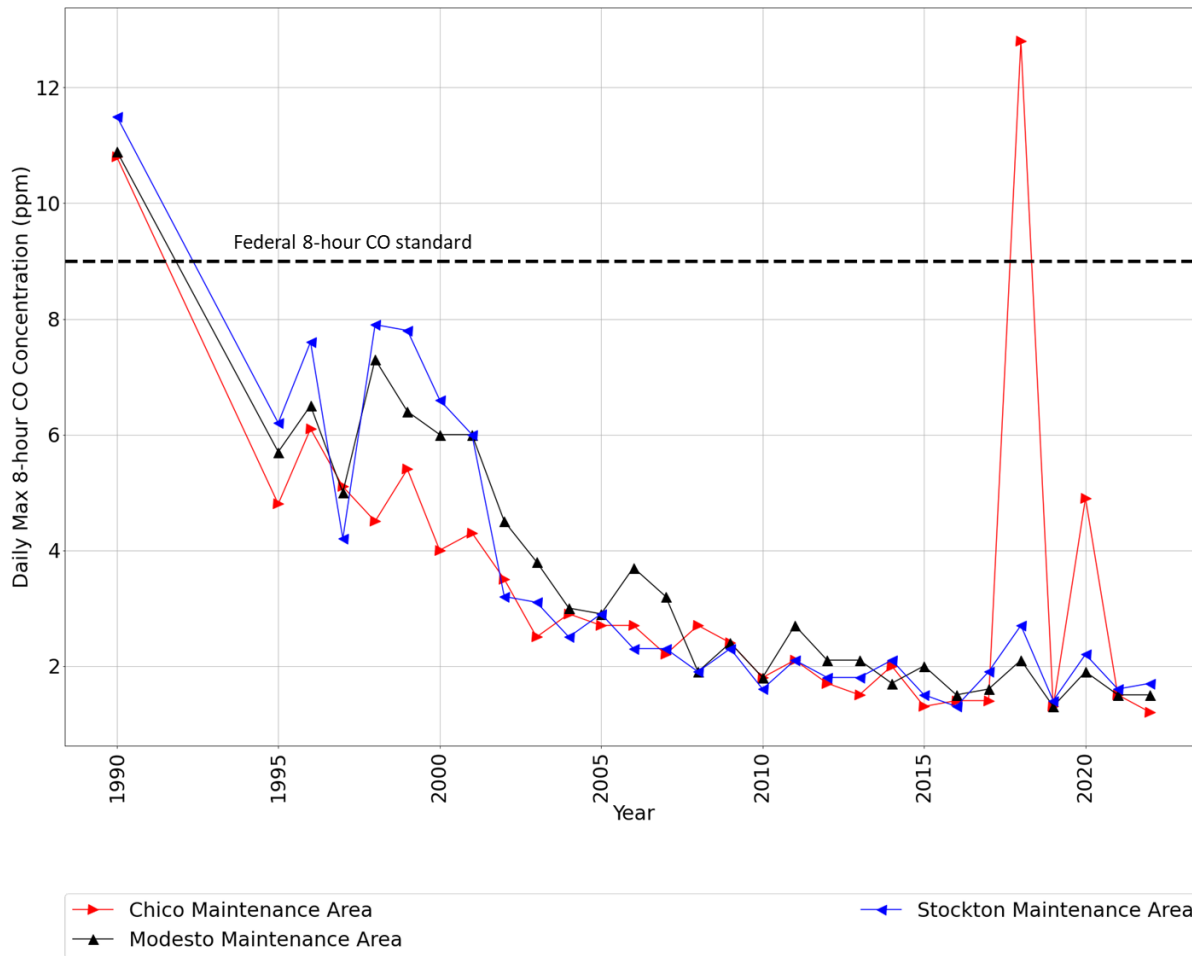


The 2017-2018 and 2018-2019 spike in the CO design value in the Chico maintenance area is due to spikes in CO concentrations in November 2018 due to the Camp Fire. Appendix A provides the evidence to support that the Camp Fire impacted CO concentrations.

II. Carbon Monoxide Peak 8-Hour Concentration

Figure 2 shows that the yearly peak 8-hour CO values between 1990 and 2023 are currently well below the federal 8-hour CO standard of 9 ppm. The peak 8-hour CO concentration at Chico, Modesto, and Stockton has declined by 89%, 86%, and 85%, respectively between 1990 and 2022.

Figure 2: Yearly peak 8-hour CO concentration at Chico from 1990 to 2023



Since 1995, only one maintenance area has exceeded the federal 8-hour CO standard. This occurrence happened in the Chico maintenance area in 2018. Appendix A provides the evidence to support that the 2018 spike in the maximum (max) 8-hour CO concentration is due to wildfire smoke impacts from the Camp Fire.

Emission Estimates

Data from the CARB’s California Emission Projection Analysis Model (CEPAM) 2019 SIP Baseline Emission Inventory for Winter (version 1.04 with approved external adjustments) were used to evaluate trends in CO emissions over the whole state of California (Table 3 and Figure 3) and in the three maintenance areas (Table 4 and Figure 4).

I. Statewide Trends

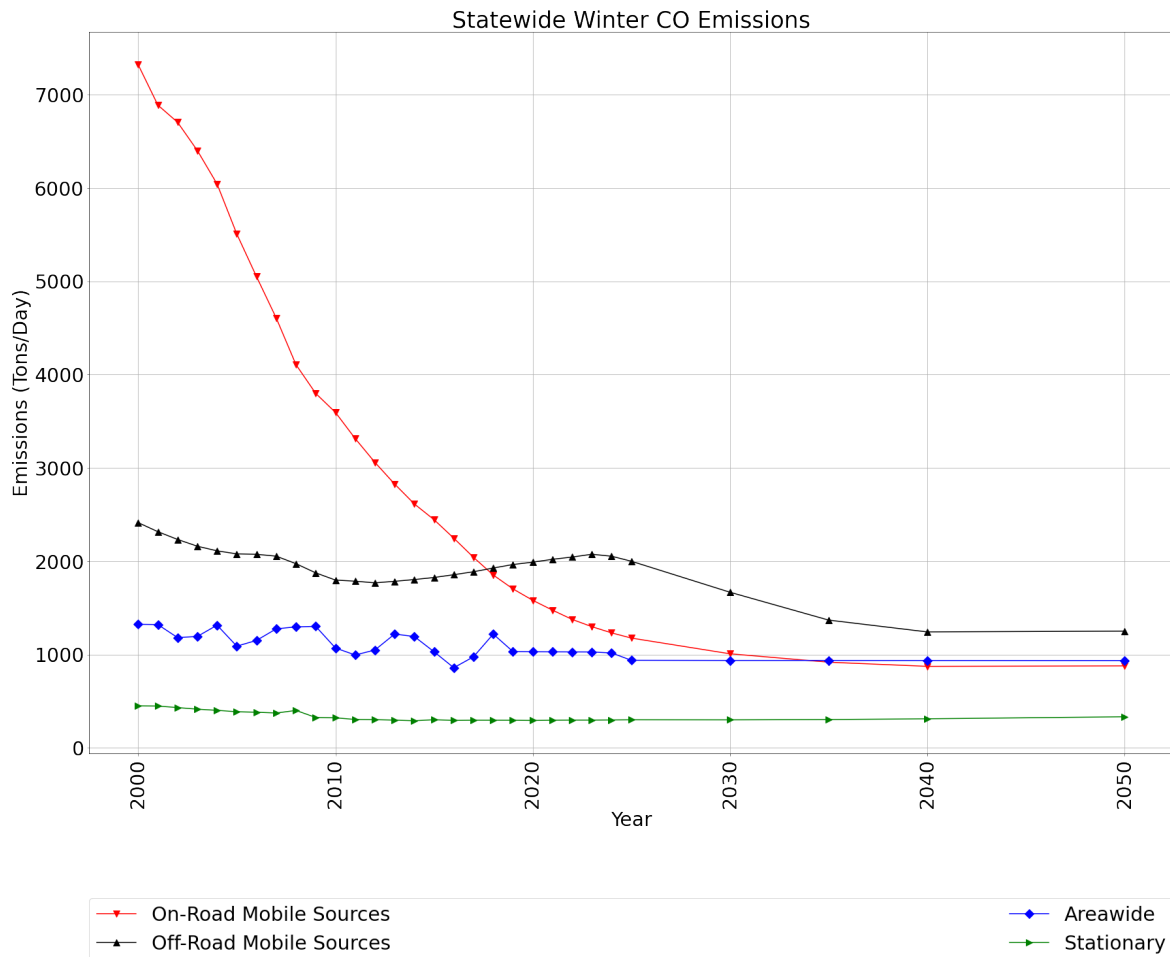
Statewide CO emission trends are looked at by the top four major source categories (stationary, areawide, on-road mobile and off-road mobile sources), to provide a context for what is happening across California. Table 3 and Figure 3 shows the statewide winter CO

emissions for informational purposes. Total CO emissions declined by 59%, between 2000 and 2023, mostly driven by the 82% reduction in on-road motor vehicle emissions. Stationary and areawide sources have also seen a decline in CO emissions by 34% and 22% respectively, during the same period. As State mobile source controls continue to be implemented, the total CO emissions as well as on- and off-road motor vehicle CO emissions are predicted to decrease an additional 28%, 32%, and 40%, respectively, between 2023 and 2050.

Table 3: Statewide total winter CO emissions (tons per day) in each source category

Source Category	2000	2005	2010	2015	2023	2035	2050
Stationary Sources	451	388	323	302	298	304	334
Areawide Sources	1,325	1,091	1,071	1,031	1,029	938	937
On-Road Mobile Sources	7,322	5,508	3,596	2,446	1,299	919	880
Off-Road Mobile Sources	2,415	2,080	1,799	1,826	2,076	1,370	1,252
Total	11,513	9,066	6,789	5,605	4,702	3,531	3,403

Figure 3: Statewide total winter CO emissions in each source category



Mobile sources are the largest source of CO emissions throughout California (Figure 3). The CO emissions presented in this section are based on the CEPAM 2019 SIP Baseline Emission Inventory for Winter (version 1.04 with approved external adjustments) released in March 2022. CARB's recently adopted mobile source measures (see Control Strategy section below) will drive the CO emission reductions even further for the future years.

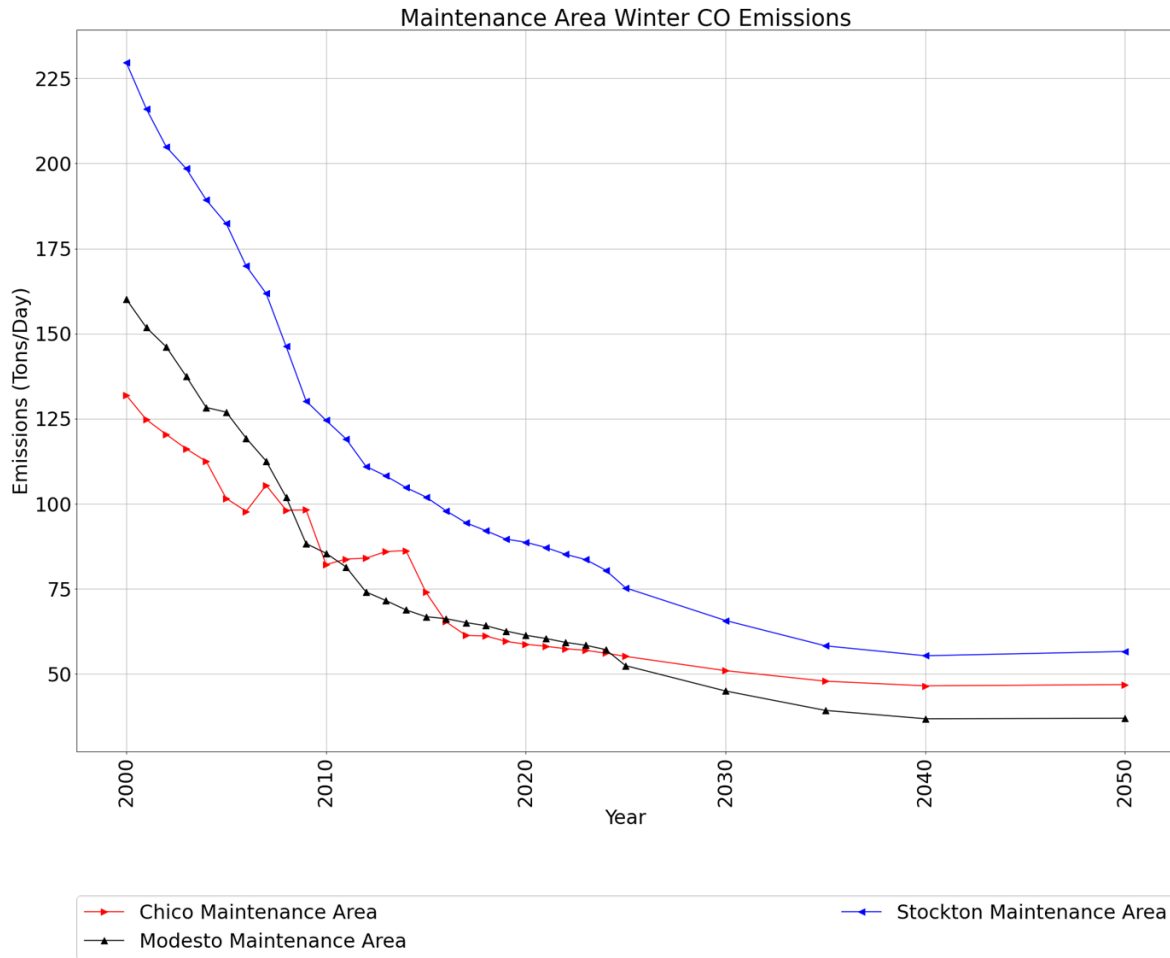
II. Emissions in the Carbon Monoxide Maintenance Areas

Table 4 and Figure 4 shows the statewide winter CO emissions in the three maintenance areas between 2000 and 2050, based on CEPAM 2019 SIP Baseline Emission Inventory for Winter (version 1.04 with approved external adjustments) released in March 2022. The data shows that between 2000 and 2023 emissions decreased by 57% to 64%, depending upon the area. Then, between 2023 and 2050, emissions are projected to decrease further by 18% to 37%.

Table 4: Total winter CO emissions in each maintenance area (winter seasonal emissions in tons per day)

CO Maintenance Area	Area Included in Inventory	2000	2010	2023	2030	2050
Chico	Butte County	132	82	57	51	47
Modesto	Stanislaus County	160	85	58	45	37
Stockton	San Joaquin County	230	125	84	66	57

Figure 4: Total winter CO emissions (tons/day) in each maintenance area



CO emissions in 2023 and onward are significantly lower than they were in 2004, when the 2004 CO Maintenance Plan revision was adopted. This occurs despite growth in population and vehicle miles traveled due to the benefits of increasing tighter emissions standards for new engines, fuel requirements, and turnover of the vehicle fleet to lower-emitting models and eventually zero emission vehicles.

Control Strategy

CO emissions will decrease even more in the coming years as California adopts and implements new regulations as part of ozone and particulate matter SIPs. Given the severity of California’s air quality challenges, CARB has implemented the most stringent mobile source emissions control program in the nation. CARB’s comprehensive strategy to reduce emissions from mobile sources consists of emissions standards for new vehicles, in-use programs to reduce emissions from existing vehicle and equipment fleets, cleaner fuels, and incentive programs to accelerate the penetration of the cleanest vehicles beyond that achieved by regulations alone. Table 5 includes CARB’s control measure commitments from the 2022 State

SIP Strategy. CARB also committed to achieve emission reductions as detailed in various SIPs¹⁸ such as in the San Joaquin Valley ozone SIP.¹⁹

CARB's groundbreaking Advanced Clean Cars (ACC)²⁰ program is providing emission reductions and ushering in a new zero emission passenger transportation system. Since 2012 when the ACC program was approved, it has helped reduce emissions by combining the control of smog, soot causing pollutants and greenhouse gas emissions for model years 2015 through 2025. The ACC program also included amendments that affects the current zero-emission vehicles requirements. Going forward, the Advanced Clean Cars II (ACC II)²¹ has the goal of cutting emissions from new combustion vehicles while taking all new vehicle sales to 100% zero-emission no later than 2035.

In addition to the ACC II program, the Advanced Clean Fleets Regulation²² and the In-Use Locomotive Regulation²³ will reduce mobile source emissions from heavy-duty trucks and other sources around warehouses, railyards, and ports, as well as reducing other emissions, which in turn will reduce corresponding health risk in California's most impacted communities.

All the control strategy emission reductions from adopted CARB measures (Table 5) will generate progressively more benefits over time, effectively decreasing CO emissions well below the levels needed for attainment. Based on current and future control strategies it seems unlikely that the maintenance areas will exceed the federal 8-hour CO standard in the future, outside of wildfire impacted events.

¹⁸ CARB, *All Nonattainment Area Plans*.

¹⁹ CARB, *The San Joaquin Valley SIP*.

²⁰ CARB, *Advanced Clean Cars program*.

²¹ CARB, *Advanced Clean Cars II program*.

²² CARB, *Advanced Clean Fleets program*.

²³ CARB, *In-Use Locomotive Regulation*.

Table 5: CARB measures and schedule

Measure	Action	Implementation Begins
On-Road Heavy-Duty		
Advanced Clean Fleets Regulation	2023	2024
Zero-Emissions Trucks Measure	2028	2030
On-Road Light-Duty		
On-Road Motorcycle New Emissions Standards	2022	2025
Clean Miles Standard	2021	2023
Off-Road Equipment		
Tier 5 Off-Road Vehicles and Equipment	2025	2029
Amendments to the In-Use Off-Road Diesel-Fueled Fleets Regulation	2022	2024
Transport Refrigeration Unit Regulation Part 2	2026	2028
Commercial Harbor Craft Amendments	2022	2023
Cargo Handling Equipment Amendments	2025	2026
Off-Road Zero-Emission Targeted Manufacturer Rule	2027	2031
Clean Off-Road Fleet Recognition Program	2025	2027
Spark-Ignition Marine Engine Standards	2029	2031
Primarily-Federally and Internationally Regulated Sources – CARB Measures		
In-Use Locomotive Regulation	2023	2024
Future Measures for Aviation Emissions reductions	2027	2029
Future Measures for Ocean-Going Vessel Emissions Reductions	2027	TBD

Environmental Analysis and Environmental Justice

I. Environmental Analysis

A. Introduction

This section provides the basis for CARB’s determination that the 2023 CO SIP revision is exempt from the requirements of the California Environmental Air Quality Act (CEQA). A brief explanation of this determination is provided below. CARB’s regulatory program, which involves the adoption, approval, amendment, or repeal of standards, rules, regulations, or plans for the protection and enhancement of the State’s ambient air quality, has been certified by the California Secretary for Natural Resources under Public Resources Code section 21080.5 of the CEQA (14 CCR 15251(d)). Public agencies with certified regulatory programs are exempt from certain CEQA requirements, including but not limited to, preparing environmental impact reports, negative declarations, and initial studies. CARB, as a lead agency, prepares a substitute environmental document (referred to as an “Environmental Analysis” or “EA”) as part of the Staff Report prepared for a proposed action to comply with

CEQA (17 CCR 6000060008). If the SIP is finalized, a Notice of Exemption will be filed with the Natural Resources Agency for public inspection.

B. Analysis

CARB has determined that the 2023 CO SIP revision is exempt from CEQA under the “general rule” or “common sense” exemption (14 CCR 15061(b)(3)). The common sense exemption states a project is exempt from CEQA if “the activity is covered by the general rule that CEQA applies only to projects which have the potential for causing a significant effect on the environment. Where it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA.” The 2023 CO SIP revision will not result in a significant adverse impact on the environment since it relies on already adopted regulations for continued emission reductions. The 2023 CO SIP revision does not contain any proposals for new emission control measures or other actions that could result in adverse impacts to the environment. Based on CARB’s review it can be seen with certainty that there is no possibility that the 2023 CO SIP revision may result in a significant adverse impact on the environment; therefore, this activity is exempt from CEQA.

II. Environmental Justice

The 2023 CO SIP revision demonstrates that CO levels, already well below attainment levels, will continue to remain well below attainment into the foreseeable future. CO levels are highly correlated to populated areas with high traffic—freeways and heavily traveled roads in close proximity to residential areas, schools, and other sensitive sites. As CO emissions decrease, so too will public exposure in nearby communities as well as overburdened communities. However, governments and transportation agencies should consider and address the potential for high localized CO levels from new transportation systems, projects, and off-road mobile sources that may be sited in close proximity to populated areas and where emission reductions are most important.

Conclusion

The 2023 CO SIP revision complies with the Act section 110(l) by demonstrating that the removal of the contingency measures, and the monitoring requirements, will not interfere with maintenance or any other Act requirements for the federal 8-hour CO standard.

Air quality data demonstrates the three areas (Chico Urbanized Area, Modesto Urbanized Area, and Stockton Urbanized Area) continue to be in attainment. Based on historical data, it has been over 20 years since any of the maintenance areas have exceeded the federal 8-hour CO standard (9 ppm), outside of wildfire impacted events. Currently the 8-hour CO design value in the three maintenance areas are 81% to 86% below the federal 8-hour CO standard. Due to current 8-hour CO design values being greater than 80% below the federal 8-hour standard, ambient monitoring in these three maintenance areas is no longer necessary.

Total CO emissions have declined by 59% between 2000 and 2023, mostly driven by the 82% reduction in on-road motor vehicle CO emissions (Table 3). Stationary and areawide sources

have also seen a decline in CO emissions by 34% and 22%, respectively, during the same period. As State mobile source controls continue to be implemented, the total CO emissions as well as on- and off-road motor vehicle CO emissions are predicted to decrease an additional 28%, 32%, and 40%, respectively, between 2023 and 2050.

CO emissions in 2023 and projected onward are significantly lower than they were in 2004, when the 2004 CO Maintenance Plan revision was adopted. Also, control strategy emission reductions from adopted CARB measures generate progressively more benefits over time, effectively decreasing CO emissions well below the levels that resulted in attainment. Based on current and future control strategies it seems unlikely that the maintenance areas will exceed the federal standard in the future, outside of wildfire impacted events.

Therefore, it is appropriate to amend the 2004 CO Maintenance Plan to remove the contingency measure and monitoring requirements. U.S. EPA can now move forward to approve a monitoring discontinuation request, in the three maintenance areas, under 40 CFR 58.14(c)(1).²⁴

Staff Recommendation

CARB staff has reviewed the 2023 Revision to the California State Implementation Plan for Carbon Monoxide - Revision CO Maintenance Plan. CARB staff recommends that Executive Officer approve and submit the proposed 2023 CO SIP revision, to remove the contingency measures and the monitoring requirement, for three federal Planning Areas (Chico Urbanized Area, Modesto Urbanized Area, and Stockton Urbanized Area) to U.S. EPA for federal approval.

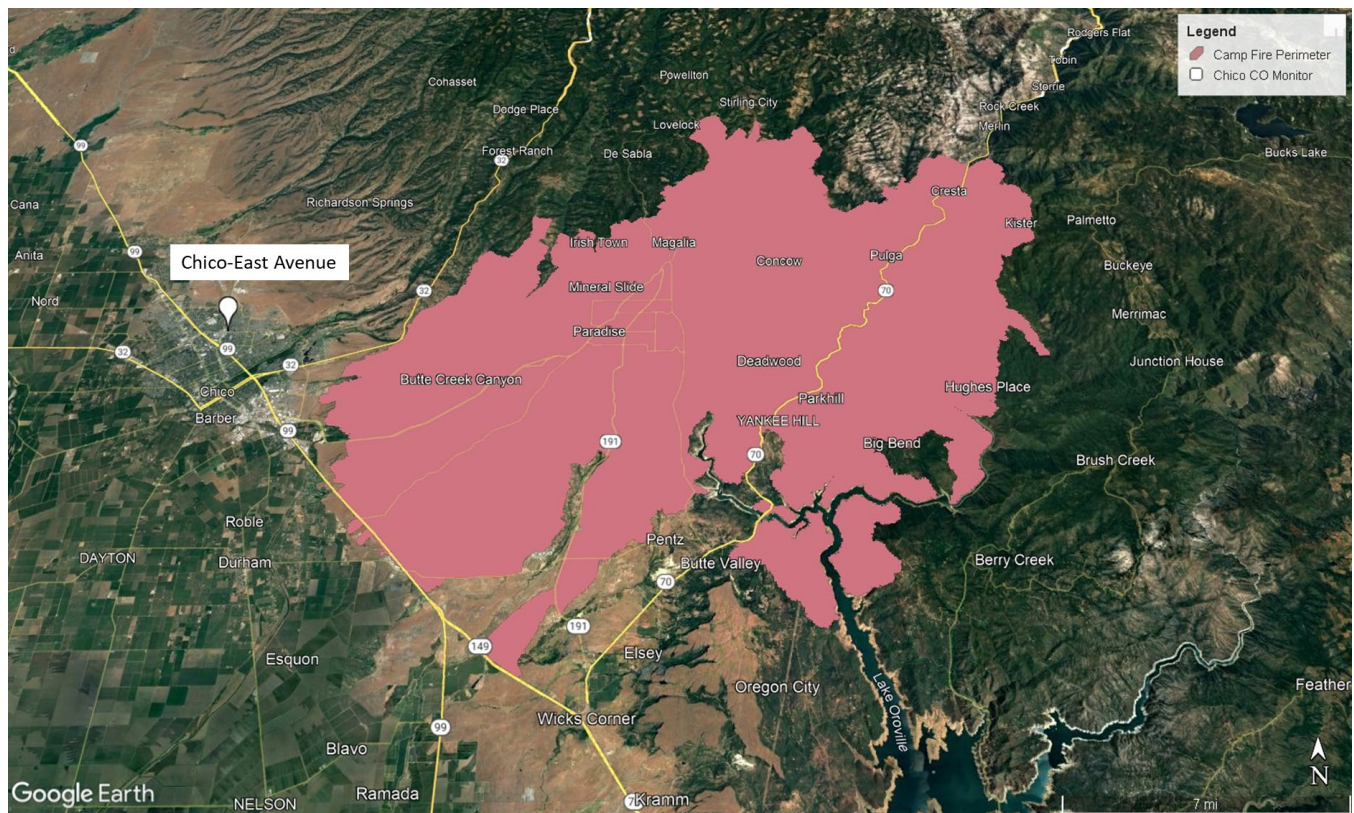
²⁴ Code of Federal Regulations: [40 CFR 58.14\(c\)\(1\)](#)

Appendix A: Exceptional Events Demonstration for Carbon Monoxide Exceedances

I. Chico Maintenance Area: November 2018 Camp Fire

In November 2018, the Camp Fire burned more than 150,000 acres, including most of the town of Paradise, and grew to the eastern neighborhoods of Chico (Figure 5), from November 8 until November 25, 2018, when it was considered fully contained. Smoke from the fire began impacting Chico and other communities almost immediately. Thick smoke plumes initially spread due west, migrating towards Chico with smoke advisories issued by various local air districts almost immediately. For a full analysis on the Camp Fire and the impact it had on California air quality see the CARB report ‘Camp Fire Air Quality Data Analysis’.²⁵

Figure 5: Location of the Chico CO air monitor relative to the perimeter of the Camp Fire



A. Summary of Event: November 9-10, 2018

On November 9, 2018, the Chico CO maintenance area had a maximum (max) 8-hour CO reading of 12.8 ppm. Then, on November 10, 2018, the Chico maintenance area had a max 8-

²⁵ CARB, [Camp Fire Air Quality Data Analysis](#).

hour CO reading of 10.9 ppm. These are the only two days since 1995 that the Chico maintenance area has violated the federal 8-hour CO standard (9 ppm).

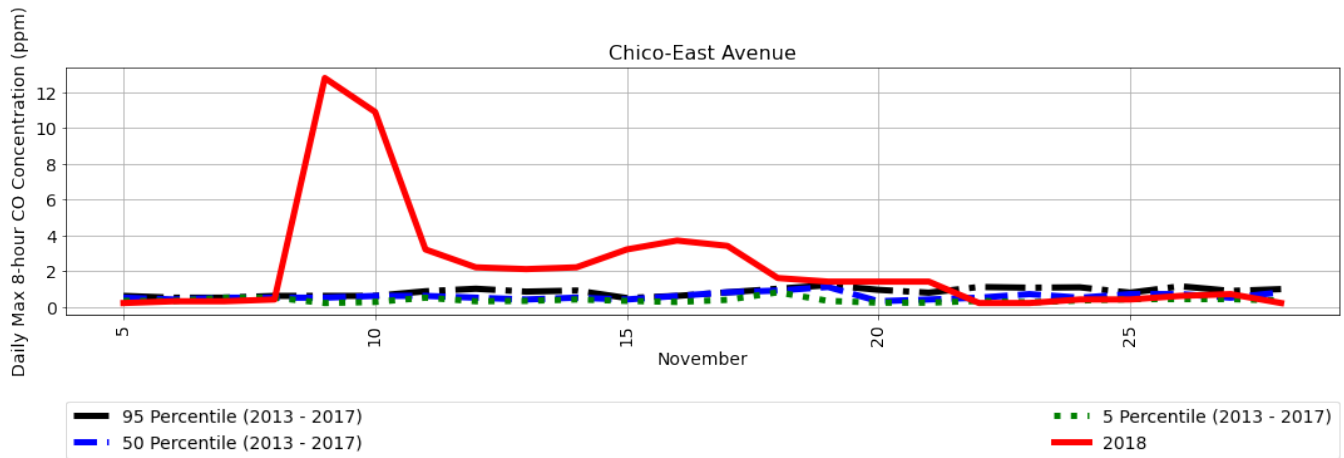
Table 6: Summary of CO and PM concentrations on November 9-10, 2018

Date	Daily Max 8-hr CO	Max 1-hr CO in the daily max 8-hour time-period	24-hr PM _{2.5}
2018-11-09	12.8 ppm	20.8 ppm	279.7 µg/m ³
2018-11-10	10.9 ppm	20.8 ppm (occurred on 11-09)	246.8 µg/m ³

The daily max 8-hour CO concentration is calculated by taking an 8-hour average concentration, allowing for two days to be affected by the same high 1-hour CO concentration. This happened on November 9 and 10, 2018. On November 9, the first hour of the daily max 8-hour concentration is on November 9 at 14:00 PST with the max 1-hour concentration being on November 9 at 18:00 PST (CO concentration of 20.8 ppm). On November 10, the first hour of the daily max 8-hour concentration is on November 9 at 17:00 PST with the max 1-hour concentration being on November 9 at 18:00 PST (CO concentration of 20.8 ppm). This is due to the November 10 daily max 8-hour CO concentration being for the hours of November 9 17:00 through November 10 at 00:00.

The percentile plot (Figure 6) shows that there were periods of elevated 8-hour CO concentrations between November 9 to November 21 in 2018 with November 9 to November 17 being much higher than the previous five years (2013-2017). The 24-hour fine Particulate Matter (PM_{2.5}) concentration is above 245 µg/m³ on November 9-10, 2018 (Table 6). Based on PM_{2.5} concentrations and trends in CO since 1995, it is reasonable to state that the Chico maintenance area was impacted by the nearby Camp Fire during this time period.

Figure 6: Chico CO concentrations between November 5 and November 28, 2018



1. 1-Hour CO Concentrations

The 1-hour CO concentration helps support that this site was impacted by the Camp Fire. On November 9, 2018, the peak 1-hour CO concentration was 20.8 ppm and it occurred during the 18:00-19:00 hour window. This was the peak 1-hour CO concentration for both November 9 and 10, 2018, daily max 8-hour CO concentrations. The percentile plot (Figure 7) shows that on November 9, 2018, the 1-hour CO concentration was much higher than the 95th percentile CO concentration when looking at the month of November during the previous five years (2013-2017). There were periods of elevated 1-hour CO concentrations (Figure 8) during November, when the Camp Fire was active, providing further support that the CO concentrations at the site were impacted by the nearby Camp Fire.

Figure 7: Chico 1-hour CO on November 9, 2018

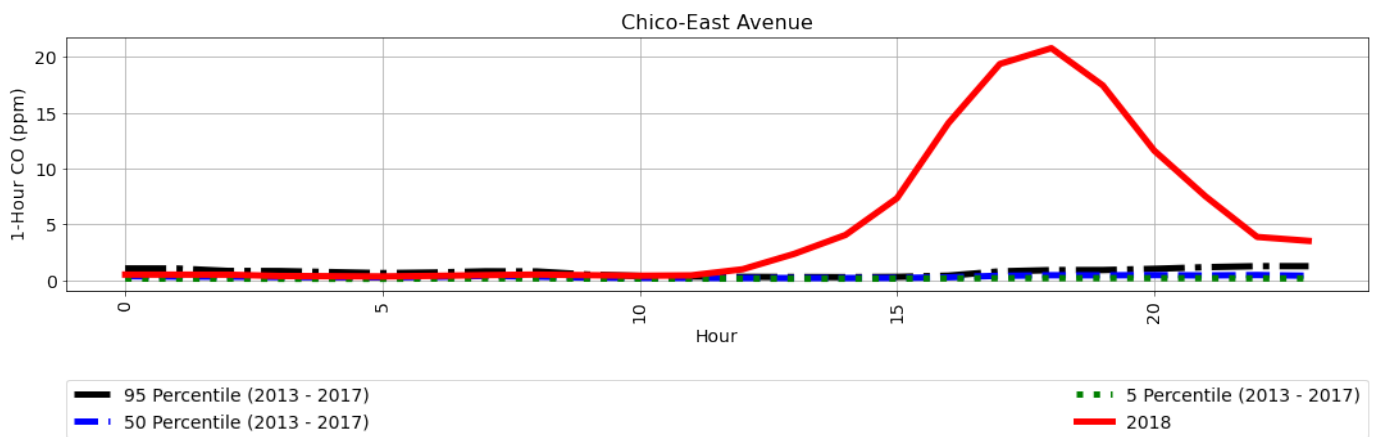
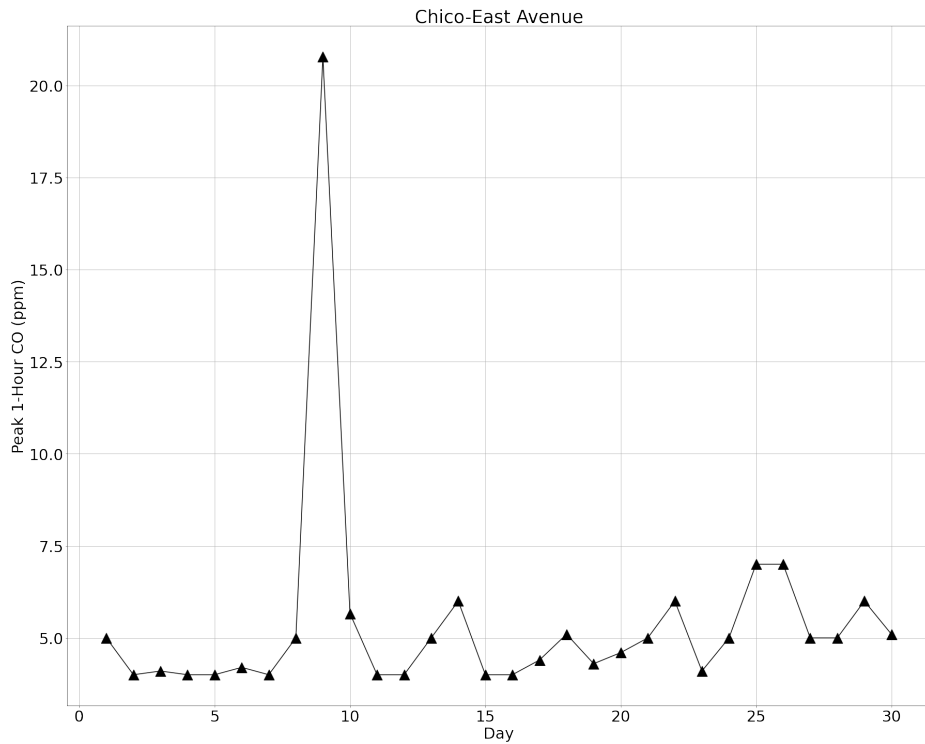


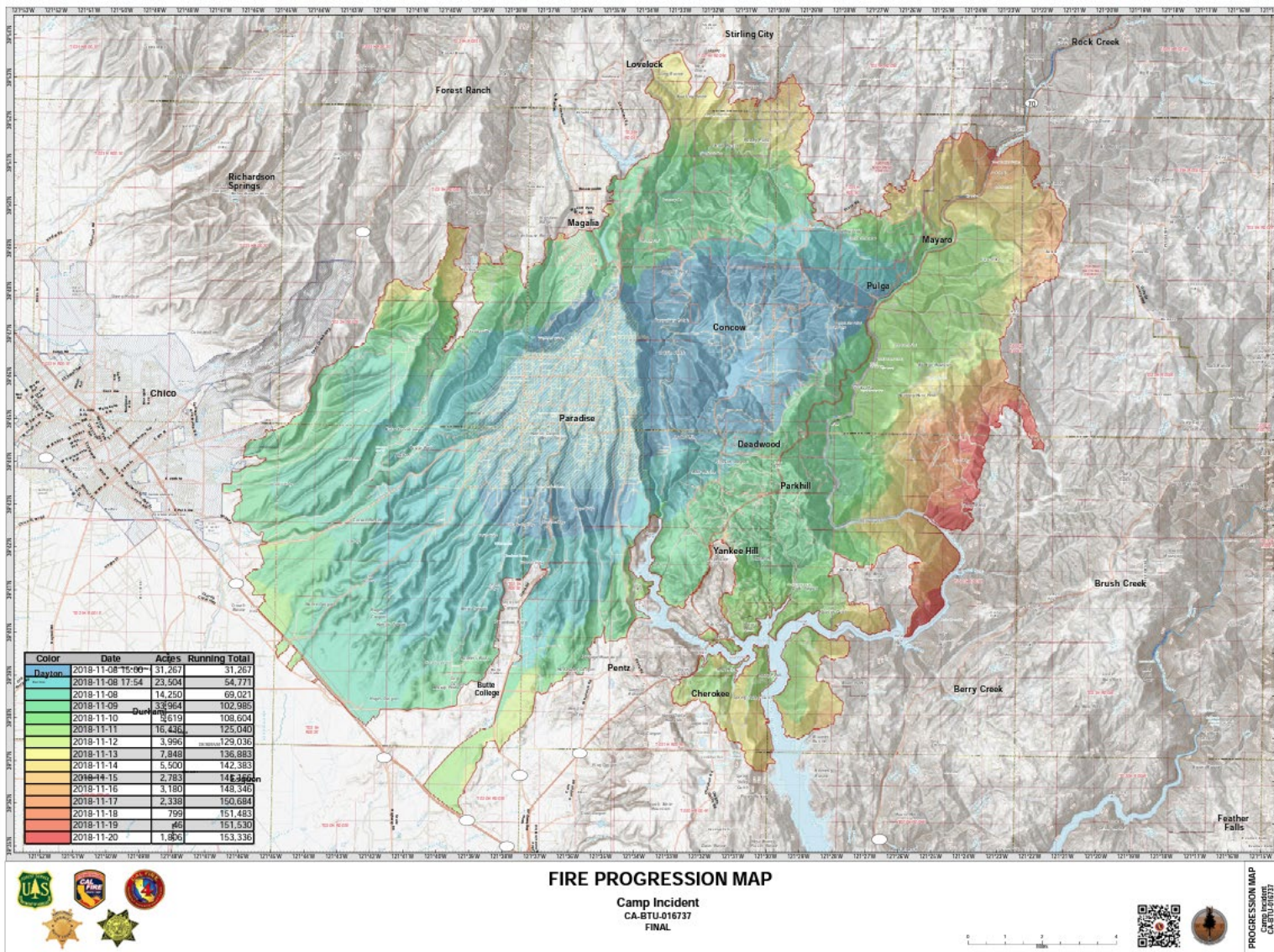
Figure 8: Chico daily peak 1-Hour CO (ppm) for November 2018



B. Camp Fire Progression Map

Figure 9 shows the Camp Fire progression map. On November 9 (green colors) the Camp Fire was actively burning toward the town of Chico, impacting Chico’s air quality, and elevating both CO and PM_{2.5} in the area (Table 6).

Figure 9: Camp Fire progression map, November 11-20, 2018



C. Satellite Imagery

Figure 10 and Figure 11 shows the satellite images for November 9, 2018. There is visible smoke at the Chico site in the satellite images, this provides evidence of smoke at the monitor on the impacted days.

Figure 10: MODIS Terra satellite image, November 9, 2018

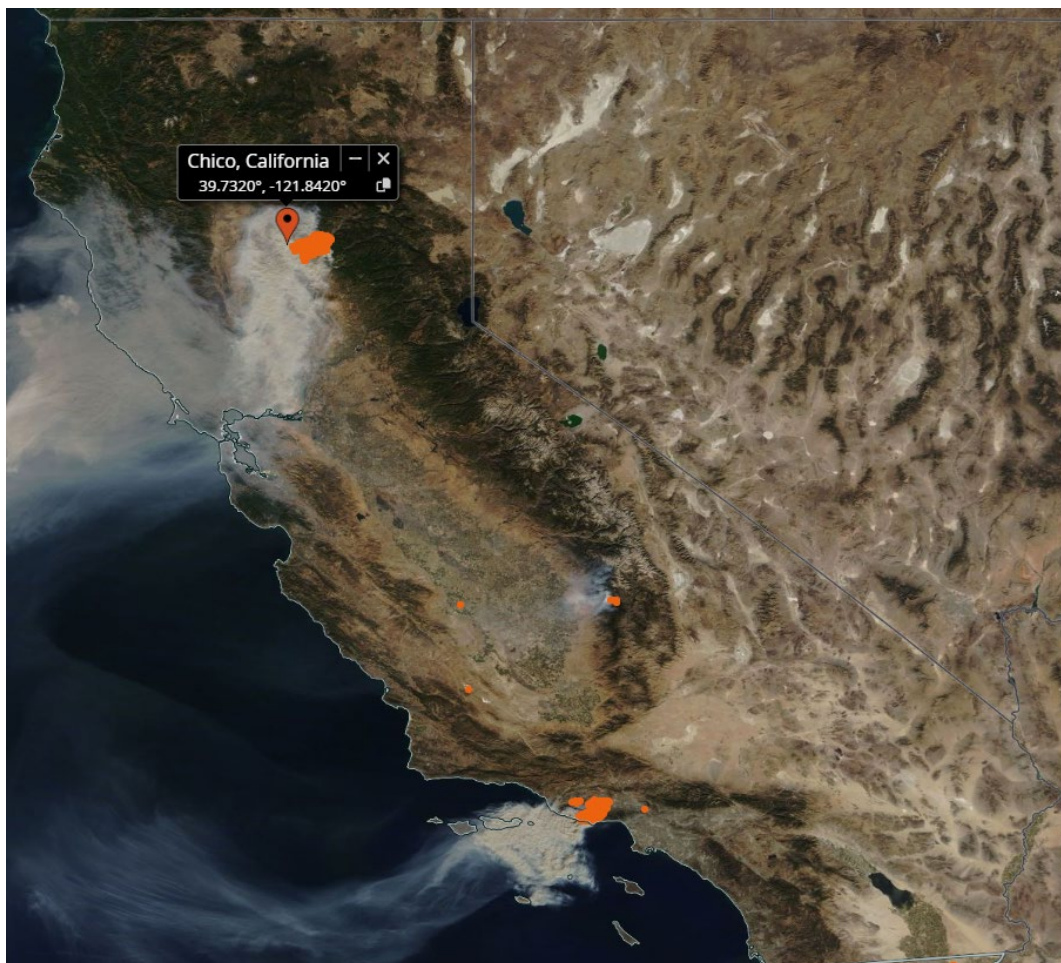
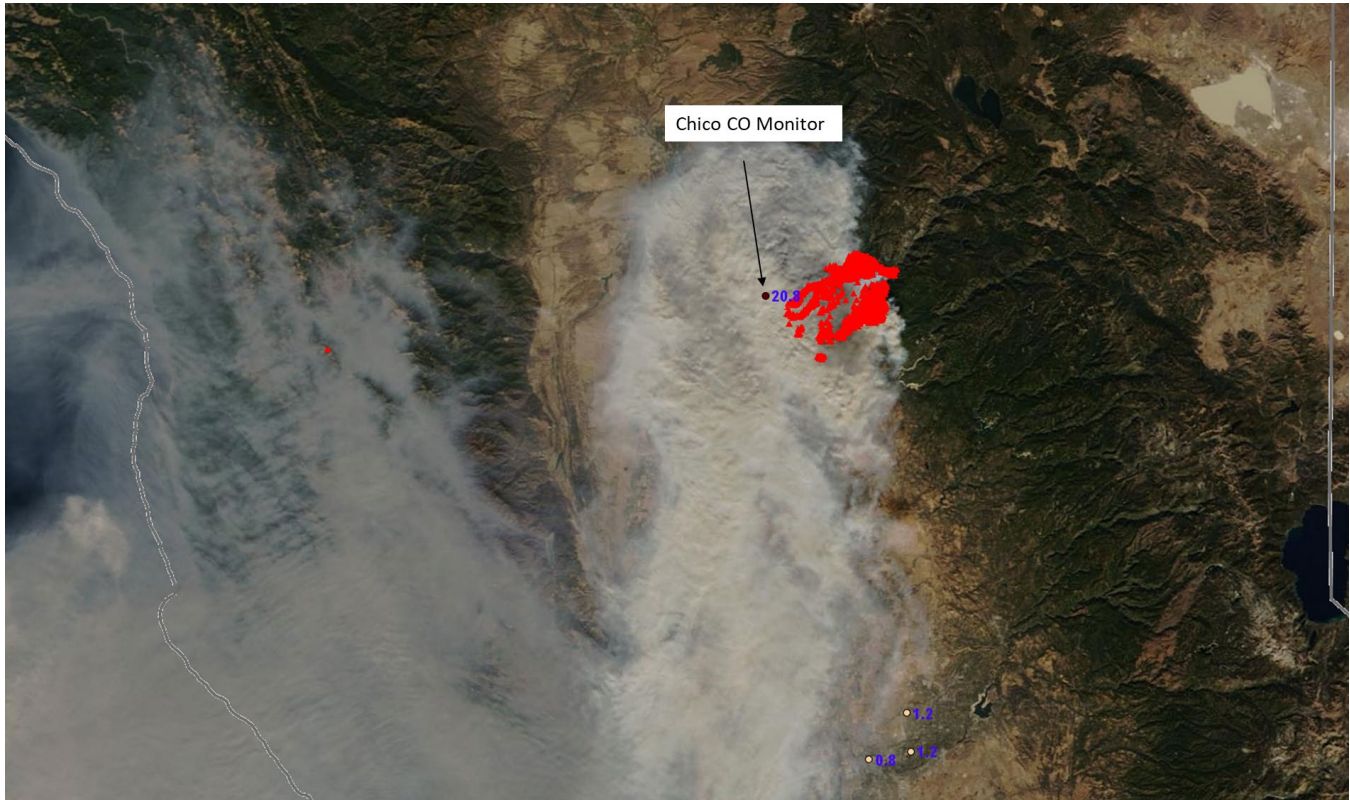


Figure 11: Zoomed in MODIS Terra satellite image for November 9, 2018



D. HYSPLIT Backward Trajectory (from Monitor)

National Oceanic and Atmospheric Administration's (NOAA's) Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model was used to determine simple back-trajectories showing the path that an air parcel took for a specified time-period (here, 24 hours) before reaching the Chico CO monitor at the hour of maximum concentration in the exceeding 8-hour time-period. The North American Mesoscale Forecast System (NAM) 12km (hybrid sigma-pressure, U.S., 03-2010-present) Meteorology archived data set was used with, three height levels (red: 100 meters (m) above ground level (AGL), blue: 500m AGL; green: 1000m AGL) were used to indicate transport near the surface and in the mid to upper levels of the atmosphere. Table 7 indicates the first hour of the exceeding 8-hour time-period and the hour of the maximum concentrations within that 8-hour time period, both in PST (Pacific Standard Time) and UTC (Universal Coordinated Time).

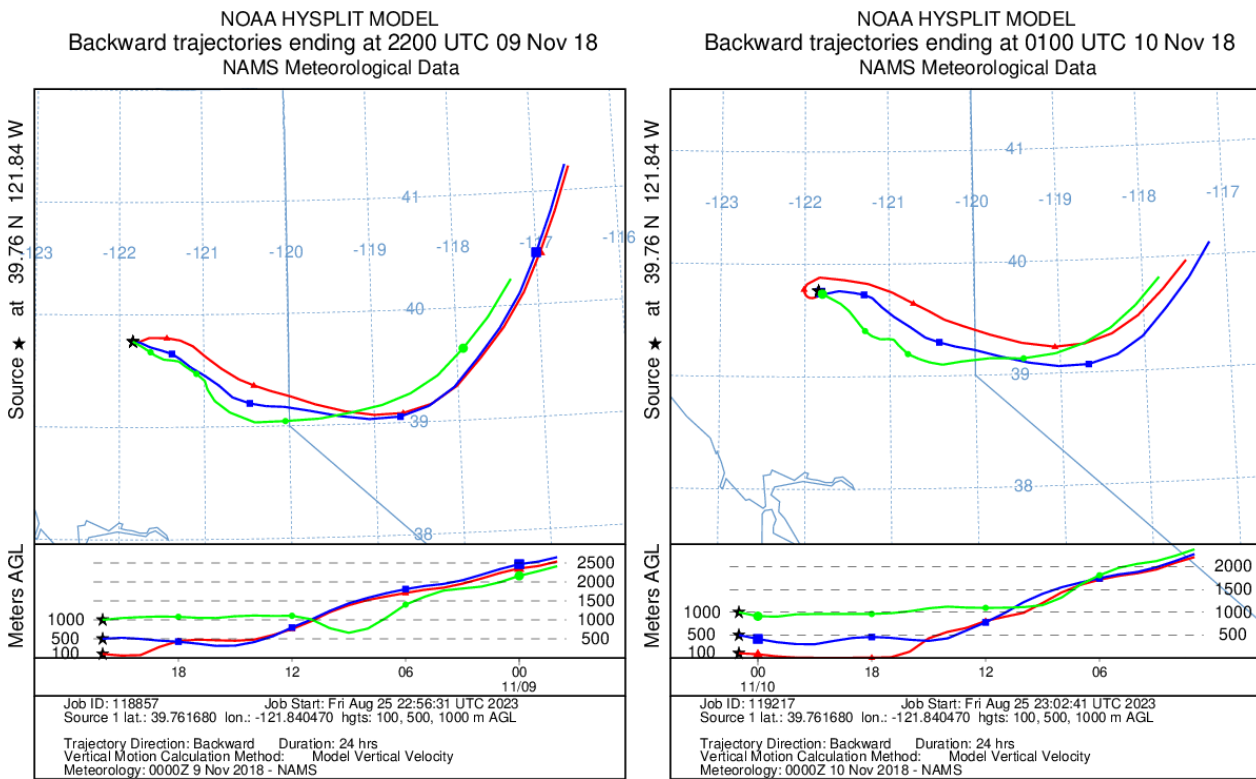
The daily max 8-hour CO concentration is calculated by taking an 8-hour average concentration, allowing for two days to be affected by the same high 1-hour CO concentration. This happened on November 9 and 10, 2018; due to the November 10 daily max 8-hour CO concentration for the hours of November 9 17:00 through November 10 at 00:00.

Table 7: Date and first and max hour of CO 1-hour concentration in both PST and UTC

Date of 8-hour exceedance (PST)	Date (PST)	First Hour (PST)	Date (PST)	Max Hour (PST)	Date (UTC)	First Hour (UTC)	Date (UTC)	Max Hour (UTC)
2018-11-09	11-09	14:00	11-09	18:00	11-09	22:00	11-10	2:00
2018-11-10	11-09	17:00	11-09	18:00	11-10	1:00	11-10	2:00

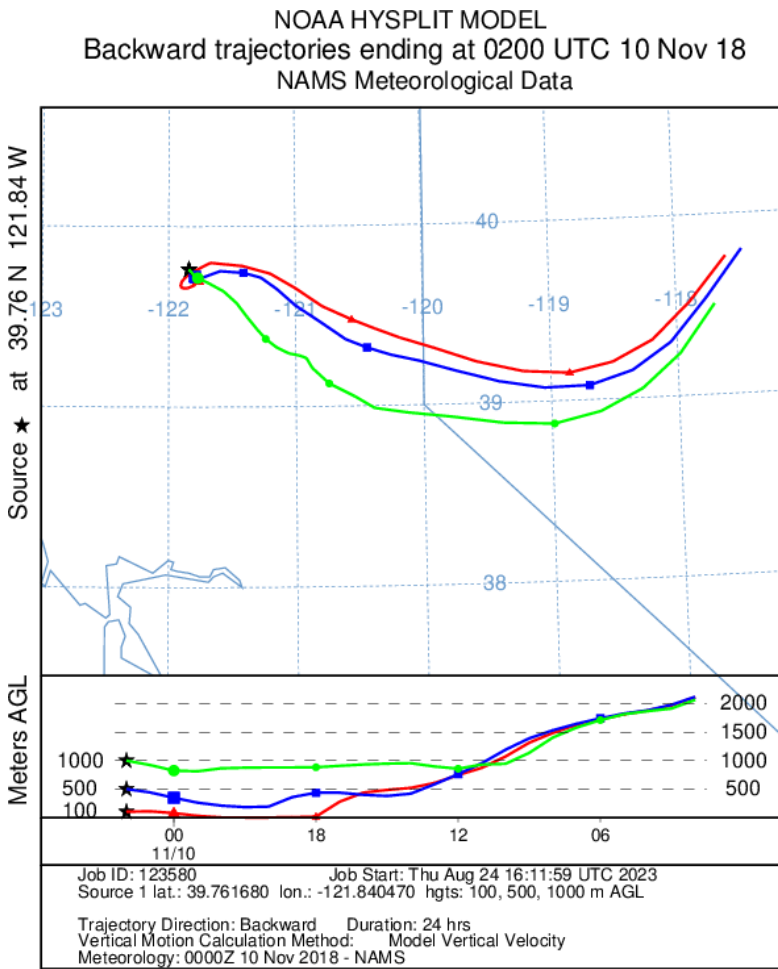
The first hour backward trajectory (Figure 12) indicates transport through the smoke plume right before coming to the Chico CO monitor. The first hour for the November 9 daily max 8-hour exceedance is shown on the left and the first hour for the November 10 daily max 8-hour exceedance is shown on the right.

Figure 12: First Hour November 09, 2018, 14PST (left) and November 09, 2018, 17PST (right)



The max concentration backward trajectory (Figure 13) indicates transport through the smoke plume right before coming to the Chico CO monitor. The first hour and max hour backward trajectories provide further support that the CO levels at the site were impacted by the nearby Camp Fire.

Figure 13: Max Hour November 09, 2018, 18PST (2018-11-10 02UTC)



E. NOAA Smoke Text Products

The NOAA Smoke Text Product²⁶ is a text-based analysis of data from multiple satellites. These products are used to give an overall view of smoke origins, current locations, and potential transport, and can supplement information from other media. Most of these reports highlight the large amounts of smoke issued on an almost daily basis and their impacts on California and the rest of the U.S. individual areas at the county level are not specifically noted. Figure 14 and Figure 15 shows the smoke text issued on November 9, 2018, at 19:15 UTC (11:15 PST on November 9) and November 10, 2018, at 03:57 UTC (19:57 PST on November 9), respectively. The smoke text talks about “very thick smoke” being emitted from the Camp Fire and how it is observed over northern Sacramento Valley (which includes Chico).

²⁶ NOAA Smoke Text.

Figure 14: November 9, 2018, at 19:15 UTC (11:15 PST on November 9) Smoke Text

Friday, November 9, 2018

DESCRIPTIVE TEXT NARRATIVE FOR SMOKE/DUST OBSERVED IN SATELLITE IMAGERY THROUGH 1800Z November 9, 2018.

SMOKE.

Northern California/Santa Ana Mountains/Pacific Ocean...
 The Camp wildfire in northern California continues to emit very thick smoke this morning and afternoon. This smoke plume is moving towards the west within the Sacramento Valley and then moving south towards the San Francisco Bay area. Older, remnant smoke is observed across portions of the Pacific ocean, from just south of Tijuana, Mexico west to about the (34N, 132W) point (putting the smoke over 900 km offshore) and north and north-northwest towards the mountains just north of the San Francisco Bay area. The remnant smoke closer to the fire is moderate to thick in density while the smoke further away is lighter in nature. The Hill fire in Los Angeles and Ventura Counties, which has spread rapidly toward the coast this morning, is also producing dense smoke. This smoke plume is moving out across the Channel Islands into the Pacific, where the plume meets up with the plume from the Camp Fire.

Southeastern San Joaquin Valley...
 The ongoing Alder fire in Sequoia National Park was observed emitting moderately dense to thick smoke this afternoon. The smoke is initially moving off toward the west, but is then moved back north and east back into the Sierras, accumulating along the valley rim and just seeping over the lowest passes.

Southern Florida...
 Seasonal/agricultural burning was detected across portions of south Florida near Lake Okeechobee. This smoke was moving off towards the west-northwest across Lake Okeechobee, with some smoke possible off to the southwest of Lake Okeechobee that is obscured by cloud cover.

Hosley

THIS TEXT PRODUCT IS PRIMARILY INTENDED TO DESCRIBE SIGNIFICANT AREAS OF SMOKE ASSOCIATED WITH ACTIVE FIRES AND SMOKE WHICH HAS BECOME DETACHED FROM THE FIRES AND DRIFTED SOME DISTANCE AWAY FROM THE SOURCE FIRE. TYPICALLY OVER THE COURSE OF ONE OR MORE DAYS. AREAS OF BLOWING DUST ARE ALSO DESCRIBED. USERS ARE ENCOURAGED TO VIEW A GRAPHIC DEPICTION OF THESE AND OTHER PLUMES WHICH ARE LESS EXTENSIVE AND STILL ATTACHED TO THE SOURCE FIRE IN VARIOUS GRAPHIC FORMATS ON OUR WEB SITE:

- JPEG: <http://www.ospo.noaa.gov/data/land/fire/currenthms.jpg>
- GIS: <ftp://satpsanone.nesdis.noaa.gov/FIRE/HMS/GIS/>
- KML: <http://www.ospo.noaa.gov/data/land/fire/fire.kml> (fire)
- <http://www.ospo.noaa.gov/data/land/fire/smoke.kml> (smoke)

ANY QUESTIONS OR COMMENTS REGARDING THIS PRODUCT SHOULD BE SENT TO:
 SSDFireTeam@noaa.gov

Figure 15: November 10, 2018, at 03:57 UTC (19:57 PST on November 9) Smoke Text

Friday, November 9, 2018

DESCRIPTIVE TEXT NARRATIVE FOR SMOKE/DUST OBSERVED IN SATELLITE IMAGERY THROUGH 0200Z November 10, 2018.

SMOKE:

Northern California/Santa Ana Mountains/Pacific Ocean...
The Camp wildfire in northern California continues to produce very thick smoke which generally spread to the south and west though some of the northern portion of the smoke over the northern Sacramento Valley was gradually spreading to the north toward Redding by late in the day. Thicker smoke from this fire blanketed much of north central California from the Sacramento Valley (including the city of Sacramento) westward to the northern and central coast (including the San Francisco-Oakland metro areas) and well offshore from there where it merged with smoke from the southern California wildfires.

Southern California/Southern Arizona...
Huge destructive wildfires in southeastern Ventura and southwestern Los Angeles counties were emitting large quantities of dense smoke which moved to the southwest and fanning out as it pushed offshore. The smoke eventually merged offshore with smoke emanating from the Camp wildfire in northern California. In addition, a narrow swath of mainly thin density smoke from the southern California fires had wrapped back inland to the east over northern Baja and a portion of southern Arizona.

Southeastern San Joaquin Valley...
The ongoing Alder fire in Sequoia National Park was observed emitting moderately dense to thick smoke this afternoon. The smoke is initially moving off toward the valley to the west, but then also fanning out to the north and south along the western slopes of the nearby Sierras.

Northwestern U.S./Southwestern Canada...
Another day of extensive seasonal/agricultural fires was seen over portions of western Montana, Idaho, Oregon, and Washington in the Northwestern U.S. and British Columbia, Alberta, and southern Saskatchewan in southwestern Canada. Little smoke though was visible in satellite imagery in part due to higher cloudiness passing across the region.

JS

THIS TEXT PRODUCT IS PRIMARILY INTENDED TO DESCRIBE SIGNIFICANT AREAS OF SMOKE ASSOCIATED WITH ACTIVE FIRES AND SMOKE WHICH HAS BECOME DETACHED FROM THE FIRES AND DRIFTED SOME DISTANCE AWAY FROM THE SOURCE FIRE. TYPICALLY OVER THE COURSE OF ONE OR MORE DAYS. AREAS OF BLOWING DUST ARE ALSO DESCRIBED. USERS ARE ENCOURAGED TO VIEW A GRAPHIC DEPICTION OF THESE AND OTHER PLUMES WHICH ARE LESS EXTENSIVE AND STILL ATTACHED TO THE SOURCE FIRE IN VARIOUS GRAPHIC FORMATS ON OUR WEB SITE:

JPEG: <http://www.ospo.noaa.gov/data/land/fire/currenthms.jpg>
GIS: <ftp://satpsanone.nesdis.noaa.gov/FIRE/HMS/GIS/>
KML: <http://www.ospo.noaa.gov/data/land/fire/fire.kml> (fire)
<http://www.ospo.noaa.gov/data/land/fire/smoke.kml> (smoke)

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