ANNUAL REPORT ON VOLATILE ORGANIC COMPOUND EMISSIONS FROM PESTICIDES: EMISSIONS FOR 1990-2023

July 2024

California Environmental Protection Agency
Department of Pesticide Regulation
Environmental Monitoring Branch
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Air 24-03

Executive Summary

This report fulfills the requirements of Title 3 California Code of Regulations (3 CCR) section 6881, requiring the Director of the California Department of Pesticide Regulation (DPR) to issue an annual report on volatile organic compound (VOC) emissions from pesticides for the Sacramento Metro, San Joaquin Valley, South Coast, Southeast Desert, and Ventura ozone nonattainment areas (NAAs). It includes emissions data for May 1 -October 31 of each year between 1990 and 2023, with an emphasis on the most recent five years of data.

In 2023, all five ozone NAAs were in compliance with the State Implementation Plan (SIP) goals.

- Sacramento Metro NAA: Emissions in 2023 remain in compliance with the SIP goal of 2.2 tpd and were 51% lower than the 1990 base year. Emissions increased by 0.274 tons per day (tpd), from 1.097 tpd in 2022 to 1.371 tpd.

- San Joaquin Valley NAA: Emissions in 2023 remain in compliance with the SIP goal of 18.1 tpd and were 28% lower than the 1990 base year. Emissions increased by 2.260 tpd, from 12.528 tpd in 2022 to 14.788 tpd. Prohibition of certain uses of high-VOC nonfumigant products went into effect in 2015. Once prohibition is triggered, DPR regulations require prohibition to continue each year until at least two consecutive years of total hypothetical emissions are less than the trigger level [3 CCR section 6884(c)]. In the previous year's report, DPR determined that the prohibition should continue through 2023 to assess whether the observed emission reductions reflected a long-term trend or a temporary decrease due to exceptional drought conditions. This is the first year that hypothetical emissions have remained below the trigger level while agricultural practices and pesticide use in the San Joaquin Valley NAA were not significantly impacted by severe climate conditions. Emissions in 2023 increased by 2.260 tpd, rising from 12.528 tpd in 2022 to 14.788 tpd (an 18% increase), returning emissions to levels close to those seen in 2020. A preliminary review of 2024 pesticide use data suggests a continued upward trend in emissions, with projections approaching the 2019 level, when emissions exceeded the 17.2 tpd trigger. These observations support the conclusion that the prior decreases were temporary and related to adverse climate conditions. Therefore, DPR determines that the prohibition should continue through 2025 to ensure emissions remain below the trigger level of 17.2 tpd and in compliance with the SIP goal of 18.1 tpd.

- Southeast Desert NAA: Emissions in 2023 remain in compliance with the SIP goal of 0.92 tpd and were 57% lower than the 1990 base year. Emissions increased by 0.185 tpd, from 0.308 tpd in 2022 to 0.493 tpd.

- Ventura NAA: Emissions in 2023 remain in compliance with the SIP goal of 3.0 tpd and were 66% lower than the 1990 base year. Emissions decreased by 0.003 tpd, from 1.289 tpd in 2022 to 1.286 tpd.

- South Coast NAA: Emissions in 2023 remain in compliance with the SIP goal of 8.7 tpd and were 90% lower than the 1990 base year. Emissions increased by 0.225 tpd, from 0.804 tpd in 2022 to 1.031 tpd.

3 CCR section 6881(b) requires a 45-day public comment period of the draft report.

Abbreviations

AI	Active Ingredient
AMAF	Application Method Adjustment Factor
APCD	Air Pollution Control District
CARB	California Air Resources Board
DPR	Department of Pesticide Regulation
EC	Emulsifiable Concentrate
EP	Emission Potential
ER	Emission Rating
FFM	Field Fumigation Methods
GIS	Geographic Information System
MUF	Method Use Fraction
NAA	Nonattainment Area
PUR	Pesticide Use Report
SIP	State Implementation Plan
TGA	Thermogravimetric Analysis
TIF	Totally Impermeable Film
tpd	Tons Per Day
VOC	Volatile Organic Compound

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Acknowledgements

The authors wish to thank the reviewers whose unique perspectives and experiences helped ensure the accuracy and readability of this report. We gratefully acknowledge the staff of DPR and cooperating federal, state, local, and private agencies for contributing to the database.

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Introduction

Volatile Organic Compounds

Under the federal Clean Air Act, the United States Environmental Protection Agency (USEPA) develops National Ambient Air Quality Standards to limit the concentration of airborne pollutants and designates areas that do not attain the standards, called nonattainment areas (NAAs). In partnership with USEPA, states develop State Implementation Plans (SIPs) specifying how they plan to attain and maintain standards for these federal NAAs. The California Air Resources Board (CARB) coordinates the development of California's SIP, which includes measures for attaining ground-level ozone standards. Ground-level ozone, also known as smog, forms from the chemical interaction of nitrogen oxides, volatile organic compounds (VOCs), and sunlight. Because pesticides are a known source of atmospheric VOC emissions, the California Department of Pesticide Regulation (DPR) maintains a VOC emissions inventory ("inventory") for specific uses of pesticide products and compares emissions to emissions-reduction targets for five ozone NAAs.

SIP Goals

DPR compares the results of its inventory to emissions reduction targets in the SIP, referred to hereafter as "SIP goals." The SIP requires 20% reductions in emissions relative to 1990 in four NAAs (Sacramento Metro, South Coast, Southeast Desert, and Ventura) and reduction to 18.1 tpd in the San Joaquin Valley NAA (USEPA 1997). Prior to USEPA approval of DPR's SIP amendment in 2012, the SIP goal for the San Joaquin Valley NAA was a 12% reduction relative to 1990 (USEPA 2012). The superseding SIP goal of 18.1 tpd is equivalent to the 12% reduction, calculated using a specific methodology. The same methodology must be used to calculate future emissions to ensure a legitimate comparison to SIP goals. Emission estimates for pesticide application methods that were used in 1990 cannot be modified, absent a SIP revision. Similarly, nonfumigant emission potentials (EPs) of formulations that were used in the base year cannot be changed, absent a SIP revision.

Compliance with the SIP goals is made possible by regulations that are part of the SIP. These regulations describe the information that must be included in the annual inventory report and provide enforcement mechanisms to limit emissions from fumigants and nonfumigants.

Regulatory Background

Annual Inventory Report

In 2008, DPR adopted Title 3 California Code of Regulations (3 CCR) section 6452.4 requiring an annual inventory report that includes the following information:

- Total agricultural and structural emissions for the previous years;
- Evaluation of whether emissions are in compliance with regulatory benchmarks (equivalent to the SIP goals) in 3 CCR section 6452.2;[1]
- Fumigant emission limits for the upcoming year pursuant to 3 CCR section 6452.2;
- Emission ratings (ERs), also known as application method adjustment factors (AMAFs), for each fumigation method.

Section 6452.4 also required a 45-day public comment period of the draft report.

In 2013, DPR amended the 2008 regulations, moving the requirements for the annual report from 3 CCR section 6452.4 to section 6881 and adding the following report elements:

- Prohibitions on use of high-VOC nonfumigant products pursuant to 3 CCR section 6452.2(f), and if applicable, determination of whether prohibitions remain in effect pursuant to 3 CCR section 6884(c);
- A list of nonfumigant products that are designated as low-VOC pursuant to 3 CCR section 6880; and
- A list of actively registered nonfumigant products that are designated as high-VOC pursuant to 3 CCR section 6880.

This report contains all of the information specified above, including: 1) unadjusted emission estimates for 1990-2023; 2) adjusted emissions estimates for 1990 and 2004-2023; 3) whether 2023 emissions exceed levels that trigger fumigant limits or nonfumigant prohibitions; and 4) the status of previously enacted fumigant emissions limits and nonfumigant prohibitions.

Fumigants

The 2008 regulations that describe the content of the annual inventory report also included measures to limit emissions from fumigant applications. During the ozone season, fumigation methods with known application method adjustment factors (AMAFs)—the proportion of applied fumigant mass that contributes to VOC emissions under field conditions—are required within the five NAAs, and “low-emission” fumigant application methods are required within the San Joaquin Valley, Southeast Desert, and Ventura NAAs. Updated permissible and prohibited fumigant application methods are listed in Appendix 1b. If emissions equal or exceed a “trigger level” (equal to 95% of the SIP goal) for an NAA, DPR will ensure compliance with the SIP goal by establishing a fumigant limit equal to the difference between the SIP

[1] The first report for which these two terms are equivalent is “ANNUAL REPORT ON VOLATILE ORGANIC COUMPOUND EMISSIONS FROM PESTICIDES: EMISSIONS FOR 1990 – 2008” (2010). These terms previously represented different numbers due to a now-overturned court order.

goal and calculated nonfumigant emissions, enforced by DPR and County Agricultural Commissioners (CACs) through grower allowances or other methods.[2]

3 CCR section 6452 describes the interim and rulemaking processes that DPR uses to evaluate and approve new low-emission fumigant application methods. In April 2013, DPR granted interim approval allowing use of the USEPA-approved totally impermeable film (TIF) tarp method for certain fumigants. The regulation that gave permanent approval for TIF tarp methods became effective on April 1, 2016. The continued increase in adoption of low-emission application methods and products by growers, registrants, and others significantly contributes to SIP compliance and reducing emissions.

In January 2024, DPR approved six new application methods for 1,3-D and revised the emission ratings (ERs) of existing 1,3-D application methods. These methods, which were previously based on field application monitoring studies, were updated to reflect the results of new soil-moisture requirements in the rulemaking and recent HYDRUS modeling that incorporates these requirements (Brown 2022, 2023). Many of the older methods were approved for use on chloropicrin and assigned chloropicrin-specific ERs. These chloropicrin ERs cannot be revised without making additional regulatory changes. Chloropicrin ERs for the new methods are borrowed from the closest analogs among the older methods for consistency with those methods. Appendix 1b contains a list of methods and their associated ERs used for the 2023 inventory report. The default methods used for applications that fail to report a method or report an incorrect method are also changing in response to changes to the list of high-emission methods and their ERs (Tables 5 and 6).

The next year's (i.e., 2024) inventory report will be the first to officially incorporate changes stemming from the 2024 rulemaking. To promote public awareness of these changes, the 2023 total adjusted emissions reported in this inventory were recalculated using the post-2024 ERs (Appendix 1c) for comparison and as a preview of the scale of the difference in emissions totals between the new and old ERs. In all NAAs, the differences were modest and contingent on the existing distribution of methods used in each NAA in 2023 (Table 1). Note that applications will not begin reporting use of the newly approved application methods until after January 1, 2024, so the effect on emissions of the new methods cannot be reliably estimated in advance.

Table 1. Comparison of 2023 adjusted emissions when applying the new ERs for 2024.

Nonattainment Area	Actual emissions (tpd)	Emissions with post-2024 ERs (tpd)
Sacramento Metro	1.371	1.355
San Joaquin Valley	14.788	14.804
Southeast Desert	0.493	0.508
Ventura	1.286	1.236
South Coast	1.031	1.058

[2] The percentage(s) of the SIP goals that constitute the trigger level has historically changed as a result of subsequent regulations, court orders, and SIP revisions. The current value of 95% is included in the discussion of the 2008 regulations for simplicity.

Nonfumigants

Because a majority of emissions in the San Joaquin Valley NAA historically stemmed from nonfumigant use, the 2013 regulations replaced the San Joaquin Valley NAA's fumigant limit with prohibitions on certain uses of nonfumigant products designated as high-VOC.

Designation of High-VOC Nonfumigant Products

3 CCR section 6880 establishes EP thresholds for regulatory classification of nonfumigant products containing abamectin, chlorpyrifos, gibberellins, and/or oxyfluorfen:

Table 2. EP thresholds established in 3 CCR section 6880.

Primary AI	EP Threshold
ABAMECTIN	35%
CHLORPYRIFOS	25%
GIBBERELLINS	25%
OXYFLUORFEN	15%

DPR classifies products containing any of the four pesticides listed above into three groups:

- **High-VOC product:** (1) contains any of the four pesticides as a primary AI; (2) is labeled for agricultural use; and (3) the EP is greater than the threshold.
- **Low-VOC product:** (1) contains any of the four pesticides as a primary AI; (2) is labeled for agricultural use; and (3) the EP is equal to or less than the threshold.
- **Excluded product:** (1) contains any of the four pesticides, but not as a primary AI; or (2) is labeled for non-agricultural use only.

If a product contains multiple AIs, the primary AI(s) are those present at the highest percentage in a product. Products with a primary AI not listed in Table 2 (including products with multiple primary AIs) are excluded.

Products labeled only for non-agricultural uses are also excluded. Non-agricultural uses include: a) home use; b) use in structural pest control; c) industrial or institutional use; d) control of an animal pest under the written prescription of a veterinarian; or e) vector control. All other uses are considered agricultural.

Appendix 4 lists the currently registered products designated as high-VOC or low-VOC.

Prohibitions on High-VOC Nonfumigant Products

When emissions in the San Joaquin Valley NAA exceed the trigger level, applications of high-VOC products to alfalfa, almonds, citrus, cotton, grapes, pistachios, or walnuts are prohibited in the San Joaquin Valley NAA between May 1 and October 31,[3] with the following exceptions:[4]

- Use of chlorpyrifos products to control aphids on cotton.
- Use of gibberellins products when applied at an application rate of 16 grams of AI per acre or less.
- Use of oxyfluorfen products when applied at an application rate of 0.125 (1/8) pounds of AI per acre or less.
- Uses for which USEPA has issued an emergency exemption from registration under Section 18 of the Federal Insecticide, Fungicide, and Rodenticide Act.
- Uses registered as a Special Local Need under Section 24(c) of the Federal Insecticide, Fungicide, and Rodenticide Act.
- Applications made by or under the direction of the US Department of Agriculture, the California Department of Food and Agriculture, or CACs to control, suppress, or eradicate pests.
- Applications using precision spray technology meeting the criteria of the California Office of the Natural Resources Conservation Service's Environmental Quality Incentives Program.

Property operators must obtain a written recommendation from a licensed pest control adviser before application.[5] In turn, pest control advisers cannot make a recommendation that violates any active high-VOC prohibitions. If an exception to a prohibition applies, the exception must be identified in the written recommendation.[6]

When prohibitions for high-VOC nonfumigant products are in effect, those prohibitions must remain in effect until the total hypothetical VOC emissions detailed in the annual inventory report (see the report section "Emissions Relative to SIP Goals and Trigger Levels") are less than the trigger level for at least two consecutive years.[7]

Emission Calculation

Input Data

The pesticide use report (PUR) dataset is one of two primary inputs to the inventory. The inventory includes all pesticide applications that are made for agricultural and commercial structural use, as

[3] 3 CCR section 6884(a)
[4] 3 CCR section 6884(b)
[5] 3 CCR section 6883
[6] 3 CCR section 6558
[7] 3 CCR section 6884(c)

defined by law, in five ozone NAAs, during the peak ozone period in California (May 1-October 31).[8] The inventory excludes applications outside of these NAAs, months, and uses.[9] DPR updates its inventory annually when PUR data from the previous year becomes available. Data was queried from the PUR database on NA. The key PUR data fields used to calculate emissions are shown in Table 3.

EP data form the other primary input of the inventory. The EP is the mass fraction of a pesticide product that contributes to atmospheric VOC emissions. For the period covered by this report, the data for each year consist of EP values for approximately 5,605 products.

Other inputs to the inventory include geospatial data, due to the inventory's focus on specific NAAs within California. The boundaries of these NAAs and a listing of counties that fall within the boundaries are shown in Figure 1 and Table 4, respectively.

Table 3. Key information included in PURs that form the basis of DPR's VOC emissions inventory.

Information	Production Agriculture Reports	Non-production Agriculture and Non-agricultural Reports
Product Applied	Yes	Yes
Crop/Site Treated	Yes	Yes
Amount Applied	Yes - each application	Monthly Total
Date Applied	Date and Time	Month
Application Method	Yes	No
Acres/Units Treated	Yes	Monthly Total
Location of Application	Township/Range/Section	County
Fumigant Method Code	Yes*	No

* Field fumigant use reports only

[8] Production agricultural use covers applications to approximately 400 commodities/crops. Non-production agricultural use includes applications to approximately 20 sites such as cemeteries, golf courses, parks, and rights-of-way. Structural use includes all applications by structural pest control businesses, regardless of site treated.
[9] The excluded uses are home use, industrial use, institutional use, applications made for vector control purposes, and veterinary use.

Table 4. A listing of counties wholly or partially within the five ozone NAAs in California.

NAA	Counties within the NAA
Sacramento Metro	All of Sacramento, Yolo. Parts of Sutter, Solano, Placer, El Dorado.
San Joaquin Valley	All of Fresno, Kings, Madera, Merced, San Joaquin, Stanislaus, Tulare. Western Part of Kern.
Southeast Desert	Parts of Los Angeles, San Bernardino, Riverside.
Ventura	All of Ventura.
South Coast	All of Orange. Western Parts of Los Angeles, San Bernardino, Riverside.

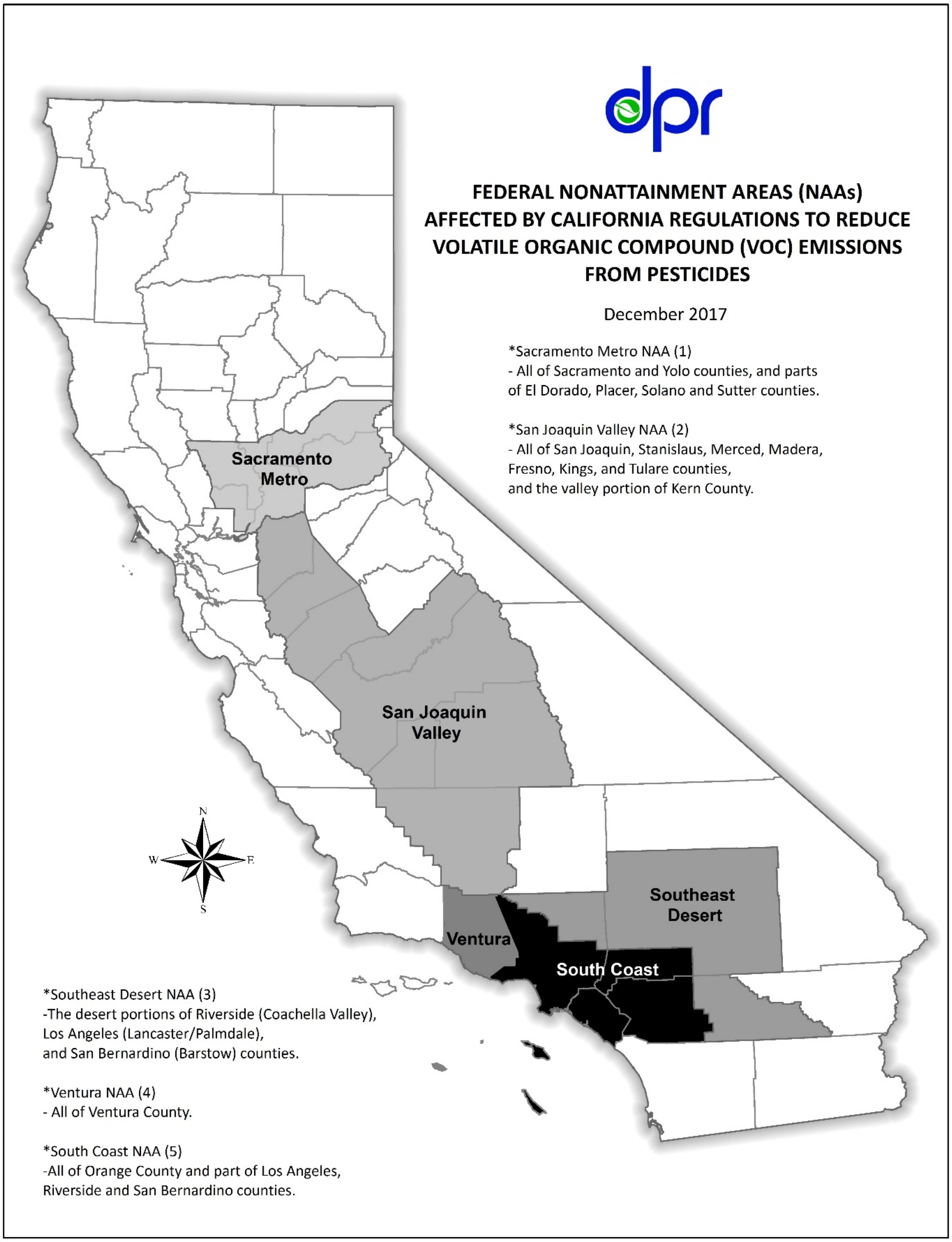

Figure 1. Federal ozone NAAs affected by California regulations to reduce VOC emissions from pesticides.

Data Revisions

DPR continually evaluates input data to the inventory for reliability. DPR thoroughly evaluates registrant-submitted thermogravimetric analysis (TGA) data to determine EPs for new and existing products. Previous inventories have shown that changes in a widely used product's EP can significantly influence the inventory.

Changes to a product's EP can occur when an EP determined by alternative methods is replaced by an EP derived from TGA data. Products lacking TGA data are assigned default EP values based on the type of product formulation. Updates to DPR's Product/Label database may reflect changes in the product formulation and thus alter its default EP. Between 2022 and 2023 annual inventories there were no nonfumigant products with substantially changed EP values.

DPR also evaluates the inventory data for past errors in TGA-based EP values (e.g., approval of deficient TGA data or erroneous bridging of one product's EP to another "substantially similar" product). If any such errors are discovered by DPR, DPR can request that the registrant provide new TGA data for a product, after which a new EP can be determined.

Emission Calculation Procedure

Prior to 2008, DPR reported an unadjusted inventory that assumed the entire volatile portion of a fumigant product eventually volatilizes, contributing to atmospheric VOC loadings. In the unadjusted inventory, VOC emissions from the application of a fumigant or nonfumigant product equals the applied product mass multiplied by the EP (Spurlock 2006).

emissions = lbs of product used * EP

Several dozen field studies have shown that actual emissions from soil-applied fumigants such as methyl bromide vary by application method and are generally less than 100% (Majewski et al. 1995, Wang et al. 1997, Williams e al. 1999, Yagi et al. 1993). DPR has developed an adjustment procedure to account for the effect of application method on reducing fumigant emissions.[10]

In the adjusted inventory, the emissions from an applied fumigant product are the sum of the emissions from each fumigant AI within the product.[11] The emissions from each AI equals the applied product mass multiplied by the EP—generally the percent of the AI in the product—and an AMAF, which has been determined from field study data and is specific to a given combination of AI and application method (Barry et al. 2007).

emission = lbs of product used * EP * AMAF

The 2008 regulations facilitated adjusted calculations by requiring that each field fumigant application made within the ozone NAAs during the ozone season report the application method. In 2023, none of the 1,149 field fumigant applications were reported with errors in their field fumigation method (FFM)

[10] Nonfumigant product emissions are calculated using the unadjusted inventory procedure, due to a lack of data to support adjusted calculations.

[11] In addition to the emissions derived from fumigant AIs, inert ingredients for products that contain chloropicrin, methyl bromide, and 1,3-dichloropropene are assumed to be volatile and are included in the inventory calculations. For the highest use products containing metam sodium, metam potassium, sodium tetrathiocarbonate, and dazomet, analysis of their confidential statements of formula determined that the composition of inerts is non-volatile and so does not contribute to the EP of these products.

code. For any such records, DPR uses a conservative approach by assigning each record the highest AMAF of any method allowed by the regulations for the applied fumigant (Table 5). The regulations establish different lists of permissible application methods for Sacramento Metro and South Coast than for the other NAAs. Within San Joaquin Valley, Southeast Desert, and Ventura NAAs, only low-emission methods are permitted during the ozone season. The highest AMAFs for these NAAs is chosen from low-emission methods that were designated based on their AMAF rather than their application rate.[12] See Appendix 1b for the full list of permitted FFMs and their associated AMAFs.

Table 5. Default AMAFs (highest allowed by the regulations) assigned to fumigant applications with missing or invalid FFM codes. These codes will be replaced by the new default codes in Table 6 and will be reflected in the 2024 inventory report.

Active Ingredient	Default AMAF
Methyl Bromide with or without Chloropicrin	48%
1,3-Dichloropropene with or without Chloropicrin	44%
Chloropicrin Only	44%
Metam-Sodium or Potassium N-Methyldithiocarbamate	28%
Dazomet	17%
Sodium Tetrathiocarbonate	10%

[12] This includes FFM codes 1210, 1211, 1413, and 1772.

Table 6. New Default FFM codes (with highest AMAFs allowed by the regulations) assigned to fumigant applications with a missing or invalid FFM code. For products that contain a combination of chloropicrin and either 1,3-D or methyl bromide, chloropicrin is never considered to be the primary AI for purposes of selecting a default application method. For some AIs, multiple FFM codes may be associated with the same maximum combination of AMAFs, but only one is displayed below. These will replace the AMAFs listed in Table 5 and will be reflected in the 2024 inventory report.

Nonattainment Area	FFM Code	Primary AI	AMAF	Secondary AI	AMAF
San Joaquin Valley, Southeast Desert, and Ventura	1103	Chloropicrin	44%		
Sacramento Metro and South Coast	1102	Chloropicrin	64%		
All NAAs	1501	Dazomet	17%		
San Joaquin Valley, Southeast Desert, and Ventura	1103	Methyl Bromide	48%	Chloropicrin	44%
Sacramento Metro and South Coast	1106	Methyl Bromide	100%	Chloropicrin	64%
San Joaquin Valley, Southeast Desert, and Ventura	1204	1,3-Dichloropropene	35%	Chloropicrin	43%
Sacramento Metro and South Coast	1209	1,3-Dichloropropene	52%	Chloropicrin	12%
San Joaquin Valley, Southeast Desert, and Ventura	1402	Metam-Sodium/Potassium N-Methyldithiocarbamate	28%		
Sacramento Metro and South Coast	1413	Metam-Sodium/Potassium N-Methyldithiocarbamate	100%		
All NAAs	1601	Sodium Tetrathiocarbamate	10%		

Prior to 2008, fumigant applications did not report FFM codes. DPR developed an alternative procedure to adjust the total emissions—across all applications in a given year and NAA—of each fumigant AI, rather than the emission of an AI from a single application of a fumigant product. This procedure relies on Method Use Fractions (MUFs), which are the fraction of a fumigant AI's total applied mass that uses a specific fumigation method. MUF values are specific to combinations of fumigant AI, application method, NAA, and year, reflecting differences in fumigant use patterns across time and space. Total adjusted emissions from all applications of an AI made using a specific fumigation method equals the product of total AI mass, MUF, and AMAF. This can also be calculated by multiplying MUF and AMAF for all of an AI's methods, summing the results, then multiplying the sum by total AI mass. Summation of all the fumigant AIs' emissions yield total adjusted emissions from fumigant products.

Appendix 1a contains MUFs and AMAFs for 2008 and earlier years. For 2008, MUFs were derived from information available in the PUR database. For 2007 and earlier years, surrogate data were used to estimate MUFs. The type of surrogate data differed for different AIs. For 1,3-dichloropropene, the MUFs were determined from use data collected by the registrant in support of DPR's township application caps. For metam sodium and metam potassium, grower/applicator surveys were conducted to determine types of applications for different crops and areas. Methyl bromide and chloropicrin MUFs were based on expert opinion and regulatory history. Finally, MUFs for dazomet and sodium tetrathiocarbonate equal one because the AMAFs for each of these two fumigants are constant, independent of application method (Barry et al. 2007).

Non-production agriculture and non-agricultural pesticide applications are reported to DPR as "monthly summary data" with no geographic location information beyond the county of application (Table 3). These applications include commercial structural, landscape maintenance, rights-of-way, and commodity fumigations. In cases where two or more air basins, one of which may be in an NAA, are present within a single county, these applications must be proportionally allocated. DPR allocates these monthly summary applications using surrogate data that are assumed to have similar geographic distributions. In 2012, the surrogate data were updated to provide the most accurate estimated geographic distribution of emissions, reflecting changes in California's population and transportation infrastructure. US Census data for the 2010 decennial census together with TIGER/Line shapefiles for roads, rail roads, and linear hydrography were used as surrogates for commercial structural, landscape maintenance, and rights-of-way applications. Commodity fumigation data were provided by California CACs (Neal and Spurlock 2012).

Emissions are aggregated from individual PUR records at various levels: by year, NAA, primary AI, commodity or application site, and emissions category as defined by CARB. The primary AI is defined as the AI present at the highest percentage in a pesticide product. If a product contains 20% of AI "A" and 10% of AI "B", all calculated emissions from that product are assigned to the primary AI "A". CARB defines four emission categories: methyl bromide emissions from agricultural applications, non-methyl bromide emissions from agricultural applications, methyl bromide emissions from structural applications, and non-methyl bromide emissions from structural applications.

Emissions are reported as US tons per day (tpd) throughout this report.

Results

Emissions Relative to SIP Goals and Trigger Levels

Restrictions are triggered if emissions in an NAA exceed its trigger level (95% of its SIP goal). For the Sacramento Metro, Southeast Desert, South Coast, and Ventura NAAs the restrictions are a fumigant emissions limit. If emissions exceed the trigger level for the San Joaquin Valley NAA, certain uses of high-VOC products are prohibited until at least two consecutive years of total hypothetical emissions are less than the trigger level. More information about the calculation of total hypothetical emissions can be found in Appendix 3. For all five NAAs, restrictions are triggered for the upcoming ozone season based on the most recent inventory. For example, the 2023 inventory is used to determine if restrictions will go into effect on May 1, 2025.

As shown in Table 7, 2023 emissions in all five NAAs were less than their trigger levels and SIP goals.

Table 7. SIP goals, trigger levels and 2023 emissions.

NAA	SIP Goal (tpd)	Trigger Level (95% of SIP Goal) (tpd)	2023 Emissions (tpd)
Sacramento Metro	2.20	2.090	1.371
San Joaquin Valley	18.10	17.195	14.788
Southeast Desert	0.92	0.874	0.493
Ventura	3.00	2.850	1.286
South Coast	8.70	8.265	1.031

Emissions reported in the 2013 annual inventory report for the San Joaquin Valley NAA exceeded the SIP goal by 0.183 tpd. In the 2014 annual inventory report, revised emissions calculations for 2013 yielded 19.518 tpd (1.418 tpd above the SIP Goal). This increase was largely due to revised TGA-based EP values for fenpyroximate and hexythiazox products with emulsifiable concentrate formulations. Therefore, DPR enacted prohibitions on high-VOC nonfumigant products from May 1 through October 31 of 2015 and 2016. When nonfumigant prohibitions are in effect, those prohibitions must remain in effect until the total hypothetical emissions detailed in the annual inventory report are less than the trigger level for at least two consecutive years.

Emissions in 2023 remain in compliance with the SIP goal of 18.1 tpd and were 28% lower than the 1990 base year. Emissions increased by 2.260 tpd, from 12.528 tpd in 2022 to 14.788 tpd. In the previous year's report, DPR determined that the prohibition should continue through 2023 to assess whether the observed emission reductions reflected a long-term trend or a temporary decrease due to exceptional drought conditions.

This is the first year that hypothetical emissions have remained below the trigger level while agricultural practices and pesticide use in the San Joaquin Valley NAA were not significantly impacted by severe climate conditions. However, as noted above, emissions in 2023 increased by 18% compared to the previous year (12.528 tpd in 2022 to 14.788 tpd in 2023), returning emissions to levels close to those seen in 2020. A preliminary review of 2024 pesticide use data suggests a continued upward trend in associated emissions, with projections approaching the 2019 level, when emissions exceeded the 17.2 tpd trigger. These observations support the conclusion that the prior decreases were temporary and related to adverse climate conditions. Therefore, DPR determines that the prohibition should continue through 2025 to ensure emissions remain below the trigger level of 17.2 tpd and in compliance with the SIP goal of 18.1 tpd.

Emissions in the Ozone NAAs

In 2023, all five ozone NAAs were in compliance with the SIP goals.

- Sacramento Metro NAA: Emissions in 2023 remain in compliance with the SIP goal of 2.2 tpd and were 51% lower than the 1990 base year. Emissions increased by 0.274 tpd, from 1.097 tpd in 2022 to 1.370 tpd.

- San Joaquin Valley NAA: Emissions in 2023 remain in compliance with the SIP goal of 18.1 tpd and were 28% lower than the 1990 base year. Emissions increased by 2.260 tpd, from 12.528 tpd in 2022 to 14.788 tpd.

- Southeast Desert NAA: Emissions in 2023 remain in compliance with the SIP goal of 0.92 tpd and were 57% lower than the 1990 base year. Emissions increased by 0.185 tpd, from 0.308 tpd in 2022 to 0.493 tpd.

- Ventura NAA: Emissions in 2023 remain in compliance with the SIP goal of 3.0 tpd and were 66% lower than the 1990 base year. Emissions decreased by 0.003 tpd, from 1.289 tpd in 2022 to 1.286 tpd.

- South Coast NAA: Emissions in 2023 remain in compliance with the SIP goal of 8.7 tpd and were 90% lower than the 1990 base year. Emissions increased by 0.225 tpd, from 0.804 tpd in 2022 to 1.031 tpd.

Total emissions for all available years of data are shown in Figures 2 and 3. Appendix 2 lists these data in table form, as well as additional emissions data discussed below.[13]

Pesticide use varies from year to year due to weather, drought, pest problems, economics, and types of crops planted. Increases and decreases in pesticide use in the span of a few years do not necessarily indicate a trend. Such variances are and will continue to be a normal occurrence. A more detailed explanation of pesticide use patterns is given in DPR's annual summary of PURs, which is available at *http://www.cdpr.ca.gov/docs/pur/purmain.htm*.

[13] Table A2-1-1 is interpreted as Appendix 2, NAA 1, Table 1. Tables in Appendix 3 are similar, though they are not specific to an NAA. E.g., Table A3-1 is interpreted as Appendix 3, Table 1. These formats are standard throughout this report.

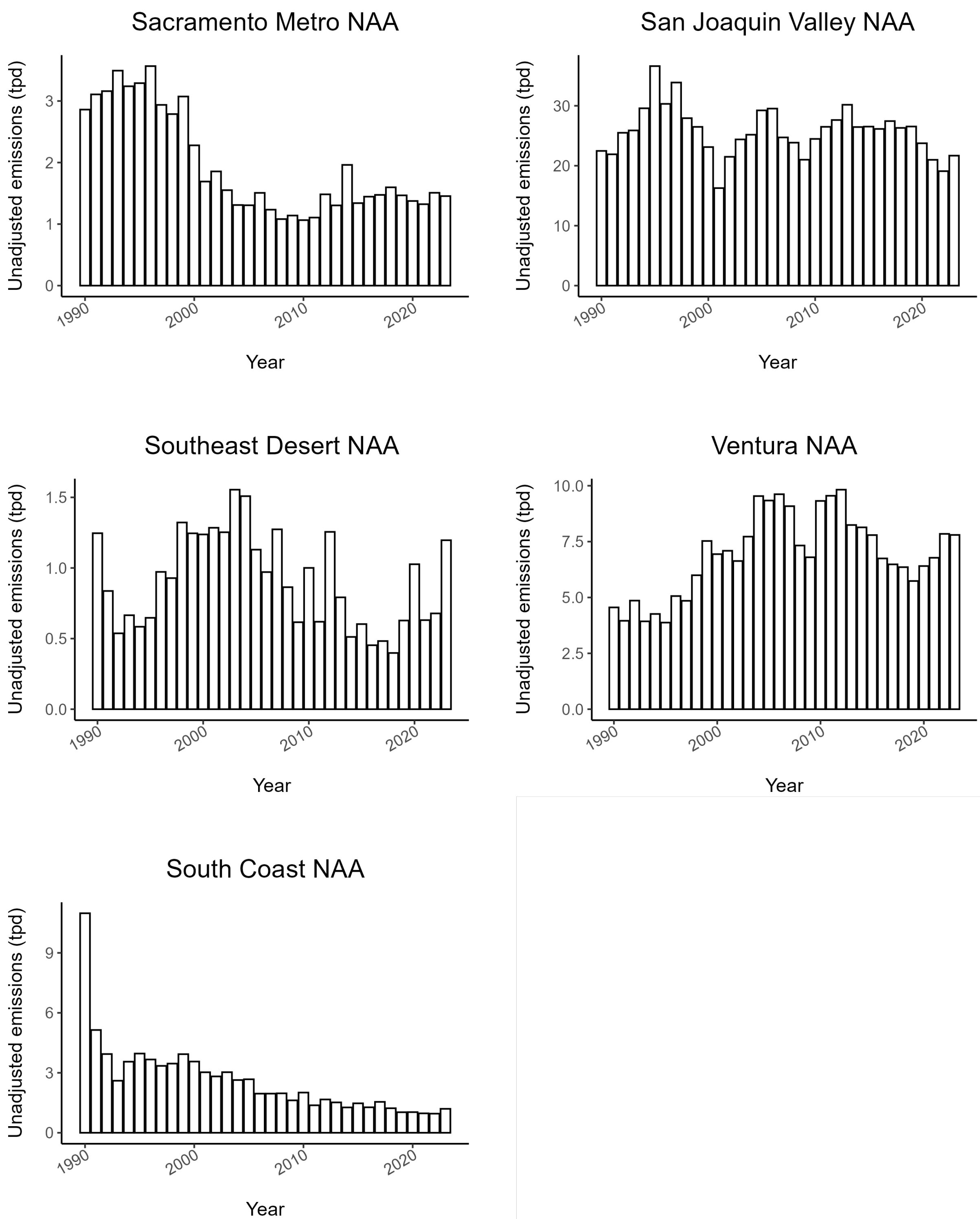

Figure 2. Total unadjusted emissions in each NAA from 1990 to 2023.

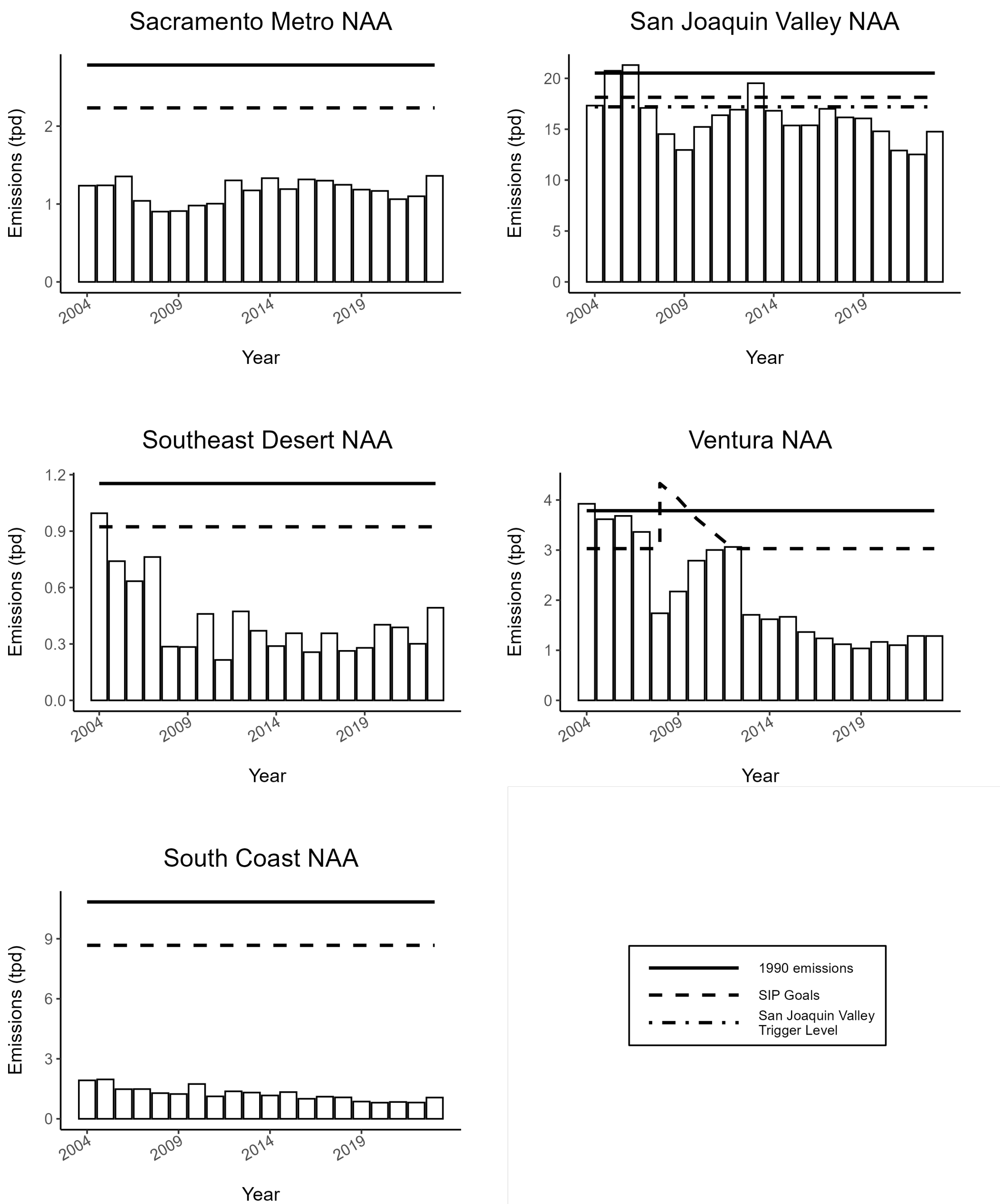

Figure 3. Total adjusted emissions in each NAA from the earliest available year of adjusted emissions data (2004) to 2023, in comparison to 1990 emissions, the SIP goals, and the San Joaquin Valley NAA trigger level. The 2007 SIP revision temporarily increased Ventura's SIP goal above 4 tpd in 2008, then gradually reduced the goal each year until 2012. Since 2012, the goal for Ventura remains 3 tpd.

Sacramento Metro NAA

In the Sacramento Metro NAA, 2023 emissions from pesticides increased by 0.274 tpd between 2022 and 2023, from 1.097 to 1.371 tpd. Emissions were 34% (-0.719 tpd) below the regulatory trigger level (95% of the SIP goal) of 2.1 tpd.

Fumigant emissions decreased by 0.156 tpd from 0.192 to 0.037 tpd. There were four fumigant product formulations responsible for fumigant emissions and 3% of total emissions. Pressurized gas was the most used formulation accounting for 67% of fumigant emissions and 2% of total emissions. Not counting inert ingredients there were six fumigant primary AIs responsible for fumigant emissions and 2% of total emissions. Methyl bromide was the AI with the largest contribution to emissions accounting for 51% of fumigant emissions and 1% of total emissions. There were 11 commodities treated by fumigant products. The top site—soil application, preplant-outdoor (seedbeds, etc.)—accounted for 50% of all fumigant emissions but only 1% of total emissions.

Nonfumigant emissions increased by 0.430 tpd from 0.904 to 1.334 tpd. There were 18 nonfumigant product formulations; however, the top three formulations accounted for 73% of all nonfumigant emissions and 70% of total emissions. Emulsifiable concentrate was the most used formulation and accounted for 45% of nonfumigant emissions and 43% of total emissions. There were 367 nonfumigant primary AIs; however, the top 10 AIs accounted for 51% of nonfumigant emissions and 49% of total emissions. Propanil was the most applied nonfumigant AI and accounted for 9% of nonfumigant emissions and 9% of total emissions. There were 112 commodities treated by nonfumigant products; however, the top 10 commodities accounted for 86% of nonfumigant emissions and 73% of total emissions. Rice (all or unspecified) was the top commodity responsible for 26% of nonfumigant emissions and 25% of total emissions.

Table A2-1-10 shows unadjusted emissions using the CARB California Emissions Inventory Development and Reporting System (CEIDARS) classifications. Unadjusted emissions from agricultural applications of methyl bromide decreased by 0.002 tpd from 0.047 tpd in 2022 to 0.045 tpd. Unadjusted emissions from agricultural applications of non-methyl bromide products decreased by 0.125 tpd from 1.342 tpd to 1.218 tpd. Emissions from structural applications of methyl bromide continued to be below a reportable level. Unadjusted emissions from structural applications of non-methyl bromide products increased by 0.073 tpd from 0.109 tpd to 0.182 tpd.

San Joaquin Valley NAA

In the San Joaquin Valley NAA, 2023 emissions from pesticides increased by 2.260 tpd between 2022 and 2023, from 12.528 to 14.788 tpd. Emissions were 14% (-2.412 tpd) below the regulatory trigger level (95% of the SIP goal) of 17.2 tpd.

Fumigant emissions increased by 0.253 tpd from 2.330 to 2.583 tpd. There were five fumigant product formulations responsible for fumigant emissions and 18% of total emissions. Liquid concentrate was the most used formulation accounting for 62% of fumigant emissions and 11% of total emissions. Not counting inert ingredients, there were five fumigant primary AIs responsible for fumigant emissions and 16% of total emissions. 1,3-dichloropropene was the AI with the largest contribution to emissions accounting for 42% of fumigant emissions and 7% of total emissions. There were 46 commodities treated by fumigant products. The top commodity—almonds— accounted for 24% of fumigant emissions and 4% of total emissions.

Nonfumigant emissions increased by 2.007 tpd from 10.198 to 12.205 tpd. There were 18 nonfumigant product formulations; however, the top three formulations accounted for 79%% of all nonfumigant emissions and 64% of total emissions. Emulsifiable concentrate was the most used formulation and accounted for 48% of nonfumigant emissions and 39% of total emissions. There were 455 nonfumigant primary AIs; however, the top 10 AIs accounted for 52% of nonfumigant emissions and 42% of total emissions. Glufosinate-ammonium was the most applied nonfumigant AI and accounted for 10% of nonfumigant emissions and 8% of total emissions. There were 170 commodities treated by nonfumigant products; however, the top 10 commodities accounted for 83% of nonfumigant emissions and 66% of total emissions. Almonds was the top commodity responsible for 33% of nonfumigant emissions and 27% of total emissions.

Table A2-2-10 shows unadjusted emissions using the CARB CEIDARS classifications. Unadjusted emissions from agricultural applications of methyl bromide increased by 0.128 tpd from 0.882 tpd in 2022 to 1.010 tpd. Unadjusted emissions from agricultural applications of non-methyl bromide products increased by 20519 tpd from 17.951 tpd to 20.469 tpd. Emissions from structural applications of methyl bromide continued to be below a reportable level. Unadjusted emissions from structural applications of non-methyl bromide products decreased by 0.038 tpd from 0.266 tpd to 0.228 tpd.

Southeast Desert NAA

In the Southeast Desert NAA, 2023 emissions from pesticides increased by 0.185 tpd between 2022 and 2023, from 0.308 to 0.493 tpd. Emissions were 44% (-0.381 tpd) below the regulatory trigger level (95% of the SIP goal) of 0.87 tpd.

Fumigant emissions increased by 0.183 tpd from 0.088 to 0.271 tpd. There were eight fumigant product formulations responsible for fumigant emissions and 54% of total emissions. Liquid concentrate was the most used fumigant formulation accounting for 49% of fumigant emissions and 29% of total emissions. Not counting inert ingredients, there were five fumigant primary AIs responsible for fumigant emissions and 51% of total emissions. 1,3-dichloropropene was the AI with the largest contribution to emissions and accounted for 59% of fumigant emissions and 32% of total emissions. There were 10 commodities treated by fumigant products. The top commodity—peaches—accounted for 54% of fumigant emissions and 30% of total emissions.

Nonfumigant emissions increased by 0.002 tpd from 0.221 to 0.222 tpd. There were 18 nonfumigant product formulations; however, the top three formulations accounted for 74% of all nonfumigant emissions and 33% of total emissions. Emulsifiable concentrate was the most used formulation and accounted for 44% of nonfumigant emissions and 20% of total emissions. There were 333 nonfumigant primary AIs; however, the top 10 AIs accounted for 56% of nonfumigant emissions and 26% of total emissions. Bensulide was the most applied nonfumigant AI and accounted for 10% of nonfumigant emissions and 5% of total emissions. There were 91 commodities treated by nonfumigant products; however, the top 10 commodities accounted for 79% of nonfumigant emissions and 37% of total emissions. Nonfumigant applications to structural pest control was the top site responsible for 24% of nonfumigant emissions and 11% of total emissions.

Table A2-3-10 shows unadjusted emissions using the CARB CEIDARS classifications. Unadjusted emissions from agricultural applications of methyl bromide increased from 0.000 tpd in 2022 to 0.075 tpd. Unadjusted emissions from agricultural applications of non-methyl bromide products increased by 0.422 tpd from 0.647 tpd to 1.070 tpd. Emissions from structural applications of methyl bromide continued to be below a reportable level. Unadjusted emissions from structural applications of non-methyl bromide products increased by 0.014 tpd from 0.039 tpd to 0.053 tpd.

Ventura NAA

In the Ventura NAA, 2023 emissions from pesticides decreased by 0.003 tpd between 2022 and 2023, from 1.289 to 1.286 tpd. Emissions were 55% (-1.565 tpd) below the regulatory trigger level (95% of the SIP goal) of 2.85 tpd.

Fumigant emissions decreased by 0.023 tpd from 0.916 to 0.893 tpd. There were five fumigant product formulations responsible for fumigant emissions and 70% of total emissions. The pressurized gas formulation was the most used fumigant formulation accounting for 56% of fumigant emissions and 39% of total emissions. Not counting inert ingredients, there were five fumigant primary AIs responsible for fumigant emissions and 50% of total emissions. Chloropicrin was the AI with the largest contribution to emissions and accounted for 39% of fumigant emissions and 27% of total emissions. There were 8 commodities treated by fumigant products. The top commodity— strawberries (all or unspecified)— accounted for 98% of fumigant emissions and 68% of total emissions.

Nonfumigant emissions increased by 0.020 tpd from 0.373 to 0.393 tpd. There were 18 nonfumigant product formulations; however, the top three formulations accounted for 75% of all nonfumigant emissions and 23% of total emissions. Emulsifiable concentrate was the most used formulation and accounted for 35% of nonfumigant emissions and 11% of total emissions. There were 316 nonfumigant primary AIs; however, the top 10 AIs accounted for 39% of nonfumigant emissions and 12% of total emissions. Mineral oil was the most applied nonfumigant AI and accounted for 9% of nonfumigant emissions and 3% of total emissions. There were 108 commodities treated by nonfumigant products; however, the top 10 commodities accounted for 78% of nonfumigant emissions and 22% of total emissions. Lemons was the top commodity responsible for 16% of nonfumigant emissions and 5% of total emissions.

Table A2-4-10 shows unadjusted emissions using the CARB CEIDARS classifications. Unadjusted emissions from agricultural applications of methyl bromide decreased by 0.001 tpd from 0.007 tpd in 2022 to 0.006 tpd. Unadjusted emissions from agricultural applications of non-methyl bromide products decreased by 0.059 tpd from 7.830 tpd to 7.771 tpd. Emissions from structural applications of methyl bromide continued to be below a reportable level. Unadjusted emissions from structural applications of non-methyl bromide products increased by 0.011 tpd from 0.012 tpd to 0.022 tpd.

South Coast NAA

In the South Coast NAA, 2023 emissions from pesticides increased by 0.225 tpd between 2022 and 2023, from 0.804 to 1.031 tpd. Emissions were 88% (-7.235 tpd) below the regulatory trigger level (95% of the SIP goal) of 8.3 tpd.

Fumigant emissions increased by 0.018 tpd from 0.093 to 0.111 tpd. There were eight fumigant product formulations responsible for fumigant emissions and 10% of total emissions. Pressurized gas was the most used fumigant formulation accounting for 57% of fumigant emissions and 6% of total emissions. Not counting inert ingredients, there were five fumigant primary AIs responsible for fumigant emissions and 10% of total emissions. Methyl bromide was the AI with the largest contribution to emissions and accounted for 44% of fumigant emissions and 5% of total emissions. There were eight commodities treated by fumigant products. The top site— rights of way —accounted for 31% of fumigant emissions and 3% of total emissions.

Nonfumigant emissions increased by 0.207 tpd from 0.721 to 0.919 tpd. There were 18 nonfumigant product formulations; however, the top three formulations accounted for 77% of all nonfumigant emissions and 70% of total emissions. Pressurized liquid/sprays/foggers were the most used formulation and accounted for 27% of nonfumigant emissions and 25% of total emissions. There were 371 nonfumigant primary AIs; however, the top 10 AIs accounted for 62% of nonfumigant emissions and 56% of total emissions. Piperonyl butoxide was the most applied nonfumigant AI and accounted for 14% of nonfumigant emissions and 13% of total emissions. There were 91 commodities treated by nonfumigant products; however, the top 10 commodities accounted for 96% of nonfumigant emissions and 63% of total emissions. Structural pest control was the top site responsible for 70% of nonfumigant emissions and 63% of total emissions.

Table A2-5-10 shows unadjusted emissions using the CARB CEIDARS classifications. Unadjusted emissions from agricultural applications of methyl bromide decreased by 0.001 tpd from 0.049 tpd in 2022 to 0.049 tpd. Unadjusted emissions from agricultural applications of non-methyl bromide products increased by 0.036 tpd from 0.450 tpd to 0.486 tpd. Emissions from structural applications of methyl bromide continued to be below a reportable level. Unadjusted emissions from structural applications of non-methyl bromide products increased by 0.180 tpd from 0.449 tpd to 0.630 tpd.

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