Appendix J
Modeling Emission Inventory

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Modeling Emission Inventory for the PM2.5 State Implementation Plan in the San Joaquin Valley

Prepared by

California Air Resources Board

San Joaquin Valley Air Pollution Control District

Prepared for

United States Environmental Protection Agency Region IX

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1. Development of $PM_{2.5}$ Emissions Inventories

Emission inputs for air quality modeling (commonly and interchangeably referred to as "modeling inventories" or "gridded inventories") have been developed by the California Air Resources Board (CARB) and staff from multiple air districts. These inventories support multiple SIPs across California to address nonattainment of the federal $PM_{2.5}$ (particulate matter 2.5µ in diameter and smaller) standards. CARB maintains an electronic database of emissions and other useful information to generate aggregate emission estimates at the county, air basin, and district level. This database is called the California Emission Inventory Development and Reporting System (CEIDARS). CEIDARS provides a foundation for the development of a more refined (hourly, grid cell-specific) set of emission inputs that are required by air quality models. The CEIDARS base year inventory is a primary input to the state's emission forecasting system, known as the California Emission Projection Analysis Model (CEPAM). CEPAM produces the projected emissions that are then gridded and serve as the emission input for the air quality models.

The following sections of this document describe how base and future year emissions inventory estimates are prepared.

1.1. Inventory Coordination

CARB convened the SIP Inventory Working Group (SIPIWG) to provide an opportunity and means for interested parties (CARB, districts, etc.) to discuss issues pertaining to the development and review of base year, future year, planning and gridded inventories to be used in SIP modeling. The group met every four to six weeks from March 2013 to May 2016 (CARB, 2016). Group participants included staff from Bay Area, Butte, Eastern Kern, El Dorado, Feather River, Imperial, Northern Sierra, Placer, Sacramento, San Diego, San Joaquin Valley, San Luis Obispo, South Coast, Ventura, and Yolo-Solano air districts.

Additionally, CARB established the SIPIWG Spatial Surrogate Sub-committee, which focuses on improving input data to spatially disaggregate emissions at a more refined level needed for air quality modeling. Local air districts that participate include San Joaquin Valley, South Coast, Ventura, and Sacramento.

In addition to the two coordination groups described above, a great deal of work preceded this modeling effort through the Central California Air Quality Studies (CCAQS). CCAQS consisted of two studies: 1) the Central California Ozone Study (CCOS); and 2) the California Regional PM_{10} (particulate matter 10μ in diameter and smaller) /$PM_{2.5}$ Air Quality Study (CRPAQS).

1.2. Background

California's emission inventory is an estimate of the amounts and types of pollutants emitted from thousands of industrial facilities, millions of motor vehicles, and myriad emission sources such as consumer products and fireplaces. The development and maintenance of the emission inventory involves several agencies. This multi-agency effort includes: CARB, 35 local air pollution control and air quality management districts (Districts), regional transportation planning agencies (RTPAs), and the California Department of Transportation (Caltrans). CARB is responsible for the compilation of the final statewide emission inventory, and for maintaining this information in CEIDARS. In addition to the statewide emission inventory, emissions from northern Mexico (Kwong, 2017) are also incorporated in the final emission inventory used for modeling. The final emission inventory reflects the best information available at the time.

The basic principle for estimating county-wide regulatory emissions is to multiply an estimated, per-unit emission factor by an estimate of typical usage or activity. For example, on-road motor vehicle emission factors are estimated for a specific vehicle type and applied to all applicable vehicles. The estimates are based on dynamometer tests of a small sample for a vehicle type. The activity for any given vehicle type is based on an estimate of typical driving patterns, number of vehicle starts, and typical miles driven. Assumptions are also made regarding typical usage: it is assumed that all vehicles of a certain vehicle type are driven under similar conditions in each region of the state.

Developing emission estimates for stationary sources involves the use of per unit emission factors and activity levels. Under ideal conditions, facility-specific emission factors are determined from emission tests for a particular process at a facility. A continuous emission monitoring system (CEMS) can also be used to determine a gas or particulate matter concentration or emission rate (U.S. EPA, 2016). More commonly, a generic emission factor is developed by averaging the results of emission tests from similar processes at several different facilities. This generic factor is then used to estimate emissions from similar types of processes when a facility-specific emission factor is not available. Activity levels from stationary sources can be derived from the amount of product produced, solvent used, or fuel used.

The district-reported and CARB-estimated emissions totals are stored in the CEIDARS database for any given pollutant. Both criteria and toxic air pollutant emission inventories are stored in this complex database. These are typically annual average emissions for each county, air basin, and district. Modeling inventories for reactive organic gases (ROG) are estimated from total organic gases (TOG). Similarly, the modeling inventories for PM_{10} and $PM_{2.5}$ are estimated from total particulate matter (PM). Details about chemical and size resolved speciation of emissions for modeling can be found in Section 2.4. Additional information on CARB emission inventories can be found at http://www.arb.ca.gov/ei/ei.htm.

1.3. Inventory Years

The emission inventory scenarios used for air quality modeling must be consistent with U.S. EPA's Modeling Guidance (U.S. EPA, 2014). Since changes in the emissions inventory can affect the calculation of the relative response factors (RRFs) used to project air quality to future years, the terms used in the preparation of the emission inventory scenarios must be clearly defined. In this document, the following inventory definitions will be used.

1.3.1. Base Case Modeling Inventory (2013)

Base case modeling is intended to evaluate model performance and demonstrate confidence in the modeling system used for the modeled attainment test. The base case modeling inventory is not used as part of the modeled attainment test itself. Model performance is assessed relative to how well model-simulated concentrations match actual measured concentrations. The modeling inputs are developed to represent (as best as possible) actual, day-specific conditions. Therefore, the base case modeling inventory for 2013 includes day-specific emissions for certain sectors. This includes, for instance, available day-specific activities and emission adjustments. Actual district-reported point source emissions were gathered for the year 2012 and forecasted to 2013. The year 2013 was selected to coincide with the year selected for baseline design values (described below). The U.S. EPA modeling guidance states that once the model has been shown to perform adequately, the use of day-specific emissions is no longer needed. In preparation for SIP development, both CARB and the local air districts began a comprehensive review and update of the emission inventory several years ago resulting in a comprehensive emissions inventory for 2013.

1.3.2. Reference Year Modeling Inventory (2013)

The reference year inventory is intended to be a representation of emission patterns occurring through the baseline design value period and the emission patterns expected in the future year. U.S. EPA modeling guidance describes the reference year modeling inventory as “a common starting point” that represents average or “typical” conditions that are consistent with the baseline design value period. U.S. EPA guidance also states “using a ‘typical’ or average reference year inventory provides an appropriate platform for comparisons between baseline and future years.” The 2013 reference year inventory represents typical average conditions and emission patterns through the 2013 design value period. This reference emissions inventory is not developed to capture day-specific emission characteristics; however, this reference inventory includes temperature, relative humidity, and solar insolation effects, for 2013.

1.3.3. Future Year Modeling Inventory (2020/2024/2025)

Future year modeling inventories, along with the reference year modeling inventory, are used in the model-derived RRF calculation. Projected inventory years were chosen to address the following standards.

- 2020 is the modeled attainment year for the 24-hour 1997 $PM_{2.5}$ standard of 65 µg/m^3 and the annual 1997 $PM_{2.5}$ standard of 15 µg/m^3.
- 2024 is the modeled attainment year for the 24-hour 2006 $PM_{2.5}$ standard of 35 µg/m^3.
- 2025 is the modeled attainment year for the annual 2012 $PM_{2.5}$ standard of 12 µg/m^3.

Each of these years reflects the date by which attainment can be achieved as expeditiously as practicable for the relevant $PM_{2.5}$ standard.

These inventories maintain the “typical,” average patterns of the 2013 reference year modeling inventory. The 2020, 2024 or 2025 inventory will include temperature, relative humidity, and solar insolation effects from reference year (2013) meteorology. Future year point and area source emissions are projected from the 2012 baseline emissions used in the 2013 reference year modeling inventory. Additionally, future year on-road emission inventories are used, as projected by EMFAC. The application of control measure reduction factors is discussed in Section 3.8.

1.4. Spatial Extent of Emission Inventories

The emissions model-ready files that are prepared for use as an input for the air quality model conform to the definition and extent of the grids shown in Figure 1.

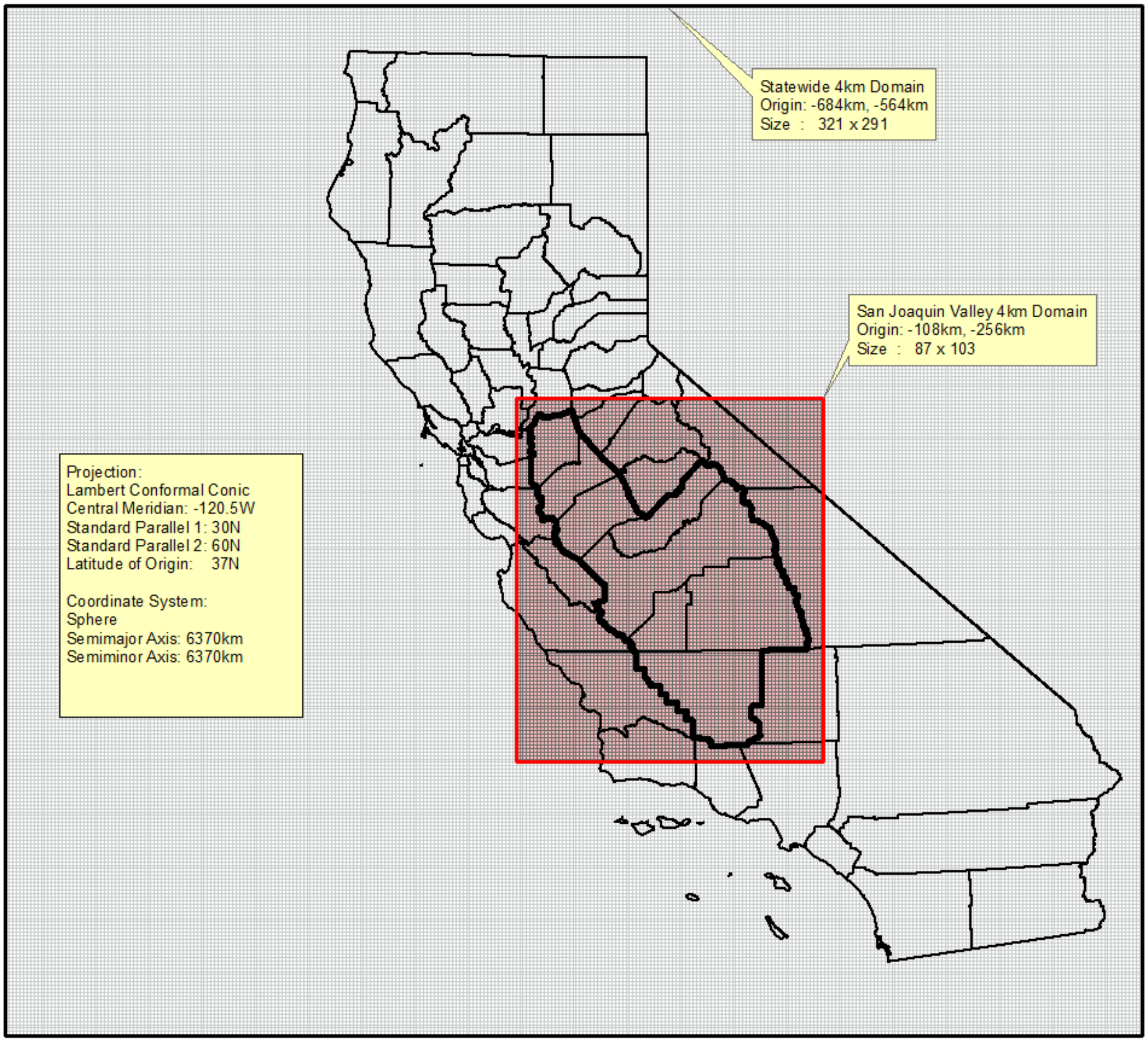

Figure 1 Spatial coverage and parameter summary of modeling domains

The domain uses a Lambert projection and assumes a spherical Earth. The emissions inventory grid uses a Lambert Conical Projection with two parallels. The parallels are at 30° and 60° N latitude, with a central meridian at 120.5° W longitude. The coordinate system origin is offset to 37° N latitude. The emissions inventory uses a grid with a spatial resolution of 4 km x 4 km. The state modeling domain extends entirely over California and 100 nautical miles west over the Pacific Ocean. A smaller 4km x 4km subdomain is used for the San Joaquin Valley. The specifications for the statewide and San Joaquin Valley domains are summarized in Table 1.

Table 1 Modeling domain parameters

Parameter	Statewide domain	San Joaquin Valley subdomain
Map Projection	Lambert Conformal Conic	Lambert Conformal Conic
Datum	None (Clarke 1866 spheroid)	None (Clarke 1866 spheroid)
1st Standard Parallel	30.0° N	30.0° N
2nd Standard Parallel	60.0° N	60.0° N
Central Meridian	-120.5° W	-120.5° W
Latitude of projection origin	37.0° N	37.0° N
COORDINATE SYSTEM		
Units	Meters	Meters
Semi-major axis	6370 km	6370 km
Semi-minor axis	6370 km	6370 km
DEFINITION OF GRID		
Grid size	4km x 4km	4km x 4km
Number of cells	321 x 291 cells	87 x 103 cells
Lambert origin	(-684,000 m, -564,000 m)	(-108,000 m, -256,000 m)
Geographic center	-120.5° Lat and 37.0° Lon	-120.5° Lat and 37.0° Lon

2. Estimation of Base Year Modeling Inventory

As mentioned in Section 1.3, base case modeling is intended to demonstrate confidence in the modeling system used for the modeled attainment test. The following sections describe the temporal and spatial distribution of emissions and how each of the sectors within the modeling inventories are prepared.

2.1. Terminology

The terms “point sources” and “area sources” are often confused. Traditionally, these terms have had different meanings to the developers of emissions inventories and the developers of modeling inventories. Table 2 summarizes the difference in the terms. Both sets of terms are used in this document. In modeling terminology, “point sources” traditionally refer to elevated emission sources that exit from a stack and have an associated plume rise. While the current inventory includes emissions from stacks, all emission sources reported by the San Joaquin Valley Air Pollution Control District (SJVAPCD) associated with a facility are treated as potential elevated sources. The emissions processor calculates plume rise if appropriate; non-elevated sources are treated as ground-level sources. Examples of non-elevated emissions sources include gas dispensing facilities and storage piles. “Area sources” refers collectively to area-wide sources, stationary-aggregated sources, and other mobile sources (including aircraft, trains, ships, and all off-road vehicles and equipment). That is, “area sources” are low-level sources from a modeling perspective.

Table 2 Inventory terms for emission source types

Modeling Term	Emission Inventory Term	Examples
Point	Stationary – Point Facilities	Stacks at Individual Facilities
Area	Off-road Mobile	Construction Equipment, Farm Equipment, Trains, Recreational Boats
Area	Area-wide	Residential Fuel Combustion, Livestock Waste, Consumer Products, Architectural Coatings
Area	Stationary - Aggregated	Industrial Fuel Use
On-road Motor Vehicles	On-road Mobile	Cars and Trucks
Biogenic	Biogenic	Trees

The following sections describe in more detail the temporal, spatial, and chemical disaggregation of the emissions inventory for point sources and area sources.

2.2. Temporal Distribution of Emissions

The emissions are temporally resolved by month, week, day, and hour to more accurately gauge model performance and ultimately to better assess the influence of control measures on attainment. This section covers the temporal distributions of the point, area, and off-road mobile sources. The temporal distribution of the emissions from on-road, biogenic, and ocean-going vessel (OGV) sources are discussed in Sections 3.4, 3.5 and 3.6. The temporal distribution of residential wood combustion (RWC) and agricultural ammonia sectors are described in Section 3.7.5 and Section 3.7.6, respectively.

Temporal data are stored in CARB's emission inventory database. Each local air district assigns temporal data for all processes at each facility in their district to represent when emissions at each process occur. For example, emissions from degreasing may operate differently than a boiler. CARB or district staff also assign temporal data for each area source category by county/air basin/district.

2.2.1. Monthly Variation

Emissions are adjusted temporally to represent variations by month. Some emission sources operate the same throughout a year. For example, a process heater at a refinery or a line haul locomotive likely operates the same month to month. Other emission categories, such as a tomato processing plant or use of recreational boats, vary significantly by season. CARB's emission inventory database stores the relative monthly fractional activity for each process, the sum of which is 100. Using an example of emission sources that typically operate the same over each season, emissions from refinery heaters and line haul locomotives would have a monthly fraction (throughput) of 8.33 for each month (calculated as 100/12 = 8.33). This is considered a flat monthly profile. To apply monthly variations to create a gridded inventory, the annual average day's emissions (yearly emissions divided by 365) is multiplied by the typical monthly throughput. For example, a typical monthly throughput in July for recreational boats of 15 results in emissions about 1.8 times higher (15 / 8.33 = 1.8) than a day in a month with a flat monthly profile.

2.2.2. Weekly Variation

Emissions are adjusted temporally to represent variations by day of the week. Some operations are the same over a week, such as a utility boiler or a landfill. Many businesses operate only 5 days per week. Other emissions sources are similar on weekdays, but may operate differently on weekend days, such as architectural coatings or off-road motorcycles. To accommodate variations in days of the week, each process or emission category is assigned a days-per-week code or DPWK. Table 3 shows the current DPWK codes and Table 17 in Appendix D shows additional DPWK codes used for agricultural-related emissions.

Table 3 Day of week variation factors

Code	WEEKLY CYCLE CODE DESCRIPTION	M	T	W	TH	F	S	S
1	One day per week	1	1	1	1	1	0	0
2	Two days per week	1	1	1	1	1	0	0
3	Three days per week	1	1	1	1	1	0	0
4	Four days per week	1	1	1	1	1	0	0
5	Five days per week - Uniform activity on week days; non on Saturday and Sunday	1	1	1	1	1	0	0
6	Six days per week - Uniform activity on week days; non on Saturday and Sunday	1	1	1	1	1	1	0
7	Seven days per week – Uniform activity every day Of the week	1	1	1	1	1	1	1
20	Uniform activity on Saturday and Sunday; no activity the remainder of the week	0	0	0	0	0	1	1
21	Uniform activity on Saturday and Sunday; half as much activity on week days	5	5	5	5	5	10	10
22	Uniform activity on week days; reduced activity on weekends	10	10	10	10	10	7	4
23	Uniform activity on week days; reduced activity on weekends (For on-road motor vehicles)	10	10	10	10	10	8	8
24	Uniform activity on week days; half as much activity on Saturday. Little activity on Sunday	10	10	10	10	10	5	1
25	Uniform activity on week days; one third as much on Saturday; little on Sunday	10	10	10	10	10	3	1
26	Uniform activity on week days; little activity on Saturday; no activity on Sunday	10	10	10	10	10	3	0
27	Uniform activity on week days; half as much activity on weekends	10	10	10	10	10	5	5
28	Uniform activity on week days; five times as much activity on weekends	2	2	2	2	2	10	10
29	Uniform activity on Monday through Thursday; increased activity on Friday, Saturday, Sunday	8	8	8	8	10	10	10

2.2.3. Daily Variation

Emissions are adjusted temporally to represent variations by hour of day. Many emission sources occur 24 hours per day, such as livestock waste or a sewage treatment plant whereas many businesses operate 8 hours per day. Other emissions sources vary significantly over a day, such as residential space heating or pesticide application. Each process or emission category is assigned an hours-per-day (HPDY) code. Table 4 displays the daily variation factors or current HPDY codes. These codes are mostly current except for Code 33 which changed in response to RWC temporal allocation methods (see Section 3.7.5). Specifically, the morning-evening peak pattern is replaced with an evening-only profile up to midnight. Table 18 in Appendix D shows additional daily variation codes used for agricultural-related emissions.

Table 4 Daily variation factors

Code	CODE DESCRIPTION	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
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1	1 HOUR PER DAY	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
5	5 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
6	6 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
7	7 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
8	8 HOURS PER DAY - UNIFORM ACTIVITY FROM 8 A.M. TO 4 P.M. (NORMAL WORKING SHIFT)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
9	9 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
10	10 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
11	11 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
12	12 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
13	13 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
14	14 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
15	15 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
16	16 HOURS PER DAY - UNIFORM ACTIVITY FROM 8 A.M. TO MIDNIGHT (2 WORKING SHIFTS)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	17 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	18 HOURS PER DAY	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	19 HOURS PER DAY	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
20	20 HOURS PER DAY	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
21	21 HOURS PER DAY	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
22	22 HOURS PER DAY	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
23	23 HOURS PER DAY	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24	24 HOURS PER DAY - UNIFORM ACTIVITY DURING THE DAY	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
31	MAJOR ACTIVITY 5-9 P.M., AVERAGE DURING DAY, MINIMAL IN EARLY A.M.(GAS STATIONS)	3	1	1	1	1	1	1	5	5	5	5	5	5	5	5	5	5	10	10	10	10	7	7	3
33	MAX ACTIVITY 7-9 A.M. & 7-11 P.M.,AVERAGE DURING DAY, LOW AT NIGHT (RESIDENTIAL FUEL COMBUSTION)	2	2	2	2	2	2	2	10	10	6	6	5	5	5	5	5	5	5	5	10	10	10	10	2
34	ACTIVITY 1 TO 9 A.M.; NO ACTIVITY REMAINDER OF DAY (i.e. ORCHARD HEATERS)	0	8	8	8	8	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	MAX ACTIVITY 7 A.M. TO 1 A.M., REMAINDER IS LOW (i.e. COMMERCIAL AIRCRAFT)	10	1	1	1	1	1	1	8	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
37	ACTIVITY DURING DAYLIGHT HOURS; LESS CHANCE IN EARLY MORNING AND LATE EVENING	0	0	0	0	0	1	3	6	9	10	10	10	10	10	10	10	10	9	6	3	1	0	0	0
38	ACTIVITY DURING MEAL TIME HOURS (i.e. RESIDENTIAL COOKING)	0	0	0	0	0	2	6	6	2	2	1	2	4	4	2	1	1	3	10	8	7	6	1	0
50	PEAK ACTIVITY AT 7 A.M. & 4 P.M.; AVERAGE DURING DAY (ON-ROAD MOTOR VEHICLES)	1	1	1	1	1	1	6	10	6	5	5	5	5	5	5	6	10	8	6	4	1	1	1	1
51	ACTIVITY FROM 6 A.M. TO 12 P.M. (PETROLEUM DRY CLEANING)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
52	MAJOR ACTIVITY FROM 6 A.M.-12 P.M., LESS FROM 12-7 P.M. (PESTICIDES)	0	0	0	0	0	1	6	10	10	10	10	10	6	3	3	3	3	4	4	0	0	0	0	0
53	ACTIVITY FROM 7 A.M. TO 12 P.M. (AGRICULTURAL AIRCRAFT)	0	0	0	0	0	0	0	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0
54	UNIFORM ACTIVITY FROM 7 A.M. TO 9 P.M. (DAYTIME BIOGENICS)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
55	UNIFORM ACTIVITY FROM 9 P.M. TO 7 A.M. (NIGHTIME BIOGENICS)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
56	MAX ACTIVITY 8 A.M. TO 5 P.M, MINIMAL AT NIGHT & EARLY MORNING(CAN&COIL/METAL PARTS COATINGS)	0	0	0	0	1	1	2	3	10	10	10	10	10	10	10	10	9	1	1	1	1	1	1	1
57	MAX ACTIVITY 7 A.M. TO 2 P.M., MINIMAL AT EVENING AND MORNING HOURS (CONSTRUCTION EQUIPMENT ON HOT	0	0	0	0	0	1	6	10	10	10	10	10	10	9	8	4	2	1	1	0	0	0	0	0
58	MAX ACTIVITY 7 A.M. TO NOON.;REDUCED ACTIVITY NOON TO 6 P.M. (AUTO REFINISHING)	0	0	0	0	0	0	0	10	10	10	10	10	8	8	8	8	8	8	0	0	0	0	0	0
59	MAXIMUM ACTIVITY FROM 7:00 AM TO 3:00 PM; REDUCED ACTIVITY FROM 3:00 TO 6:00 PM.(CONSTRUCTION	0	0	0	0	0	0	2	10	10	10	10	10	10	10	10	7	3	1	1	0	0	0	0	0
60	MAXIMUM ACTIVITY FROM NOON TO 7:00 PM; REDUCED ACTIVITY EVENING AND MORNING HOURS (RECREATIONAL	0	0	0	0	0	0	0	2	4	6	7	9	10	10	10	10	10	10	10	7	5	3	1	0
81	MAX ACTIVITY 9 AM TO 3 PM; HALF THE ACTIVITY REMAINING HOURS (WASTE FROM DAIRY CATTLE)	7	6	6	5	4	4	4	5	7	8	9	10	10	10	7	3	3	3	4	4	5	6	7	7
82	ACTIVITY FROM 10 AM TO 9 PM RISING TO PEAK AT 3; NO ACTIVITY REMAINDER OF DAY (WASTE FROM POULTRY)	0	0	0	0	0	0	0	0	0	3	3	7	7	7	10	10	7	3	3	3	3	0	0	0
83	ACTIVITY FROM 9 AM TO 12 AM RISING TO PEAK AT 3; MINIMUM ACTIVITY REMAINDER OF DAY (WASTE FROM SWINE)	0	0	0	0	0	0	0	1	1	2	4	6	8	8	9	10	8	4	3	3	2	1	1	1
84	MAJOR ACTIVITY FROM 11AM TO 6PM; REDUCED OTHER HOURS (EVAP-COASTAL COUNTIES)	7	7	6	6	6	6	6	7	8	8	9	9	10	10	10	10	9	9	8	8	7	7	7	7
85	MAJOR ACTIVITY FROM 11AM TO 6PM; REDUCED OTHER HOURS (EVAP-NON-COASTAL COUNTIES)	5	5	5	5	4	4	5	5	6	7	8	9	9	10	10	10	9	9	8	7	6	6	6	5

2.3. Spatial Allocation

Once the base case, reference, or future year inventories are developed, the next step of modeling inventory development is to spatially allocate the emissions. Air quality models attempt to replicate the physical (e.g. transport) and chemical processes that occur in the atmosphere within a modeling domain. Therefore, it is important that the physical location of emissions be specified as accurately as possible. Ideally, the actual location of all emissions would be known exactly. In reality, however, some categories of emissions would be virtually impossible to determine—for example, the actual amount and location of consumer products (e.g. deodorant) used every day. To the extent possible, the spatial allocation of emissions in a modeling inventory approximates as closely as possible the actual location of emissions.

Spatial allocation is typically accomplished by using spatial surrogates. These spatial surrogates are processed into spatial allocation factors in order to geographically distribute county-wide area source emissions to individual grid cells. Spatial surrogates are developed based on demographic, land cover, and other data that exhibit patterns that vary geographically. Sonoma Technology, Inc. (STI) (Funk, et al., 2001) under the CCOS contract, originally developed many of the spatial surrogates by creating a base year (2000) and various future year surrogate inventories. STI updated the underlying spatial data and developed new surrogates (Reid, et al., 2006), completing the project in 2008. CARB and districts have since continued to update and improve many of the spatial surrogates, adding new ones as more data become available.

Three basic types of surrogate data were used to develop the original spatial allocation factors: land use and land cover, facility location, and demographic and socioeconomic data. Land use and land cover data are associated with specific land uses, such as agricultural harvesting or recreational boats. Facility locations are used for sources such as gas stations and dry cleaners. Demographic and socioeconomic data, such as population and housing, are associated with residential, industrial, and commercial activity (e.g. residential fuel combustion). To develop spatial allocation factors of high quality and resolution, local socioeconomic and demographic data were used when available for developing base case, baseline, and future year inventories. These data were available from local MPOs or RTPAs, where they are used as inputs for travel demand models. In rural regions for which local data were not available, data from Caltrans' Statewide Transportation Model were used.

Since 2008, CARB and district staffs have continued to search for more recent or improved sources of data, since the underlying data used by STI were prior to the 2007-2009 recession. CARB and district staffs have updated many of the spatial surrogates and added many new ones.

- Updates to land use categories were made using the National Land Cover Database 2011 (Homer, et al., 2015).
- Many surrogates were updated using the locations from Dun & Bradstreet's Market Insight Database (Dun and Bradstreet, 2015). The types of sources were defined by Standard Industrial Classification (SIC) code. Fourteen new surrogates were developed for industrial-related sources using SIC and whether manufacturing occurred at the facility.
- U.S. Census American Community Survey (FactFinder, 2011) data by census block were used to update residential fuel use.
- Sierra Research developed nine new surrogates related to agricultural activities (Anderson, et al., 2012), some of which incorporated crop-specific factors.
- Seven new surrogates were developed using vessel traffic data, or Automatic Identification System (AIS) data, collected by the U.S. Coast Guard.
- A new surrogate was created to represent the location of construction equipment. The distribution is a combination of two sets of data: 90% change in "imperviousness" between 2006 and 2011 from NLCD 2011 and 10% road network. Impervious surfaces are mainly artificial structures such as pavements (roads, sidewalks, driveways, and parking lots) that are covered by materials impenetrable to a satellite such as asphalt, concrete, brick, stone, and rooftops.
- A new surrogate was compiled to distribute emissions from transport refrigeration units (TRUs) from three sources: 65 percent distribution centers, 34 percent road network, and 1 percent grocery stores / food processing facilities. Information on distribution centers were retrieved from ARBER, the

CARB Equipment Registration database for the TRU Airborne Toxic Control Measure and the Drayage Truck Regulation.

- Development of a wilderness mask for application of population-based spatial surrogates (see Section 2.3.1).
- Utilization of Digital Map Products California state-wide parcel database to develop a new fireplace surrogate (see Section 2.3.7).

In all, 99 unique surrogates are available for use. A summary of the spatial surrogates for which spatial allocation factors were developed is shown below in Table 5.

Table 5 Spatial surrogates

Surrogate Name	Surrogate Definition
AEROSPACE	Spatial distribution of businesses involved in aerospace
Airports	Spatial locations of all airports
All_PavedRds	Spatial distribution of road network (all paved roads)
AutobodyShops	Locations of autobody repair and refinishing shops
CAFO	Spatial distribution of concentrated animal feeding operations
CANCOIL	Spatial distribution of businesses involved in can and coil operations
Cemeteries	Spatial locations of cemeteries
Comm_Airports	Spatial locations of commercial airports
COMPOST	Spatial distribution of composting
CONSTRUCTION_EQUIP	Spatial distribution of where construction equipment is used
Devplnd_HiDensity	Spatial distribution of developed land - low density, medium density and high density
Devplnd_LoDensity	Spatial distribution of developed land - open space (lowest density)
DREDGE	Locations of dredging
Drycleaners	Locations of dry cleaning facilities
DryLakeBeds	Locations of dry lake beds
Elev5000ft	Topological contours – areas above 5000 feet
Employ_Roads	Spatial distribution of total employment and road density (all paved roads)
FABRIC	Spatial distribution of businesses involved in fabric manufacturing
FERRIES	Locations of ferry ports and routes
FISHING_COMM	Locations of commercial fishing
Forestland	Spatial distribution of forest land
Fugitive_Dust	Spatial distribution of barren land
GAS_DISTRIBUTION	Location of gas pipelines
GAS_SEEP	Location of natural-occurring gas seeps
GasStations	Locations of gasoline service stations
GASWELL	Locations of gas wells
GolfCourses	Spatial locations of golf courses
HE_Sqft	Computed surrogate based on housing and employment (est. ft2 / person)
Hospitals	Spatial locations of hospitals
Housing	Spatial distribution of total housing
Housing_Autobody	Spatial distribution of housing and autobody refinishing shops
Housing_Com_Emp	Spatial distribution of total housing and commercial employment
Housing_Restaurants	Spatial distribution of total housing and restaurants/bakeries
Surrogate Name	Surrogate Definition
INDUSTRIAL	Spatial distribution of industrial businesses where manufacturing occurs (SIC<4000)
Industrial_Emp	Spatial distribution of industrial employment
InlandShippingLanes	Spatial distribution of major shipping lanes within bays and inland areas
Irr_Cropland	Spatial location of agricultural cropland
Lakes_Coastline	Locations of lakes, reservoirs, and coastline

Surrogate Name	Surrogate Definition
LAKES_RIVERS_RECBOAT	Locations of lakes, rivers and reservoirs where recreational boats are used
LANDFILLS	Locations of landfills
LANDPREP	Spatial distribution of dust from land preparation operations (e.g. tilling)
LINEHAUL	Spatial distribution of Class I rail network
LiveStock	Spatial distribution of cattle ranches, feedlots, dairies, and poultry farms
MARINE	Spatial distribution of businesses involved in marine
METALFURN	Spatial distribution of businesses involved in metal furniture
METALPARTS	Spatial distribution of businesses involved in metal parts and products
Metrolink_Lines	Spatial distribution of metrolink network
MILITARY_AIRCRAFT	Locations of landing strips on military bases
MILITARY_SHIPS	Locations of military ship activity
MILITARY_TACTICAL	Military bases where tactical equipment are used
MiltaryBases	Locations of military bases
NON_PASTURE_AG	Spatial distribution of farmland
NonIrr_Pastureland	Spatial location of pasture land
NonRes_Chg	Computed surrogate based on spatial distribution of non-residential areas
OCEAN_RECBOAT	Locations of recreational boat activity that can occur on the ocean and SF Bay
OIL_SEEP	Location of naturally-occurring oil seeps
OILWELL	Locations of oil wells (both onshore and offshore)
OTHERCOAT	Spatial distribution of businesses with SIC<4000 not included in another category
PAPER	Spatial distribution of businesses involved in paper
PASTURE	Spatial distribution of grazing land
PEST_ME_BR	Spatial distribution of methyl bromide pesticides
PEST_NO_ME_BR	Spatial distribution of non-methyl bromide pesticides
PLASTIC	Spatial distribution of businesses involved in plastic
Pop_ComEmp_Hos	Spatial distribution of hospitals, population and commercial employment
Population	Spatial distribution of population
Ports	Locations of shipping ports
POTWs	Coordinate locations of publicly owned treatment works (POTWs)
PrimaryRoads	Spatial distribution of road network (primary roads)
PRINT	Spatial distribution of print businesses
Raillines	Spatial distribution of railroad network
RailYards	Locations of rail yards
Rds_HE	Calculated surrogate based on road densities and housing/employment (est. ft2 / person)
RefinieriesTankFarms	Coordinate locations of refineries and tank farms
Res_NonRes_Chg	Computed surrogate based on spatial distribution of residential and non-residential areas
ResGasHeating	Spatial distribution of homes using gas supplied by a utility as primary source of heating
Residential_Chg	Computed surrogate based on spatial distribution of residential areas
ResLPGHeat	Spatial distribution of homes using gas (bottled, tank or LP) as primary source of heating
ResNonResChg_IndEmp	Spatial distribution of industrial employment and residential/non-residential change
ResOilHeat	Spatial distribution of homes using fuel oil or kerosene as primary source of heating
Restaurants	Locations of restaurants
ResWoodHeating	Spatial distribution of homes using wood as primary source of heating
FIREPLACES	Spatial distribution of residential wood heating actually being used by RWC woodstoves and fireplaces
Surrogate Name	Surrogate Definition
SandandGravelMines	Locations of sand/gravel excavation and mining
Schools	Spatial locations of schools
SecondaryPavedRds	Spatial distribution of road network (secondary roads)
SEMICONDUCT	Spatial distribution of businesses involved in semiconductors
Ser_ComEmp_Sch_GolfC_Cem	Spatial distribution of service and commercial employment, schools, cemeteries,golf courses
Service_Com_Emp	Spatial distribution of service and commercial employment
Shiplanes	Spatial distribution of major shipping lanes
SILAGE	Spatial distribution of silage operations
SingleHousingUnits	Spatial distribution of single dwelling units
TRU	Spatial distribution of transport refrigeration units
TUG_TOW	Spatial distribution of tug and tow boats
UnpavedRds	Spatial distribution of road network (unpaved roads)
Wineries	Locations of wineries
WOOD	Spatial distribution of businesses using wood
WOODFURN	Spatial distribution of businesses involved in wood furniture

2.3.1 Wilderness Mask

Recent updates to the spatial surrogates include the creation of a wilderness mask. A wilderness mask was developed by CARB staff to incorporate land area in certain grid cells that had reported population from the census block but in reality are remote or desolate wilderness. Figure 2 illustrates a "wilderness surrogate" developed based on compiled data from the United States Forest Service, National Park Service, Bureau of Land Management, and state park systems. Wilderness is defined as an area of undeveloped land without permanent improvements or human habitation (Funk, et al., 2001).

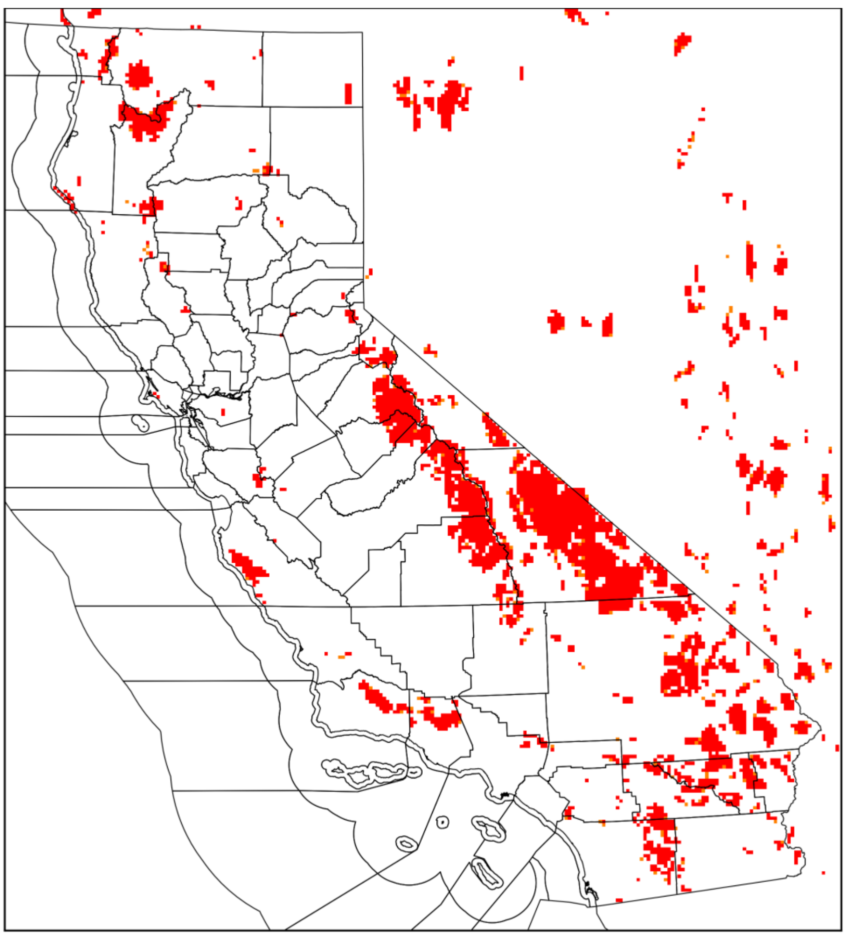

Figure 2 Wilderness mask on ca-4km state domain

The wilderness “mask” was applied to approximately 20 surrogates to remove fractions of disaggregated emissions in areas where no humans live. Figure 3 illustrates how the wilderness mask removes county fractions in certain areas in the population surrogate while Table 6 describes all surrogates in which the mask was applied.

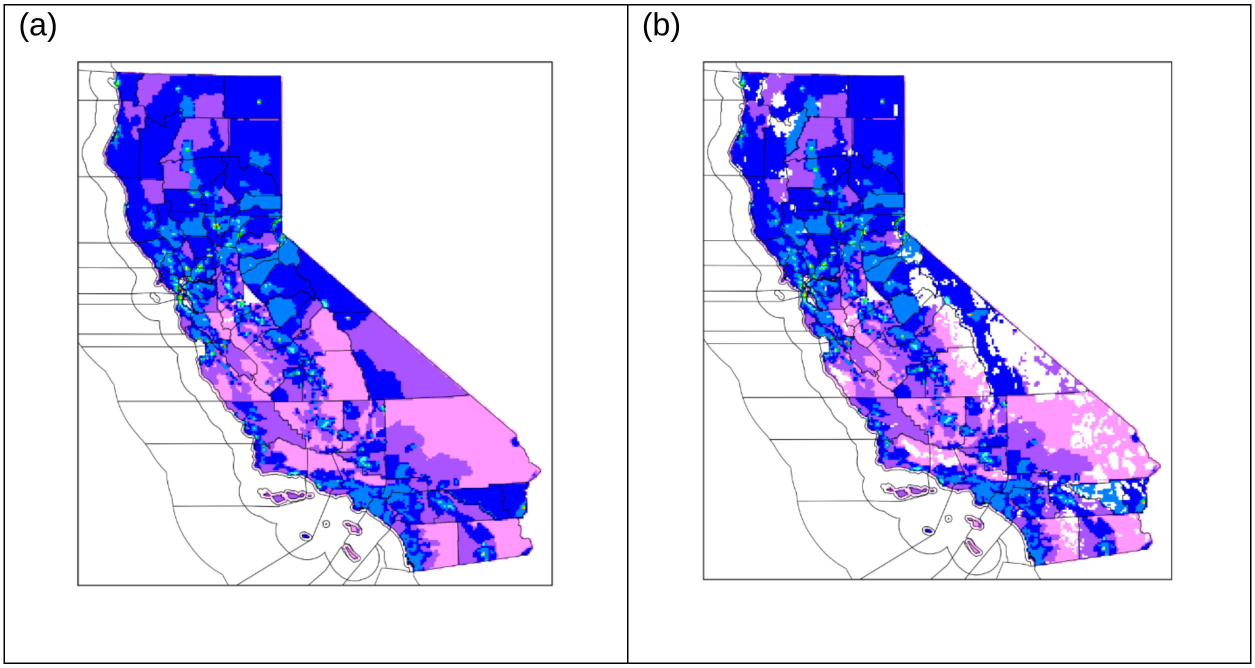

Figure 3 Example of population surrogate before (a) and after (b) wilderness mask application

Table 6 List of surrogates in which the wilderness mask was applied

Number / Shape File Name	Description
180 – Employ Roads	Spatial distribution of total employment and road density (all paved roads)
230 – HE_Sqft	Computed surrogate based on housing and employment (est. ft2 / person)
250 – Housing	Spatial distribution of total housing
260 – Housing Autobody	Spatial distribution of housing and auto-body refinishing shops
270 – Housing_Com_Emp	Spatial distribution of total housing and commercial employment
280 – Housing_Restaurants	Spatial distribution of total housing and restaurants/bakeries
300 – Industrial_Emp	Spatial distribution of industrial employment
440 – Population	Population
450 – Pop_ComEmp_Hos	Spatial distribution of hospitals, population and commercial employment
530 – ResGasHeating	Spatial distribution of homes using gas supplied by a utility as primary source of heating
540 - Residential Change	Computed surrogate based on spatial distribution of residential areas
550 - Res Non Res Change Industrial Employment	Spatial distribution of industrial employment and residential/non-residential change
570 - Res Wood Heating	Spatial distribution of homes using wood as primary source of heating
571 - Res Oil Heating	Spatial distribution of homes using fuel oil or kerosene as primary source of heating
572 - Res LPG Heating	Spatial distribution of homes using gas (bottled, tank or LP) as primary source of heating
573 - Fireplaces	Spatial distribution of residential wood heating actually being used by RWC woodstoves and fireplaces
580 - Res Non Res Change	Computed surrogate based on spatial distribution of residential and non-residential areas
620 - Service Com Employment	Spatial distribution of service and commercial employment

650 - Ser Com Emp Schools Golf Course Cemeteries	Spatial distribution of service and commercial employment, schools, cemeteries, golf courses
672 - Developed Land High Density	Spatial distribution of developed land - low density, medium density and high density

The following sections describe in more detail the type of spatial disaggregation used for each sector of the emissions inventory.

2.3.2 Spatial Allocation of Area Sources

Each area source category is assigned a spatial surrogate that is used to allocate emissions to a grid cell in CARB's 4km statewide modeling domain. Examples of surrogates include population, land use, and other data with known geographic distributions for allocating emissions to grid cells, as described above.

2.3.3 Spatial Allocation of Point Sources

Each point source is allocated to grid cells using the latitude and longitude reported for each stack. If there are no stack latitude and longitude, the facility coordinates are used. There are two types of point sources: elevated and non-elevated sources. Vertical distribution of elevated sources is allocated using the plume rise algorithm in the emissions processor, Sparse Matrix Operator Kernel Emissions (SMOKE) (see Section 3.3), while non-elevated are allocated to the first layer. Most stationary point sources with existing stacks are regarded as elevated sources. Those without physical stacks that provide only latitude/longitude, such as airports or landfills, are considered non-elevated.

2.3.4 Spatial Allocation of Wildfires, Prescribed Burns, and Wildland Fire Use

Emissions from wildfires, prescribed burns, and wildland fires are event- and location-based. A fire event can last a few hours or span multiple days. Each fire is spatially allocated to grid cells using the extent of each fire event while the temporal distribution also reflects the actual duration of the fire. The spatial information to allocate the fire emissions comes from a statewide interagency fire perimeters geodatabase maintained by the Fire and Resource Assessment Program (FRAP) of the California Department of Forestry and Fire Protection (CALFIRE). More details on the methodology and estimation of the wildfire emissions can be found in Section 3.7.1.

2.3.5 Spatial Allocation of Ocean-going Vessels (OGV)

Ship emissions are allocated to the grids corresponding to the vessel traffic lanes in CARB's OGV model (CARB-PTSD, 2011) These traffic lanes were estimated from three different sources: 1.) National Waterway Network, 2.) The Ship Traffic and 3.) Energy and Environment Model Automated Instrumentation System (AIS) telemetry data collected in 2007.

2.3.6 Spatial Allocation of On-road Motor Vehicles

The spatial allocation of on-road motor vehicles is based on DTIM as described in Section 3.4.

2.3.7 Spatial Allocation of Biogenic Emissions

As described in Section 3.5, gridded biogenic emissions are derived using the Model of Emissions of Gases and Aerosols from Nature (MEGAN). MEGAN utilizes gridded emission factors and plant functional type data, adjusted by local meteorological conditions and satellite-derived leaf area data, to estimate hourly biogenic emissions within each grid cell of the modeling domain. More details about MEGAN can be found at http://lar.wsu.edu/megan/.

2.3.8 Spatial Allocation of Residential Wood Combustion Emissions

A parcel database developed by Digital Map Products was utilized to create a new spatial surrogate for residential wood combustion. The CA-statewide parcel data included a vast amount of data regarding property information. A specific "true/false" tag for fireplaces was provided for each parcel of land. The database was filtered for properties that had a fireplace tag set to true and then manually filtered for inconsistencies based on land type and reported tag (example: non-residential and vacant agricultural parcels that were reported to have a fireplace tag were removed based on conversation with CARB staff).

For some counties, the data were extremely limited. This may be the result of building restrictions and permit issues for fireplaces in new homes. Therefore, for the counties in which the parcel data seemed unreasonable, the original RWC surrogate (570) was used as default. This original surrogate was based on the residential wood heating data from the American Community Survey. The counties where the original default surrogate was applied are San Diego, Los Angeles, Mendocino, Ventura, Santa Barbara, San Luis Obispo, Imperial, Contra Costa, Alameda, and Del Norte. Figure 4 shows the new fireplace surrogate (573) and illustrates the spatial distribution of residential woodstoves and fireplaces.

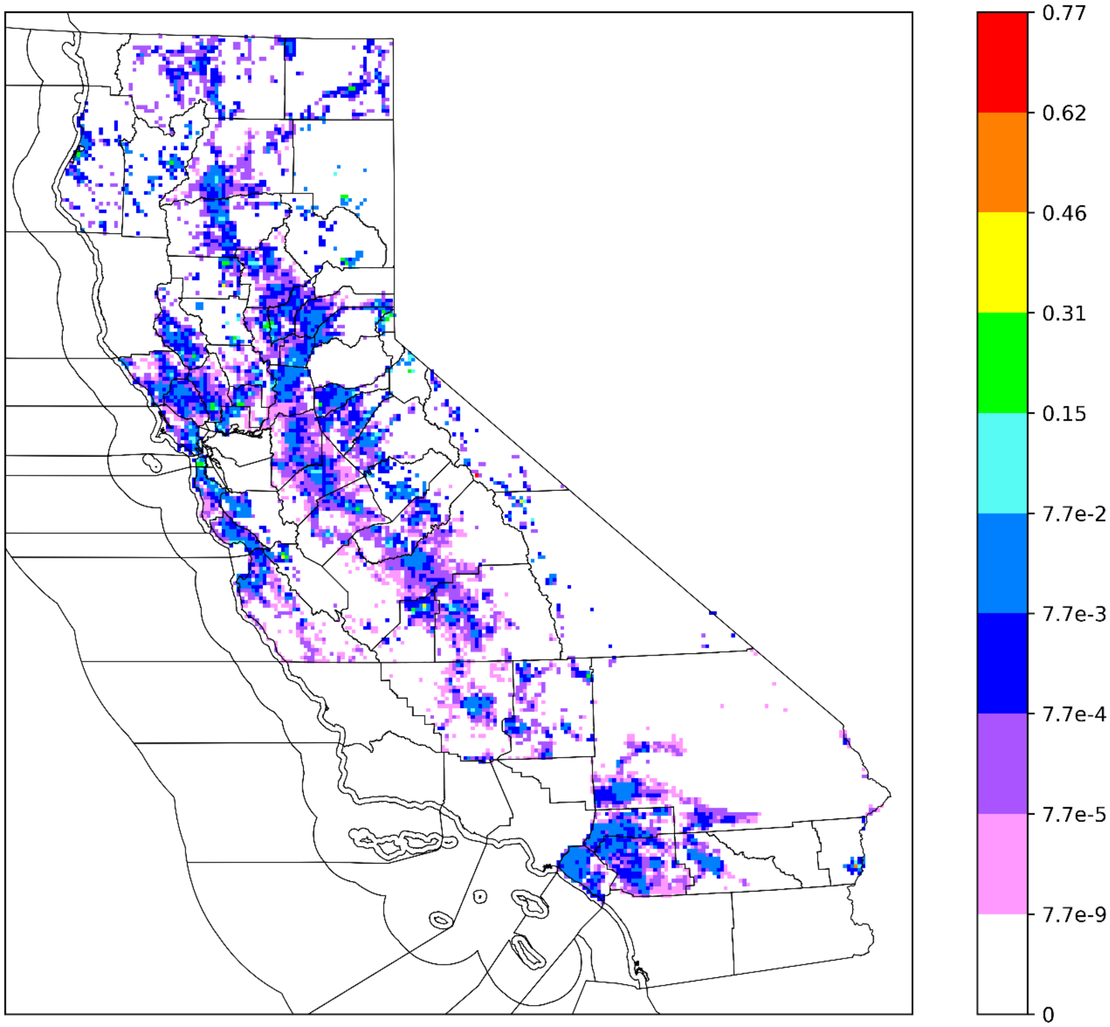

Figure 4 New spatial surrogate of fireplaces (2017)

Residential wood curtailment (i.e. no-burn days) was applied after spatial allocation for each district. Figure 5 illustrates where emissions are reduced due to residential wood curtailment programs in three air districts, and more description regarding curtailment methods are discussed in Section 3.7.5.

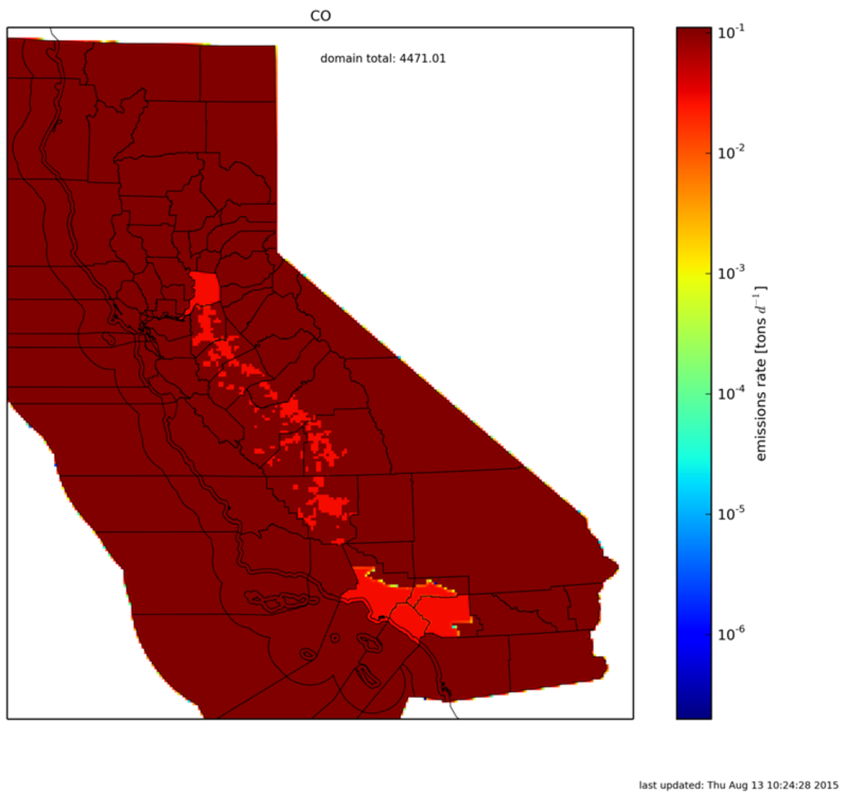

Figure 5 Map of residential wood curtailment areas

In the San Joaquin Valley, a reduction in emissions due to curtailment was only applied to areas where natural gas service is available (e.g. provided by a municipality) as reflected in Rule 4901 (October 2008 version of the rule).

2.4 Speciation Profiles

CARB's emission inventory lists the amount of pollutants discharged into the atmosphere by source in a certain geographical area during a given time period. It currently contains estimates for CO, NH_3, NOx, SOx, total organic gases (TOG) and PM. CO and NH3 each are single species; NOx emissions are composed of NO, NO_2 and HONO; and SOx emissions are composed of SO_2 and SO_3. TOG and PM potentially contain over hundreds of different chemical species, and speciation is the process of disaggregating those inventory pollutants into individual chemical species components or groups of species. CARB maintains and updates such species profiles for organic gases (OG) and PM for a variety of source categories.

Photochemical models simulate the physical and chemical processes in the lower atmosphere, and include all emissions of the important classes of chemicals involved in photochemistry as well as less reactive compounds that are of concern from a health or visibility standpoint. Organic gases emitted to the atmosphere are referred to as Total Organic Gas or TOG. TOG includes all organic compounds that can become airborne (through evaporation, sublimation, as aerosols, etc.), excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate. TOG emissions reported in the CARB's emission inventory are the basis for deriving the Reactive Organic Gas (ROG) emission components, which are also reported in the inventory. ROG is defined as TOG minus CARB's exempt compounds (e.g., methane, ethane, various chlorinated fluorocarbons, acetone, perchloroethylene, volatile methyl siloxanes, etc.). ROG is nearly identical to U.S. EPA's Volatile Organic Compounds (VOC), which is based on EPA's exempt list. For all practical purposes, use of the terms ROG and VOC are interchangeable[1].

The OG speciation profiles are applied to estimate the amounts of various organic compounds that make up TOG emissions. A speciation profile contains a list of organic compounds and the weight fraction that each compound comprises of the TOG

[1] see Appendix G, page 2 footnote 5

emissions from a particular source type. In addition to the chemical name for each chemical constituent, the file also shows the 5-digit CARB internal identification chemical code The speciation profiles are applied to TOG to develop both the photochemical model inputs and the emission inventory for ROG. It should be noted that districts are allowed to report their own reactive fraction of TOG that is used to calculate ROG rather than use the information from the assigned organic gas speciation profiles. These district-reported fractions are not used in developing modeling inventories because the information needed to calculate the amount of each organic compound is not available.

The PM emissions are size-fractionated by using PM size distribution profiles, which contain the total weight fraction for $PM_{2.5}$ and PM_{10} out of total PM. The fine and coarse PM chemical compositions are characterized by applying the PM chemical speciation profiles for each source type, which contain the weight fractions of each chemical species for $PM_{2.5}$, $PM_{10,}$ and total PM. PM chemical speciation profiles may also vary for different PM size fractions even for the same emission source. PM size profiles and speciation profiles are typically generated based on source testing data. In most previous source testing studies aimed at determining PM chemical composition, filter-based sampling techniques were used to collect PM samples for chemical analyses.

The original OG profiles and PM profiles are available for download from CARB's speciate web site at: http://www.arb.ca.gov/ei/speciate/speciate.htm. Based on these original profiles, a model-ready speciation file, gspro, was generated for a specific chemical mechanism (for example, SAPRC07) to separate aggregated inventory pollutant emission totals into emissions of model species required by the air quality model.

Each process or product category is keyed to one of the OG profiles and one of the PM profiles. Also available for download from CARB's web site (see link in previous paragraph) is a cross-reference file that indicates which OG profile and PM profile are assigned to each category in the inventory. The inventory source categories are represented by an 8-digit source classification code (SCC) for point sources, or a 14-

digit emission inventory code (EIC) for area and mobile sources. Some of the OG profiles and PM profiles related to motor vehicles, ocean going vessels, and fuel evaporative sources vary by the inventory year of interest, due to changes in fuel composition, vehicle fleet composition, and emissions control devices such as diesel particulate filters (DPFs). Details can be found in CARB's references of speciation profile development available under the previous speciate website link. Mapping of each category to OG and PM profiles is summarized in rogpm and gsref files.

Research studies are conducted regularly to improve CARB's speciation profiles. These profiles support ozone and PM modeling studies but are also designed to be used for regional toxics modeling. Other health or welfare related modeling studies where the compounds of interest cannot always be anticipated make use of these profiles. Therefore, speciation profiles need to be as complete and accurate as possible. CARB has an ongoing effort to update speciation profiles as data become available, such as through testing of emission sources or surveys of product formulations. New speciation data generally undergo technical and peer review, and updating of the profiles is coordinated with users of the data. The recent addition to CARB's speciation profiles include (CARB, 2017):

(1) Organic gas profile

- Consumer products
- Architectural coating
- Gasoline fuel and headspace vapor
- Gasoline vehicle hot soak and diurnal evaporation
- Gasoline vehicle start and running exhaust
- Silage
- Aircraft exhaust
- Compressed Natural Gas (CNG) bus running exhaust

(2) PM profile

- Gasoline vehicle exhaust
- On-road diesel exhaust
- Off-road diesel exhaust
- Ocean going vessel exhaust
- Aircraft exhaust

- Concrete batching
- Commercial cooking
- Residential fuel combustion-natural gas
- Coating/painting
- Cotton ginning
- Stationary combustion

3. Methodology for Developing Base Case, Baseline, and Future Projected Emissions Inventories

As mentioned in Section 1, the base case and reference inventories include temperature, humidity, and solar insolation effects for some emission categories; development of these data is described in Sections 3.1 and 3.2. Sections 3.3 through 3.8 detail how the base case and reference inventories were created for different sectors of the inventory such as point, area, on-road motor vehicles, biogenic, OGV, and other day-specific sources.

3.1 Surface Temperature and Relative Humidity Fields

The calculation of gridded emissions for some categories of the emissions inventory is dependent on various meteorological variables. As an example, biogenic emissions are sensitive to air temperatures and solar radiation while emissions from on-road mobile sources are sensitive to air temperature and relative humidity. Therefore, estimates of air temperature (T), relative humidity (RH), and solar radiation are needed for each grid cell in the modeling domain in order to take into account the effects of these meteorological variables.

Gridded temperature and humidity fields are readily available from prognostic meteorological models such as the Weather Research and Forecasting (WRF) model (http://www.wrf-model.org/index.php), which is used to prepare meteorological inputs for the air quality model; however, prognostic meteorological models can at times have difficulty capturing diurnal temperature extremes (Valade, 2009; Caldwell, 2009; Fovell, 2008). Since temperature and the corresponding relative humidity extremes can have an appreciable influence on some emissions categories, such as on-road mobile and biogenic sources, measurement-based fields for these parameters are used in processing emissions. The CALMET (http://www.src.com/) diagnostic meteorological model is utilized to generate both the gridded temperature and relative humidity fields used in processing emissions. The principal steps involved in generating a gridded, surface-level temperature field using CALMET include the following:

1. Compute the relative weights of each surface observation station to each grid cell (the weight is inversely proportional to the distance between the surface observation station and grid cell center).
2. Adjust all surface temperatures to sea level. In this step, a lapse rate of -0.0049 ^{o}C/m is used (this lapse rate is based on private communication with Gary Moore of Earth Tech, Inc., Concord, MA). This lapse rate (=2.7 ^{o}F/1000 feet) is based on observational data.
3. Use the weights to compute a spatially-averaged sea-level temperature for each grid cell.
4. Correct all sea-level temperatures back to 10 m height above ground level (i.e. the standard height of surface temperature measurements) using the lapse rate of -0.0049 ^{o}C/m again.
5. The current version of CALMET does not generate estimates of relative humidity. As a result, a post-processing program was used to produce gridded, hourly relative humidity estimates from observed relative humidity data. The major steps needed to generate gridded, surface-level relative humidity are described as follows:
    a. Calculate actual vapor pressure from observed relative humidity and temperature at all meteorological stations. The (Mc. Rae, 1980) method is used to calculate the saturated vapor pressure from temperature.
    b. Compute the relative weights of each surface observation station to each grid in question, exactly as done by CALMET to compute the temperature field.
    c. Use the weights from step 2 to compute a spatially-averaged estimate of actual vapor pressure in each grid cell.
    d. For each grid cell, calculate relative humidity from values for actual vapor pressure and temperature for the same grid cell.

3.2 Insolation Effects

Insolation data were used in the estimation of the gridded emissions inventory and provided by the WRF meteorological fields as mentioned in Section 3.5.

3.3 Estimation of Gridded Area and Point Sources

Emissions inventories that are temporally, chemically, and spatially resolved are needed as inputs for the photochemical air quality model. Point sources and area sources (area-wide, off-road mobile, and aggregated stationary) are processed into emissions inventories for photochemical modeling using the SMOKE modeling system (https://www.cmascenter.org/smoke/). California-specific improvements to SMOKE were implemented under a CARB contract for version 4.0 of SMOKE (Baek, 2015); however, GenTpro, a pre-SMOKE utility program that modulates annual hourly temporal profiles based on modeled meteorology, cannot run in CARB SMOKE due to the fact that it does not recognize the COABDIS-defined region code as an acceptable alphanumeric parameter. In 2018, CARB SMOKE was replaced with the CMAS-released SMOKEv4.0 (referred as Official SMOKE hereafter) and included changes to the GenTpro program that accepted the numeric CARB GAI region code. COABDIS-based cross-reference files were subsequently changed to GAI in order to match the Official SMOKE format.

Inputs for SMOKE are annual emissions totals from CEPAM and information for allocating to temporal, chemical, and spatial resolutions. Temporal inputs for SMOKE are screened for missing or invalid temporal codes as discussed in Section 4.1. Temporal allocation of emissions using SMOKE involves the disaggregation of annual emissions totals into monthly, day-of-week, and hour-of-day emissions totals. The temporal codes from Table 3 and Table 4 are reformatted into an input-ready format as explained in the SMOKE user's manual. Chemical speciation profiles, as described in Section 2.4, and emissions source cross-reference files used as inputs for SMOKE are developed by CARB staff. SMOKE uses the files for the chemical speciation of NOx, SOx, TOG, and PM to produce the species needed by photochemical air quality models.

Emissions for area sources are allocated to grid cells as stated by the modeling grid domain defined in Section 1.4. Emissions are spatially disaggregated by the use of spatial surrogates as described in Section 2.3. These spatial surrogates are converted to a SMOKE-ready format as described in the SMOKE user's manual. Emissions for point sources are allocated to grid cells by SMOKE using the latitude and longitude coordinates reported for each stack.

3.4 Estimation of On-road Motor Vehicle Emissions

The EMFAC emissions model is used by CARB to assess emissions from on-road vehicles including cars, trucks, and buses in California, and to support air quality planning efforts to meet the Federal Highway Administration's transportation planning requirements. EMFAC is designed to produce county-level, average-day estimates. As a result, these estimates must be disaggregated spatially and temporally into gridded, hourly estimates for air quality modeling.

The general methodology used to disaggregate EMFAC emission estimates is a two-step approach. The first step uses the Direct Travel Impact Model (DTIM4) (Systems Applications Inc., 2001) to produce gridded, hourly emission estimates. The second step distributes EMFAC emissions according to the spatiotemporal output from DTIM. This methodology has been peer-reviewed by the Institute of Transportation Studies at the University of California, Irvine, under CCOS contract 11-4CCOS.

The spatiotemporal allocation of emissions from DTIM does not vary dramatically with small changes in meteorological data (T/RH), resulting in a negligible monthly variation of the spatial surrogate; however, differences in DTIM's winter versus summer spatiotemporal allocation are slightly appreciable. Therefore, different spatial surrogates are created for a winter and a summer day.

At the time of the development of these inventories the most recent version of EMFAC that has been approved by U.S. EPA for SIP and conformity purposes is EMFAC2014 (80 FR 77337). EMFAC2014 has three separate modules that are relevant for the preparation of the on-road emissions gridded inventory: one that estimates emissions, one that estimates emission rates, and one that estimates activity data. The emissions module runs for every county and every day of the modeled year using day-specific temperature and relative humidity. On a less granular level, the emissions rates module runs for every county for a summer day and a winter day. Lastly, the activity module runs once to estimates vehicle miles traveled (VMT), number of vehicle trips, fuel consumption, and the number of vehicles in use.

3.4.1 General Methodology

Mobile source emissions are sensitive to ambient temperature and humidity. Both EMFAC and DTIM account for meteorological effects using day-specific inputs. For EMFAC, hourly gridded temperature and humidity fields are averaged by county using a gridded VMT-weighted average (i.e. weighted proportional to the VMT per grid cell in a county). DTIM accepts gridded, hourly data directly (CALMET-formatted data). See Section 3.1 for more information on CALMET.

EMFAC provides vehicle class- and fuel-specific emissions estimates for exhaust, evaporative, tire wear, and brake wear emissions. EMFAC also produces estimates of: VMT, number of vehicle trips, fuel consumption, and the number of vehicles in use. More information on EMFAC can be found at CARB's Mobile Source Emissions Inventory - Categories website: https://www.arb.ca.gov/msei/categories.htm (CARB-MSEI, 2015). The vehicle activity is the most important input for spatiotemporal distribution of emissions. DTIM uses hourly vehicle miles traveled on each highway link and each of the vehicle trips in the modeling domain. The detailed vehicle activity data is obtained from CARB's Integrated Transportation Network (ITN) version 3 database.

The overall processing of on-road emissions to create the gridded emissions inventory is shown in Figure 6. Activity data from the ITN (see Section 3.4.2) is developed for the thirteen EMFAC 2007 vehicle types, but activity is split for gas and diesel, resulting in a total of 26 vehicle types as shown in the block diagram. The forecasted on-road modeling inventories are developed using the same methodology as the baseline year, where future year emissions are based on running EMFAC 2014 in Emissions Mode for the associated future year.

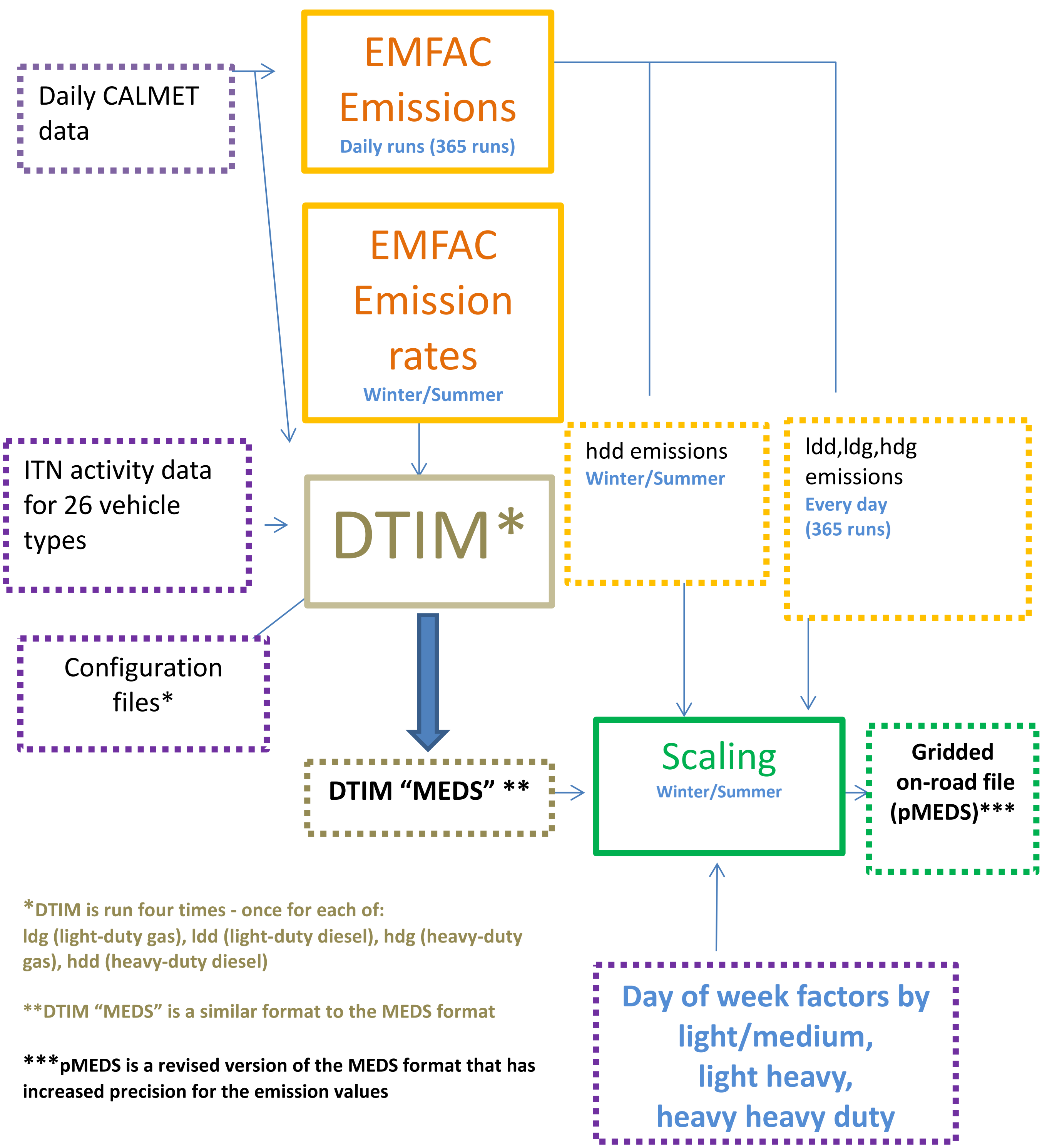

Figure 6 Block diagram for on-road processing

3.4.2 ITN Activity Data

The ITN is a database which is populated with link-based and Traffic Analysis Zone (TAZ)-based travel activity from travel demand models provided by different MPOs, Caltrans and other California RTPAs. The vintage and types of data used in the current version of the ITN are shown in Table 7. Different types of quality control parameters like vehicle mix, hourly distributions, and post-mile coverage are obtained from default EMFAC and Caltrans databases. After these various pieces of data are imported to the database, the data can be examined for quality assurance. These input data sets are later moved into consolidated and geographically-referenced master tables of link and TAZ activity data. Finally, these master tables are processed to produce hourly tables and hourly activity data input files for DTIM.

Table 7 Vintage of travel demand models for link-based and traffic analysis zone

Metropolitan Planning Organizations	TDM Version Base year	Data types received	Data received on
AMBAG	2010	Links, Trips	06/15/2015
BCAG	2010	Links, Trips	05/13/2015
FCOG	2008	Links†	06/11/2015
CALTRANS	2010	Links, Trips	12/09/2014
KCOG	2010	Links†	06/11/2015
KCAG	2010	Links†	06/11/2015
MTC	2010	Links, Trips	03/23/2015
MCTC	2010	Links†	06/11/2015
MCAG	2010	Links, Trips	06/11/2015
SACOG	2010	Links, Trips	05/08/2014
SANDAG	2008	Links, Trips	12/09/2014
SBCAG	2010	Links, Trips	04/06/2015
SCAG	2008	Links, Trips	01/23/2014
SJCOG	2010	Links, Trips	06/11/2015
SLOCOG	2010	Links, Trips	12/19/2014
StanCOG	2010	Links, Trips	06/11/2015
SCRTPA	2010	Links, Trips	07/13/2015
TCAG	2010	Links†	06/11/2015
TMPO	2010	Links, Trips	04/02/2015

† Trips data from Caltrans Statewide Travel Demand model were used

3.4.3 Spatial Adjustment

The spatial allocation of county-wide EMFAC emissions is accomplished using gridded, hourly emission estimates from DTIM normalized by county. DTIM uses emission rates from EMFAC along with activity data, digitized roadway segments (links) and traffic analysis zone centroids to calculate gridded, hourly emissions for travel and trip ends. DTIM considers fewer vehicle categories than EMFAC outputs; therefore, a mapping between EMFAC and DTIM vehicle categories is necessary. Categories of emissions after running DTIM are presented in Table 8. The categories are represented by the listed SCCs developed by CARB and depend on vehicle type, technology, and whether the vehicle is catalyst, non-catalyst, or diesel. Light- and medium-duty vehicles are separated from heavy-duty vehicles to allow for separate reporting and control strategy applications.

Table 8 DTIM emission categories

SCC for light- and medium-duty gas vehicles	SCC for heavy-duty gas vehicles	SCC for light- and medium-duty diesel vehicles	SCC for heavy-duty diesel vehicles	Description
202	302			Catalyst Start
203	303			Catalyst Running
204	304			Non-catalyst Start
205	305			Non-catalyst
206	306			Hot Soak
207	307			Diurnal
		808	408, 508	Diesel Exhaust
209	309			Running
210	310			Resting
211	311			Multi-Day Resting
212	312			Multi-Day Diurnal
213	313	813	413, 513, 613,	PM Tire Wear
214	314	814	414, 514, 614,	PM Brake Wear
215	315			Catalyst Buses
216	316			Non-catalyst
		817	617, 717	Diesel Bus
218	318			Catalyst Idle
219	319			Non-catalyst Idle
		820	420, 520, 620,	Diesel Idle
221	321			PM Road Dust

DTIM and EMFAC2014 are both run using the 13 vehicle types shown in Table 9. In order to obtain better resolved spatiotemporal surrogates, the DTIM runs are split by light-duty (LDA, LDT1, LDT2, MDV, LHDT1, LHDT2, Urban Bus, MH, MCY) and heavy-duty (T6/T7 HHDT, SBUS, Other BUS) vehicle classes, and also by fuel type (gas, diesel). Each DTIM run outputs emissions for categories from 1-13; therefore, the mapping from Table 9 is used to preserve the spatial surrogates for each of the four DTIM runs. These codes depend on vehicle type, technology, and whether the vehicle is catalyst, non-catalyst, or diesel.

Table 9 Vehicle classification and type of adjustment

DTIM Category	Vehicle type	Type of adjustment
1	LDA	LD
2	LDT1	LD
3	LDT2	LD
4	MDV	LD
5	LHDT1	LM
6	LHDT2	LM
7	T6	LM
8	T7 HHDT	HHDT
9	Other Bus	LM
10	School Bus	Unadjusted on weekdays, zeroed on weekends
11	Urban Bus	LD
12	Motorhomes	LD
13	Motorcycles	LD

3.4.4 Temporal Adjustment (Day-of-week adjustments to EMFAC daily totals)

EMFAC 2014 produces average day-of-week (DOW) estimates that represent Tuesday, Wednesday, and Thursday. In order to more accurately represent daily emissions, DOW adjustments are made to enable emissions estimation for other days including Friday, Saturday, Sunday, and Monday. The DOW adjustment factors are developed using California Vehicle Activity Database (CalVAD) data. CalVAD, developed by UC Irvine for CARB, is a system that fuses available ground-truth data sources from Caltrans to produce a “best estimate” of vehicle activity by vehicle class. The CalVAD data set includes hourly ground-truth measurements of VMT on the road network covers all California roadways at a fine spatial (state 4k grid) and temporal (hourly) resolution; however, DOW adjustment filtered out counties that have missing data, malfunctioned detectors, and so on. Therefore, only 34 of the 58 counties had good quality data. In order to fill the missing 24 counties’ data to cover all of California, a county which is nearby and similar in geography is used as a substitute. The temporal fractions are developed for three categories of vehicles: passenger cars (LD), light- and medium-duty trucks (LM), and heavy heavy-duty trucks (HHDT). Table 9 also shows the corresponding assignment to each vehicle type. Furthermore, the CalVAD fractions are scaled so that a typical workday (Tuesday, Wednesday, or

Thursday) gets a scaling factor of 1.0. All other days of the week receive a scaling factor where their VMT is related back to the typical work day. This means there are a total of five weekday scaling factors. Lastly, the CalVAD data were used to create a typical holiday, because the traffic patterns for holidays are quite different than a typical week day. Thus, in the end, there are six daily fractions for each of the three vehicle classes, for all 58 counties. The DOW factors and vehicle type can be found in Table 15.

3.4.5 Temporal Adjustment (Hour-of-day redistribution of hourly travel network volumes)

The travel networks provided by local transportation agencies and used with DTIM represent an hourly distribution for an average day. As for EMFAC, it is assumed that these average day-of-week hourly distributions represent hourly mid-week activities (i.e. for Tuesday, Wednesday, and Thursday). As such, they lack the temporal variations that are known to occur on other days of the week. To rectify this, the CalVAD data are used to develop hour-of-day profiles for Friday through Monday and a typical holiday. In a similar manner as the DOW factors, these hour-of-day profiles are used to re-allocate the hourly travel network distributions used in DTIM to Friday through Monday and a typical holiday. The hour-of-day profiles can be found in Table 16.

3.4.6 Summary of On-road Emissions Processing Steps

Eight steps are used to spatially and temporally allocate EMFAC emissions by hour and grid cell:

1. Activity Data
    a. EMFAC is run in default mode for a single day to generate hourly activity data for each vehicle type and county: VMT, vehicle population, and number of vehicle trips. This is a single day’s run, as EMFAC2014 yields the same hourly activity data for every day of the year.

   b. The activity data are used to generate various input files for ITN and DTIM. The general goal is to determine how much each activity belongs to each vehicle type through the day.

2. Road Network
   a. Pull a full copy of the California road network from the ITN database, using MPO inputs.
   b. Convert the ITN results to a form readable by DTIM.
   c. Apply hourly DOW fractions to travel network volumes.
3. Meteorological Input Data
   a. Gridded, hourly temperature (T) and relative humidity (RH) are modeled using CALMET. Section 3.1 describes the development of these meteorological (met) data in more detail.
   b. Daily met files are prepared in formats readable by both EMFAC2014 and DTIM4.
4. EMFAC Emission Rates
   a. EMFAC is run in emissions rates mode (using monthly-average T and RH) to generate a look-up table of on-road mobile source emission rates by speed, temperature, and relative humidity for each county. These results are created on a monthly-average basis to save processing time.
   b. The emissions rates are pulled from the EMFAC database and reformatted in the DTIM-ready IRS file format.
5. EMFAC Emissions
   a. EMFAC is run in emissions mode (using day-specific T and RH) to provide county-wide on-road mobile source emission estimates by day and hour for EMFAC categories.
   b. These results are saved for later use.
6. DTIM
   a. DTIM is run for one week (five representative days since Tuesday, Wednesday and Thursday are treated as a single day) in the summer and in the winter.
   b. Convert the DTIM output results into MEDS format for further processing.

More details on the DTIM and scaling processing can be found in Appendix C.

7. Scale EMFAC Emissions Using DTIM
   a. For each day of EMFAC emissions, the closest day-of-week matching DTIM file is chosen for scaling.
   b. The daily, county-wide EMFAC emissions are distributed spatially and temporally using the DTIM MEDS files as surrogates, as shown by the equation:

$$E_{P,ij,hr,cat} = \frac{EF_{P,daily,cat,cnty} \times DTIM_{P,ij,hr,cat}}{DTIM_{P,daily,cat,cnty}}$$

Where the variables above are defined as:

E = grid cell emissions
EF = EMFAC emissions
DTIM = DTIM emissions
p = pollutant
i,j = grid cell
hr = hourly emissions
cat = emission category
daily = daily emissions
cnty = county

   c. Finally, the Caltrans day-of-week factors are applied to the gridded, hourly emissions to better match traffic patterns.

8. Final Formatting
   a. The final step of on-road emissions processing is to convert the gridded, hourly emissions data to a Network Common Data Form (NetCDF) file usable by the Community Multiscale Air Quality (CMAQ) photochemical model.

3.4.7 Adjustment to the Future Year On-road Emissions

CARB is committed to reduce the diesel NOx emissions for medium heavy-duty diesel trucks and heavy heavy-duty diesel trucks in the San Joaquin Valley for

2024 and 2025. The reductions are 18.2 tpd and 18.9 tpd for 2024 and 2025 respectively. The county-specific factors are applied to the 2024 and 2025 on-road emissions for medium heavy-duty diesel trucks and heavy heavy-duty diesel trucks. The factors for 2024 and 2025 are shown in Table 10 and Table 11 respectively.

Table 10 County-specific factors for 2024

County	Factor
Fresno	0.409
Kern	0.430
King	0.444
Madera	0.432
Merced	0.439
San Joaquin	0.829
Stanislaus	0.829
Tulare	0.409

Table 11 County-specific factors for 2025

County	Factor
Fresno	0.407
Kern	0.429
King	0.444
Madera	0.431
Merced	0.438
San Joaquin	0.828
Stanislaus	0.828
Tulare	0.407

3.5 Estimation of Gridded Biogenic Emissions

Biogenic emissions were estimated using the Model of Emissions of Gases and Aerosols from Nature (MEGAN) version 2.04 (Guenther, et al., 2006). MEGAN estimates biogenic emissions as a function of normalized emission rates (i.e. emission rates at standard conditions), which are adjusted to reflect variations in temperature, light, leaf area index (LAI), and leaf age (estimated from changes in LAI). The default

MEGAN input databases for emission factors (EFs), plant functional types (PFTs), and LAI are not used in the application of MEGAN in California. Instead, California-specific emission factor and PFT databases were translated from those used in the Biogenic Emission Inventory GIS (BEIGIS) system (Scott & Benjamin, 2003) to improve emission estimates and to maintain consistency with previous California biogenic emission inventories. LAI data were derived from the MODIS 8-day LAI satellite product. Hourly surface temperatures were from observations gridded with the CALMET meteorological model and insolation data were provided by the WRF meteorological fields, as discussed in Section 3.1. Emissions of isoprene, monoterpenes, and methylbutenol were estimated from California-specific gridded emission factor data, while emissions of sesquiterpenes, methanol, and other volatile organic compounds were estimated from California-specific PFT data and PFT-derived emission rates.

MEGAN emissions estimates for California were evaluated during the California Airborne BVOC Emission Research in Natural Ecosystems Transects (CABERNET) field campaign in 2011 (Karl, et al., 2013), (Misztal, et al., 2014) and were shown to agree to within +/-20% of the measured fluxes (Misztal, et al., 2015), which is well within the stated model uncertainty of 50%.

3.6 Estimation of Ocean-going Vessel (OGV) Emissions

As of March 2018, an average-day OGV emission file was provided by an in-house CARB OGV model (CRB-PTSD) and ship emissions were allocated corresponding to the vessel traffic lanes. These traffic lanes were estimated from three different sources:

- National Waterway Network,
- The Ship Traffic, Energy and Environment Model, and
- Automated Instrumentation System (AIS) telemetry data collected in 2007.

The emission data output from the OGV model contains criteria pollutants as well as fuel consumption. The South Coast Air Quality Management District (SCAQMD) provided port activity data for 2012. The weekly port activity for every month of the year was applied to the entire south coast subdomain.

After applying the port activity factors mentioned above, emissions were separated by at-berth and everything else. At-berth emissions are processed through SMOKE and plume rise is calculated for every day of the year (Kwok, 2015). For transit, maneuvering, and anchorage, emissions are distributed evenly in two vertical layers (2 and 3) (Kwok, 2015).

It is worth nothing that the minimal impact from OGV emissions for the San Joaquin Valley domain is limited to emissions at the Port of Stockton and emissions at sea off the coast of San Luis Obispo County.

3.7 Estimation of Other Day-specific Sources

Day-specific data were used for preparing base case inventories when data were available. CARB and district staff were able to gather hourly/daily emission information for 1) wildfires and prescribed burns, 2) paved and unpaved road dust, and 3) agricultural burns in six districts (more details highlighted below). Additionally, CARB and district staff reflected residential wood curtailment programs in the base case, reference and future year modeling inventories. In addition, emissions in future years were removed for facilities that have closed after 2013.

For the reference and future year inventories, which are used to calculate RRFs, day-specific emissions for wildfires, prescribed burns, and wildland fires use (WFU) are left out of the inventory. All other day-specific data are included in both reference and future year modeling inventories.

3.7.1 Wildfires and Prescribed Burns

Day-specific, base case estimates of emissions from wildfires and prescribed fires were developed in a two part process. The first part consisted of estimating micro-scale, fire-specific emissions (i.e. at the fire polygon scale, which can be at a smaller spatial scale than the grid cells used in air quality modeling). The second part consisted of several steps of post-processing fire polygon emission estimates into gridded, hourly emission estimates that were formatted for use in air quality modeling.

Fire event-specific emissions were estimated using a combination of geospatial databases and a federal wildland fire emission model (Clinton, et al., 2006). A series of pre-processing steps were performed using a Geographic Information System (GIS) to develop fuel loading and fuel moisture inputs to the First Order Fire Effects (FOFEM) fire emission model (Lutes, et al., 2012). Polygons from a statewide interagency fire perimeters geodatabase (fire12_1.gdb, downloaded June 4, 2013) maintained by the Fire and Resource Assessment Program (FRAP) of the California Department of Forestry and Fire Protection (CALFIRE) provided georeferenced information on the location, size (area), spatial shape, and timing of wildfires and prescribed burns. Under interagency Memorandums of Understanding, federal, state, and local agencies report California wildfire and prescribed burning activity data to FRAP. Using GIS software, fire polygons were overlaid upon a vegetation fuels raster dataset called the Fuel Characteristic Classification System (FCCS) (Ottmar, et al., 2007). The FCCS maps vegetation fuels at a 30 meter spatial resolution, and is maintained and distributed by LANDFIRE.GOV, a state and federal consortium of wildland fire and natural resource management agencies. With spatial overlay of fire polygons upon the FCCS raster, fuel model codes were retrieved and component areas within each fire footprint tabulated. For each fuel code, loadings (tons/acre) for fuel categories were retrieved from a FOFEM look-up table. Fuel categories included dead woody fuel size classes, overstory live tree crown, understory trees, shrubs, herbaceous vegetation, litter, and duff. Fuel moisture values for each fire were estimated by overlaying fire polygons on year- and month-specific 1 km spatial resolution fuel moisture raster files generated from the national Wildland Fire Assessment System (WFAS.net) and retrieving moisture values from fire polygon centroids. Fire event-specific fuel loads and fuel moisture values were compiled and formatted to a batch input file and run through FOFEM.

A series of post-processing steps were performed on the FOFEM batch output to include emission estimates (pounds/acre) for three supplemental pollutant species (NH_3, TNMHC, and N_2O) in addition to the seven species native to FOFEM (CO, CO_2, $PM_{2.5}$, PM_{10}, CH_4, NO_x, and SO_2), and to calculate total emissions (tons) by pollutant species for each fire. Emission estimates for NH_3, TNMHC, and N_2O were based on mass ratios to emitted CO and CO_2 (Gong, et al., 2003).

Fire polygon emissions were apportioned to CMAQ model grid cells using area fractions, developed using GIS software, by intersecting fire polygons to the grid domain.

Another set of post-processing steps were applied to allocate fire polygon emissions by date and hour of the day. Fire polygon emissions were allocated evenly between fire start and end dates, taken from the fire perimeters geodatabase. Daily emissions were then allocated to hour of day and to the model grid cells and distributed vertically using a method developed by the Western Regional Air Partnership (WRAP), which specifies a pre-defined diurnal temporal profile, plume bottom, and plume top for each fire (WRAP, 2005).

3.7.2 Paved Road Dust

Statewide emissions from paved road dust were adjusted for each day of the baseline year. The adjustment reduced emissions by 25% from paved road dust on days when precipitation occurred. Paved road dust emissions are calculated using the methods described in EPA's AP-42, Fifth Edition, Volume I Chapter 13: Miscellaneous Sources (U.S. EPA, 2006).

This methodology includes equations that adjust emissions based on average precipitation in a month; these precipitation-adjusted emissions were placed in the CEIDARS and CEPAM databases. Since daily precipitation totals are readily available, CARB and district staff agreed that paved road dust emissions should be estimated for each day rather than by month as described in the AP-42 methodology. The emissions from CEIDARS were replaced with day-specific data. A description of the steps used to calculate day-specific emissions is as follows.

Daily uncontrolled emissions for each county/air basin are estimated from the AP-42 methodology [Equation (1) on page 13.2.1-4]. No monthly precipitation adjustments are incorporated into the equation to estimate emissions.

To adjust for precipitation, daily precipitation data for 2013 were provided by an in-house database maintained by CARB staff that stores meteorological data collected from outside sources. The specific data sources for these data include Remote Automated Weather Stations (RAWS), Atmospheric Infrared Sounder (AIRS), California Irrigation Management Information System (CIMIS) networks, San Francisco Bay Area Meteorology (SFBMET), and Federal Aviation Administration (FAA). FAA data provide precipitation data collected from airports in California.

If the precipitation is greater than or equal to 0.01 inches (measured anywhere in a county or county/air basin piece on a particular day), then the uncontrolled emissions are reduced by 25% for that day only. This reduction of emissions follows the recommendation in AP-42 as referenced above.

Replace the annual average emissions with day-specific emissions for every day in the corresponding emission inventory dataset.

3.7.3 Unpaved Road Dust

Statewide emissions from unpaved road dust were adjusted for rainfall suppression for each day of the year. The adjustment reduced county-wide emissions by 100% (total suppression) from unpaved road dust on days when precipitation greater than 0.01 inches occurred in a county/air basin. Dust emissions from unpaved roads were calculated using an emission factor derived from tests conducted by the University of California, Davis, and the Desert Research Institute (DRI). Unpaved road vehicle miles traveled (VMT) were based on county-specific road mileage estimates.

Emissions were assumed to be suppressed for each day with rainfall of 0.01 inch or greater using equation (2) from pages 13.2.2-6 to 13.2.2-7 in the Unpaved Road Dust section of AP-42 (U.S. EPA, 2006). The equation adjusts emissions based on annual precipitation; these precipitation-adjusted emissions were placed in the CEIDARS database. Similar to paved road dust, CARB and district staff agreed that unpaved road dust emissions should be estimated for each day. The emissions from CEIDARS were replaced with day-specific data for the appropriate years. Following is a description of the steps that were taken to calculate day-specific emissions.

Start with the daily uncontrolled emissions for each county/air basin as estimated from CARB's methodology. In other words, no precipitation adjustments have been incorporated in the emission estimates.

Use the same daily precipitation data as for paved road dust (see above)

If the precipitation is greater than or equal to 0.01 inches measured anywhere in a county or county/air basin portion on a particular day, then the emissions are removed for that day only.

Replace the annual average emissions with day-specific emissions for every day.

3.7.4 Agricultural Burning

Agricultural burning day-specific emission estimations were incorporated into the inventory for the following areas.

San Joaquin Valley

The San Joaquin Valley Air Pollution Control District estimated emissions for each day of 2013 when agricultural burning occurred. Emissions were estimated for the burning of pruning, field crops, weed abatement, and other solid fuels. Information needed to estimate emissions came from the district's Smoke Management System, which stores information on burn permits issued by the district. In order to obtain a daily burn authorization, the person requesting the burn provides information to the district, including the acres and type of material to be burned, the specific location of the burn, and the date of the burn. Acres are converted to tons of fuel burned using a fuel loading factor based on the specific crop to be burned. Emissions are calculated by multiplying the tons of fuel burned by a crop-specific emission factor. More information can be found in (CARB-Miscellaneous Methodologies, 2013).

To determine the location of the burn, district staff created spatial allocation factors for each 4 kilometer grid cell used in modeling. These factors were developed for "burn zones" in the San Joaquin Valley based on the agricultural land coverage. Daily emissions in each "agricultural burn zone" were then distributed across the zone/grid cell combinations using the spatial allocation factors. Emissions were summarized by grid cell and day.

Burning was assumed to occur over three hours from 10:00 a.m. to 1:00 p.m., except for two categories. Orchard removals were assumed to burn over eight hours from 10:00 a.m. to 6:00 p.m. Vineyard removals were assumed to burn over five hours from 10:00 a.m. to 3:00 p.m.

<u>Sacramento</u>

Sacramento Metropolitan Air Quality Management District provided information needed to calculate emissions in Sacramento County from agricultural burning for each day of 2013 when agricultural burning occurred. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement and other solid fuels. Information needed to estimate emissions came from burn permits issued by the district. In order to obtain a burn permit, the person requesting the burn provides information to the district, including the acres to be burned, the specific location of the burn and the date of the burn. Acres are converted to tons of fuel burned using a fuel loading factor based on the specific crop to be burned. Emissions are calculated by multiplying the tons of fuel burned by a crop-specific emission factor. The location of the burn was converted to latitude/longitude based on the address or description of location provided by the burn permit holder, then ultimately to grid cell. Burning was assumed to occur over eight hours from 10:00 a.m. to 6:00 p.m.

<u>Yolo-Solano</u>

Yolo-Solano Air Quality Management District provided information needed to calculate emissions from agricultural burning for each day of 2013 when agricultural burning occurred. Data were provided for their region: all of Yolo County and the Sacramento Valley portion of Solano County. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement and range improvement. The location of the burn was converted to latitude/longitude based on the address or description of location provided by the burn permit holder, then ultimately to grid cell. Burning was assumed to occur over five hours from 11:00 a.m. to 4:00 p.m.

Feather River

Feather River Air Quality Management District provided information needed to calculate emissions from agricultural and prescribed burning for each day of 2013 when agricultural burning occurred. Data were provided for Sutter and Yuba Counties. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement and other solid waste. The location of each burn was converted to latitude/longitude based on the address or description of location provided by the burn permit holder, then ultimately to grid cell. Orchard prunings were assumed to occur from 9:00 a.m. to 4:00 p.m. The burning of field crops, rice, weeds and ditch banks were assumed to occur from 10:00 a.m. to 5:00 p.m. from March 1 through August 31 and from 10:00 a.m. to 4:00 p.m. from September 1 through February 29. Prescribed burns over 10 acres were assumed to occur from 9:00 a.m. to 12:00 a.m. while prescribed burns less than 10 acres were assumed to occur from 9:00 a.m. to 6:00 p.m.

Ventura

Ventura County Air Pollution Control District provided emissions in Ventura County from agricultural burning for each day of 2013 when agricultural burning occurred. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement, range improvement and prescribed burns not included in the wildfires / prescribed burns discussed in the San Joaquin Valley portion of Section 3.7.4. Information needed to estimate emissions came from burn permits issued by the district. In order to obtain a burn permit, the person requesting the burn provides information to the district, including the acres to be burned, the specific location of the burn and the date of the burn. Acres are converted to tons of fuel burned using a fuel loading factor based on the specific crop to be burned. Emissions are calculated by multiplying the tons of fuel burned by a crop-specific emission factor. The location of the burn was converted to latitude/longitude based on the address or description of location provided by the burn permit holder, then ultimately to grid cell. Burning was assumed to occur over three hours from 9:00 a.m. to 12:00 p.m.

3.7.5 Residential Wood Curtailment

Emissions were reduced to reflect residential wood curtailment (RWC) days (no burn days) in three districts: San Joaquin Valley APCD, South Coast AQMD, and Sacramento Metropolitan AQMD. As of March 2018, there are two major changes in the SMOKE processing of RWC, and one major change in future-year curtailment.

The first change in the SMOKE-processing of RWC is in temporal allocation. In the past, SMOKE temporally allocated RWC emissions with monthly, weekly and diurnal profiles provided by CARB planning staff. Now the profiles are replaced with the ones based on modeled ambient temperature from WRF with respect to the reference model year (2013). Specifically, a pre-SMOKE utility program called GenTpro is used to generate county-specific temporal profiles taking into account average temperature by grid cell (Manual 3.1, Manual 4.0, Kwok 2016a). Emissions for any given county will only be allocated whenever the daily average temperature by grid cell is below 50 F. In addition, the diurnal profile has also changed. In previous versions the profile consisted of morning-evening peaks; however, now the profile reflects evening-only activities beginning from 7pm and ending at midnight, with each hour carrying an equal weight.

The second change in the SMOKE-processing of RWC is in spatial allocation. A new spatial surrogate for fireplaces was constructed based on the population of houses, apartments, and any other residential dwellings with fireplaces (see Section 2.3.7). This surrogate is applied to both woodstoves and fireplaces emissions in SMOKE.

The change in RWC curtailment programs is only for San Joaquin Valley; the corresponding programs remain unchanged for South Coast (SC) and Sacramento Valley (SACV). The following describes the current curtailment programs for SC, SACV, and SJV as well as proposed changes to SJV’s curtailment program.

San Joaquin Valley

In the San Joaquin Valley (SJV), current RWC curtailment programs for base year 2013 and future years 2020, 2024, and 2025 are in effect. The programs are also referred to as Rule 4901. Additional RWC reductions are expected as areas of gas utility accessibility increase and a woodstove swap-out program (Burn Cleaner program) rolls out. Here, we summarize the current curtailment programs before describing the new woodstove swap-out program in detail.

Current program

Base Year (2013): SJVAPCD staff provided the dates in 2013 when a residential wood curtailment was declared based on the October 2008 district rule 4901. When observed $PM_{2.5}$ reached or exceeded 35 µg/m^3, the curtailment was declared. Consequently, emissions were reduced by 65% (i.e. 35% remaining) in the appropriate geographic regions (see Section 2.3.7).

Future Years (2020, 2024 and 2025): RWC in future years reflects the latest revision to Rule 4901, based on a September 2014 three-level curtailment program:

Level 0 – burning allowed

Level 1 – burning permitted by cleaner-burning woodstoves only

Level 2 – no burning

The consecutive levels are partitioned by values called cut-points, which are also based on the observed $PM_{2.5}$ concentrations. For example, cut-points 20-65 denotes the observed $PM_{2.5}$ at 20 µg/m^3 and 65 µg/m^3, respectively. Cut-point-20 applies the Level 1 curtailment, whereas cut-point-65 applies a more restrictive Level 2 curtailment.

Updates to the Current Program

The SJV RWC curtailment program has been updated to include the Burn Cleaner program. The Burn Cleaner program is applied to the uncurtailed SJV RWC emissions inventory prior to application of Rule 4901. In the Burn Cleaner program, the SJVAPCD staff identified hot spots within the SJV air basin as shown in Figure 7. The hot spots are either new areas of gas utility or areas deemed to have persistently poor air quality. The SJVAPCD provides Burn Cleaner reduction factors (or equivalently retention factors) for both the hot spots and the remaining areas, as shown in Table 12. These factors are applied to registered woodstoves only; fireplace emissions are subject to 97% compliance at Level 1 or above.

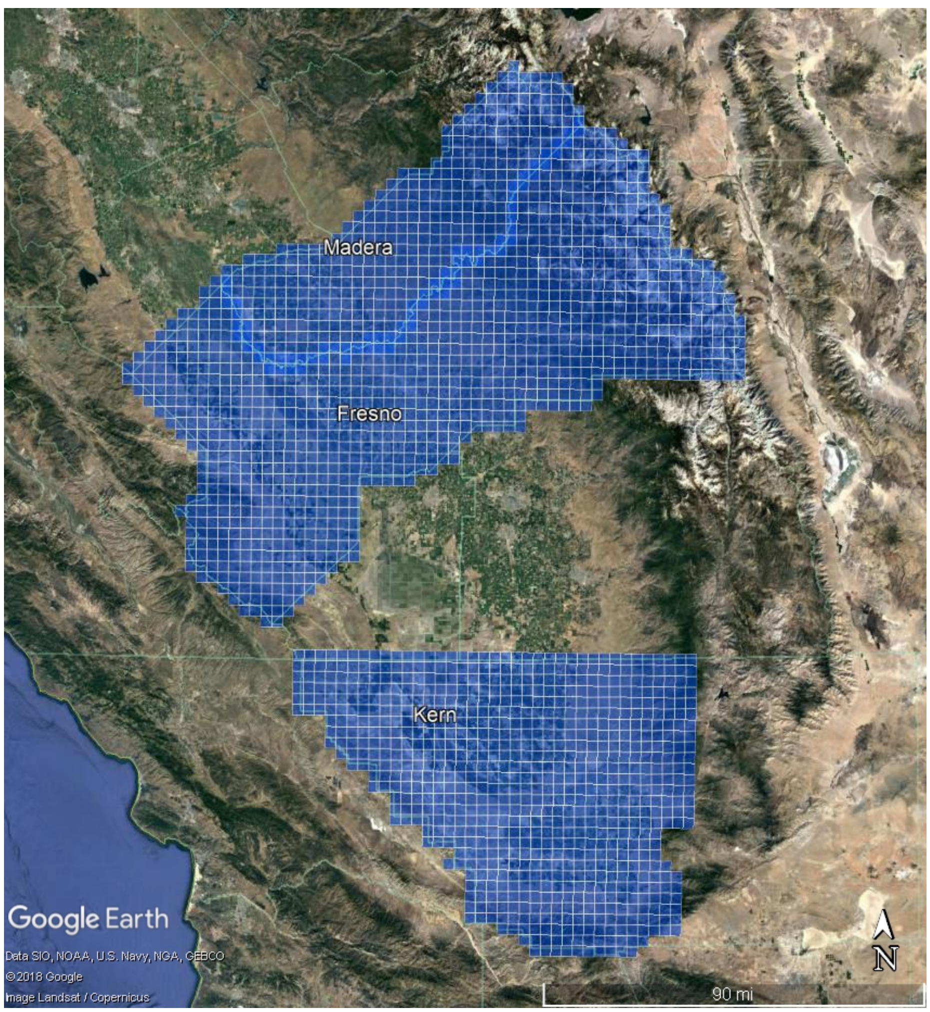

Figure 7 Hot spot areas in San Joaquin Air Basin

Table 12 County-specific burn cleaner retention factors

County Number	County Name	Hotspot Retention	Non-hotspot Retention
10	Fresno	0.564	1.000
15	Kern	0.635	1.000
16	Kings	N/A	0.900
20	Madera	0.855	N/A
24	Merced	N/A	0.922
39	San Joaquin	N/A	0.812
50	Stanislaus	N/A	0.872
54	Tulare	N/A	0.900

Based on the remaining emissions after the Burn Cleaner reductions are applied, county-specific curtailment is then determined; however, the county-specific curtailment criteria are defined differently for hot spot versus non-hot spot areas. Hot spot areas have curtailment on days where observed $PM_{2.5}$ is greater than or equal to 12 $\mu g/m^3$, prompting the Level 1 measure. If $PM_{2.5}$ hits 35 $\mu g/m^3$, then the Level 2 measure is triggered. For non-hotspot areas, curtailment occurs on days where $PM_{2.5}$ is greater than 20 $\mu g/m^3$, prompting a Level 1 measure, or greater than 65 $\mu g/m^3$ prompting a Level 2 measure.

For a Level 2 curtailment, declared measured emissions were reduced by 97% (i.e. 3% remaining) in the appropriate geographic regions.

Greater reductions due to curtailment are assumed in the future years to reflect increased public awareness and thus greater compliance with district rules. To avoid double-counting emission reductions on curtailment days, the modeling inventories were only grown without the control profile applied. Since emissions from RWC have flat growth, the same reductions are used for all future years (2015 and later).

<u>South Coast</u>

SCAQMD staff provided the dates in 2013 when a residential wood combustion curtailment (RWCC) was declared based on district rule 455. When an RWCC was declared emissions were reduced by 75% (i.e. 25% remaining) in the appropriate geographic regions (see Section 2.3.7). In future years, emissions continued to be reduced by 75%, using the same dates as in 2013.

<u>Sacramento</u>

SMAQMD staff provided the dates in 2013 when an RWCC was declared based on district rule 421. Per this rule, a mandatory curtailment (no burning) is called when:

> Stage 1: the 24-hour average $PM_{2.5}$ concentration may exceed 31 $\mu g/m^3$ but is not likely to exceed 35 $\mu g/m^3$
>
> Stage 2: the 24-hour average $PM_{2.5}$ concentration may exceed 35 $\mu g/m^3$

When an RWCC was declared, emissions in Sacramento County (see Section 2.3.7) were reduced as follows:

> For Stage 1: 57% (i.e. 43% remaining)
>
> For Stage 2: 70% (i.e. 30% remaining)

In future years, emissions were continued to be reduced by 57% and 70% for Stage 1 and Stage 2, respectively. The same calendar dates from 2013 were used in future years.

3.7.6 Estimation of Agricultural Ammonia Emissions:

Ammonia emissions from fertilizers/pesticides (EIC3 530) and livestock (EIC3 620) are separated from the aggregated area source inventory as they are affected by local meteorology. In previous work, a flat temporal profile was assigned to both sectors but due to the dependence on meteorology factors a more realistic approach to temporal representation was needed. For EIC3 530, the depending factors are WRF's two-meter temperature and ten-meter wind speed. For EIC3 620, the factors are WRF's ground temperature and aerodynamic resistance. Through GenTpro these meteorological factors are averaged by county before creating year-long hourly profiles for each of the respective sectors. All algorithms are described in the SMOKE Manual 4.0, while the results of CARB in-house tests are presented by Kwok (2016).

3.7.7 Closed Facilities

Emissions in future years were removed for facilities that have closed beyond the reference year. In other words, the emissions were removed from future year inventories for a facility that was included in the 2012 inventory but stopped operating after 2013. Local air district staff members provided the lists of these facilities.

3.8 Application of Control Measure Reduction Factors in San Joaquin Valley

Controls were applied to reduce emissions in the future year attainment modeling inventories for 2020, 2024, and 2025. Control strategies for RWC and charbroiling are outlined in Sections 3.8.1 and 3.8.2. A summary of the control strategies applied to each future year is described in Sections 3.8.3 and 3.8.4.

3.8.1 Charbroiling

Control strategies to reduce $PM_{2.5}$ emissions from commercial under-fired charbroilers are achieved through District rule 4692 and a charbroiler incentive program. Reductions from charbroilers are located in two counties, Fresno and Kern, as well as the city of Madera (see Figure 8). Table 13 lists the locations and reductions to charbroiler emissions in those areas.

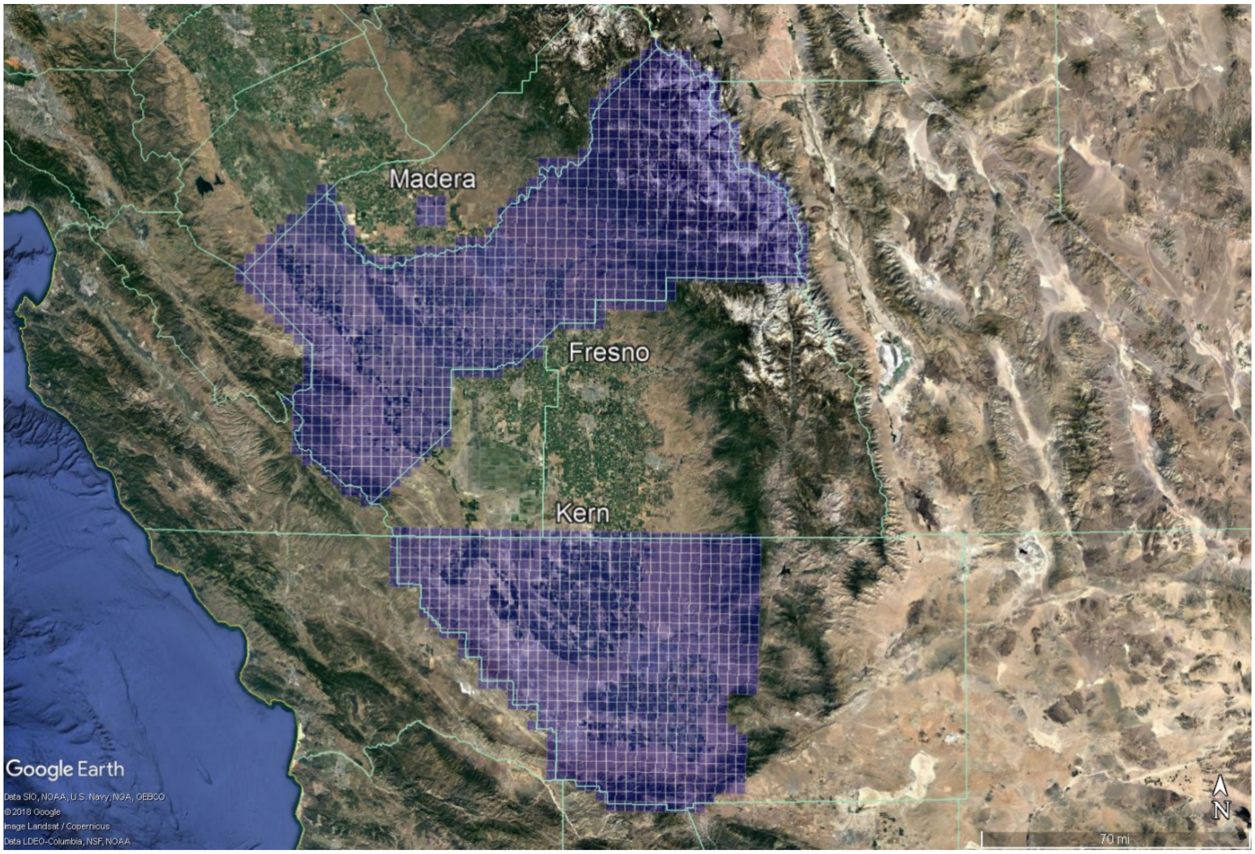

Figure 8 Hot spot areas for application of under-fired charbroiling $PM_{2.5}$ reductions.

Table 13 Charbroiling reductions by area for 2024 and 2025 **(SJVUAPCD, 2017)**

Location	Existing Restaurant Reduction	Large New Restaurant Reduction	Total Reduction
Fresno County	22.8%	7.8%	30.6%
Kern County	22.5%	7.8%	30.3%
City of Madera	22.5%	7.8%	30.3%

3.8.2 Residential Wood Combustion

Control strategies to reduce emissions from residential wood combustion (RWC) were applied in accordance with future year curtailment rules described in Section 3.7.5.

3.8.3 Future Year 2020

The only controls applied on top of the projected 2020 inventory emissions were to RWC. Prior to reduction, the RWC emissions were allocated to locations by the new fireplace surrogates. Subsequently, the RWC emissions were reduced according to future year baseline curtailment rules using a compliance rate of 97% (refer to Section 3.7.5).

3.8.4 Future Years 2024 and 2025

Residential Wood Combustion

For future year attainment modeling of 2024 and 2025, RWC emissions are subject to more stringent controls. RWC emissions are reduced per the Burn Cleaner program as explained in Section 3.7.5. The value of the RWC emissions reductions is expected to the same for 2024 and 2025 given the lack of growth in RWC emissions, and the application of the curtailment is the same in both years.

Charbroiling

For both future years 2024 and 2025, emissions from under-fired charbroilers are reduced in hot spot regions (described in Section 3.8.1).

Other reductions

In addition to reductions from RWC and charbroiling, control strategies are applied to other sources in order to further reduce NOx and $PM_{2.5}$ emissions in future years 2024 and 2025 (refer to Table 14 or a list of these sources).

Table 14 NOx and $PM_{2.5}$ other source emissions reductions

Reduction Source	NOx	$PM_{2.5}$
Electrification of agriculture IC engines	X	X
Stationary source fuel combustion	X	
Agriculture equipment	X	X
Off-road equipment	X	
Locomotives	X	
Heavy duty diesel trucks	X	
Flaring operations	X	
Enhanced conservation management practices (tillage)		X
Enhanced conservation management practices (fallow land)		X

Each of the sources in Table 14 is based on specific measures at the District or State level.

- Electrification of agriculture IC engines - CARB - *Cleaner In-Use Agricultural Equipment* measure and District Rule 4702 (see Chapter 4, Appendix D and Appendix E)
- Stationary source fuel combustion – District Incentive Measure for Stationary Agricultural Pump Engine Replacements (see Appendix E)
- Ag equipment - CARB Accelerated Turnover of Agricultural Tractors (see Chapter 4)
- Off-road equipment – CARB Accelerated Turnover of Off-road Equipment (see Chapter 4 and Appendix E)
- Locomotives – CARB and Rail Yard MOU (see Appendix D and E)
- Heavy duty diesel trucks – CARB Accelerated turnover of Trucks and Buses (see Appendix D and E)
- Flares – District Rule 4311 (see Chapter 4)
- Conservation Management practices (tillage and fallow land) – District Rule 4550 (see Chapter 4)

Each of these reductions are implemented in as reduction factors in the SMOKE model. Reduction factors for each of these sectors are specified separately for NOx and PM2.5 in the years 2024 and 2025. Table 15 shows the reduction factors that are input to the CNTLMAT program in SMOKE which applies the reductions uniformly across the district to the sources by their EIC number.

Table 15 District-wide Reduction Factors by Sources

San Joaquin Valley District-wide Source Reductions	Year	NOx	PM2.5
		Reduction factor	Reduction factor
Electrification of agriculture IC engines	2024	0.50	0.50
	2025	0.50	0.50
Stationary source fuel combustion	2024	0.05	-
	2025	0.05	-
Agriculture equipment	2024	0.41	0.48
	2025	0.38	0.51
Locomotives	2024	0.23	-
	2025	0.23	-
Off-road equipment	2024	0.25	-
	2025	0.23	-
Flaring operations	2024	0.20	-
	2025	0.20	-
Enhanced conservation management practices (tillage)	2024	-	0.05
	2025	-	0.05
Enhanced conservation management practices (fallow land)	2024	-	0.02
	2025	-	0.02

4 Quality Assurance of Modeling Inventories

As mentioned in Section 1.3, base case modeling is intended to demonstrate confidence in the modeling system. Quality assurance of the data is fundamental in order to detect any possible outliers and potential problems with emission estimates. The most important quality assurance checks of the modeling emissions inventory are summarized in the following sections.

4.1 Area and Point Sources

Before utilizing SMOKE to process the annual emissions totals into temporally, chemically, and spatially-resolved emissions inventories for photochemical modeling, all SMOKE inputs are subject to extensive quality assurance procedures performed by CARB staff. Annual and forecasted emissions are carefully reviewed before input into SMOKE. CARB and district staff review data used to calculate emissions along with other associated data, such as the location of facilities and assignment of SCC to each process. Growth and control information are reviewed and updated as needed.

The next check is to compare annual average emissions from CEPAM with planning inventory totals to ensure data integrity. The planning and modeling inventories start with the same annual average emissions. The planning inventory is developed for an average summer day and an average winter day, whereas the modeling inventory is developed by month. Both inventory types use the same temporal data described in Section 2.2. The summer planning inventory uses the monthly throughputs from May through October. Similarly, the winter planning inventory uses the monthly throughputs from November through April. The modeling inventory produces emissions for a weekday, Saturday, and Sunday for each month.

Annual emissions totals are plotted using the same gridding inputs as used in SMOKE in order to visually inspect and analyze the spatial allocation of emissions independent of temporal allocation and chemical speciation. Spatial plots by source category like the one shown in Figure 9 are carefully screened for proper spatial distribution of emissions.

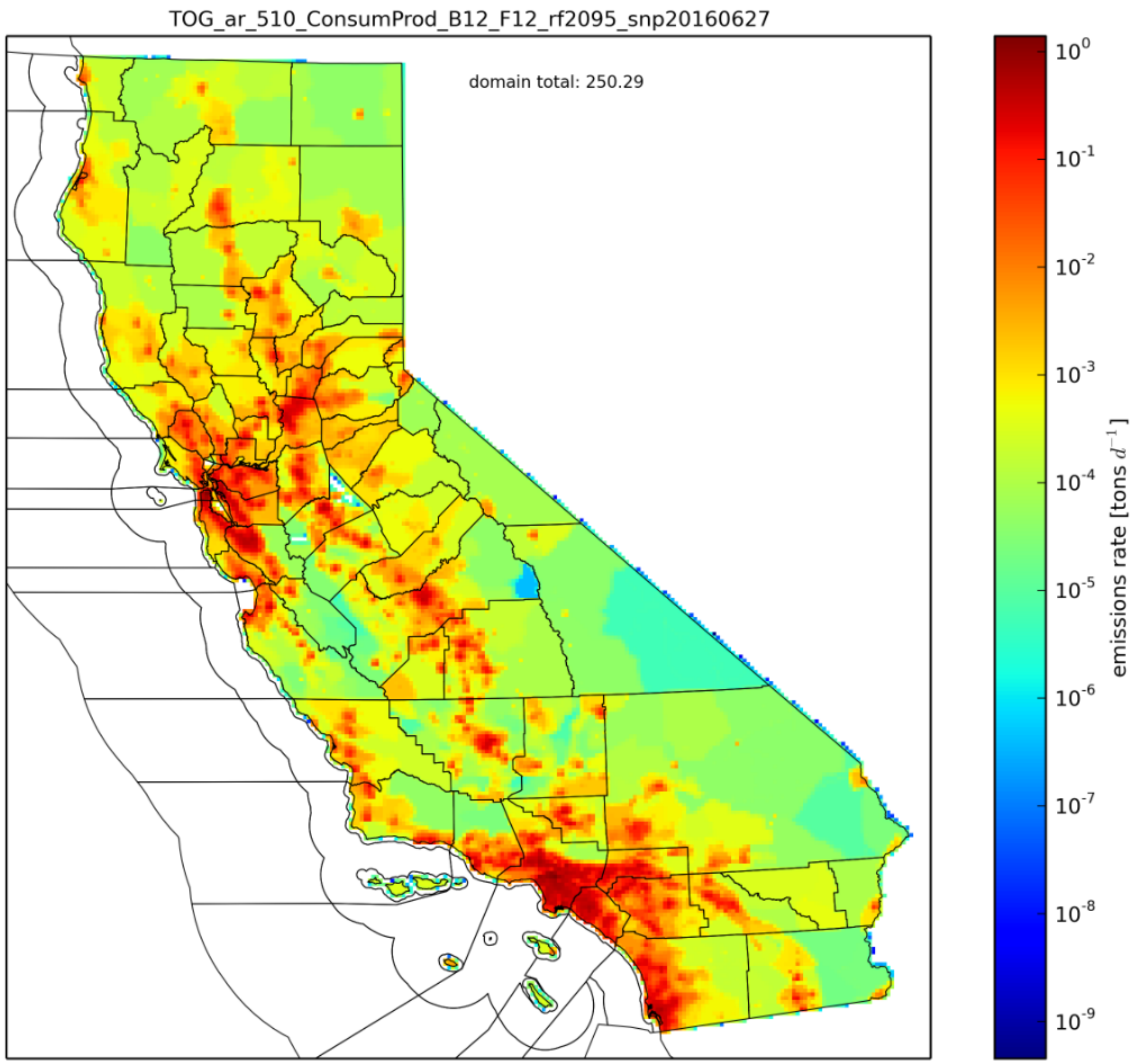

Figure 9 Example of a spatial plot by source category

Before air quality model-ready emissions files are generated by SMOKE, the run configurations and parameters set within the SMOKE environment are checked for consistency for both the reference and future years.

To aid in the quality assurance process, SMOKE is configured to generate inventory reports of temporally, chemically, and spatially-resolved emissions inventories. CARB staff utilize the SMOKE reports by checking emissions totals by source category and region, creating and analyzing time series plots, and comparing aggregate emissions totals with the pre-SMOKE emissions totals obtained from CEPAM. A screenshot capture of a portion of such report can be seen in Figure 10.

```
# Processed as Area sources
# Base inventory year      2012
# No gridding matrix applied
# No speciation matrix applied
# Temporal factors applied for episode from
#      Wednesday Aug. 8, 2012   at 080000 to
#      Thursday Aug. 9, 2012   at 080000
# Annual total data basis in report
#          ,             ,                     , [tons/day]    , [tons/day]    , [tons/day]    , [tons/day]    , [tons/day]    , [tons/day]
#Date      , Region      , SCC                 , CO            , NOX           , TOG           , NH3           , SOX           , PM
 08/09/2012, 0LC006017LAK, 00000005204212000010,    0.19098E-01,   0.46288E-01,   0.44956E-02,   0.00000E+00,   0.16055E-03,   0.16051E-02
 08/09/2012, 0LC006017LAK, 00000005204212000011,    0.94908E-02,   0.21052E-01,   0.30532E-02,   0.00000E+00,   0.00000E+00,   0.11252E-02
 08/09/2012, 0LC006017LAK, 00000011011003000000,    0.00000E+00,   0.00000E+00,   0.00000E+00,   0.63987E-03,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000012012202420000,    0.00000E+00,   0.00000E+00,   0.00000E+00,   0.29915E-01,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000019917002400000,    0.00000E+00,   0.00000E+00,   0.00000E+00,   0.13904E-01,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000021020033000000,    0.00000E+00,   0.00000E+00,   0.13736E-01,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000021020081500000,    0.00000E+00,   0.00000E+00,   0.31439E-02,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020405000000,    0.00000E+00,   0.00000E+00,   0.31245E-01,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020430220000,    0.00000E+00,   0.00000E+00,   0.72951E-03,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020430830000,    0.00000E+00,   0.00000E+00,   0.36475E-03,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020432040000,    0.00000E+00,   0.00000E+00,   0.36475E-03,   0.00000E+00,   0.00000E+00,   0.00000E+00
```

Figure 10 Screen capture of a SMOKE-generated QA report

4.1.1 Area and Point Sources Temporal Profiles

Checks for missing or invalid temporal assignments are conducted to ensure accurate temporal allocation of emissions. Special attention is paid to checking monthly throughputs and appropriate monthly temporal distribution of emissions for each source category. In addition, checks for time-invariant temporal assignments are done for certain source categories and suitable alternate temporal assignments are determined and applied. For the agricultural source sector (e.g. agricultural pesticides/fertilizers, farming operations, fugitive windblown dust, managed burning and disposal, and farm equipment), replacement temporal assignments are extracted from the Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool) (Anderson, et al., 2012). The AgTool is a database management system capable of temporally and spatially allocating emissions from the agricultural source sector. It was developed by Sierra Research, Inc., and its subcontractor Alpine Geophysics, LLC, along with collaboration from CARB and SJVAPCD. Temporal allocation data outputs from the AgTool were compiled using input data provided by the UC Cooperative Extension, U.S. Department of Agriculture, and the CA Department of Pesticide Regulation.

Further improvements to temporal profiles used in the allocation of area source emissions are performed using suitable alternate temporal assignments determined by CARB staff. Select sources from manufacturing and industrial, degreasing, petroleum marketing, mineral processes, consumer products, residential fuel combustion, farming operations, aircraft, and commercial harbor craft sectors are among the source categories included in the application of adjustments to temporal allocation.

4.2 On-road Emissions

There are several processes to conduct quality assurance of the on-road mobile source modeling inventory at various stages of the inventory processing. The specific steps taken are described below.

1. Generate an ITN spatial plot to check if there were any missing network activities.
2. Generate a time series plot for each county to check the diurnal pattern of network activities.
3. Generate time series plots for the DTIM output files by county and by SCC to check the diurnal pattern.
4. Generate time series plots for the on-road mobile source files after scaling to EMFAC 2014 emissions (MEDS files) by county and SCC to check the diurnal pattern.
5. Compare the statewide daily total emissions for the MEDS files and the EMFAC 2014 emissions files to ensure that the emissions are the same.
6. Generate the spatial plot for the MEDS file to check if there were any missing emissions.
7. Generate time series and spatial plots again to check the final MEDS files.

4.3 Day-specific Sources

4.3.1 Wildfires and Prescribed Burns

GIS records for 364 wildfires and 125 prescribed wildland burn events reported for 2013 were downloaded from http://frap.cdf.ca.gov and imported to a geodatabase. Data fields included wildfire or burn project name, burned area, and start and end dates. A series of geoprocessing steps were used to map and overlay wildfire and prescribed burn footprint polygons on the statewide vegetation fuels (FCCS) and moisture raster datasets, to retrieve associated fuel loadings and moisture values for use as input to FOFEM. Wildfire and prescribed burn footprint polygons were also overlaid on the statewide 4-km modeling grid to assign grid cell IDs to each wildfire and prescribed burn. Emission estimates for each wildfire and prescribed burn event were generated by FOFEM and summarized in an Access database.

4.3.2 Paved Road Dust

The average daily emissions inventory was adjusted with day-specific precipitation data to produce a day-specific emissions inventory. Total emissions by county before the adjustment were compared to CEPAM for a reasonable match. After the adjustment, the day-specific total emissions by county were compared to CEPAM using time series plots. These plots were verified to confirm that there were only two values for every county/air basin/district: high values and low values. The high values are emissions that were not affected by rain adjustment, while the low values are emissions that were affected by the 25% rain adjustment reduction. Additionally the day-specific total was also compared to other inventory years to verify the expected growth trend.

4.3.3 Unpaved Road Dust

Unpaved road dust followed the same quality assurance process as paved road dust. The reduction efficiency for unpaved roads is increased to 100% on precipitation days.

4.3.4 Agricultural Burning

Checks were done to verify the quality of the agricultural burn data. The day-specific emissions from agricultural burning were compared to the emissions from CEPAM for each county to check for reasonableness. Time series plots were reviewed for each county to see that days when burning occurred matched the days provided by the local air district. For each county, a few individual fires were calculated by hand starting from the raw data through all the steps to the final MEDS files to make sure the calculations were done correctly. Spatial plots were made to double check the locations of each burn.

4.4 Additional Quality Assurance

In addition to the quality assurance described above, comparisons are made between annual average inventories from CEPAM and modeling inventories. The modeling inventory shows emissions by month and subsequently calculates the annual average for comparison with CEPAM emissions. Annual average inventories and modeling inventories can be different, but differences should be well understood. For example, modeling inventories are adjusted to reflect different days of the week for on-road motor vehicles as detailed in Section 3.4; since weekend travel is generally less than weekday travel, modeling inventory emissions are usually lower when compared to annual average inventories from CEPAM. Figure 11 provides a screen capture of a report that summarizes different emission categories for San Luis Obispo County. Please note that this report is only an example since emissions have been updated from what is displayed here.

County:***40*** Spec:***NOx***

EIC	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	CEPAM	Difference
10	electric utilities	0.12	0.11	0.1	0.06	0.09	0.13	0.13	0.16	0.14	0.16	0.14	0.13	0.12	0.12	0.00
20	cogeneration	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.00
30	oil and gas production (combustion)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00
40	petroleum refining (combustion)	0.3	0.3	0.26	0.3	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.26	0.31	0.31	0.00
50	manufacturing and industrial	0.06	0.06	0.06	0.06	0.07	0.06	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.00
52	food and agricultural processing	0.19	0.19	0.19	0.34	0.34	0.34	0.38	0.38	0.38	0.18	0.18	0.18	0.27	0.27	0.00
60	service and commercial	0.91	0.92	0.92	0.92	0.92	0.9	0.9	0.91	0.91	0.91	0.92	0.91	0.91	0.91	0.00
99	other (fuel combustion)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.00
110	sewage treatment	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
120	landfills	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
130	incinerators	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
140	soil remediation	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
199	other (waste disposal)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
210	laundering	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
220	degreasing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
230	coatings and related process solvents	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
240	printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
250	adhesives and sealants	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
299	other (cleaning and surface coatings)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
310	oil and gas production	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
320	petroleum refining	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
330	petroleum marketing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
399	other (petroleum production and marketing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
410	chemical	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
420	food and agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
430	mineral processes	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.00
440	metal processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
450	wood and paper	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
460	glass and related products	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
470	electronics	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
499	other (industrial processes)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
510	consumer products	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
520	architectural coatings and related process sol	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
530	pesticides/fertilizers	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
540	asphalt paving / roofing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
610	residential fuel combustion	0.73	0.73	0.68	0.65	0.57	0.57	0.57	0.57	0.57	0.65	0.7	0.73	0.64	0.64	0.00
620	farming operations	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
630	construction and demolition	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
640	paved road dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
645	unpaved road dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
650	fugitive windblown dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
660	fires	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
670	managed burning and disposal	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00
690	cooking	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
699	other (miscellaneous processes)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
700	on-road vehicles	9.34	9.32	9.36	9.17	9.06	8.81	8.69	8.77	8.63	8.79	9.3	9.23	9.04	9.60	0.56
810	aircraft	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00
820	trains	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.93	0.74
830	ships and commercial boats	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
833	ocean going vessels	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.52	0.29
835	commercial harbor craft	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	0.83	-0.29
840	recreational boats	0.05	0.05	0.17	0.18	0.16	0.47	0.46	0.43	0.12	0.11	0.11	0.06	0.2	0.20	0.00
850	off-road recreational vehicles	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.00
860	off-road equipment	1.08	1.24	1.21	1.24	1.25	1.28	1.25	1.25	1.28	1.21	1.19	1.12	1.21	1.21	0.00
870	farm equipment	1.08	1.22	1.72	1.77	2.21	2.21	2.16	2.21	2.17	1.52	1.14	1.06	1.71	1.71	0.00
890	fuel storage and handling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
920	geogenic sources	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
***	Total	26.78	27.05	27.59	27.61	27.93	28.05	27.88	28.01	27.55	26.87	27.01	26.67	27.42	28.73	1.31

Notes:

CEPAM refers to annual average emissions from 2016 SIP Baseline Emission Inventory Tool with external adjustments: http://outapp.arb.ca.gov/cefs/2016o

Monthly gridded emissions comes from GeoVAST mo-yr/avg tabular summary - gid 319

On-road vehicles: The modeling inventory adjusts on-road by day of week as well as day-specific temperatures and relative humidity - Fridays are higher wi
time series plots shows weekdays are ~9-10 tpd

Trains: The modeling inventory reflects the revised locomotive emissions; the planning inventory reflects the previous emission estimates

OGV model produces gridded OGV emissions, which can vary from planning inventory (these emissions include OC1 and OC2 offshore air basins)

CHC The modeling inventory reflects the revised commercial harbor craft emissions; the planning inventory reflects the previous emission estimates

Figure 11 Screenshot of comparison of inventories report

Staff also review how modeling emissions vary over a year. Figure 12 provides an example of a modeling inventory time series plot for San Luis Obispo County for area-wide sources, on-road sources and off-road sources. Again, this figure is <u>only an example</u>.

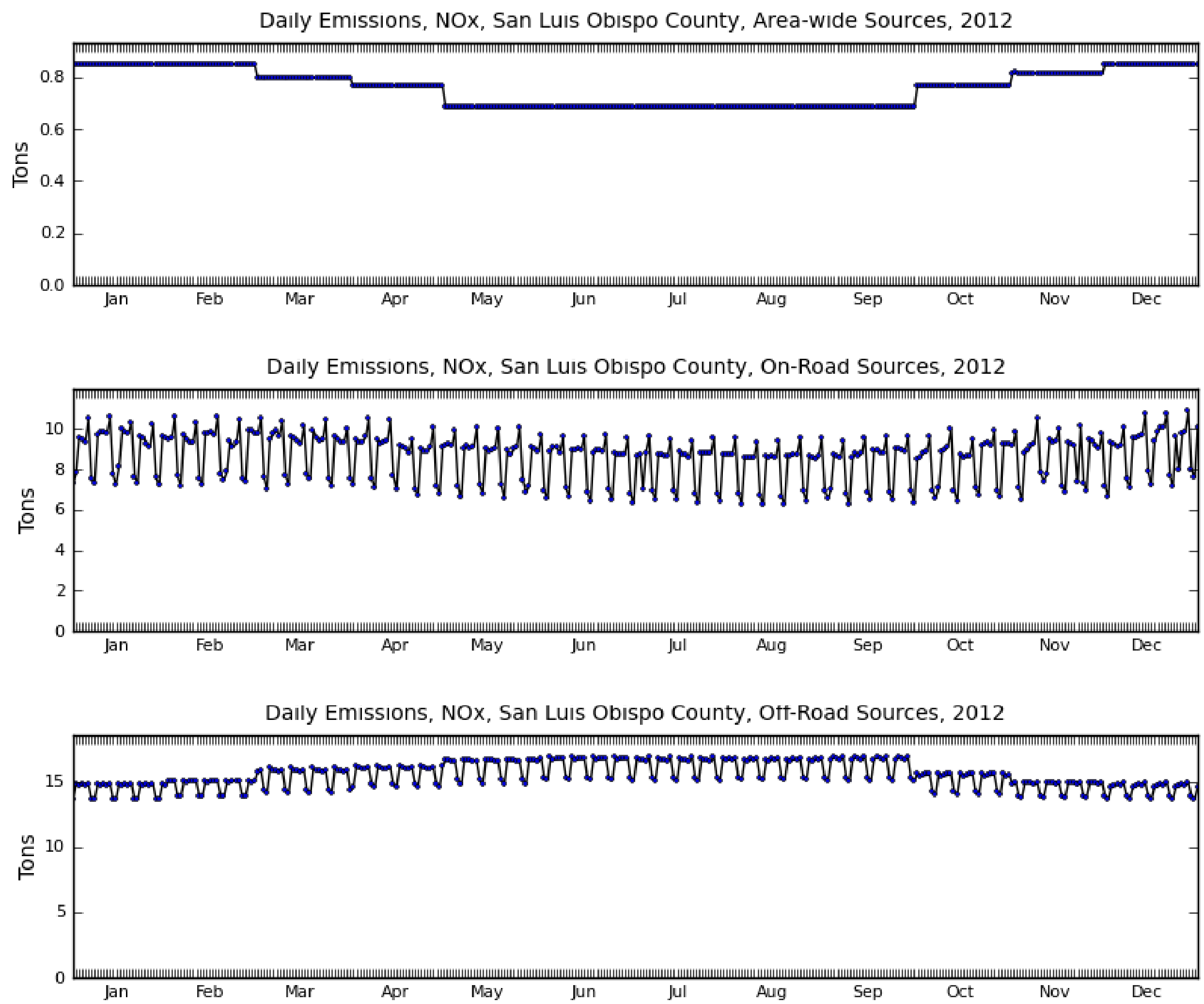

Figure 12 Daily variation of NOx emissions for mobile sources for San Luis Obispo

4.5 Model-ready Files Quality Assurance

Prior to developing the modeling inventory emissions files used in the photochemical models, the same model-ready emissions files developed for the individual source categories (e.g. on-road, area, point, day-specific sources) are checked for quality assurance. Extensive quality assurance procedures are already performed by CARB staff on the intermediate emissions files (e.g. MEDS, SMOKE-generated reports); however, further checks are needed to ensure data integrity is preserved when the model-ready emissions files are generated from those intermediate emissions files.

Comparisons of the totals for both the intermediate and model-ready emissions files are made. Emissions totals are aggregated spatially, temporally, and chemically to single-layer, statewide, daily values by inventory pollutant. Spatial plots are also generated for both the intermediate and model-ready emissions files using the same graphical utilities and aggregated to the same spatial, temporal, and chemical resolution to allow equal comparison of emissions. Any discrepancies in the emissions totals are reconciled before proceeding with the development of the model-ready inventory emissions files.

Before combining the model-ready emissions files of the individual source category inventories into a single model-ready inventory, they are checked for completeness. Day-specific source inventories (when necessary) should have emissions for every day in the modeling period. Likewise, source inventories with emissions files that use averaged temporal allocation (e.g. day-of-week, weekday/weekend, monthly) should have model-ready emissions files to represent every day in the modeling period. In particular, it is important that during these checks source inventories with missing files are identified and resolved. Once all constituent source inventories are complete, they are used to develop the model-ready inventory used in photochemical modeling. When the modeling inventory files are generated, log files are also generated documenting the constituents of each daily model-ready emissions file as an additional means of verifying that each daily model-ready inventory is complete.

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Appendix A: Day-of-week Redistribution Factors by Vehicle Type and County

The factors shown in Table 16 represent the “day-of-week” factors for each county for a broad vehicle class: LD is Light-Duty, LM is Light- and Medium-Duty Trucks, and HH is Heavy Heavy-Duty Trucks.

Table 16 Day-of-week adjustment by vehicle class and county

County	Day of Week	LD	LM	HH
Fresno	Sunday	0.851	0.443	0.396
Fresno	Monday	1.016	0.934	0.878
Fresno	Tues/Wed/Thurs	1	1	1
Fresno	Friday	1.155	1.026	0.927
Fresno	Saturday	0.946	0.563	0.478
Fresno	Holiday	0.799	0.774	0.784
Kern	Sunday	1.114	0.63	0.416
Kern	Monday	1.061	0.942	0.849
Kern	Tues/Wed/Thurs	1	1	1
Kern	Friday	1.253	1.044	0.9
Kern	Saturday	1.1	0.734	0.535
Kern	Holiday	0.986	0.911	0.837
Kings	Sunday	0.663	0.358	0.355
Kings	Monday	0.961	0.909	0.89
Kings	Tues/Wed/Thurs	1	1	1
Kings	Friday	1.045	0.982	0.947
Kings	Saturday	0.807	0.52	0.454
Kings	Holiday	0.669	0.665	0.758
Madera	Sunday	1.017	0.478	0.4
Madera	Monday	1.024	0.942	0.902
Madera	Tues/Wed/Thurs	1	1	1
Madera	Friday	1.176	1.022	0.96
Madera	Saturday	1.105	0.602	0.476
Madera	Holiday	0.866	0.833	0.832
Merced	Sunday	1.002	0.593	0.421
Merced	Monday	1.009	0.958	0.904
Merced	Tues/Wed/Thurs	1	1	1
Merced	Friday	1.185	1.103	0.97
Merced	Saturday	1.055	0.713	0.477
Merced	Holiday	0.977	0.897	0.797
San Joaquin	Sunday	0.933	0.5	0.393
San Joaquin	Monday	0.984	0.918	0.908
San Joaquin	Tues/Wed/Thurs	1	1	1
San Joaquin	Friday	1.128	1.086	0.976
San Joaquin	Saturday	1.035	0.657	0.466
San Joaquin	Holiday	0.907	0.77	0.757
Stanislaus	Sunday	1.002	0.593	0.421
Stanislaus	Monday	1.009	0.958	0.904
Stanislaus	Tues/Wed/Thurs	1	1	1
Stanislaus	Friday	1.185	1.103	0.97
Stanislaus	Saturday	1.055	0.713	0.477
Stanislaus	Holiday	0.977	0.897	0.797
Tulare	Sunday	1.029	0.429	0.185
Tulare	Monday	1.052	0.936	0.912
Tulare	Tues/Wed/Thurs	1	1	1
Tulare	Friday	1.099	1.02	0.97
Tulare	Saturday	0.993	0.67	0.503
Tulare	Holiday	0.942	0.585	0.567

Appendix B: Hour-of-day Profiles by Vehicle Type and County

The factors shown in the table below represent the differently hourly profiles for different days of the week for each county for a broad vehicle class: LD is Light-Duty, LM is Light- and Medium-Duty Trucks, and HH is Heavy Heavy-Duty Trucks.

Table 17 Hour-of-day profiles by vehicle type and county

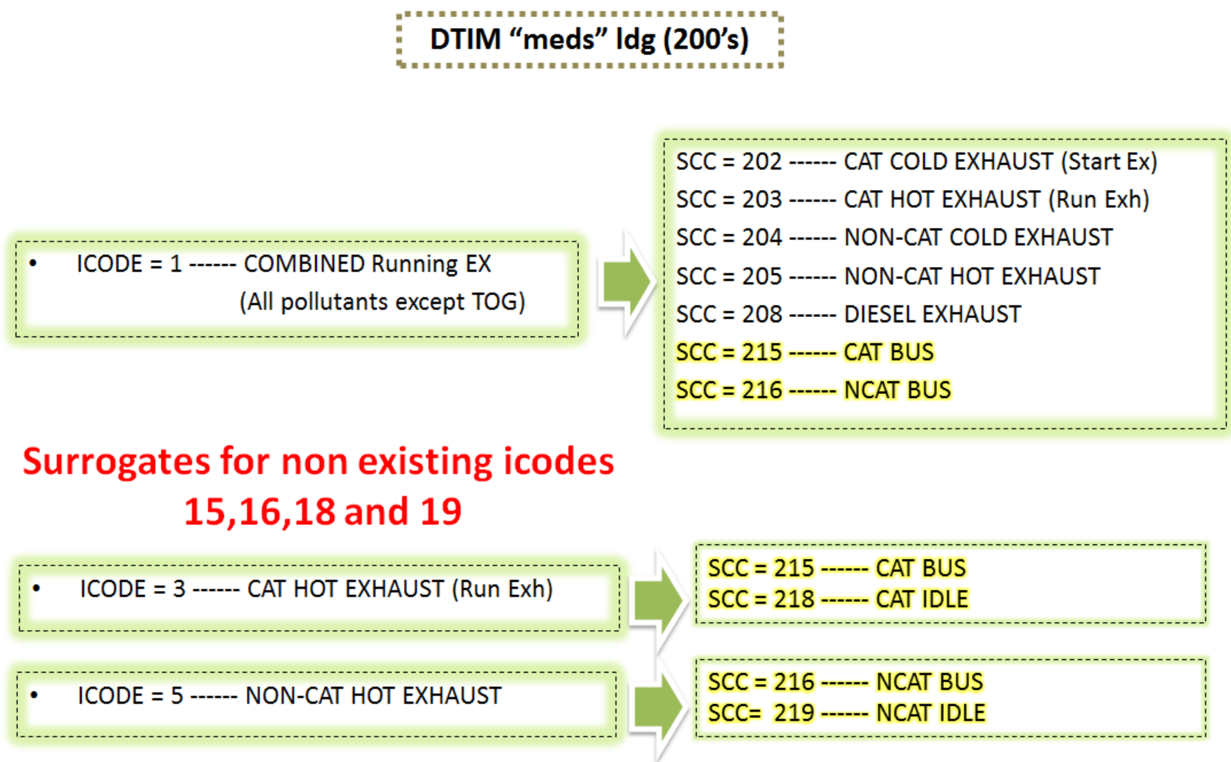
		Fresno			Kern			Kings			Madera			Merced			San Joaquin			Stanislaus			Tulare		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.015	0.033	0.043	0.014	0.028	0.041	0.016	0.031	0.042	0.014	0.037	0.044	0.014	0.025	0.037	0.016	0.024	0.039	0.014	0.025	0.037	0.022	0.015	0.017
Sunday	1	0.01	0.03	0.04	0.01	0.024	0.038	0.01	0.025	0.038	0.008	0.032	0.04	0.009	0.019	0.032	0.01	0.017	0.034	0.009	0.019	0.032	0.024	0.015	0.009
Sunday	2	0.008	0.027	0.037	0.007	0.022	0.034	0.007	0.026	0.036	0.005	0.028	0.037	0.007	0.016	0.029	0.007	0.015	0.031	0.007	0.016	0.029	0.023	0.011	0.008
Sunday	3	0.005	0.025	0.034	0.006	0.02	0.033	0.005	0.022	0.031	0.004	0.026	0.035	0.005	0.015	0.028	0.006	0.014	0.03	0.005	0.015	0.028	0.023	0.009	0.01
Sunday	4	0.006	0.024	0.034	0.007	0.021	0.033	0.004	0.02	0.031	0.004	0.025	0.034	0.006	0.016	0.028	0.008	0.015	0.03	0.006	0.016	0.028	0.024	0.01	0.018
Sunday	5	0.01	0.026	0.034	0.012	0.024	0.033	0.008	0.023	0.031	0.009	0.027	0.034	0.01	0.019	0.029	0.011	0.018	0.031	0.01	0.019	0.029	0.026	0.018	0.025
Sunday	6	0.017	0.029	0.036	0.016	0.027	0.034	0.018	0.029	0.036	0.016	0.03	0.036	0.015	0.023	0.031	0.017	0.022	0.033	0.015	0.023	0.031	0.03	0.031	0.042
Sunday	7	0.022	0.032	0.037	0.024	0.032	0.035	0.023	0.03	0.035	0.022	0.033	0.036	0.021	0.029	0.035	0.023	0.027	0.036	0.021	0.029	0.035	0.034	0.035	0.05
Sunday	8	0.032	0.038	0.04	0.032	0.039	0.038	0.034	0.04	0.04	0.033	0.039	0.04	0.031	0.038	0.04	0.032	0.036	0.04	0.031	0.038	0.04	0.035	0.042	0.052
Sunday	9	0.044	0.046	0.044	0.042	0.045	0.04	0.048	0.049	0.046	0.046	0.047	0.044	0.043	0.05	0.047	0.045	0.048	0.046	0.043	0.05	0.047	0.04	0.057	0.047
Sunday	10	0.055	0.052	0.046	0.051	0.051	0.042	0.059	0.057	0.049	0.056	0.052	0.046	0.055	0.06	0.051	0.056	0.059	0.05	0.055	0.06	0.051	0.044	0.066	0.054
Sunday	11	0.063	0.057	0.047	0.059	0.056	0.045	0.071	0.064	0.052	0.065	0.057	0.048	0.063	0.065	0.054	0.063	0.067	0.054	0.063	0.065	0.054	0.047	0.07	0.055
Sunday	12	0.071	0.062	0.049	0.066	0.06	0.046	0.084	0.077	0.057	0.071	0.059	0.049	0.07	0.07	0.055	0.068	0.071	0.056	0.07	0.07	0.055	0.051	0.076	0.058
Sunday	13	0.076	0.064	0.049	0.071	0.063	0.047	0.083	0.077	0.056	0.073	0.059	0.049	0.075	0.071	0.056	0.071	0.074	0.055	0.075	0.071	0.056	0.054	0.073	0.07
Sunday	14	0.077	0.063	0.048	0.075	0.065	0.047	0.08	0.072	0.055	0.076	0.059	0.048	0.077	0.069	0.055	0.073	0.073	0.054	0.077	0.069	0.055	0.056	0.071	0.068
Sunday	15	0.077	0.061	0.047	0.078	0.064	0.048	0.076	0.065	0.052	0.076	0.058	0.047	0.078	0.07	0.053	0.073	0.071	0.053	0.078	0.07	0.053	0.059	0.071	0.067
Sunday	16	0.075	0.059	0.046	0.077	0.063	0.048	0.074	0.062	0.05	0.077	0.058	0.047	0.077	0.067	0.052	0.073	0.068	0.05	0.077	0.067	0.052	0.06	0.066	0.066
Sunday	17	0.073	0.056	0.045	0.074	0.06	0.047	0.068	0.056	0.046	0.074	0.055	0.046	0.075	0.062	0.049	0.072	0.063	0.049	0.075	0.062	0.049	0.061	0.063	0.064
Sunday	18	0.066	0.05	0.044	0.069	0.055	0.046	0.059	0.044	0.042	0.068	0.048	0.043	0.068	0.055	0.046	0.067	0.055	0.044	0.068	0.055	0.046	0.06	0.052	0.056
Sunday	19	0.057	0.044	0.042	0.061	0.049	0.046	0.05	0.037	0.037	0.06	0.043	0.041	0.061	0.047	0.042	0.061	0.047	0.041	0.061	0.047	0.042	0.059	0.05	0.051
Sunday	20	0.05	0.038	0.041	0.053	0.042	0.045	0.043	0.032	0.037	0.052	0.039	0.04	0.051	0.039	0.04	0.054	0.04	0.039	0.051	0.039	0.04	0.055	0.037	0.04
Sunday	21	0.04	0.033	0.04	0.042	0.035	0.044	0.036	0.028	0.035	0.042	0.034	0.039	0.041	0.031	0.038	0.044	0.031	0.036	0.041	0.031	0.038	0.048	0.029	0.028
Sunday	22	0.03	0.028	0.04	0.032	0.03	0.045	0.028	0.022	0.034	0.031	0.028	0.038	0.029	0.024	0.036	0.031	0.024	0.035	0.029	0.024	0.036	0.038	0.018	0.029
Sunday	23	0.02	0.023	0.039	0.021	0.025	0.046	0.015	0.015	0.033	0.018	0.023	0.037	0.019	0.019	0.037	0.019	0.019	0.036	0.019	0.019	0.037	0.028	0.014	0.019
Monday	0	0.009	0.019	0.024	0.013	0.022	0.025	0.005	0.013	0.019	0.007	0.021	0.024	0.011	0.017	0.023	0.01	0.012	0.022	0.011	0.017	0.023	0.022	0.004	0.006
Monday	1	0.005	0.018	0.023	0.009	0.019	0.024	0.002	0.012	0.019	0.003	0.02	0.024	0.007	0.015	0.022	0.006	0.01	0.021	0.007	0.015	0.022	0.023	0.004	0.004
Monday	2	0.004	0.018	0.023	0.008	0.019	0.024	0.001	0.014	0.02	0.002	0.02	0.024	0.006	0.015	0.022	0.006	0.01	0.022	0.006	0.015	0.022	0.023	0.004	0.005
Monday	3	0.005	0.02	0.025	0.011	0.022	0.026	0.001	0.012	0.019	0.004	0.023	0.026	0.009	0.018	0.025	0.011	0.015	0.025	0.009	0.018	0.025	0.024	0.006	0.011
Monday	4	0.011	0.023	0.027	0.021	0.029	0.028	0.003	0.015	0.021	0.012	0.028	0.029	0.018	0.027	0.032	0.029	0.028	0.033	0.018	0.027	0.032	0.027	0.015	0.02
Monday	5	0.024	0.034	0.033	0.04	0.041	0.033	0.012	0.021	0.027	0.029	0.039	0.036	0.03	0.039	0.039	0.043	0.043	0.042	0.03	0.039	0.039	0.035	0.035	0.032
Monday	6	0.044	0.047	0.041	0.047	0.046	0.034	0.034	0.04	0.038	0.05	0.051	0.044	0.044	0.051	0.045	0.053	0.052	0.048	0.044	0.051	0.045	0.04	0.056	0.05
Monday	7	0.069	0.064	0.048	0.056	0.054	0.038	0.07	0.071	0.056	0.072	0.063	0.051	0.058	0.058	0.05	0.061	0.059	0.053	0.058	0.058	0.05	0.044	0.063	0.057
Monday	8	0.063	0.062	0.049	0.05	0.052	0.038	0.073	0.071	0.056	0.063	0.059	0.049	0.053	0.058	0.051	0.055	0.057	0.053	0.053	0.058	0.051	0.046	0.071	0.059
Monday	9	0.055	0.056	0.047	0.049	0.052	0.039	0.061	0.062	0.053	0.058	0.056	0.049	0.051	0.059	0.053	0.051	0.056	0.055	0.051	0.059	0.053	0.046	0.066	0.06
Monday	10	0.055	0.056	0.048	0.052	0.053	0.042	0.059	0.062	0.054	0.057	0.057	0.051	0.054	0.062	0.056	0.051	0.058	0.056	0.054	0.062	0.056	0.049	0.07	0.066
Monday	11	0.057	0.059	0.05	0.057	0.056	0.044	0.059	0.063	0.056	0.059	0.059	0.053	0.057	0.064	0.057	0.052	0.06	0.058	0.057	0.064	0.057	0.051	0.07	0.065
Monday	12	0.061	0.061	0.052	0.061	0.059	0.046	0.062	0.064	0.056	0.06	0.062	0.055	0.06	0.064	0.058	0.054	0.061	0.058	0.06	0.064	0.058	0.056	0.072	0.066
Monday	13	0.063	0.062	0.054	0.064	0.06	0.049	0.064	0.067	0.058	0.061	0.061	0.054	0.061	0.064	0.058	0.056	0.063	0.057	0.061	0.064	0.058	0.055	0.073	0.071
Monday	14	0.069	0.065	0.056	0.068	0.063	0.052	0.073	0.071	0.064	0.066	0.062	0.057	0.067	0.066	0.058	0.063	0.068	0.058	0.067	0.066	0.058	0.058	0.073	0.07
Monday	15	0.074	0.068	0.058	0.074	0.067	0.057	0.078	0.072	0.064	0.071	0.064	0.058	0.072	0.065	0.057	0.069	0.072	0.059	0.072	0.065	0.057	0.061	0.077	0.074

		Fresno			Kern			Kings			Madera			Merced			San Joaquin			Stanislaus			Tulare		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Monday	16	0.079	0.068	0.059	0.073	0.065	0.058	0.086	0.073	0.062	0.075	0.062	0.057	0.075	0.063	0.055	0.072	0.071	0.056	0.075	0.063	0.055	0.061	0.073	0.064
Monday	17	0.076	0.062	0.057	0.067	0.058	0.057	0.087	0.07	0.062	0.074	0.058	0.055	0.074	0.055	0.051	0.07	0.065	0.052	0.074	0.055	0.051	0.059	0.059	0.057
Monday	18	0.053	0.043	0.05	0.05	0.044	0.053	0.056	0.046	0.053	0.052	0.041	0.047	0.055	0.042	0.042	0.055	0.045	0.041	0.055	0.042	0.042	0.05	0.037	0.047
Monday	19	0.037	0.03	0.043	0.037	0.034	0.049	0.037	0.028	0.038	0.037	0.03	0.039	0.042	0.031	0.036	0.041	0.031	0.033	0.042	0.031	0.036	0.045	0.024	0.036
Monday	20	0.03	0.023	0.039	0.032	0.028	0.048	0.029	0.021	0.033	0.03	0.022	0.034	0.034	0.023	0.031	0.033	0.023	0.028	0.034	0.023	0.031	0.04	0.017	0.031
Monday	21	0.024	0.018	0.035	0.026	0.023	0.048	0.023	0.015	0.029	0.025	0.017	0.031	0.027	0.018	0.028	0.027	0.017	0.026	0.027	0.018	0.028	0.035	0.013	0.023
Monday	22	0.018	0.013	0.032	0.021	0.018	0.044	0.016	0.01	0.024	0.019	0.014	0.027	0.02	0.014	0.027	0.021	0.013	0.023	0.02	0.014	0.027	0.029	0.01	0.017
Monday	23	0.012	0.01	0.029	0.014	0.015	0.042	0.009	0.007	0.021	0.012	0.011	0.024	0.014	0.011	0.025	0.014	0.01	0.022	0.014	0.011	0.025	0.022	0.006	0.011
Tues/Wed/Thurs	0	0.007	0.018	0.027	0.01	0.021	0.032	0.004	0.013	0.022	0.005	0.02	0.027	0.008	0.016	0.025	0.009	0.011	0.024	0.008	0.016	0.025	0.021	0.004	0.009
Tues/Wed/Thurs	1	0.004	0.017	0.027	0.006	0.019	0.031	0.002	0.012	0.021	0.001	0.019	0.026	0.005	0.014	0.024	0.006	0.01	0.023	0.005	0.014	0.024	0.021	0.004	0.007
Tues/Wed/Thurs	2	0.003	0.017	0.027	0.006	0.019	0.031	0	0.011	0.021	0.001	0.019	0.027	0.005	0.014	0.025	0.005	0.01	0.023	0.005	0.014	0.025	0.022	0.004	0.009
Tues/Wed/Thurs	3	0.004	0.019	0.028	0.009	0.022	0.031	0	0.012	0.021	0.002	0.022	0.028	0.008	0.018	0.028	0.01	0.014	0.026	0.008	0.018	0.028	0.024	0.005	0.012
Tues/Wed/Thurs	4	0.009	0.023	0.031	0.019	0.029	0.034	0.003	0.014	0.023	0.01	0.027	0.032	0.017	0.026	0.034	0.027	0.026	0.034	0.017	0.026	0.034	0.028	0.014	0.018
Tues/Wed/Thurs	5	0.024	0.032	0.036	0.039	0.041	0.037	0.012	0.021	0.029	0.027	0.037	0.039	0.03	0.039	0.042	0.043	0.041	0.042	0.03	0.039	0.042	0.035	0.033	0.032
Tues/Wed/Thurs	6	0.044	0.047	0.044	0.048	0.046	0.039	0.035	0.04	0.042	0.05	0.05	0.047	0.044	0.05	0.047	0.054	0.051	0.049	0.044	0.05	0.047	0.041	0.056	0.052
Tues/Wed/Thurs	7	0.07	0.064	0.051	0.058	0.053	0.042	0.07	0.066	0.055	0.074	0.063	0.054	0.059	0.059	0.052	0.062	0.059	0.054	0.059	0.059	0.052	0.044	0.067	0.06
Tues/Wed/Thurs	8	0.065	0.063	0.051	0.052	0.052	0.042	0.073	0.071	0.058	0.065	0.059	0.052	0.055	0.058	0.052	0.056	0.057	0.054	0.055	0.058	0.052	0.046	0.071	0.063
Tues/Wed/Thurs	9	0.055	0.057	0.049	0.049	0.05	0.041	0.06	0.062	0.054	0.057	0.057	0.051	0.051	0.059	0.054	0.051	0.055	0.055	0.051	0.059	0.054	0.047	0.067	0.065
Tues/Wed/Thurs	10	0.054	0.056	0.05	0.05	0.051	0.042	0.057	0.06	0.054	0.055	0.057	0.052	0.052	0.06	0.056	0.049	0.056	0.056	0.052	0.06	0.056	0.049	0.069	0.065
Tues/Wed/Thurs	11	0.055	0.058	0.051	0.054	0.054	0.044	0.058	0.063	0.056	0.056	0.058	0.052	0.054	0.061	0.057	0.05	0.058	0.056	0.054	0.061	0.057	0.052	0.071	0.062
Tues/Wed/Thurs	12	0.058	0.06	0.051	0.059	0.056	0.046	0.06	0.064	0.056	0.057	0.059	0.053	0.057	0.062	0.057	0.052	0.059	0.056	0.057	0.062	0.057	0.054	0.069	0.065
Tues/Wed/Thurs	13	0.061	0.062	0.053	0.062	0.058	0.047	0.061	0.064	0.057	0.059	0.06	0.054	0.06	0.063	0.056	0.055	0.062	0.056	0.06	0.063	0.056	0.056	0.072	0.067
Tues/Wed/Thurs	14	0.068	0.065	0.054	0.068	0.062	0.05	0.071	0.07	0.059	0.065	0.063	0.055	0.066	0.065	0.056	0.062	0.068	0.057	0.066	0.065	0.056	0.059	0.074	0.07
Tues/Wed/Thurs	15	0.074	0.067	0.056	0.075	0.067	0.053	0.077	0.072	0.062	0.072	0.064	0.056	0.073	0.066	0.055	0.069	0.074	0.058	0.073	0.066	0.055	0.061	0.08	0.071
Tues/Wed/Thurs	16	0.08	0.067	0.056	0.075	0.066	0.054	0.086	0.073	0.06	0.078	0.064	0.055	0.077	0.064	0.053	0.072	0.074	0.057	0.077	0.064	0.053	0.06	0.072	0.063
Tues/Wed/Thurs	17	0.078	0.063	0.054	0.07	0.06	0.053	0.087	0.072	0.06	0.079	0.061	0.053	0.076	0.057	0.049	0.07	0.067	0.053	0.076	0.057	0.049	0.057	0.059	0.054
Tues/Wed/Thurs	18	0.055	0.045	0.047	0.052	0.046	0.048	0.059	0.051	0.051	0.055	0.043	0.044	0.058	0.044	0.041	0.056	0.048	0.041	0.058	0.044	0.041	0.051	0.037	0.043
Tues/Wed/Thurs	19	0.039	0.032	0.04	0.039	0.036	0.044	0.039	0.032	0.038	0.04	0.031	0.036	0.044	0.032	0.034	0.043	0.033	0.033	0.044	0.032	0.034	0.045	0.025	0.036
Tues/Wed/Thurs	20	0.032	0.024	0.035	0.033	0.03	0.042	0.032	0.023	0.032	0.033	0.024	0.032	0.036	0.025	0.03	0.034	0.025	0.028	0.036	0.025	0.03	0.041	0.019	0.027
Tues/Wed/Thurs	21	0.027	0.019	0.032	0.029	0.025	0.041	0.026	0.017	0.028	0.028	0.019	0.028	0.028	0.019	0.026	0.028	0.019	0.025	0.028	0.019	0.026	0.035	0.014	0.021
Tues/Wed/Thurs	22	0.02	0.014	0.028	0.023	0.02	0.039	0.018	0.011	0.023	0.021	0.014	0.025	0.021	0.014	0.025	0.021	0.014	0.022	0.021	0.014	0.025	0.029	0.01	0.015
Tues/Wed/Thurs	23	0.013	0.01	0.025	0.015	0.017	0.038	0.01	0.007	0.019	0.013	0.011	0.023	0.015	0.012	0.023	0.015	0.01	0.021	0.015	0.012	0.023	0.022	0.006	0.011
Friday	0	0.007	0.019	0.03	0.009	0.021	0.035	0.006	0.014	0.024	0.005	0.02	0.029	0.008	0.016	0.027	0.008	0.012	0.025	0.008	0.016	0.027	0.02	0.004	0.01
Friday	1	0.004	0.018	0.03	0.007	0.019	0.034	0.002	0.012	0.024	0.002	0.019	0.029	0.006	0.014	0.025	0.006	0.01	0.024	0.006	0.014	0.025	0.021	0.003	0.007
Friday	2	0.003	0.017	0.029	0.006	0.019	0.034	0.001	0.011	0.022	0.001	0.019	0.029	0.005	0.014	0.026	0.005	0.01	0.024	0.005	0.014	0.026	0.023	0.004	0.008
Friday	3	0.004	0.019	0.031	0.008	0.021	0.035	0.001	0.013	0.024	0.003	0.021	0.03	0.008	0.017	0.029	0.009	0.013	0.027	0.008	0.017	0.029	0.022	0.005	0.013
Friday	4	0.009	0.023	0.034	0.015	0.027	0.037	0.002	0.015	0.025	0.008	0.026	0.034	0.014	0.024	0.035	0.022	0.023	0.034	0.014	0.024	0.035	0.027	0.013	0.02
Friday	5	0.02	0.032	0.039	0.031	0.037	0.04	0.011	0.021	0.031	0.022	0.036	0.04	0.024	0.035	0.042	0.036	0.036	0.042	0.024	0.035	0.042	0.034	0.032	0.033
Friday	6	0.037	0.044	0.046	0.039	0.043	0.043	0.031	0.039	0.043	0.039	0.047	0.048	0.036	0.045	0.047	0.046	0.045	0.048	0.036	0.045	0.047	0.038	0.051	0.057
Friday	7	0.059	0.06	0.053	0.048	0.05	0.045	0.063	0.064	0.057	0.059	0.058	0.054	0.049	0.053	0.052	0.053	0.052	0.053	0.049	0.053	0.052	0.042	0.062	0.063
Friday	8	0.057	0.059	0.053	0.045	0.05	0.045	0.067	0.069	0.059	0.054	0.058	0.054	0.047	0.054	0.053	0.049	0.051	0.054	0.047	0.054	0.053	0.046	0.07	0.063
Friday	9	0.052	0.056	0.052	0.045	0.049	0.046	0.057	0.062	0.057	0.051	0.056	0.054	0.047	0.056	0.055	0.046	0.052	0.055	0.047	0.056	0.055	0.047	0.066	0.063
Friday	10	0.053	0.057	0.052	0.049	0.053	0.047	0.057	0.063	0.056	0.052	0.057	0.054	0.051	0.06	0.058	0.048	0.055	0.057	0.051	0.06	0.058	0.05	0.07	0.066
Friday	11	0.056	0.059	0.053	0.054	0.055	0.048	0.059	0.065	0.058	0.054	0.059	0.054	0.054	0.062	0.06	0.05	0.058	0.059	0.054	0.062	0.06	0.052	0.071	0.063
Friday	12	0.059	0.061	0.053	0.058	0.057	0.049	0.061	0.064	0.058	0.056	0.06	0.055	0.057	0.063	0.06	0.054	0.061	0.058	0.057	0.063	0.06	0.054	0.07	0.067
Friday	13	0.062	0.063	0.054	0.063	0.06	0.05	0.062	0.066	0.058	0.059	0.062	0.055	0.061	0.065	0.059	0.058	0.065	0.058	0.061	0.065	0.059	0.056	0.072	0.067
Friday	14	0.068	0.066	0.055	0.068	0.063	0.051	0.07	0.069	0.058	0.065	0.063	0.055	0.068	0.067	0.058	0.065	0.07	0.059	0.068	0.067	0.058	0.058	0.074	0.07
Friday	15	0.073	0.067	0.055	0.072	0.067	0.053	0.073	0.069	0.06	0.071	0.064	0.056	0.074	0.067	0.056	0.069	0.075	0.059	0.074	0.067	0.056	0.059	0.075	0.068
Friday	16	0.077	0.067	0.053	0.073	0.064	0.052	0.079	0.073	0.06	0.077	0.062	0.053	0.076	0.064	0.053	0.071	0.073	0.057	0.076	0.064	0.053	0.059	0.07	0.059
Friday	17	0.074	0.061	0.05	0.07	0.059	0.05	0.079	0.065	0.055	0.076	0.057	0.049	0.075	0.058	0.048	0.069	0.069	0.053	0.075	0.058	0.048	0.055	0.057	0.055
Friday	18	0.06	0.047	0.043	0.06	0.048	0.044	0.061	0.05	0.047	0.063	0.046	0.042	0.064	0.048	0.04	0.061	0.052	0.041	0.064	0.048	0.04	0.053	0.041	0.043
Friday	19	0.046	0.034	0.036	0.049	0.039	0.039	0.045	0.034	0.036	0.05	0.035	0.035	0.052	0.037	0.032	0.05	0.038	0.031	0.052	0.037	0.032	0.045	0.027	0.036
Friday	20	0.038	0.026	0.03	0.042	0.032	0.035	0.036	0.023	0.028	0.042	0.026	0.029	0.043	0.029	0.026	0.042	0.029	0.026	0.043	0.029	0.026	0.042	0.02	0.026
Friday	21	0.034	0.02	0.026	0.037	0.027	0.032	0.031	0.017	0.024	0.037	0.021	0.025	0.035	0.022	0.022	0.035	0.022	0.022	0.035	0.022	0.022	0.039	0.017	0.019
Friday	22	0.028	0.015	0.023	0.031	0.023	0.029	0.028	0.013	0.019	0.03	0.015	0.02	0.027	0.016	0.02	0.028	0.017	0.019	0.027	0.016	0.02	0.032	0.014	0.015

		Fresno			Kern			Kings			Madera			Merced			San Joaquin			Stanislaus			Tulare		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Friday	23	0.02	0.011	0.02	0.021	0.018	0.027	0.017	0.008	0.016	0.021	0.012	0.018	0.02	0.012	0.018	0.02	0.012	0.017	0.02	0.012	0.018	0.026	0.011	0.01
Saturday	0	0.015	0.028	0.041	0.016	0.028	0.043	0.013	0.022	0.035	0.012	0.031	0.042	0.015	0.026	0.04	0.014	0.021	0.037	0.015	0.026	0.04	0.025	0.01	0.013
Saturday	1	0.01	0.025	0.038	0.011	0.023	0.041	0.008	0.019	0.032	0.008	0.027	0.039	0.01	0.02	0.035	0.009	0.016	0.032	0.01	0.02	0.035	0.025	0.007	0.01
Saturday	2	0.008	0.024	0.037	0.009	0.022	0.04	0.005	0.017	0.031	0.006	0.025	0.038	0.008	0.018	0.032	0.007	0.014	0.031	0.008	0.018	0.032	0.026	0.007	0.011
Saturday	3	0.006	0.023	0.036	0.009	0.021	0.04	0.003	0.016	0.03	0.005	0.024	0.036	0.008	0.019	0.032	0.007	0.015	0.031	0.008	0.019	0.032	0.027	0.009	0.013
Saturday	4	0.009	0.024	0.037	0.014	0.025	0.041	0.004	0.016	0.031	0.008	0.027	0.037	0.011	0.021	0.035	0.011	0.018	0.033	0.011	0.021	0.035	0.029	0.014	0.024
Saturday	5	0.016	0.029	0.04	0.027	0.034	0.044	0.01	0.022	0.033	0.017	0.032	0.041	0.017	0.028	0.039	0.018	0.025	0.037	0.017	0.028	0.039	0.036	0.033	0.032
Saturday	6	0.026	0.036	0.045	0.034	0.038	0.045	0.023	0.031	0.041	0.026	0.039	0.046	0.025	0.036	0.045	0.027	0.033	0.042	0.025	0.036	0.045	0.042	0.056	0.054
Saturday	7	0.036	0.043	0.049	0.042	0.045	0.047	0.036	0.041	0.048	0.036	0.045	0.05	0.034	0.044	0.05	0.036	0.042	0.048	0.034	0.044	0.05	0.041	0.055	0.068
Saturday	8	0.045	0.05	0.052	0.05	0.052	0.05	0.045	0.049	0.053	0.047	0.052	0.054	0.044	0.053	0.055	0.045	0.05	0.054	0.044	0.053	0.055	0.043	0.057	0.069
Saturday	9	0.053	0.055	0.054	0.056	0.056	0.052	0.053	0.054	0.057	0.055	0.057	0.056	0.054	0.061	0.06	0.054	0.059	0.058	0.054	0.061	0.06	0.045	0.061	0.069
Saturday	10	0.06	0.061	0.056	0.06	0.057	0.053	0.061	0.063	0.059	0.062	0.062	0.06	0.062	0.068	0.063	0.061	0.067	0.062	0.062	0.068	0.063	0.048	0.066	0.068
Saturday	11	0.066	0.064	0.056	0.063	0.059	0.053	0.067	0.072	0.062	0.067	0.063	0.058	0.067	0.071	0.064	0.065	0.071	0.063	0.067	0.071	0.064	0.05	0.067	0.068
Saturday	12	0.069	0.065	0.056	0.065	0.061	0.052	0.071	0.072	0.064	0.068	0.062	0.056	0.069	0.07	0.062	0.067	0.072	0.062	0.069	0.07	0.062	0.052	0.068	0.065
Saturday	13	0.069	0.063	0.054	0.066	0.061	0.05	0.071	0.069	0.06	0.068	0.059	0.054	0.07	0.067	0.058	0.067	0.07	0.059	0.07	0.067	0.058	0.053	0.067	0.068
Saturday	14	0.07	0.063	0.053	0.067	0.06	0.049	0.071	0.07	0.06	0.068	0.059	0.051	0.07	0.064	0.054	0.067	0.068	0.056	0.07	0.064	0.054	0.055	0.07	0.07
Saturday	15	0.069	0.06	0.049	0.067	0.06	0.048	0.07	0.067	0.055	0.068	0.056	0.049	0.069	0.061	0.049	0.067	0.065	0.052	0.069	0.061	0.049	0.058	0.077	0.065
Saturday	16	0.067	0.057	0.046	0.064	0.056	0.044	0.07	0.061	0.049	0.068	0.054	0.046	0.068	0.057	0.045	0.066	0.061	0.048	0.068	0.057	0.045	0.057	0.066	0.055
Saturday	17	0.063	0.051	0.042	0.058	0.052	0.041	0.066	0.056	0.046	0.064	0.05	0.041	0.064	0.051	0.04	0.063	0.055	0.043	0.064	0.051	0.04	0.054	0.053	0.05
Saturday	18	0.056	0.044	0.036	0.051	0.046	0.036	0.059	0.048	0.038	0.057	0.042	0.035	0.056	0.042	0.033	0.057	0.045	0.036	0.056	0.042	0.033	0.052	0.04	0.039
Saturday	19	0.047	0.036	0.031	0.044	0.037	0.032	0.049	0.036	0.03	0.049	0.034	0.029	0.048	0.034	0.027	0.049	0.036	0.03	0.048	0.034	0.027	0.046	0.034	0.03
Saturday	20	0.041	0.031	0.027	0.039	0.033	0.028	0.043	0.032	0.027	0.043	0.03	0.025	0.041	0.029	0.024	0.043	0.03	0.026	0.041	0.029	0.024	0.042	0.027	0.021
Saturday	21	0.038	0.027	0.023	0.035	0.029	0.026	0.04	0.027	0.022	0.039	0.027	0.022	0.037	0.024	0.021	0.04	0.026	0.023	0.037	0.024	0.021	0.038	0.023	0.018
Saturday	22	0.034	0.024	0.021	0.03	0.024	0.024	0.037	0.024	0.02	0.035	0.024	0.019	0.031	0.02	0.019	0.035	0.023	0.021	0.031	0.02	0.019	0.032	0.019	0.011
Saturday	23	0.024	0.019	0.019	0.023	0.02	0.02	0.024	0.017	0.017	0.025	0.02	0.018	0.023	0.016	0.017	0.025	0.017	0.019	0.023	0.016	0.017	0.025	0.014	0.008
Holiday	0	0.013	0.023	0.029	0.015	0.023	0.028	0.011	0.017	0.026	0.01	0.023	0.027	0.013	0.02	0.027	0.012	0.015	0.027	0.013	0.02	0.027	0.024	0.008	0.009
Holiday	1	0.007	0.022	0.027	0.009	0.021	0.028	0.006	0.018	0.023	0.004	0.024	0.028	0.009	0.017	0.025	0.008	0.013	0.025	0.009	0.017	0.025	0.024	0.007	0.01
Holiday	2	0.005	0.022	0.027	0.007	0.02	0.028	0.002	0.018	0.027	0.002	0.022	0.027	0.007	0.015	0.024	0.006	0.012	0.025	0.007	0.015	0.024	0.023	0.006	0.007
Holiday	3	0.004	0.021	0.028	0.008	0.021	0.028	0.001	0.019	0.027	0.001	0.023	0.028	0.007	0.016	0.026	0.008	0.014	0.026	0.007	0.016	0.026	0.023	0.007	0.011
Holiday	4	0.008	0.024	0.03	0.013	0.024	0.028	0.002	0.015	0.027	0.006	0.026	0.03	0.011	0.02	0.029	0.015	0.02	0.03	0.011	0.02	0.029	0.027	0.016	0.017
Holiday	5	0.016	0.031	0.034	0.027	0.032	0.032	0.01	0.021	0.027	0.016	0.033	0.035	0.019	0.028	0.033	0.023	0.028	0.035	0.019	0.028	0.033	0.033	0.03	0.032
Holiday	6	0.028	0.039	0.038	0.033	0.037	0.033	0.026	0.034	0.037	0.028	0.04	0.039	0.027	0.035	0.038	0.031	0.035	0.039	0.027	0.035	0.038	0.035	0.045	0.052
Holiday	7	0.04	0.046	0.041	0.039	0.043	0.036	0.043	0.046	0.041	0.037	0.045	0.042	0.035	0.042	0.042	0.036	0.04	0.043	0.035	0.042	0.042	0.04	0.052	0.064
Holiday	8	0.045	0.049	0.043	0.043	0.047	0.037	0.05	0.052	0.042	0.044	0.051	0.045	0.04	0.048	0.046	0.041	0.045	0.047	0.04	0.048	0.046	0.043	0.065	0.066
Holiday	9	0.049	0.052	0.047	0.05	0.05	0.04	0.051	0.052	0.05	0.051	0.053	0.048	0.048	0.055	0.05	0.047	0.051	0.05	0.048	0.055	0.05	0.045	0.061	0.058
Holiday	10	0.057	0.059	0.049	0.055	0.055	0.042	0.06	0.067	0.052	0.06	0.06	0.053	0.059	0.064	0.055	0.055	0.061	0.056	0.059	0.064	0.055	0.05	0.075	0.055
Holiday	11	0.065	0.063	0.051	0.064	0.06	0.047	0.067	0.07	0.059	0.068	0.064	0.055	0.065	0.07	0.06	0.063	0.069	0.061	0.065	0.07	0.06	0.049	0.076	0.055
Holiday	12	0.07	0.067	0.054	0.068	0.061	0.05	0.073	0.077	0.064	0.072	0.066	0.056	0.069	0.072	0.061	0.066	0.072	0.062	0.069	0.072	0.061	0.058	0.075	0.06
Holiday	13	0.072	0.067	0.056	0.071	0.066	0.051	0.075	0.072	0.057	0.071	0.067	0.058	0.071	0.071	0.061	0.068	0.074	0.062	0.071	0.071	0.061	0.052	0.069	0.068
Holiday	14	0.074	0.066	0.055	0.073	0.064	0.052	0.076	0.07	0.062	0.073	0.064	0.058	0.072	0.069	0.059	0.07	0.073	0.06	0.072	0.069	0.059	0.055	0.069	0.07
Holiday	15	0.076	0.067	0.056	0.075	0.067	0.055	0.072	0.073	0.063	0.075	0.062	0.054	0.073	0.068	0.058	0.071	0.072	0.058	0.073	0.068	0.058	0.062	0.07	0.078
Holiday	16	0.076	0.064	0.055	0.072	0.064	0.055	0.075	0.066	0.057	0.076	0.06	0.054	0.073	0.065	0.055	0.071	0.068	0.054	0.073	0.065	0.055	0.065	0.074	0.069
Holiday	17	0.072	0.058	0.052	0.066	0.059	0.054	0.071	0.059	0.053	0.073	0.056	0.053	0.07	0.057	0.05	0.068	0.061	0.05	0.07	0.057	0.05	0.053	0.057	0.062
Holiday	18	0.058	0.046	0.049	0.056	0.046	0.049	0.059	0.046	0.048	0.061	0.044	0.046	0.06	0.046	0.044	0.06	0.05	0.042	0.06	0.046	0.044	0.051	0.04	0.046
Holiday	19	0.047	0.035	0.043	0.047	0.042	0.05	0.047	0.032	0.038	0.05	0.035	0.04	0.05	0.036	0.039	0.051	0.04	0.037	0.05	0.036	0.039	0.047	0.031	0.041
Holiday	20	0.039	0.028	0.04	0.039	0.033	0.046	0.04	0.029	0.033	0.043	0.029	0.037	0.042	0.029	0.034	0.044	0.031	0.032	0.042	0.029	0.034	0.046	0.027	0.026
Holiday	21	0.032	0.022	0.036	0.031	0.027	0.046	0.034	0.024	0.033	0.035	0.022	0.032	0.034	0.023	0.03	0.037	0.025	0.029	0.034	0.023	0.03	0.04	0.019	0.021
Holiday	22	0.026	0.017	0.032	0.025	0.021	0.043	0.03	0.015	0.031	0.028	0.018	0.029	0.027	0.017	0.028	0.029	0.019	0.026	0.027	0.017	0.028	0.034	0.014	0.014
Holiday	23	0.018	0.013	0.029	0.016	0.018	0.041	0.018	0.009	0.022	0.018	0.014	0.026	0.018	0.014	0.026	0.02	0.013	0.024	0.018	0.014	0.026	0.024	0.011	0.011

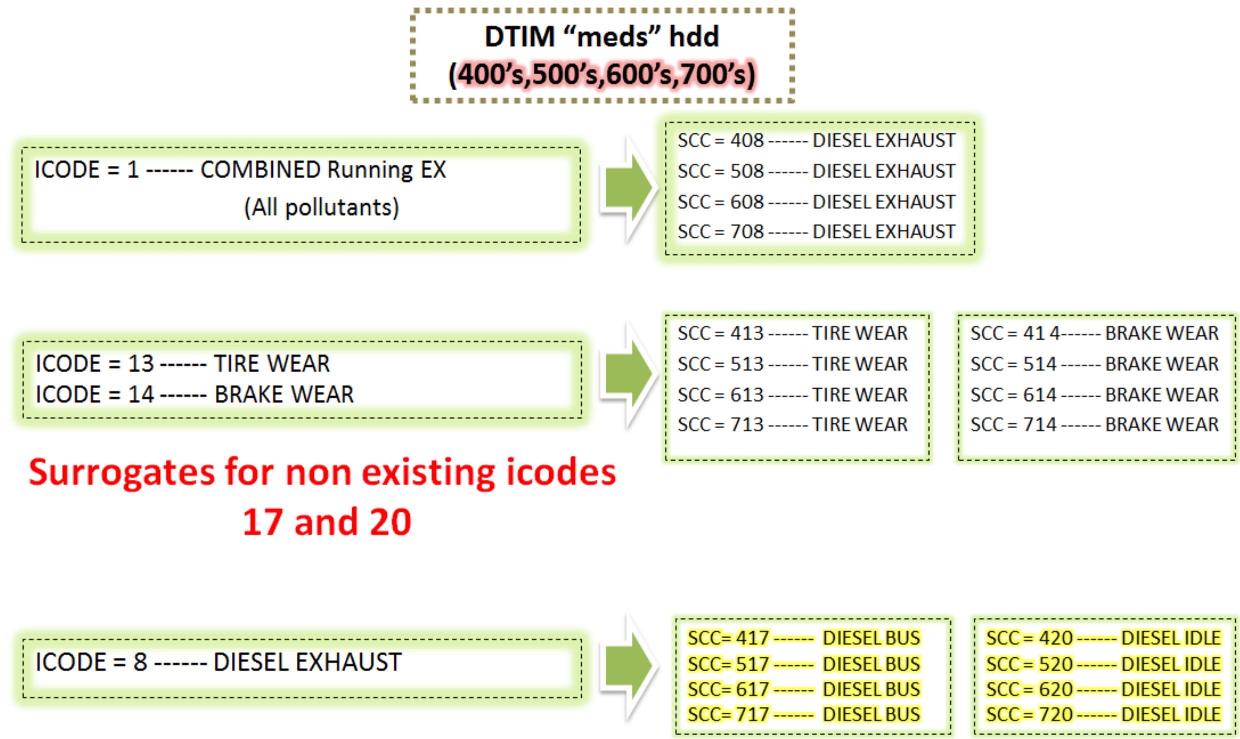
C1. Block Diagram of Scaling Process: ldg (gas: heavy- and light-duty; diesel: light-duty)

DTIM has 1 to 12 Source Classification Codes (SCC) that vary by species. For CO, NOx, SOx, and PM species, DTIM only uses SCC=1 for the running exhaust emissions regardless of the fuel type and process; however, distribution of the running exhaust emissions according to the fuel type and process is needed. The following diagram explains how to distribute the running exhaust emissions for the light-duty gas. The running exhaust emissions are distributed to the catalyst cold exhaust, catalyst hot exhaust, non-catalyst cold exhaust, non-catalyst hot exhaust, catalyst bus and non-catalyst bus by using the corresponding emissions from EMFAC. Since there are no idle emissions in DTIM, surrogates are needed for the catalyst idle and non-catalyst idle. The surrogates for the catalyst idle and non-catalyst idle are catalyst hot exhaust, and non-catalyst hot exhaust, respectively.



C2. Block Diagram of Scaling Process: hdd (heavy-duty diesel)

The following diagram explains how to distribute the running exhaust emissions for heavy-duty diesel. The running exhaust emissions are distributed to the diesel exhaust or diesel bus exhaust depending on the vehicle type by using the corresponding emissions from EMFAC. Since there are no idle emissions in DTIM, a surrogate is used. The surrogate for the diesel idle emissions is diesel exhaust or diesel bus exhaust, depending on the vehicle type.



Appendix D: Additional Temporal Profiles

Temporal profiles developed from the AgTool are applied as potential replacements when processing the emissions inventories for modeling using the SMOKE processor. This would apply for agriculturally related emissions with time-invariant temporal distributions, which includes the following emission source categories: food and agricultural processing, pesticides and fertilizers, farming operations, unpaved road dust, fugitive windblown dust, managed burning and disposal, and farming equipment

Table 18 Day-of-week temporal profiles from the Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool)

Code	M	T	W	TH	F	S	S
201	1	174	248	182	203	97	95
202	1	2	1	0	2	1	993
203	1	117	192	190	229	222	48
204	2	16	13	13	10	928	17
205	3	342	597	25	4	5	24
206	4	100	33	241	105	455	62
207	5	50	284	126	125	315	95
208	6	94	41	40	348	358	112
209	7	203	111	236	340	0	102
210	8	221	225	123	117	80	225
211	9	37	63	667	111	37	77
212	11	2	881	41	40	18	8
213	12	96	105	153	201	425	8
214	13	370	306	90	47	101	73
215	13	368	72	498	2	41	6
216	19	562	125	102	47	39	107
217	22	348	74	115	125	215	102
218	22	292	63	229	65	104	224
219	22	482	41	111	167	93	83
220	25	184	100	136	223	152	182
221	25	192	107	223	278	75	101
222	27	40	51	99	310	58	415
223	29	51	237	127	172	308	77
224	30	219	195	158	222	112	64
225	30	185	151	125	186	120	203
226	35	131	195	172	151	201	114
227	35	146	162	175	157	180	143
228	36	179	200	93	188	186	117
229	37	82	363	208	2	73	235
230	40	211	162	182	160	165	81
231	40	468	0	420	0	72	0
232	41	269	293	118	95	121	62
233	44	56	399	13	268	61	160
234	45	335	72	82	210	180	77
235	46	124	139	148	199	168	177
236	46	207	54	453	54	134	52
237	48	310	346	83	84	91	38
238	52	201	140	196	121	160	132
239	53	134	123	144	206	192	149
240	53	108	150	163	171	207	148
241	57	156	183	117	92	220	175
242	63	105	176	154	148	195	160

Code	M	T	W	TH	F	S	S
243	63	186	136	175	187	134	120
244	64	230	173	136	83	251	63
245	66	249	149	127	105	185	120
246	67	222	278	236	65	129	2
247	70	120	192	168	188	145	116
248	74	95	170	197	157	144	162
249	74	190	108	126	246	116	138
250	77	295	104	187	155	88	93
251	79	135	291	129	86	182	97
252	80	360	9	19	424	79	29
253	81	133	132	125	226	167	135
254	82	136	151	118	160	196	157
255	82	92	125	207	177	153	164
256	85	133	152	145	188	173	124
257	87	295	16	111	47	244	201
258	96	128	104	169	161	224	119
259	104	196	118	155	202	132	94
260	104	111	196	121	181	127	162
261	107	161	70	90	227	243	102
262	107	145	115	203	187	147	95
263	111	171	137	0	297	202	81
264	112	121	144	165	155	172	131
265	113	199	97	132	218	147	94
266	113	167	15	156	399	70	80
267	115	150	128	153	192	139	122
268	115	103	120	138	117	251	156
269	119	125	119	87	144	158	248
270	120	145	130	137	155	166	147
271	125	155	141	108	179	149	142
272	130	140	137	170	93	139	192
273	135	222	191	83	169	110	90
274	136	160	156	162	144	156	86
275	138	109	107	137	227	147	137
276	139	101	117	171	167	171	134
277	143	143	143	143	143	143	143
278	150	230	118	72	144	170	116
279	163	118	106	135	185	112	181
280	199	136	81	163	143	180	99
281	218	8	2	14	6	525	226
282	250	35	290	130	50	109	137
283	255	116	82	103	128	63	252
284	278	182	148	36	105	112	139
285	326	168	189	0	105	0	211
286	0	212	165	131	202	128	161
287	0	289	0	0	356	222	133
288	0	321	93	208	109	81	188
289	0	431	4	160	246	15	144
290	0	515	122	111	48	128	76
291	0	0	0	916	84	0	0
292	0	0	0	0	148	0	852
294	0	0	0	0	1000	0	0

Table 19 Daily temporal profiles from the Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool)

Code	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
201	0	0	0	0	0	10	102	2	26	358	259	134	65	1	26	10	3	2	1	0	0	0	0	0
202	0	0	0	5	3	2	5	59	44	38	28	640	19	21	48	34	21	22	10	1	0	1	0	0
203	1	0	0	0	10	162	64	51	139	270	115	46	61	3	15	16	16	4	12	6	3	1	3	2
204	1	0	0	0	0	1	139	405	79	126	69	54	33	31	13	20	14	14	2	0	0	0	0	0
205	1	3	6	2	3	8	1	2	5	29	73	112	125	115	101	164	46	49	65	68	3	10	5	2
206	2	5	0	4	22	5	6	8	26	31	88	90	66	397	38	28	43	100	34	5	0	0	0	0
207	2	3	0	0	37	177	45	57	167	203	123	102	23	15	8	6	22	6	1	0	0	0	0	1
208	2	0	0	0	0	20	1	498	9	15	28	8	42	6	358	2	2	0	9	0	0	0	0	0
209	2	0	0	12	54	3	41	471	18	105	94	31	7	9	68	33	43	7	0	0	0	0	0	0
210	2	4	2	4	4	3	17	40	60	137	87	178	42	67	82	198	60	6	3	1	1	1	1	1
211	3	2	3	2	0	2	6	12	43	75	220	413	2	199	2	5	4	7	0	0	0	0	0	0
212	4	5	0	0	6	220	16	73	212	321	135	6	0	0	0	0	0	0	3	0	0	0	0	0
213	4	159	11	187	7	0	0	16	71	536	0	1	0	0	0	0	0	0	7	0	0	0	0	0
214	5	5	5	7	6	13	6	91	50	29	237	161	11	37	123	78	76	1	51	1	1	1	1	2
215	8	5	19	15	44	48	35	44	88	109	96	100	58	112	62	44	30	52	13	3	3	3	3	6
216	9	0	0	0	0	10	19	157	83	105	65	92	15	19	73	308	32	6	2	4	1	0	1	0
217	9	9	6	7	10	84	13	35	113	187	138	63	57	58	25	40	44	45	30	4	5	4	3	13
218	10	3	6	5	7	11	17	61	30	44	61	73	88	56	119	265	18	3	108	3	1	3	3	6
219	0	0	0	0	0	393	374	26	0	139	0	4	11	1	2	15	33	2	0	0	0	0	0	0
220	11	11	8	2	25	16	144	131	173	251	106	55	56	4	1	4	1	0	0	0	0	0	0	0
221	13	13	15	25	32	11	8	12	8	123	19	135	6	47	157	65	26	96	154	7	6	6	6	8
222	9	9	2	19	3	19	7	16	76	20	39	156	44	277	29	52	176	37	2	2	2	1	1	2
223	5	5	3	4	13	23	108	64	68	61	92	278	59	38	56	34	38	22	14	5	1	1	2	5
224	1	1	10	4	8	32	50	118	64	72	75	123	130	51	72	63	61	24	8	2	16	2	11	1
225	4	4	8	12	25	22	33	74	62	76	86	114	72	84	86	92	80	33	12	7	3	4	3	4
226	4	4	8	11	12	26	26	46	37	85	114	231	83	67	71	91	57	12	4	4	1	2	3	2
227	7	7	9	10	19	39	25	45	61	92	97	102	73	120	66	66	72	45	19	7	5	5	5	5
228	4	4	8	9	28	20	30	24	34	58	53	180	122	60	128	104	67	29	22	3	2	4	4	3
229	10	10	15	14	18	171	37	47	47	41	38	40	45	22	27	57	13	3	305	4	6	5	5	20
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235	2	2	2	5	6	31	48	95	72	51	41	460	48	29	19	20	34	17	9	8	1	0	0	0
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237	18	18	12	10	15	7	11	24	20	49	77	80	54	38	59	177	120	20	10	35	38	44	39	26
238	1	1	1	4	1	20	52	86	79	118	93	120	71	56	132	73	42	27	8	4	2	3	3	1
239	2	2	1	3	2	42	31	82	79	79	87	78	85	78	76	67	142	38	15	4	1	2	2	1
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