Emissions Modeling Technical Support Document: Tier 3 Motor Vehicle Emission and Fuel Standards

United States
Environmental Protection
Agency

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EPA United States Environmental Protection Agency

EPA-454/R-14-003
February 2014

TABLE OF CONTENTS

Acronyms

ACI	Activated Carbon Injection
AE5	CMAQ Aerosol Module, version 5, introduced in CMAQ v4.7
AE6	CMAQ Aerosol Module, version 6, introduced in CMAQ v5.0
AEO	Annual Energy Outlook
AIM	Architectural and Industrial Maintenance (coatings)
ARW	Advanced Research WRF
BAFM	Benzene, Acetaldehyde, Formaldehyde and Methanol
BEIS3.14	Biogenic Emissions Inventory System, version 3.14
BELD3	Biogenic Emissions Land use Database, version 3
Bgal	Billion gallons
BPS	Bulk Plant Storage
BTP	Bulk Terminal (Plant) to Pump
C1/C2	Category 1 and 2 commercial marine vessels
C3	Category 3 (commercial marine vessels)
CAEP	Committee on Aviation Environmental Protection
CAIR	Clean Air Interstate Rule
CAMD	The EPA's Clean Air Markets Division
CAM_X	Comprehensive Air Quality Model with Extensions
CAP	Criteria Air Pollutant
CARB	California Air Resources Board
CB05	Carbon Bond 2005 chemical mechanism
CBM	Coal-bed methane
CEC	North American Commission for Environmental Cooperation
CEM	Continuous Emissions Monitoring
CEPAM	California Emissions Projection Analysis Model
CISWI	Commercial and Industrial Solid Waste Incineration
Cl	Chlorine
CMAQ	Community Multiscale Air Quality
CMV	Commercial Marine Vessel
CO	Carbon monoxide
CSAPR	Cross-State Air Pollution Rule
EO, E10, E85	0%, 10% and 85% Ethanol blend gasolines, respectively
EBAFM	Ethanol, Benzene, Acetaldehyde, Formaldehyde and Methanol
ECA	Emissions Control Area
EEZ	Exclusive Economic Zone
EF	Emission Factor
EGU	Electric Generating Units
EIS	Emissions Inventory System
EISA	Energy Independence and Security Act of 2007
EPA	Environmental Protection Agency
EMFAC	Emission Factor (California's onroad mobile model)
FAA	Federal Aviation Administration
FAPRI	Food and Agriculture Policy and Research Institute
FASOM	Forest and Agricultural Section Optimization Model
FCCS	Fuel Characteristic Classification System
FIPS	Federal Information Processing Standards
FHWA	Federal Highway Administration
HAP	Hazardous Air Pollutant

HCl	Hydrochloric acid
HDGHG	Heavy-Duty Vehicle Greenhouse Gas
Hg	Mercury
HMS	Hazard Mapping System
HPMS	Highway Performance Monitoring System
HWC	Hazardous Waste Combustion
HWI	Hazardous Waste Incineration
ICAO	International Civil Aviation Organization
ICI	Industrial/Commercial/Institutional (boilers and process heaters)
ICR	Information Collection Request
I/M	Inspection and Maintenance
IMO	International Marine Organization
IPAMS	Independent Petroleum Association of Mountain States
IPM	Integrated Planning Model
ITN	Itinerant
LADCO	Lake Michigan Air Directors Consortium
LDGHG	Light-Duty Vehicle Greenhouse Gas
LPG	Liquified Petroleum Gas
MACT	Maximum Achievable Control Technology
MARAMA	Mid-Atlantic Regional Air Management Association
MATS	Mercury and Air Toxics Standards
MCIP	Meteorology-Chemistry Interface Processor
Mgal	Million gallons
MMS	Minerals Management Service (now known as the Bureau of Energy Management, Regulation and Enforcement (BOEMRE)
MOBILE6	OTAQ's model for estimation of onroad mobile emissions factors, replaced by MOVES2010b
MOVES	Motor Vehicle Emissions Simulator -- OTAQ's model for estimation of onroad mobile emissions – replaces the use of the MOBILE model
MSA	Metropolitan Statistical Area
MSAT2	Mobile Source Air Toxics Rule
MTBE	Methyl tert-butyl ether
MWRPO	Mid-west Regional Planning Organization
NCD	National County Database
NEEDS	National Electric Energy Database System
NEI	National Emission Inventory
NESCAUM	Northeast States for Coordinated Air Use Management
NESHAP	National Emission Standards for Hazardous Air Pollutants
NH_3	Ammonia
NIF	NEI Input Format
NLCD	National Land Cover Database
NLEV	National Low Emission Vehicle program
nm	nautical mile
NMIM	National Mobile Inventory Model
NOAA	National Oceanic and Atmospheric Administration
NODA	Notice of Data Availability
NONROAD	OTAQ's model for estimation of nonroad mobile emissions
NO_X	Nitrogen oxides
NSPS	New Source Performance Standards
NSR	New Source Review

OAQPS	The EPA's Office of Air Quality Planning and Standards
OHH	Outdoor Hydronic Heater
OTAQ	The EPA's Office of Transportation and Air Quality
ORIS	Office of Regulatory Information System
ORD	The EPA's Office of Research and Development
ORL	One Record per Line
OTC	Ozone Transport Commission
PADD	Petroleum Administration for Defense Districts
PF	Projection Factor, can account for growth and/or controls
PFC	Portable Fuel Container
$PM_{2.5}$	Particulate matter less than or equal to 2.5 microns
PM_{10}	Particulate matter less than or equal to 10 microns
ppb, ppm	Parts per billion, parts per million
RCRA	Resource Conservation and Recovery Act
RBT	Refinery to Bulk Terminal
RFS2	Renewable Fuel Standard
RIA	Regulatory Impact Analysis
RICE	Reciprocating Internal Combustion Engine
RRF	Relative Response Factor
RWC	Residential Wood Combustion
RPO	Regional Planning Organization
RVP	Reid Vapor Pressure
SCC	Source Classification Code
SEMAP	Southeastern Modeling, Analysis, and Planning
SESARM	Southeastern States Air Resource Managers
SESQ	Sesquiterpenes
SMARTFIRE	Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur dioxide
SOA	Secondary Organic Aerosol
SI	Spark-ignition
SIP	State Implementation Plan
SPDPRO	Hourly Speed Profiles for weekday versus weekend
SPPD	Sector Policies and Programs Division
TAF	Terminal Area Forecast
TCEQ	Texas Commission on Environmental Quality
TOG	Total Organic Gas
TSD	Technical support document
ULSD	Ultra Low Sulfur Diesel
USDA	United States Department of Agriculture
VOC	Volatile organic compounds
VMT	Vehicle miles traveled
VPOP	Vehicle Population
WGA	Western Governors' Association
WRAP	Western Regional Air Partnership
WRF	Weather Research and Forecasting Model

List of Tables

List of Figures

1 Introduction

The U.S. Environmental Protection Agency (EPA) developed a year 2007 air quality modeling platform in support of the Tier 3 Motor Vehicle Emission and Fuel Standards. The air quality modeling platform consists of all of the emissions inventories, ancillary files needed for emissions modeling, and the meteorological, initial condition, and boundary condition files needed to run the air quality model. This platform uses all Criteria Air Pollutants (CAPs) and a select set of Hazardous Air Pollutants (HAPs). This document focuses on the emissions modeling components of the 2007 platform, including the emission inventories and the ancillary data and the approaches used to transform emission inventories for use in air quality modeling.

The Tier 3 modeling platform was developed by implementing specific modifications to the "CAP-BAFM 2007-Based Platform, Version 5", also known as the "2007v5" platform. The 2007v5 platform was used to support the Regulatory Impact Assessment (RIA) for the 2012 Final National Ambient Air Quality Standards (NAAQS) for particulate matter less than 2.5 microns ($PM_{2.5}$). The Technical Support Document (TSD) "Preparation of Emissions Inventories for the Version 5.0, 2007 Emissions Modeling Platform" contains many additional details on the aspects of the Tier 3 and 2007v5 platforms that are shared. The TSD is available from the Emissions Modeling Clearinghouse website, http://www.epa.gov/ttn/chief/emch/, under the section entitled "Particulate Matter (PM) NAAQS (2007v5) Platform". The appendices available for the 2007v5 TSD that do not reference the specific PM NAAQS modeling cases are also relevant to the "Tier 3" platform.

Many emissions inventory components of the Tier 3 air quality modeling platform are based on the 2008 National Emissions Inventory version 2, hereafter referred to as the "2008 NEI", with updated inventory data for some emission sectors. In particular, a version of the Motor Vehicle Emissions Simulator (MOVES) designed to represent the impacts of the Tier 3 Motor Vehicle Emission and Fuel Standards (MOVESTier3FRM) was used to generate emission factors for onroad mobile sources. The emissions modeling tool used to create the air quality model-ready emissions from the emission inventories was the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system (http://www.smoke-model.org/index.cfm) version 3.5 beta. Emissions were created for 36 km and 12 km national grids.

The gridded meteorological model used for Tier 3 is the Weather Research and Forecasting Model (WRF, http://wrf-model.org) version 3.3, Advanced Research WRF (ARW) core (Skamarock, et al., 2008). The WRF Model is a mesoscale numerical weather prediction system developed for both operational forecasting and atmospheric research applications. WRF was run for 2007 over a domain covering the continental United States at a 36 km and 12 km resolution with 35 vertical layers[2]. This meteorological run was different than the one used for the 2007v5 platform.

The air quality model used for the Tier 3 platform is the Community Multiscale Air Quality (CMAQ) model (http://www.epa.gov/AMD/CMAQ/). CMAQ supports modeling ozone (O_3) and particulate matter (PM) and requires hourly and gridded emissions of chemical species from the following inventory pollutants: carbon monoxide (CO), nitrogen oxides (NO_X), volatile organic compounds (VOC), sulfur dioxide (SO_2), ammonia (NH_3), particulate matter less than or equal to 10 microns (PM_{10}), and individual component species for particulate matter less than or equal to 2.5 microns ($PM_{2.5}$). The CMAQ version used the chemical mechanism called Carbon Bond 2005 (CB05) with chlorine chemistry, which is part of the "base" version of CMAQ. CB05 allows explicit treatment of benzene, acetaldehyde, formaldehyde, and methanol

[2] For more details on the meteorological models and the run see section 2.5.1.2.

(BAFM) and includes anthropogenic HAP emissions of hydrochloric acid (HCl) and chlorine (Cl). The Tier 3 modeling used the most recent multi-pollutant version of CMAQ available at the time (CMAQ MP version 5.0.1) the modeling was performed, and an additional set of HAPs (from here out referred to as "CMAQ MP-lite HAPs"): acrolein, 1,3-butadiene and naphthalene were modeled.

The emissions and modeling effort for the Tier 3 platform consists of five emissions cases: 2007 base case, 2018 reference case, 2018 Tier 3 control case, 2030 reference case and 2030 Tier 3 control case. Table 1-1 provides more information on these emissions cases. The purpose of 2007 base case is to provide a 2007 case that is consistent with the methods used in the future-year base cases and ultimately, in the future year reference and control cases for the Final Tier 3 Rule. For regulatory applications, the 2007 base case is used with the outputs from the 2018 and 2030 reference cases in the relative response factor (RRF) calculations to identify future areas of nonattainment. For more information on the use of RRFs and air quality modeling, see "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM 2.5, and Regional Haze", available from http://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf.

Table 1-1. List of base cases run in the Tier 3 FRM Emissions Modeling Platform

Case Name	Internal EPA Abbreviation	Description
2007 base case	2007rg_v5	2007 case created using average-year wildfires data, smoothed prescribed fires, and an average-year temporal allocation approach for Electrical Generating Units (EGUs); used for computing relative response factors with 2018 and 2030 reference scenario(s).
2018 reference case	2018rg_ref2_v5[3]	2018 future year reference scenario with EGU emissions that represent the implementation of Clean Air Interstate Rule (CAIR) and final Mercury and Air Toxics (MATS), with upstream stationary and mobile sources representing the implementation of the EISA/EPAct fuel supply (RFS2 Rule)
2018 Tier 3 control case	2018rg_ctl_v5	2018 Tier 3 control case scenario sharing many aspects of the 2018 reference case, but also representing national Tier 3 vehicle and fuel emissions standards.
2030 reference case	2030rg_ref_v5	2030 future year reference scenario with EGU emissions that represent the implementation of Clean Air Interstate Rule (CAIR) and final Mercury and Air Toxics (MATS), with upstream stationary and mobile sources representing the implementation of the EISA/EPAct fuel supply (RFS2 Rule)
2030 Tier 3 control case	2030rg_ctl_v5	2030 Tier 3 control case scenario sharing many aspects of the 2030 reference case, but also representing national Tier 3 vehicle and fuel emissions standards.

This document contains five sections. Section 2 describes the inventories input to SMOKE for the 2007 base case. Section 3 describes the emissions modeling and the ancillary files used to process the emission inventories into a form that can be used by the air quality model. Section 4, describes the development of the 2018 and 2030 Tier 3 FRM reference and control case inventories (projected from 2007). Data summaries

[3] The case 2018rg_ref2_v5 is identical to an earlier case that was created for Tier 3 FRM (2018rg_ref_v5), except that the "ref2" case updated the following modeling sectors: nonpt, onroad, othpt, othar, and othon.

comparing the 2007 base case and the 2018 and 2030 reference and control cases are provided in Section 5. Section 6 provides references.

2 2007 Emission Inventories and Approaches

This section describes the 2007 emissions data created for input to SMOKE that is part of the 2007 base case; future year emissions inventory data development is discussed in Section 4. While providing some background, this section focuses on the differences between the 2007v5 platform and the updated Tier 3 platform. The starting point for the 2007 stationary source emission inputs is the 2008 NEI version 2, for which a draft TSD is available from http://www.epa.gov/ttn/chief/net/2008inventory.html.

The NEI data are largely compiled from data submitted by state, local and tribal (S/L/T) agencies for CAPs. HAP emissions data are more often augmented by EPA because they are voluntarily submitted. For fires, EPA used the SMARTFIRE2 (SF2) system in the 2008 NEI. SF2 assigns all fires as either prescribed burning or wildfire categories and includes improved emission factor estimates for prescribed burning.

The 2008 NEI includes five data categories: nonpoint (formerly called "stationary area") sources, point sources, nonroad mobile sources, onroad mobile sources, and fires. The 2008 NEI TSD uses approximately sixty sectors to further describe the emissions. In addition to the NEI data, 2007 biogenic emissions, emissions from the Canadian and Mexican inventories, and other non-NEI data are included in the 2007 platform. The non-NEI emissions components of the 2007 platform include primarily year-2007 onroad mobile and nonroad mobile emissions, a computed average fires inventory, and data received from some regional planning organizations (RPOs).

In the 2007v5 platform, some data in the 2008NEIv2 were updated with data from RPOs. The RPOs focused on addressing visibility impairment from a regional perspective and updated related inventory and ancillary data. A map of these RPOs can be found here: http://www.epa.gov/visibility/regional.html. The RPOs most involved in providing data were:

- Mid-Atlantic Regional Air Management Association (MARAMA): http://www.marama.org/
- Midwest Regional Planning Organization (MWRPO): http://www.ladco.org/
- Southeastern States Air Resource Managers (SESARM): http://www.metro4-sesarm.org/
- Western Regional Air Partnership (WRAP): http://www.wrapair2.org/

For the purposes of preparing the air quality model-ready emissions, the 2007 emissions inventory was split into inventories for each of the modeling "platform" sectors. The significance of an emissions modeling or "platform" sector is that the data is run through all of the SMOKE programs except the final merge (Mrggrid) independently from the other sectors. The final merge program is then used to combine the sector-specific gridded, speciated, hourly emissions together to create CMAQ-ready emission inputs.

Table 2-1 presents the sectors in the 2007 platform and how they generally relate to the 2008 NEI as a starting point. The sector abbreviations are provided in italics. These abbreviations are used in the SMOKE modeling scripts, inventory file names, and throughout the remainder of this document. As discussed in greater detail in Table 2-2, the Tier 3 platform emissions platform was modified in specific ways from the original 2007v5 platform.

Table 2-1. Platform sectors starting point for the 2007 platform

Platform Sector: ***abbreviation***	**2008NEI Sector**	**Description and resolution of the data input to SMOKE**
EGU (also called the IPM sector): ***ptipm***	Point	2008 NEI point source EGUs that could be mapped to the Integrated Planning Model (IPM) model using the National Electric Energy Database System (NEEDS) version 4.10. Annual resolution.
Non-EGU (non-IPM sector): ***ptnonipm***	Point	All NEI point source records not matched to the ptipm sector. Includes all aircraft emissions and some rail yard emissions. Annual resolution.
Agricultural: ***ag***	Nonpoint	NH_3 emissions from NEI nonpoint livestock and fertilizer application, county and annual resolution.
Area fugitive dust: ***afdust***	Nonpoint	PM_{10} and $PM_{2.5}$ from fugitive dust sources from the NEI nonpoint inventory. Includes building construction, road construction, paved roads, unpaved roads and agricultural dust. County and annual resolution. Processed as a separate sector to allow for the application of a land use based transport fraction and precipitation adjustments.
Class 1 & 2 CMV and locomotives: ***c1c2rail***	Mobile: Nonroad	Non-rail maintenance locomotives and category 1 and category 2 commercial marine vessel (CMV) emissions sources from the NEI nonpoint inventory. County and annual resolution.
C3 commercial marine: ***c3marine***	Mobile: Nonroad	Non-NEI, year 2007 category 3 (C3) CMV emissions projected from year 2002. Developed for the rule called "Control of Emissions from New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder", also described as the Emissions Control Area- International Maritime Organization (ECA-IMO) study: http://www.epa.gov/otaq/oceanvessels.htm. (EPA-420-F-10-041, August 2010). Annual resolution and treated as point sources.
Remaining nonpoint: ***nonpt***	Nonpoint	Primarily NEI nonpoint sources not otherwise included in other SMOKE sectors; county and annual resolution.
Nonroad: ***nonroad***	Mobile: Nonroad	Monthly nonroad equipment emissions from the National Mobile Inventory Model (NMIM) using NONROAD2008 version NR08b. NMIM was used for all states except California. Monthly emissions for California created from annual emissions submitted by the California Air Resources Board (CARB).
Onroad non-refueling: ***onroad***	Mobile: onroad	Onroad mobile gasoline and diesel vehicles from parking lots and moving vehicles. Includes the following modes: exhaust, extended idle, evaporative, permeation, and brake and tire wear. For all states, based on Motor Vehicle Emissions Simulator (MOVES) emission factor tables and monthly activity data for 2007.
Onroad refueling: ***onroad_rfl***	Mobile: onroad	Onroad mobile gasoline and diesel vehicle refueling emissions for all states. Based on MOVES emission factor tables and 2007 activity data.
Average-fire: ***avefire***	N/A	Average-year wildfire and prescribed fire emissions, county and daily resolution. This sector is used in all modeling cases.
Other point sources not from the NEI: ***othpt***	N/A	Point sources from Canada's 2006 inventory and Mexico's Phase III 2008 inventory grown from year 1999. Includes annual U.S. offshore oil 2008 NEI point source emissions. Annual resolution.
Other non-NEI nonpoint and nonroad: ***othar***	N/A	Year 2006 Canada (province resolution) and year 2008 (grown from 1999) Mexico Phase III (municipio resolution) nonpoint and nonroad mobile inventories, annual resolution.

Platform Sector: *abbreviation*	2008NEI Sector	Description and resolution of the data input to SMOKE
Other non-NEI onroad sources: ***othon***	N/A	Year 2006 Canada (province resolution) and year 2008 (grown from 1999) Mexico Phase III (municipio resolution) onroad mobile inventories, annual resolution.
Biogenic: ***beis***	N/A	Year 2007, hour-specific, grid cell-specific emissions generated from the BEIS3.14 model, including emissions in Canada and Mexico.

Table 2-2 provides a brief by-sector overview of the most significant differences between the Tier 3 platform and the 2007v5 platform. The specific by-sector updates to the 2007 platform made for Tier 3 are described in greater detail later in the following subsections. The remainder of Section 2 provides details about the data contained in each of the 2007 platform sectors. Different levels of detail are provided for different sectors, depending on the degree of changes or manipulation of the data needed to prepare it for input to SMOKE, and on whether the Tier 3 2007 platform emissions are significantly different from the original 2007v5 platform.

Table 2-2. Summary of significant changes between 2007v5 platform and 2007 Tier 3 base case by sector

Platform Sector	Summary of Significant Inventory Differences
IPM sector: ***ptipm***	• Included additional HAPs
Non-IPM sector: ***ptnonipm***	• Updated ethanol inventory • Replaced oil and gas emissions with Western Regional Air Partnership (WRAP) Phase III year 2008 emissions in select oil and gas basins
Agricultural: ***ag***	• Temporalized to hours using the Tier 3 WRF output
Area fugitive dust: ***afdust***	• Performed meteorological adjustments with the Tier 3 WRF output
Remaining nonpoint sector: ***nonpt***	• Replaced oil and gas emissions with Western Regional Air Partnership (WRAP) Phase III year 2008 emissions in select oil and gas basins
Class 1 & 2 CMV and locomotives: ***c1c2rail***	• Augmented HAPs in California and RPO data
C3 commercial marine: ***c3marine***	• Augmented HAPs
Nonroad sector: ***nonroad***	• Used updated fuels • Augmented HAPs in California
Onroad non-refueling: ***onroad***	• Used MOVESTier3FRM emission factors • Used updated fuels
Onroad non-refueling: ***onroad_rfl***	• Used MOVESTier3FRM emission factors • Used updated fuels
Average fires: ***avefire***	• Used 2007 through 2010 SMARTFIRE 2 data to generate average fire emissions

2.1 *2007 NEI point sources (ptipm and ptnonipm)*

Point sources are sources of emissions for which specific geographic coordinates (e.g., latitude/longitude) are specified, as in the case of an individual facility. A facility may have multiple emission points, which may be characterized as units such as boilers, reactors, spray booths, kilns, etc. A unit may have multiple processes (e.g., a boiler that sometimes burns residual oil and sometimes burns natural gas). With a couple of minor exceptions, this section describes only NEI point sources within the contiguous United States. The offshore oil platform (othpt sector) and category 3 CMV emissions (c3marine sector) are also point source formatted inventories that are discussed in Section 2.6 and Section 2.5.5, respectively.

After removing offshore oil platforms into the othpt sector, EPA created an initial version of two platform sectors from the remaining 2008 NEI point sources for input into SMOKE: the EGU sector – also called the IPM sector (i.e., ptipm) and the non-EGU sector – also called the non-IPM sector (i.e., ptnonipm). This split facilitates the use of different SMOKE temporal processing and future-year projection techniques for each of these sectors. The inventory pollutants processed through SMOKE for both the ptipm and ptnonipm sectors were: CO, NO_X, VOC, SO_2, NH_3, PM_{10}, and $PM_{2.5}$ and the following HAPs: HCl (pollutant code = 7647010), Cl (code = 7782505), and the CMAQ MP-lite HAPs (see Section 3.2 for details). For more details on the development of these sectors and the differences between the inventories and the 2008 NEI see the 2007v5 TSD.

2.1.1 IPM sector (ptipm)

The ptipm sector contains emissions from EGUs in the 2008 NEI point inventory that were matched to units found in the May 2012 version 4.10 of the NEEDS database (http://www.epa.gov/airmarkets/progsregs/epa-ipm/BaseCasev410.html#needs). IPM provides future-year emission inventories for the universe of EGUs contained in the NEEDS database. This matching was done (1) to provide consistency between the 2007 EGU sources and future-year EGU emissions for sources which are forecasted by IPM and (2) to avoid double counting when projecting point source emissions to future years. A comprehensive description on how EGU emissions were characterized and estimated in the 2008 NEI can be found in Section 3.10 in the 2008 NEI documentation (EPA, 2012a). The ptipm sector is identical to the 2007v5 platform except for the inclusion of CMAQ MP-lite HAPs (see Section 3.2 for details) in the 2007 model-ready files[4].

2.1.2 Non-IPM sector (ptnonipm)

With several exceptions, the non-IPM (ptnonipm) sector contains the remaining 2008 NEI point sources that were not included in the IPM (ptipm) sector. The ptnonipm sector contains all sources not reflected in future year IPM inventories. For the most part, the ptnonipm sector reflects the non-EGU component of the NEI point inventory; however, as previously discussed, it is likely that some small low-emitting EGUs that are not reflected in the CEMs database are present in the ptnonipm sector.

There are numerous modifications between the published 2008 NEI and the 2007 ptnonipm inventory used for modeling. More details on some of these modifications can be found in the 2007v5 TSD. The differences between the 2007v5 ptnonipm and the 2007 ptnonipm for this base case are limited to the following:

- Integration of BAFM (see Section 3.2.1.1 for details)
- Inclusion of the CMAQ MP-lite HAPs (see Section 3.2 for details)

[4] Note, these additional HAPs are not in the future year scenarios because IPM does not produce estimates for them.

- Removal of one cement kiln because of unreasonable emissions[5]
- Modification to the South Dakota point inventory to include 2005 NEI emissions for sources missing in the 2008 NEI.
- Updated ethanol facilities (see below)
- Updated oil and gas (see below)

Additional Ethanol facilities

An updated set of corn ethanol facilities was developed for year 2008. Any facilities already included in the 2008 NEI were removed from the set prior to including them in the 2007 base case. Locations and FIPS codes for these ethanol plants were verified using web searches and Google Earth. These emissions are included in the 2007 case as a separate FF10-format inventory for HAPs and CAPs. Emission rates for the facilities were obtained from EPA's spreadsheet model for upstream impacts developed for the Renewable Fuel Standard (RFS2) rule (EPA, 2010a). The plant emission rates for criteria pollutants used to estimate impacts are given in Table 2-3. Toxic emission rates were estimated by applying toxic-to-VOC ratios in Table 2-4 to the VOC emission rates shown in Table 2-3. For air toxics other than ethanol, toxic-to-VOC ratios were developed using emission inventory data from the 2005 NEI (EPA, 2009a). Emission rates in Table 2-3 and Table 2-4 were multiplied by facility production estimates for 2007, 2018 (via 2017 emission factors), and 2030 based on analyses performed for the industry characterization described in Chapter 1 of the RFS2 final rule regulatory impact analysis (RIA).

WRAP Phase III oil and gas emissions

The Western Regional Air Partnership (WRAP) RPO created year 2008 "Phase III" oil and gas sector point and non-point format emissions for several major basins in Colorado and Montana, New Mexico, Texas, Utah and Wyoming. These basins are listed here: Denver-Julesburg, Uinta, San Juan (North and South), Piceance, Southwest Wyoming (Green River), Powder River, Wind River and Permian. A map showing the geographic area of these basins is provided at: http://www.eia.gov/oil_gas/rpd/shale_gas.jpg.

The WRAP oil and gas Phase III project was co-sponsored by the Independent Petroleum Association of Mountain States (IPAMS) and is based on survey outreach efforts. Survey coverage varied, and survey data were generally reflected as point sources in the inventory. Unpermitted sources were based somewhat on surveys but also on activity and emission factor estimates and were generally reflected as nonpoint (nonpt sector) sources.

Overall, the Phase III project estimated emissions for a couple dozen source types, including drilling rigs, compressor stations, heaters and boilers, tank breathing venting and flashing, pneumatic devices, well and pipeline/compressor fugitive emissions, dehydrators, amine units, truck loading and other miscellaneous sources. Phase III emissions include basin-specific speciation, surrogates and hence SCCs to account for the different products extracted: oil, gas and coal-bed methane (CBM). To prevent possible double-counting of oil and gas sector emissions, all oil and gas emissions were removed from the 2008 NEI for counties that comprise the 9 basins in the WRAP Phase III inventories. The list of oil and gas SCCs that were removed from the point (and nonpoint) 2008 NEI are provided in Appendix A of the 2007v5 TSD[6].

[5] The cement kiln had emissions orders of magnitude higher than in any other year in the NEI. The particular facility is facility ID 4773111, FIPS 26017.

[6] The 2007v5 platform used the 2006 WRAP Phase III inventory.

Table 2-3. Corn Ethanol Plant Criteria Pollutant Emission Factors (grams per gallon produced)

Corn Ethanol Plant Type	Year	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	NH_3
Dry Mill Natural Gas (NG)	2005, 2017	2.29	0.58	0.99	0.94	0.23	0.01	0.00
	2030	2.29	0.58	0.94	0.94	0.23	0.01	0.00
Dry Mill NG (wet distillers grains with solubles (DGS))	2005, 2017	2.27	0.37	0.63	0.91	0.20	0.00	0.00
	2030	2.27	0.37	0.60	0.91	0.20	0.00	0.00
Dry Mill Biogas	2005, 2017	2.29	0.62	1.05	0.94	0.23	0.01	0.00
	2030	2.29	0.62	1.00	0.94	0.23	0.01	0.00
Dry Mill Biogas (wet DGS)	2005, 2017	2.27	0.39	0.67	0.91	0.20	0.00	0.00
	2030	2.27	0.39	0.63	0.91	0.20	0.00	0.00
Dry Mill Coal	2005, 2017	2.31	2.65	4.17	3.81	1.71	4.52	0.00
	2030	2.31	2.65	3.68	3.64	1.54	3.48	0.00
Dry Mill Coal (wet DGS)	2005, 2017	2.31	2.65	2.65	2.74	1.14	2.87	0.00
	2030	2.28	1.68	2.34	2.62	1.03	2.21	0.00
Dry Mill Biomass	2005, 2017	2.42	2.55	3.65	1.28	0.36	0.14	0.00
	2030	2.42	2.55	3.65	1.28	0.36	0.14	0.00
Dry Mill Biomass (wet DGS)	2005, 2017	2.35	1.62	2.32	1.12	0.28	0.09	0.00
	2030	2.35	1.62	2.32	1.12	0.28	0.09	0.00
Wet Mill NG	2005, 2017	2.35	1.62	1.77	1.12	0.28	0.09	0.00
	2030	2.33	1.04	1.68	1.00	0.29	0.01	0.00
Wet Mill Coal	2005, 2017	2.33	1.04	5.51	4.76	2.21	5.97	0.00
	2030	2.33	3.50	4.86	4.53	1.98	4.60	0.00

Table 2-4. Toxic-to-VOC Ratios for Corn Ethanol Plants

	Acetaldehyde	Acrolein	Benzene	1,3-Butadiene	Formaldehyde
Wet Mill NG	0.02580	0.00131	0.00060	2.82371E-08	0.00127
Wet Mill Coal	0.08242	0.00015	0.00048	2.82371E-08	0.00108
Dry Mill NG	0.01089	0.00131	0.00060	2.82371E-08	0.00127
Dry Mill Coal	0.02328	0.00102	0.00017	2.82371E-08	0.00119

2.2 *2007 nonpoint sources (afdust, ag, nonpt)*

The nonpoint sectors use the 2008 NEI as a starting point. EPA created several sectors from the 2008 NEI nonpoint inventory, and this section describes the *stationary* nonpoint sources. Class 1 & Class 2 (c1c2) and Class 3 (c3) commercial marine vessels and locomotives are also in the 2008 NEI nonpoint data category. However, these mobile sources are included in the mobile documentation in Sections 2.5.4 2.5.5 as the c1c2rail and c3marine sectors, respectively.

The nonpoint tribal-submitted emissions were removed to prevent possible double counting with the county-level emissions and also because spatial surrogates for tribal data were not available. Because the tribal nonpoint emissions are small, these omissions will have a limited impact on the results at the 12-km scales used for this modeling. The documentation for the nonpoint sector of the 2008 NEI is available on the 2008 NEI website (EPA, 2012a).

The following subsections describe the partitioning of the 2008 NEI nonpoint inventory into the 2007v5 modeling platform sectors, and also the differences between the nonpoint emissions in the 2007v5 platform and the 2007 base case.

2.2.1 Area fugitive dust sector (afdust)

The area-source fugitive dust (afdust) sector contains PM_{10} and $PM_{2.5}$ emission estimates for nonpoint SCCs identified by the EPA staff as dust sources. Categories included in the afdust sector are paved roads, unpaved roads and airstrips, construction (residential, industrial, road and total), agriculture production, and mining and quarrying. It does not include fugitive dust from grain elevators because these are elevated point sources.

This sector is separated from other nonpoint sectors to allow for the application of "transport fraction," and meteorology/precipitation-based reductions. These adjustments are applied via sector-specific scripts, beginning with land use-based gridded transport fractions and then subsequent daily zero-outs for days where at least 0.01 inches of precipitation occurs or days when there is snow cover on the ground. The land use data used to reduce the NEI emissions explains the amount of emissions that are subject to transport. This methodology is discussed in (Pouliot, et. al., 2010), http://www.epa.gov/ttn/chief/conference/ei19/session9/pouliot_pres.pdf, and in Fugitive Dust Modeling for the 2008 Emissions Modeling Platform (Adelman, 2012). The precipitation adjustment is then applied to remove all emissions for days where measureable rain occurs. Both the transport fraction and meteorological adjustments are based on the gridded resolution of the platform; therefore, different emissions will result from different grid resolutions. Application of the transport fraction and meteorological adjustments reduces the overestimation of fugitive dust impacts in the grid modeling as compared to ambient samples.

For more details on this approach and the differences between the 2007 base case and the 2008 NEI, see the 2007v5 TSD. The afdust sector is identical to the 2007v5 platform except for the fact that the meteorological adjustments were computed using the update WRF outputs.

2.2.2 Agricultural ammonia sector (ag)

The agricultural NH_3 "ag" sector is based on livestock and agricultural fertilizer application emissions from the 2008 NEI nonpoint inventory. The ag sector is identical to 2007v5 platform (see 2007v5 TSD for details) except for the temporalization of animal NH_3.
An updated temporal allocation methodology for animal NH_3 that allocates emissions down to the hourly level by taking into account temperature and wind speed was incorporated into the 2007 platform (see Section 3.3.3 for more details).

2.2.3 Other nonpoint sources (nonpt)

Stationary nonpoint sources that were not subdivided into the afdust or ag sectors were assigned to the "nonpt" sector. All fire emissions from the 2008 NEI nonpoint inventory were removed and replaced with SMARTFIRE emissions, described in Section 2.3. Additionally, locomotives and CMV mobile sources from the 2008 NEI nonpoint inventory are described in Section 2.5.

For more details on the development of the nonpt sector see the 2007v5 TSD. The differences between the 2007v5 nonpt and the 2007 nonpt for this base case are limited to the following:

- Replaced 2008 NEI oil and gas emissions (SCCs beginning with "23100") with year 2008 Phase III oil and gas emissions for several basins in the WRAP RPO states. These WRAP Phase III emissions contain point and nonpoint formatted data are discussed in greater detail in Section 2.1.2 and here: http://www.wrapair2.org/PhaseIII.aspx. These changes were made in counties affected by the WRAP data.

- Updated speciation and spatial surrogates were used to support the addition of the Permian basin (see Section 3.2.1.3 and3.4.1, respectively).
- Included the CMAQ MP-lite HAPs (see Section 3.2 for details)
- Updated the temporalization of the residential wood combustion (RWC) inventories to account for the updated meteorology (see Section 3.3.3 for details).

2.3 *Fires (avefire)*

Wildfire and prescribed burning emissions are contained in the ptfire and avefire sectors. The ptfire sector has emissions provided at geographic coordinates (point locations) and has daily emissions values, whereas the avefire sector contains county-summed inventories also at daily resolution. EPA used the ptfire sector in the 2007v5 evaluation case but not for this 2007 base case. For the 2007 and future base cases, the avefire sector was used instead of point fires. The SCCs in Table 2-5 are considered "fires" – note that the complete SCC description includes "Miscellaneous Area Sources" as the first tier level description.

Table 2-5. 2007 Platform SCCs representing emissions in the ptfire and avefire modeling sectors

SCC	SCC Description
2810001000	Other Combustion; Forest Wildfires; Total
2810015000	Other Combustion; Prescribed Burning for Forest Management; Total
2811015000	Other Combustion-as Event; Prescribed Burning for Forest Management; Total
2811090000	Other Combustion-as Event; Prescribed Forest Burning ;Unspecified

The avefire sector excludes agricultural burning and other open burning sources, which are included in the nonpt sector. The agricultural burning and other open burning sources are left in the nonpt sector because these categories were not factored into the development of the average fire sector. Additionally, the emissions are much lower and their year-to-year variability is much lower than that of wildfires and non-agricultural prescribed/managed burns.

The purpose of the avefire sector is to represent emissions for a typical year's fires for use in projection year inventories, since the location and degree of future-year fires are not known. This approach keeps the fires information constant between the 2007 base case and future-year cases to eliminate large and uncertain differences between those cases that would be caused by changing the fires. Using an average of multiple years of data reduces the possibility that a single-year's high or low fire activity would unduly affect future-year model-predicted concentrations. Emissions are day-specific but aggregated to county-level where spatial surrogates will allocate the fires to forest and crop/pasture land. The creation of the avefire daily nonpoint inventory is distinct for prescribed burning and wildfires. For more details on Fire Averaging Tool and the various smoothing techniques, see the 2007v5 TSD.

For this 2007 base case (and future years), EPA used 4 years (2007 through 2010) of fire data from the Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation (SMARTFIRE) version 2 for both prescribed and wildfires and used a 29 day averaging period.

2.4 *Biogenic sources (biog)*

The biogenic emissions were computed based on 2007 meteorology data using the Biogenic Emission Inventory System, version 3.14 (BEIS3.14) model within SMOKE. The BEIS3.14 model creates gridded, hourly, model-species emissions from vegetation and soils. It estimates CO, VOC (most notably isoprene, terpine, and sesquiterpene), and NO emissions for the U.S., Mexico, and Canada. The BEIS3.14 model is described further in http://www.cmascenter.org/conference/2008/slides/pouliot_tale_two_cmas08.ppt. The 2007v5 biog sector and the biog sector for this 2007 base case, the meteorology differed between the two cases. The changes in meteorology will impact both the total emissions and the temporalization and spatial distribution of these emissions. The BIOSEASONS file was also updated using the meteorology data for this case.

2.5 *2007 mobile sources (onroad, onroad_rfl, nonroad, c1c2rail, c3marine)*

For the 2007 base case, as indicated in Table 2-1, EPA separated the 2007 onroad emissions into two sectors: (1) "onroad" and (2) "onroad_rfl". As discussed in Section 2.5.2, the onroad and onroad_rfl sectors are processed separately to allow for different spatial allocation to be applied to onroad refueling (using a gas station surrogate) versus onroad vehicles (using surrogates based on roads and population). All onroad and onroad refueling emissions are generated using a new SMOKE-MOVES emissions modeling framework that leverages MOVES generated outputs (http://www.epa.gov/otaq/models/moves/index.htm) and hourly meteorology.

The nonroad sector is based on NMIM except for California which uses data provided by the California Air Resources Board (CARB). All nonroad emissions are compiled at the county/SCC level. NMIM (EPA, 2005) creates the nonroad emissions on a month-specific basis that accounts for temperature, fuel types, and other variables that vary by month.

The locomotive and commercial marine vessel (CMV) emissions are divided into two nonroad sectors: "c1c2rail" and "c3marine". The c1c2rail sector includes all railway and most rail yard emissions as well as the gasoline and diesel-fueled Class 1 and Class 2 CMV emissions. The c3marine sector emissions contain the larger residual fueled ocean-going vessel Class 3 CMV emissions and are treated as point emissions with an elevated release component; all other nonroad emissions are treated as county-specific low-level emissions (i.e., are in model layer 1).

All tribal data from the mobile sectors have been dropped because EPA does not have spatial surrogate data for tribal regions, the data may be double-counted with emissions submitted by state and local agencies for the same areas, and the emissions are small.

2.5.1 Onroad non-refueling (onroad)

For the 2007 base case, EPA estimated emissions for every county in the continental U.S[7]. EPA used a modeling framework that took into account the strong temperature sensitivity of the onroad emissions. Specifically, EPA used county-specific inputs and tools that integrated the MOVES model with the SMOKE[8] emission inventory model to take advantage of the gridded hourly temperature information available from meteorology modeling used for air quality modeling. This integrated "SMOKE-MOVES" tool was developed by EPA in 2010 and is in use by states and regional planning organizations for regional air quality modeling. SMOKE-MOVES requires emission rate "lookup" tables generated by MOVES that differentiate emissions by process (running, start, vapor venting, etc.), vehicle type, road type, temperature, speed, hour of day, etc. To generate the MOVES emission rates that could be applied across the U.S., an automated process ran MOVES to produce emission factors by temperature and speed for 146 "representative counties," to which every other county could be mapped. Using the MOVES emission rates, SMOKE selected appropriate emissions rates for each county, hourly temperature, SCC, and speed bin and multiplied the

[7] EPA estimated California as well, this is different than the approach for the 2007v5 platform.
[8] A beta version of SMOKE v3.5 was used for modeling the Tier 3 FRM. The release version is available at: http://www.smoke-model.org/index.cfm

emission rate by activity (VMT (vehicle miles travelled) or vehicle population) to produce emissions. These calculations were done for every county, grid cell, and hour in the continental U.S.

SMOKE-MOVES can be used with different versions of the MOVES model. For the 2007 platform, EPA used the latest publically released version: MOVES2010b (http://www.epa.gov/otaq/models/moves/index.htm). However, since the release of MOVES2010b, EPA has continued to collect and analyze emissions data. In particular, EPA completed two major studies of fuel effects on emissions in Tier 2 light-duty gasoline vehicles, and an important collection of studies on evaporative emissions. Because fuels and evaporative emissions are affected by Tier 3 standards, it was very important to include these data in the modeling. Therefore, in estimating the impact of the Tier 3 vehicle and fuel standards on air quality for the future years, MOVES2010b was updated to include the results from these studies, along with numerous other updates. Furthermore, the new model incorporated the changes that reflect recent EPA rules on light-duty and heavy-duty greenhouse gas emissions. These changes are documented in the docket for the NPRM[9] and in the docket for this rule[10].

The following inputs and methodologies are identical to the 2007v5 platform[11] and are detailed in the 2007v5 TSD:

- Activity data (VMT, VPOP, speed)
- Representative counties
- Fuel Months
- Local MOVES inputs
- Procedure for running MOVES to create emission factors
- Procedure for running SMOKE to create emissions

The following inputs differed between the 2007 base case and the 2007v5 modeling and are detailed below: fuels, meteorology, and extended idle adjustments.

2.5.1.1 Fuels

Although state-submitted NMIM and MOVES input data may have included information about fuel properties, the MOVES runs for the 2007 base case were run using a set of fuel properties for each county in 2007 generated by EPA. These data were developed using a combination of purchased fuel survey data, proprietary fuel refinery information, ethanol and other biofuel production levels, and known federal and local regulatory constraints. The fuel supply used in the Tier 3 FRM varies significantly from that used in the NPRM, including the introduction of a new approach to aggregating fuels by region. For more information regarding this new approach to fuels, please refer to the Tier 3 FRM, Chapter 7.1.3.2. The fuel supplied used in the Tier 3 FRM varies slightly from that used in the 2007v5, including less ethanol overall with a slightly different regional distribution, which more closely matched the new AEO regions. The fuel properties themselves are the same in 2007v5 and in Tier 3 FRM (2007 base case).

2.5.1.2 Temperature and humidity

Ambient temperature can have a large impact on emissions. Low temperatures are associated with high start emissions for many pollutants. High temperatures are associated with greater running emissions due to the higher engine load of air conditioning. High temperatures also are associated with higher evaporative emissions.

[9] U.S. EPA. 2013. "Memorandum to Docket: Updates to MOVES for the Tier 3 NPRM"
[10] U.S. EPA. 2014. "Memorandum to Docket: Updates to MOVES for the Tier 3 FRM Analysis"
[11] Tier 3 NPRM was based on the 2005 platform and hence inputs such as the representative counties, activity data, and local MOVES inputs were updated as part of the development of the 2007 platform (used for Tier 3 FRM).

The 36-km and 12-km gridded meteorological input data for the entire year of 2007 covering the continental United States were derived from simulations of version 3.3 of the Weather Research and Forecasting Model (WRF, http://wrf-model.org), Advanced Research WRF (ARW) core (Skamarock, et al., 2008). The WRF Model is a mesoscale numerical weather prediction system developed for both operational forecasting and atmospheric research applications. The Meteorology-Chemistry Interface Processor (MCIP) version 4.1.2 (http://www.cmascenter.org/help/model_docs/mcip/4.1/ReleaseNotes) was used as the software for maintaining dynamic consistency between the meteorological model, the emissions model, and air quality chemistry model. The meteorology run used for the 2007 base year[12] is different than what was used for the 2007v5 platform. Specifically it used newer versions of WRF and MCIP and 25 vertical layers[13] instead of the 24 used in 2007v5.

The SMOKE-MOVES tool Met4moves reads the gridded, hourly meteorological data (output from MCIP) to generate a list of the maximum temperature ranges, average relative humidity, and temperature profiles that are needed for MOVES to create the emission-factor lookup tables. For more details on Met4moves and the processing of meteorology for SMOKE-MOVES see the 2007v5 TSD.

2.5.1.3 Extended idle adjustments and SMOKE-MOVES

Emissions from the extended idling of long haul trucks are a subset of the exhaust emissions. These emissions are typically from trucks, which have traveled across county and state boundaries. Federal rules require that truck drivers may not drive more than 10 hours without rest. These long haul trucks are known to stop for these rest periods at truck stops along their routes and idle their trucks for hours while they rest. The MOVES model generates an estimate of the total number of extended idling hours and emissions for every county. However, when MOVES is run using the County scale, the extended idling rate (in grams per hour per truck) is not adjusted to account for allocation of the extended idling to counties where interstate travel occurs.

SMOKE has an optional input that adjusts emissions (CFPRO) by county, SCC, and mode. To account for the extended idle adjustment, EPA created an adjustment file that applies these allocation factors by county for extended idle and for the long haul type SCCs (SCC7 2230073 and 2230074) only (see the 2011v1 NEI TSD for more details).

SMOKE-MOVES, specifically Movesmrg, uses the adjustment factor file (CFPRO) for extended idle to estimate 2007 emissions that incorporates these adjustments.

2.5.2 Onroad refueling (onroad_rfl)

Onroad refueling is modeled very similarly to other onroad emissions (see Section2.5.1). MOVESTier3FRM can produce EFs for refueling. These EFs are at the resolution of the onroad SCCs. The refueling EFs were run separately from the other onroad mobile sources to allow for different spatial allocation. To facilitate this, the EFs from the refueling process were separated out into RPD refueling and RPV refueling tables[14]. EPA then ran SMOKE-MOVES using these EF tables as inputs and spatially allocated the results based on a gas stations surrogate (see Section 3.4.1).

Lastly, the Mrggrid SMOKE program combined RPD refueling and RPV refueling into a single onroad_rfl model ready output for final processing with the other sectors prior to use in CMAQ.

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[12] Note the meteorology is consistent across all 3years: 2007, 2018 and 2030.
[13] WRF was run at 35 layers and MCIP post-processed it to 25 layers.
[14] The Moves2smk post-processing script has command line arguments that will either consolidate or split out the refueling EF.

2.5.3 Nonroad mobile equipment sources: (nonroad)

This sector includes monthly exhaust, evaporative and refueling emissions from nonroad engines (not including commercial marine, aircraft, and locomotives) that are derived from NMIM for all states except California. Year-2007 inventories from CARB were used for California after the completion of several preprocessing steps discussed in the 2007v5 TSD.

NMIM (non-California) nonroad

NMIM ran the version of NONROAD, NR08b, which models all in-force nonroad controls, including the marine spark ignited (SI) and small SI engine final rule, published May 2009 (EPA, 2008). This version of NONROAD is very similar to the publicly released version, but it can model ethanol blends up to E20. The NMIM version is NMIM20090504d, which has the same results as the publicly-released NMIM version NMIM20090504a. The underlying National County Database (NCD) is NCD20101201a, but with 2007 meteorology inserted into the countymonthhour table. NCD20101201a includes state inputs for the 2008 NEI.

The NMIM run, abs2007basenr, includes the lower 48 states plus Washington D.C. ; it excludes Alaska, Hawaii, Puerto Rico and the Virgin Islands. To conserve processing time, NMIM was run using 392 county groups. The county groups are in the same state and have the same fuels and similar temperature regimes. The county from each group with the highest VMT was chosen as the representing county. All counties are mapped to their representing county in the MySQL table countymap392. The fuels database, countryyearmonth2007_Baseline_0906012, is a conversion to NMIM format of the MOVES fuels for the 2007 base case (see Section 2.5.1.1).

As with the onroad emissions, NMIM provides nonroad emissions for VOC by three emission modes: exhaust, evaporative and refueling. Unlike the onroad sector, refueling emissions from nonroad sources are not separated into a different sector.

The EPA ran NMIM to create county-SCC emissions and removed California emissions because they were replaced with a CARB inventory. Emissions were converted from monthly totals to SMOKE-ready FF10 format (http://www.cmascenter.org/smoke/documentation/3.5.1/html/ch08s02s04.html) monthly average-day based on the number of days in each month. EPA retained only CAPs and the necessary HAPs: BAFM, acrolein, butadiene, and naphthalene.

California nonroad

California year 2007 nonroad emissions were provided by CARB and are documented in a staff report (ARB, 2010a). The nonroad sector emissions in California are developed using a modular approach and include all rulemakings and updates in place by December 2010. These emissions were developed using Version 1 of the California Emissions Projection Analysis Model (CEPAM) which support various California off-road regulations such as in-use diesel retrofits (ARB, 2007), Diesel Risk-Reduction Plan (ARB, 2000) and 2007 State Implementation Plans (SIPS) for the South Coast and San Joaquin Valley air basins (ARB, 2010b).

EPA converted the CARB-supplied nonroad annual inventory to monthly emissions values by using the aforementioned EPA NMIM monthly inventories to compute monthly ratios by pollutant and SCC. Some adjustments to the CARB inventory were needed to convert the provided total organic gas (TOG) to VOC and augment the HAPs. See Section 3.2.1.3 for details on speciation of California nonroad data.

2.5.4 Class 1/Class 2 Commercial Marine Vessels and Locomotives and (c1c2rail)

The c1c2rail sector contains locomotive and commercial marine vessel (CMV) sources, except for category 3/residual-fuel (C3) CMV and railway maintenance. The "c1c2" portion of this sector name refers to the Class I/II CMV emissions, not the railway emissions. Railway maintenance emissions are included in the nonroad sector. The C3 CMV emissions are in the c3marine sector.

For more details on the development of the c1c2rail sector see the 2007v5 TSD. The differences between the 2007v5 c1c2rail and the 2007 c1c2rail for this base case are limited to the following:

- Updated an outdated FIPS in the RPO rail inventory. Specifically changed Clifton Forge, VA (51560) to Alleghany County, VA (51005)

- Augmented the CARB c1c2rail and RPO rail inventories to include the CMAQ MP-lite HAPs (see Section 3.2 and 3.2.1.3 for details)

2.5.5 Class 3 commercial marine vessels (c3marine)

The c3marine sector emissions data were developed based on a 4-km resolution ASCII raster format dataset used since the Emissions Control Area-International Marine Organization (ECA-IMO) project began in 2005, then known as the Sulfur Emissions Control Area (SECA). These emissions consist of large marine diesel engines (at or above 30 liters/cylinder) that until very recently, were allowed to meet relatively modest emission requirements, often burning residual fuel. The emissions in this sector are comprised of primarily foreign-flagged ocean-going vessels, referred to as Category 3 (C3) CMV ships. The c3marine inventory includes these ships in several intra-port modes (cruising, hoteling, reduced speed zone, maneuvering, and idling) and underway mode and includes near-port auxiliary engines. This sector is identical to the 2007v5 platform except for the addition of naphthalene (see Section 3.2.1.3). For more details on the development of this sector's emissions, see the 2007v5 TSD.

2.6 *Emissions from Canada, Mexico and offshore drilling platforms (othpt, othar, othon)*

The emissions from Canada, Mexico, and offshore drilling platforms are included as part of three emissions modeling sectors: othpt, othar, and othon.

The "oth" refers to the fact that these emissions are usually "other" than those in the U.S. state-county geographic FIPS, and the third and fourth characters provide the SMOKE source types: "pt" for point, "ar" for "area and nonroad mobile", and "on" for onroad mobile. All "oth" emissions are CAP-only inventories.

For more details on the development of the "oth" sectors see the 2007v5 TSD. The differences between the 2007v5 "oth" and the 2007 "oth" for this base case are limited to the following:

- othar has updated spatial surrogates (see Sections 3.4.3)

- othon has updated speciation and spatial surrogates (see Sections 3.2.1.3 and 3.4.3, respectively)

- othpt has updated speciation (see Sections 3.2.1.3)

2.7 *SMOKE-ready non-anthropogenic inventories for chlorine*

The ocean chlorine gas emission estimates are based on the build-up of molecular chlorine (Cl_2) concentrations in oceanic air masses (Bullock and Brehme, 2002). Data at 36 km and 12 km resolution were available and were not modified other than the name "CHLORINE" was changed to "CL2" because that is the name required by the CMAQ model.

3 Emissions Modeling Summary

Both the CMAQ and CAM_X models require hourly emissions of specific gas and particle species for the horizontal and vertical grid cells contained within the modeled region (i.e., modeling domain). To provide emissions in the form and format required by the model, it is necessary to "pre-process" the "raw" emissions (i.e., emissions input to SMOKE) for the sectors described above in Section 2. In brief, the process of emissions modeling transforms the emissions inventories from their original temporal resolution, pollutant resolution, and spatial resolution into the hourly, speciated, gridded resolution required by the air quality model. Emissions modeling includes temporal allocation, spatial allocation, and pollutant speciation. In some cases, emissions modeling also includes the vertical allocation of point sources, but many air quality models also perform this task because it greatly reduces the size of the input emissions files if the vertical layer of the sources does not need to be included.

As seen in Section 2, the temporal resolutions of the emissions inventories input to SMOKE vary across sectors, and may be hourly, daily, monthly, or annual total emissions. The spatial resolution, which also can be different for different sectors, may be individual point sources, county/province/municipio totals, or gridded emissions. This section provides some basic information about the tools and data files used for emissions modeling as part of the modeling platform. In Section 2, the emissions inventories and how they differ from the 2007v5 platform were described. In Section 3, the descriptions of data are limited to the ancillary data SMOKE uses to perform the emissions modeling steps.

SMOKE version 3.5 beta was used to pre-process the emissions inventories into emissions inputs for CMAQ. For sectors that have plume rise, the in-line emissions capability of the air quality models was used, thereby creating source-based and two-dimensional gridded emissions files that are much smaller than full three-dimensional gridded emissions files. For quality assurance of the emissions modeling steps, emissions totals by specie for the entire model domain are output as reports that are then compared to reports generated by SMOKE on the input inventories to ensure that mass is not lost or gained during the emissions modeling process.

3.1 *Emissions modeling Overview*

When preparing emissions for the air quality model, emissions for each sector are processed separately through SMOKE, and then the final merge program (Mrggrid) is run to combine the model-ready, sector-specific emissions across sectors. The SMOKE settings in the run scripts and the data in the SMOKE ancillary files control the approaches used by the individual SMOKE programs for each sector. Table 3-1 summarizes the major processing steps of each platform sector. The "Spatial" column shows the spatial approach used: here "point" indicates that SMOKE maps the source from a point location (i.e., latitude and longitude) to a grid cell; "surrogates" indicates that some or all of the sources use spatial surrogates to allocate county emissions to grid cells; and "area-to-point" indicates that some of the sources use the SMOKE area-to-point feature to grid the emissions. The "Speciation" column indicates that all sectors use the SMOKE speciation step, though biogenics speciation is done within the Tmpbeis3 program and not as a separate SMOKE step. The "Inventory resolution" column shows the inventory temporal resolution from which SMOKE needs to calculate hourly emissions. Note that for some sectors (e.g., onroad, beis), there is no input inventory; instead, activity data and emission factors are used in combination with meteorological data to compute hourly emissions.

Finally, the "plume rise" column indicates the sectors for which the "in-line" approach is used. These sectors are the only ones with emissions in aloft layers based on plume rise. The term "in-line" means that the plume rise calculations are done inside of the air quality model instead of being computed by SMOKE. The air quality model computes the plume rise using the stack data and the hourly air quality model inputs found in the SMOKE output files for each model-ready emissions sector. The height of the plume rise determines the model layer into which the emissions are placed. The c3marine, and othpt sectors are the only sectors that contain only "in-line" emissions, meaning that all of the emissions are placed in aloft layers and there are no emissions for those sectors in the two-dimensional, layer-1 files created by SMOKE.

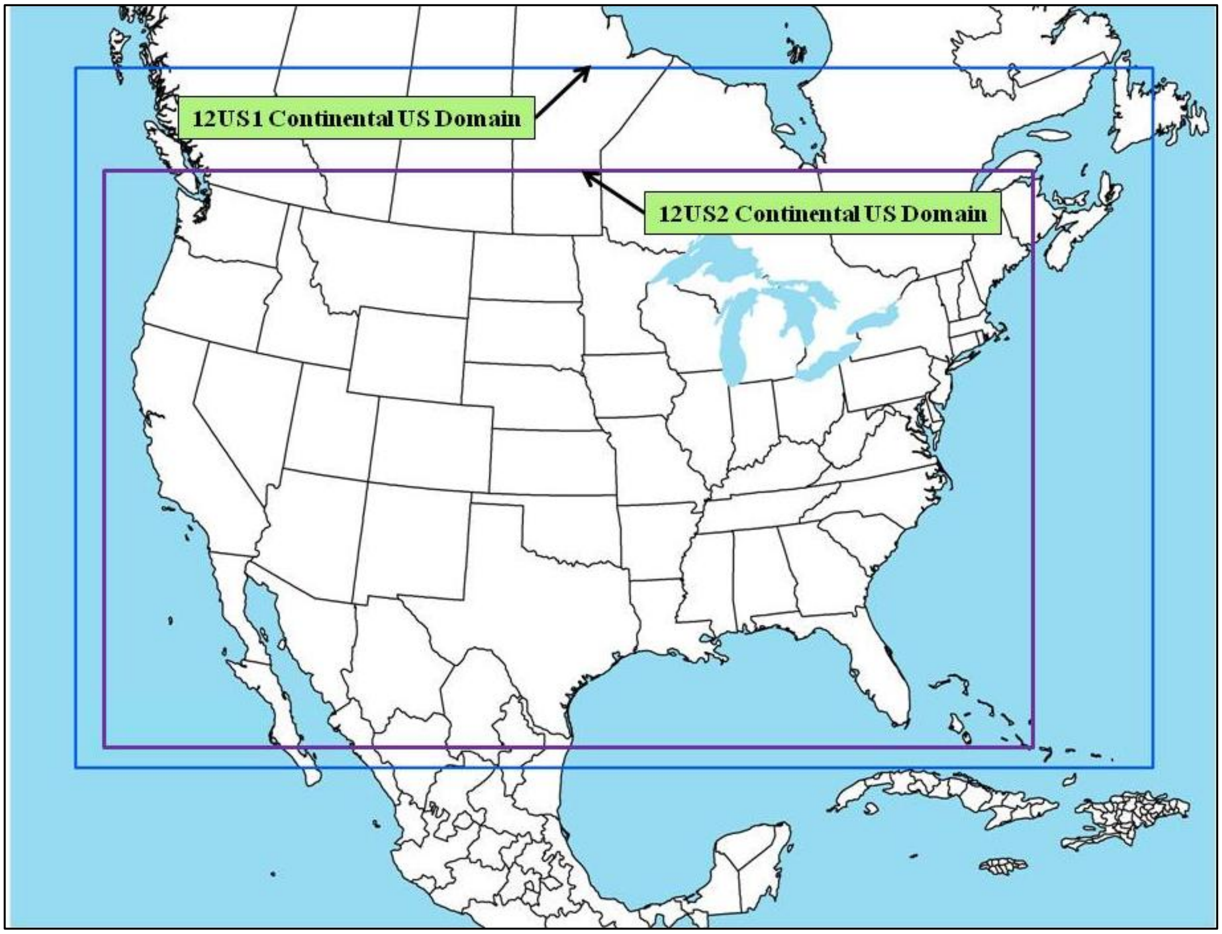
Table 3-1. Key emissions modeling steps by sector.

Platform sector	**Spatial**	**Speciation**	**Inventory resolution**	**Plume rise**
ag	Surrogates	Yes	annual (some monthly)	
afdust	Surrogates	Yes	Annual	
avefire	Surrogates	Yes	daily	
beis	Pre-gridded land use	in BEIS3.14	computed hourly	
c1c2rail	Surrogates	Yes	Annual	
c3marine	Point	Yes	Annual	in-line
nonpt	Surrogates & area-to-point	Yes	annual (some monthly)	
nonroad	Surrogates & area-to-point	Yes	Monthly	
othar	Surrogates	Yes	Annual	
onroad	Surrogates	Yes	computed hourly	
onroad_rfl	Surrogates	Yes	computed hourly	
othon	Surrogates	Yes	Annual	
othpt	Point	Yes	Annual	in-line
ptipm	Point	Yes	Daily	in-line
ptnonipm	Point	Yes	Annual	in-line

SMOKE has the option of grouping sources so that they are treated as a single stack when computing plume rise. For the 2007v5 platform, no grouping was performed because grouping combined with "in-line" processing will not give identical results as "offline" (i.e., when SMOKE creates 3-dimensional files). This occurs when stacks with different stack parameters or lat/lons are grouped, thereby changing the parameters of one or more sources. The most straightforward way to get the same results between in-line and offline is to avoid the use of grouping.

EPA ran SMOKE for the 36-km CONtinental United States "CONUS" modeling domain for the boundary conditions and for the smaller CONUS US 12-km modeling domain (12US2) shown in Figure 3-1 and described in Table 3-2.

Figure 3-1. Air quality modeling domains



Both grids use a Lambert-Conformal projection, with Alpha = 33º, Beta = 45º and Gamma = -97º, with a center of X = -97º and Y = 40º.

Table 3-2. Descriptions of the 2007v5 platform grids

Common Name	Grid Cell Size	Description (see Figure 3-1)	Grid name	Parameters listed in SMOKE grid description (GRIDDESC) file: projection name, xorig, yorig, xcell, ycell, ncols, nrows, nthik
Continental 36km grid (36US1)	36km	Entire conterminous US plus some of Mexico/Canada	36US1_148X112	'LAM_40N97W', -2736000, -2088000, 36.D3, 36.D3, 148, 112, 1
Continental 12km grid	12 km	Entire conterminous US plus some of Mexico/Canada	12US1_459X299	'LAM_40N97W', -2556000, -1728000, 12.D3, 12.D3, 459, 299, 1
US 12 km or "smaller" CONUS-12	12 km	Smaller 12km CONUS plus some of Mexico/Canada	12US2	'LAM_40N97W', -2412000 , -1620000, 12.D3, 12.D3, 396, 246, 1

Section 3.4 provides the details on the spatial surrogates and area-to-point data used to accomplish spatial allocation with SMOKE.

3.2 *Chemical Speciation*

The emissions modeling step for chemical speciation creates "model species" needed by the air quality model for a specific chemical mechanism. These model species are either individual chemical compounds or groups of species, called "model species." The chemical mechanism used for the 2007 platform is the CB05 mechanism (Yarwood, 2005). The same base chemical mechanism is used with CMAQ and CAM_X, but the implementation differs slightly between the two models. The specific versions of CMAQ and CAMx used in applications of this platform include secondary organic aerosol (SOA) and HONO enhancements.

From the perspective of emissions preparation, the CB05 with SOA mechanism is the same as was used in the 2007 platform. Table 3-3 lists the model species produced by SMOKE for use in CMAQ and CAM_X. It should be noted that the BENZENE model species is not part of CB05 in that the concentrations of BENZENE do not provide any feedback into the chemical reactions (i.e., it is not "inside" the chemical mechanism). Rather, benzene is used as a reactive tracer and as such is impacted by the CB05 chemistry. BENZENE, along with several reactive CB05 species (such as TOL and XYL) plays a role in SOA formation. Unlike the 2007v5 platform, the Tier3 FRM modeling included additional hazardous air pollutants (HAPs) and used slightly revised speciation. A "lite" version[15] of the multi-pollutant CMAQ (Version 5.0.1) was used that required additional HAP species[16] (see Table 3-3 for details): ACROLEIN, ALD2_PRIMARY, BUTADIENE13, ETOH, FORM_PRIMARY, and NAPHTHALENE .

The approach for speciating $PM_{2.5}$ emissions supports both CMAQ 4.7.1 and CMAQ 5.0 and includes speciation of $PM_{2.5}$ into a larger set of PM model species than is listed above (see the 2007v5 TSD and Section 3.2.2 for details). The TOG and $PM_{2.5}$ speciation factors that are the basis of the chemical speciation approach were developed from the SPECIATE4.3 database (http://www.epa.gov/ttn/chief/software/speciate), EPA's repository of TOG and PM speciation profiles of air pollution sources. However, a few of the profiles used in this modeling will be published in later versions of the SPECIATE database after the release of this documentation.

The approach for speciating NO_X into NO, NO_2, and HONO is consistent with the 2007v5 platform (see the 2007v5 TSD for details).

The SPECIATE database development and maintenance is a collaboration involving the EPA's ORD, OTAQ, and the Office of Air Quality Planning and Standards (OAQPS), and Environment Canada (EPA, 2006a). The SPECIATE database contains speciation profiles for TOG, speciated into individual chemical compounds, VOC-to-TOG conversion factors associated with the TOG profiles, and speciation profiles for $PM_{2.5}$.

[15] Note, that the MP version of CMAQ allows the user to control the list of HAPs that they wish to explicitly model.
[16] These additional HAPs are referred to in this document as "CMAQ MP-lite HAPs".

Table 3-3. Emission model species produced for CB05 with SOA for CMAQ and CAM_X*

Inventory Pollutant	Model Species	Model species description
CL2	CL2	Atomic gas-phase chlorine
HCl	HCL	Hydrogen Chloride (hydrochloric acid) gas
CO	CO	Carbon monoxide
NO_X	NO	Nitrogen oxide
	NO2	Nitrogen dioxide
	HONO	Nitrous acid
SO_2	SO2	Sulfur dioxide
	SULF	Sulfuric acid vapor
NH_3	NH3	Ammonia
VOC	ACROLEIN	Acrolein from the HAP inventory
	ALD2	Acetaldehyde for VOC speciation
	ALD2_PRIMARY	Acetaldehyde from the HAP inventory
	ALDX	Propionaldehyde and higher aldehydes
	BENZENE	Benzene (not part of CB05)
	BUTADIENE13	1,3-butadiene from the HAP inventory
	CH4	Methane[17]
	ETH	Ethene
	ETHA	Ethane
	ETOH	Ethanol
	FORM	Formaldehyde from VOC speciation
	FORM_PRIMARY	Formaldehyde from the HAP inventory
	IOLE	Internal olefin carbon bond (R-C=C-R)
	ISOP	Isoprene
	MEOH	Methanol
	NAPHTHALENE	Naphthalene from the HAP inventory
	OLE	Terminal olefin carbon bond (R-C=C)
	PAR	Paraffin carbon bond
	TOL	Toluene and other monoalkyl aromatics
	XYL	Xylene and other polyalkyl aromatics
VOC species from the biogenics model that do not map to model species above	SESQ	Sesquiterpenes
	TERP	Terpenes
PM_{10}	PMC	Coarse PM > 2.5 microns and ≤ 10 microns
$PM_{2.5}$[18]	PEC	Particulate elemental carbon ≤ 2.5 microns
	PNO3	Particulate nitrate ≤ 2.5 microns
	POC	Particulate organic carbon (carbon only) ≤ 2.5 microns
	PSO4	Particulate Sulfate ≤ 2.5 microns
	PMFINE	Other particulate matter ≤ 2.5 microns
Sea-salt species (non – anthropogenic)[19]	PCL	Particulate chloride
	PNA	Particulate sodium

[17] Technically, CH4 is not a VOC but part of TOG. Although we derive emissions of CH4, the AQ models do not use these emissions because the anthropogenic emissions are dwarfed by the CH4 already in the atmosphere.
[18] For CMAQ 5.0, $PM_{2.5}$ is speciated into a finer set of PM components. Listed in this table are the AE5 species
[19] These emissions are created outside of SMOKE

*The same species names are used for the CAM_X model with exceptions as follows:
1. CL2 is not used in CAM_X
2. CAM_X particulate sodium is NA (in CMAQ it is PNA)
3. CAM_X uses different names for species that are both in CBO5 and SOA for the following: TOLA=TOL, XYLA=XYL, ISP=ISOP, TRP=TERP. They are duplicate species in CAM_X that are used in the SOA chemistry. CMAQ uses the same names in CB05 and SOA for these species.
4. CAM_X uses a different name for sesquiterpenes: CMAQ SESQ = CAM_X SQT
5. CAM_X uses particulate species uses different names for organic carbon, coarse particulate matter and other particulate mass as follows: CMAQ POC = CAM_X POA, CMAQ PMC = CAM_X CPRM, CMAQ PMFINE= CAM_X FCRS, and CMAQ PMOTHR = CAMx FPRM

3.2.1 VOC speciation

3.2.1.1 The combination of HAP BAFM (benzene, acetaldehyde, formaldehyde and methanol) and VOC for VOC speciation

The VOC speciation includes HAP emissions from the NEI in the speciation process. Instead of speciating VOC to generate all of the species listed in Table 3-3, EPA integrated emissions of four specific HAPs, benzene, acetaldehyde, formaldehyde and methanol (collectively known as "BAFM") from the NEI with the NEI VOC. The integration process (described in more detail in the 2007v5 TSD) combines these HAPs with the VOC in a way that does not double count emissions and uses the HAP inventory directly in the speciation process. The basic process is to subtract the specified HAPs from VOC and to use a special integrated profile to speciate the remainder of VOC to the model species excluding the specific HAPs. Generally, the HAP emissions from the NEI are considered to be more representative of emissions of these compounds than their generation via VOC speciation.

Specific sectors fell into 3 categories: all sources are speciated from VOC directly (no integration), all sources are speciated with BAFM or EBAFM (ethanol plus BAFM) coming from the inventory (full integration), or some sources have BAFM and other sources do not (partial integration). See Table 3-4 for the integration status of each of the modeling sectors.

Table 3-4. Integration approach for BAFM and EBAFM for each platform sector

Platform Sector	Approach for Integrating NEI emissions of Benzene (B), Acetaldehyde (A), Formaldehyde (F), Methanol (M), and Ethanol (E)
ptipm	No integration
ptnonipm	Partial integration (BAFM)
avefire	No integration
Ag	N/A – sector contains no VOC
Afdust	N/A – sector contains no VOC
Nonpt	Partial integration (BAFM and EBAFM)
nonroad	Partial integration (BAFM). Except for California: no integration
c1c2rail	Partial integration (BAFM)
c3marine	Full integration (BAFM)
Onroad	Full integration (EBAFM and BAFM)
Biog	N/A – sector contains no inventory pollutant "VOC"; but rather specific VOC species
Othpt	No integration
Othar	No integration
othon	No integration

More details on the integration of specific sectors and additional details of the speciation are provided in Section3.2.1.3 and the 2007v5 TSD.

3.2.1.2 County specific profile combinations (GSPRO_COMBO)

EPA used the SMOKE feature to compute speciation profiles from mixtures of other profiles in user-specified proportions. The combinations are specified in the GSPRO_COMBO ancillary file by pollutant (including pollutant mode, e.g., EXH__VOC), state and county (i.e., state/county FIPS code) and time period (i.e., month).

EPA used this feature for onroad and nonroad mobile and gasoline-related related stationary sources whereby the emission sources use fuels with varying ethanol content, and therefore the speciation profiles require different combinations of gasoline profiles, e.g. E0 and E10 profiles. Since the ethanol content varies spatially (e.g., by state or county), temporally (e.g., by month) and by modeling year (future years have more ethanol) the feature allows combinations to be specified at various levels for different years. SMOKE computes the resultant profile using the fraction of each specific profile assigned by county, month and emission mode.

The GSREF file indicates that a specific source uses a combination file with the profile code "COMBO". Because the GSPRO_COMBO file does not differentiate by SCC and there are various levels of integration across sectors, we typically have a sector specific GSPRO_COMBO. For the onroad and onroad_rfl sectors, the GSPRO_COMBO uses E-profiles (i.e. there is EBAFM integration). Different profile combinations are specified by the mode (e.g. exhaust, evaporative, refueling, etc.) by changing the pollutant name (e.g. EXH__NONHAPTOG, EVP__NONHAPTOG, RFL__NONHAPTOG). For the nonpt sector, there is a combination of BAFM and EBAFM integration. Due to the lack of SCC in the GSPRO_COMBO, the only way to differentiate the sources that should use BAFM integrated profiles versus E-profiles is by changing the pollutant name. For example, we changed the pollutant name for the PFC future year inventory so the integration would use EVP__NONHAPVOC to correctly select the E-profile combinations while other sources used NONHAPVOC to select the typical BAFM profiles.

3.2.1.3 Additional sector specific details

The decision to integrate HAPs into the speciation was made on a sector by sector basis. For some sectors there is no integration (VOC is speciated directly), for some sectors there is full integration (all sources are integrated), and for other sectors there is partial integration (some sources are not integrated and other sources are integrated). The integrated HAPs are either BAFM (ethanol not subtracted from VOC with BAFM HAPs) or EBAFM (ethanol and BAFM HAPs subtracted from VOC). Table 3-4 summarizes the integration for each platform sector. The additional CMAQ MP-lite HAPs were evaluated and, where it was needed, augmented in the mobile sectors, with details provided below.[20]

For the c1c2rail sector, EPA integrated BAFM for most sources from the 2008 NEI. There were a few sources that had zero BAFM; therefore, they were processed as no integrate. The RPO and CARB inventories did not include HAPs; therefore, EPA processed all non-NEI source emissions in the c1c2rail sector as no integrate. For California, EPA converted the CARB inventory TOG to VOC by dividing the inventory TOG by the available VOC-to-TOG speciation factor. For CARB and the RPO inventories, EPA augmented the inventories to include the CMAQ MP-lite HAPs. In Table 3-5, "geography" indicates whether the emission factor is applied nationally or to a subset of the country and "speciation base" is the pollutant value to use in the emissions calculation.

[20] EPA analyzed the presence of acroleine, 1,3-butadiene, and naphthalene in the nonpt and point sectors and found that the coverage was very inconsistent; therefore the decision was made to augment only the mobile sectors where it was needed.

Table 3-5. HAP augmentation for c1c2rail

Pollutant	Speciation Fraction	Speciation Base	Geography	SCC	SCC Description
1,3 Butadiene	6.146E-05	PM10-PRI	California	2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations
1,3 Butadiene	6.146E-05	PM10-PRI	California	2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations
Acrolein	8.547E-05	PM10-PRI	California	2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations
Acrolein	8.547E-05	PM10-PRI	California	2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations
Napthalene	1.851E-03	PM10-PRI	California	2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations
Napthalene	1.851E-03	PM10-PRI	California	2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations
Napthalene	2.576E-03	PM10-PRI	49 States	2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations
Napthalene	2.576E-03	PM10-PRI	49 States	2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations
Acrolein	4.594E-03	PM10-PRI	49 States	2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations
Acrolein	4.594E-03	PM10-PRI	49 States	2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations
1,3 Butadiene	4.774E-03	PM10-PRI	49 States	2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations
1,3 Butadiene	4.774E-03	PM10-PRI	49 States	2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations
Acrolein	2.625E-03	VOC	National	2280002100	Marine Vessels; Commercial; Diesel; Port
Acrolein	2.188E-03	VOC	National	2280002200	Marine Vessels; Commercial; Diesel; Underway
Naphthalene	1.051E-03	PM25-PRI	National	2280002100	Marine Vessels; Commercial; Diesel; Port
Naphthalene	8.756E-04	PM25-PRI	National	2280002200	Marine Vessels; Commercial; Diesel; Underway

For the c3marine sector, EPA computed HAPs directly from the CAP inventory; therefore, the entire sector is integrated to use the VOC BAFM HAP species directly, rather than VOC speciation profiles. There is no methanol in the VOC speciation, but the remaining VOC BAF HAPs and the CMAQ MP-lite HAPs[21] emissions are derived from the following equations:

Benzene = VOC * 9.795E-06
Acetaldehyde = VOC * 2.286E-04
Formaldehyde = VOC * 1.5672E-03
Naphthalene = PM2.5 * 1.990E-5

For the onroad and onroad_rfl sectors, there are series of unique speciation issues. First, SMOKE-MOVES (see the 2007v5 TSD) is used to estimate these sectors, meaning that both the MEPROC and INVTABLE files are involved in controlling which pollutants are ingested and speciated. Second, these sectors have estimates of TOG as well as VOC; therefore, TOG can be speciated directly. Third, the gasoline sources use

[21] The c3marine sources do not emit acrolein or 1,3-butadiene.

full integration of EBAFM (i.e. use E-profiles) and the diesel sources use full integration of BAFM. Fourth, the onroad sector utilizes 7 different modes for speciation: exhaust, extended idle, auxiliary power units (APU), evaporative, permeation (gasoline vehicles only), brake wear, and tire wear. The onroad_rfl sector utilizes an eighth mode, refueling. Fifth, the gasoline exhaust profiles were updated to 8750a (revision to Gasoline Exhaust - Reformulated gasoline) and 8751a (revision to Gasoline Exhaust - E10 ethanol gasoline).[22] Sixth, the CMAQ MP-lite HAPs are produced directly from the SMOKE-MOVES processing.

For the nonroad sector, CNG or LPG sources (SCC beginning with 2268 or 2267) were not integrated because NMIM computed only VOC and no HAPs were available for these SCCs. All other nonroad sources were integrated. For California, EPA converted the CARB inventory TOG to VOC by dividing the inventory TOG by the available VOC-to-TOG speciation factor. SMOKE later applies the same VOC-to-TOG factor prior to computing speciated emissions. The CARB-based nonroad data includes exhaust and evaporative mode-specific data for VOC, but does not contain refueling. The CARB inventory also does not include HAP estimates; therefore all California nonroad emissions are processed as no integrate so that the HAP species are generated by speciating the TOG emissions. The CMAQ MP-lite HAPS are produced directly by NMIM. In California, the CMAQ MP-lite HAPs were augmented by applying state-wide SCC HAP to VOC ratios based on EPA's NMIM estimates.

For the ptnonipm sector, there is partial integration limited to the 2007 ethanol inventory (SCC 30125010), which includes BAFM . In the future year, there is also partial integration because both the ethanol and biodiesel inventories (SCC 30125010) provided by OTAQ include BAFM. See the 2007v5 TSD for additional details on this sector.

For the oil and gas sources in ptnonipm and nonpt, the WRAP Phase III sources have basin-specific VOC speciation that takes into account the distinct composition of gas. ENVIRON developed these basin-specific profiles using gas composition analysis data obtained from operators through surveys. ENVIRON separated out emissions and speciation from conventional/tight sands/shale gas from coal-bed methane (CBM) gas sources. Table 3-6 lists the basin and gas composition specific profiles used for the WRAP Phase III inventory.[23]

Table 3-6. VOC profiles for WRAP Phase III basins

Profile Code	Description
SSJCB	South San Juan Basin Produced Gas Composition for CBM Wells
SSJCO	South San Juan Basin Produced Gas Composition for Conventional Wells
WRBCO	Wind River Basin Produced Gas Composition for Conventional Wells
PRBCB	Powder River Basin Produced Gas Composition for CBM Wells
PRBCO	Powder River Basin Produced Gas Composition for Conventional Wells
DJFLA	D-J Basin Flashing Gas Composition for Condensate
DJVNT	D-J Basin Produced Gas Composition
UNT01	Uinta Basin Gas Composition at CBM Wells
UNT02	Uinta Basin Gas Composition at Conventional Wells
UNT03	Uinta Basin Flashing Gas Composition for Oil
UNT04	Uinta Basin Flashing Gas Composition for Condensate
PNC01	Piceance Basin Gas Composition at Conventional Wells

[22] These revised profiles are expected to be in the yet to be released SPECIATE 4.4.
[23] Profile PRM01 was used in Tier 3 but not in the 2007v5 modeling. All other profiles are the same between the two cases.

Profile Code	Description
PNC02	Piceance Basin Gas Composition at Oil Wells
PNC03	Piceance Basin Flashing Gas Composition for Condensate
SWFLA	SW Wyoming Basin Flash Gas Composition
SWVNT	SW Wyoming Basin Vented Gas Composition
PRM01	Permian Basin Produced Gas Composition
SWE01	Wyoming Flashing Gas Composition

Othon and othpt used a GSPRO_COMBO that included a gasoline exhaust profile updated to 8750a (revision to Gasoline Exhaust - Reformulated gasoline).

For the remaining sectors, see the 2007v5 TSD for speciation details.

3.2.1.4 Future year speciation

The VOC speciation approach used for the future year case is customized to account for the impact of fuel changes. These changes affect the onroad, onroad_rfl, nonroad, and parts of the nonpt and ptnonipm sectors.

Speciation profiles for VOC in the nonroad, onroad and onroad_rfl sectors that account for the changes in ethanol content of fuels across years. The actual fuel formulations used can be found in Sections 2.5.1.1 and 4.3.1.2. For 2007, EPA used "COMBO" profiles to model combinations of profiles for E0 and E10 fuel use. For 2018 and 2030, EPA used "COMBO" profiles to model combinations of E10, E15, and E85 fuel use. The speciation of onroad exhaust VOC additionally accounts for changes in the fraction of the vehicle fleet meeting different vehicle standards over time; currently, different exhaust profiles are available for pre-Tier 2 versus Tier 2 and later vehicles. Thus for onroad gasoline, VOC speciation uses different COMBO profiles to take into account both the increase in ethanol use, and the increase in vehicles meeting Tier 2 and later standards in the future case.

The speciation changes from fuels in the nonpt sector are for PFCs and fuel distribution operations associated with the BTP distribution. For these sources, ethanol may be mixed into the fuels; therefore, speciation is expect to change across years. The speciation changes from fuels in the ptnonipm sector include BTP distribution operations inventoried as point sources. RBT fuel distribution and BPS speciation does not change across the modeling cases because this is considered upstream from the introduction of ethanol into the fuel. For PFC, ethanol was present in the future inventories and therefore EBAFM profiles were used to integrate ethanol in the speciation. Mapping of fuel distribution SCCs to PFC, BTP, BPS, and RBT emissions categories can be found in Appendix B of the 2007v5 TSD.
Error! Reference source not found. Table 3-7 summarizes the different profiles utilized for the fuel-related sources in each of the sectors for 2007 and the future year cases. This table indicates when "E-profiles" were used instead of BAFM integrated profiles. The term "COMBO" indicates that a combination of the profiles listed was used to speciate that subcategory using the GSPRO_COMBO file. Note, the speciation for the Tier3 2018 control case is identical to the 2018 reference case and the speciation for the 2030 control case is identical to the 2030 reference case. Although many of the profiles making up the COMBO are the same between 2018 and 2030, the ratio of the profiles changes between the two years.

Table 3-7. Select VOC profiles 2007. 2018 and 2030

Sector	Sub-category	2007		2018		2030	
onroad	gasoline exhaust	COMBO: 8750aE 8751aE 8756E 8757E	 Pre-Tier 2 E0 exhaust Pre-Tier 2 E10 exhaust Tier 2 E0 Exhaust Tier 2 E10 Exhaust	COMBO: 8751aE 8757E 8758E 8855E	 Pre-Tier 2 E10 exhaust Tier 2 E10 Exhaust Tier 2 E15 Exhaust Tier 2 E85 Exhaust	COMBO: 8751aE 8757E 8758E 8855E	 Pre-Tier 2 E10 exhaust Tier 2 E10 Exhaust Tier 2 E15 Exhaust Tier 2 E85 Exhaust
onroad	gasoline evaporative	COMBO: 8753E 8754E	 E0 Evap E10 Evap	COMBO: 8754E 8872E 8934E	 E10 Evap E15 Evap E85 Evap	COMBO: 8754E 8872E 8934E	 E10 Evap E15 Evap E85 Evap
onroad	gasoline permeation	COMBO: 8766E 8769E	 E0 evap perm E10 evap perm	COMBO: 8769E 8770E 8934E	 E10 evap perm E15 evap perm E85 Evap	COMBO: 8769E 8770E 8934E	 E10 evap perm E15 evap perm E85 Evap
onroad_rfl	gasoline refueling	COMBO: 8869E 8870E	 E0 Headspace E10 Headspace	COMBO: 8870E 8871E 8934E	 E10 Headspace E15 Headspace E85 Evap	COMBO: 8870E 8871E 8934E	 E10 Headspace E15 Headspace E85 Evap
onroad	diesel exhaust	8774	Pre-2007 MY HDD exhaust	877P0	Weighted diesel exhaust for 2018	87730T3	Weighted diesel exhaust for 2030
onroad	diesel extended idle	8774	Pre-2007 MY HDD exhaust	877EIT3	Weighted diesel extended idle for 2018	877EIT3	Weighted diesel extended idle for 2018
onroad	auxiliary power units	N/A		8774	Pre-2007 MY HDD exhaust	8774	Pre-2007 MY HDD exhaust
onroad	diesel evaporative	4547	Diesel Headspace	4547	Diesel Headspace	4547	Diesel Headspace
onroad_rfl	diesel refueling	4547	Diesel Headspace	4547	Diesel Headspace	4547	Diesel Headspace
nonroad	gasoline exhaust	COMBO: 8750a 8751a	 Pre-Tier 2 E0 exhaust Pre-Tier 2 E10 exhaust	8751a	Pre-Tier 2 E10 exhaust	8751a	Pre-Tier 2 E10 exhaust
nonroad	gasoline evaporative	COMBO: 8753 8754	 E0 evap E10 evap	8754	E10 evap	8754	E10 evap
nonroad	gasoline refueling	COMBO: 8869 8870	 E0 Headspace E10 Headspace	8870	E10 Headspace	8870	E10 Headspace

Sector	Sub-category	2007		2018		2030	
nonroad	diesel exhaust	8774	Pre-2007 MY HDD exhaust	8774	Pre-2007 MY HDD exhaust	8774	Pre-2007 MY HDD exhaust
nonroad	diesel evaporative	4547	Diesel Headspace	4547	Diesel Headspace	4547	Diesel Headspace
nonroad	diesel refueling	4547	Diesel Headspace	4547	Diesel Headspace	4547	Diesel Headspace
nonpt/ ptnonipm	PFC	COMBO: 8869E 8870E	 E0 Headspace E10 Headspace	COMBO: 8870E 8871E 8934E	 E10 Headspace E15 Headspace E85 Evap	COMBO: 8870E 8871E 8934E	 E10 Headspace E15 Headspace E85 Evap
nonpt/ ptnonipm	BTP	COMBO: 8869 8870	 E0 Headspace E10 Headspace	COMBO: 8870 8871 8934	 E10 Headspace E15 Headspace E85 Evap	COMBO: 8870 8871 8934	 E10 Headspace E15 Headspace E85 Evap
nonpt/ ptnonipm	BPS/RBT	8869	E0 Headspace	8869	E0 Headspace	8869	E0 Headspace

3.2.2 PM speciation

In addition to VOC profiles, the SPECIATE database also contains the $PM_{2.5}$ speciated into both individual chemical compounds (e.g., zinc, potassium, manganese, lead), and into the "simplified" $PM_{2.5}$ components used in the air quality model. For CMAQ 4.7.1 modeling, these "simplified" components (AE5) are all that is needed. For CMAQ 5.0.1, there is a new thermodynamic equilibrium aerosol modeling tool (ISORROPIA) v2 mechanism that needs additional PM components (AE6), which are further subsets of PMFINE (see Table 3-8). EPA speciated $PM_{2.5}$ so that it included both AE5 and AE6 PM model species without causing any double counting. Therefore, emissions from these scenarios can be used with either CMAQ 4.7.1 or CMAQ 5.0.1.

Table 3-8. PM model species: AE5 versus AE6

species name	species description	AE5	AE6
POC	organic carbon	Y	Y
PEC	elemental carbon	Y	Y
PSO4	sulfate	Y	Y
PNO3	nitrate	Y	Y
PMFINE	unspeciated $PM_{2.5}$	Y	N
PNH4	ammonium	N	Y
PNCOM	non-carbon organic matter	N	Y
PFE	iron	N	Y
PAL	aluminum	N	Y
PSI	silica	N	Y
PTI	titanium	N	Y
PCA	calcium	N	Y
PMG	magnesium	N	Y
PK	potassium	N	Y
PMN	manganese	N	Y

species name	species description	AE5	AE6
PNA	sodium	N	Y
PCL	chloride	N	Y
PH2O	water	N	Y
PMOTHR	unspeciated $PM_{2.5}$	N	Y

The majority of the PM profiles come from the 911XX series, which include updated AE6 speciation[24]. Unlike the 2007v5 platform, the profile numbers used in the Tier 3 runs are consistent with SPECIATE 4.3. Although the profile numbers changed, the underlying profiles (namely the percentage of AE6 components) did not change between 2007v5 and this 2007 base case (see the 2007v5 TSD for details on the earlier profile names). This change in profile numbers impacts most sectors with PM emissions[25].

3.3 *Temporal Allocation*

Temporal allocation (i.e., temporalization) is the process of distributing aggregated emissions to a finer temporal resolution, such converting annual emissions to hourly emissions. While the total emissions are important, the timing of the occurrence of emissions is also essential for accurately simulating ozone, PM, and other pollutant concentrations in the atmosphere. Many emissions inventories are annual or monthly in nature. Temporalization takes these annual emissions and distributes them to the month, and then distributes the monthly emissions to the day, and the daily emissions to the hour. This process is typically done by applying temporal profiles to the inventories in this order: monthly, day of the week, and diurnal.

The temporal profiles and associated cross references used to create the hourly emissions inputs for the air quality model were similar to those used for the 2007v5 platform. New methodologies introduced in this platform and updated profiles are discussed in this section. Temporal factors are typically applied to the inventory by some combination of country, state, county, SCC, and pollutant. The following values are used in **Error! Not a valid bookmark self-reference.**: the value "all" means that hourly emissions computed for every day of the year and that emissions potentially have day-of-year variation. The value "week" means that hourly emissions computed for all days in one "representative" week, representing all weeks for each month. This means emissions have day-of-week variation, but not week-to-week variation within the month. The value "mwdss" means hourly emissions for one representative Monday, representative weekday (Tuesday through Friday), representative Saturday, and representative Sunday for each month. This means emissions have variation between Mondays, other weekdays, Saturdays and Sundays within the month, but not week-to-week variation within the month. The value "aveday" means hourly emissions computed for one representative day of each month, meaning emissions for all days within a month are the same. Special situations with respect to temporalization are described in the following subsections.

Table 3-9 summarizes the temporal aspects of emissions modeling by comparing the key approaches used for temporal processing across the sectors. The temporal aspects of SMOKE processing are controlled through (a) the L_TYPE (temporal type) and M_TYPE (merge type) settings used, and (b) the temporal profiles themselves. In the table, "Daily temporal approach" refers to the temporal approach for getting daily emissions from the inventory using the SMOKE Temporal program. The values given are the values of the SMOKE L_TYPE setting. The "Merge processing approach" refers to the days used to represent other days in the month for the merge step. If this is not "all", then the SMOKE merge step runs only for representative

[24] The exceptions are 5674 (Marine Vessel – Marine Engine – Heavy Fuel Oil) used for c3marine and 92018 (Draft Cigarette Smoke – Simplified) used in nonpt.

[25] It impacts the profile names (numbers) used in the sector, but it does not impact the fraction of AE6 PM species and hence will not impact the air quality model-ready files.

days, which could include holidays as indicated by the right-most column. The values given are those used for the SMOKE M_TYPE setting (see below for more information).

The following values are used in **Error! Not a valid bookmark self-reference.**: the value “all” means that hourly emissions computed for every day of the year and that emissions potentially have day-of-year variation. The value “week” means that hourly emissions computed for all days in one “representative” week, representing all weeks for each month. This means emissions have day-of-week variation, but not week-to-week variation within the month. The value “mwdss” means hourly emissions for one representative Monday, representative weekday (Tuesday through Friday), representative Saturday, and representative Sunday for each month. This means emissions have variation between Mondays, other weekdays, Saturdays and Sundays within the month, but not week-to-week variation within the month. The value “aveday” means hourly emissions computed for one representative day of each month, meaning emissions for all days within a month are the same. Special situations with respect to temporalization are described in the following subsections.

Table 3-9. Temporal settings used for the platform sectors in SMOKE

Platform sector short name	**Inventory resolutions**	**Monthly profiles used?**	**Daily temporal approach**	**Merge processing approach**	**Process Holidays as separate days**
ptipm	Daily		all	all	Yes
ptnonipm	Annual	yes	mwdss	mwdss	Yes
othpt	Annual	yes	mwdss	mwdss	
nonroad	Monthly		mwdss	mwdss	Yes
othar	Annual	yes	week	week	
c1c2rail	Annual	yes	mwdss	mwdss	
c3marine	Annual	yes	aveday	aveday	
onroad	annual & monthly[1]		all	all	Yes
onroad_rfl	annual & monthly[2]		all	all	Yes
othon	annual	yes	week	week	
nonpt	annual & monthly	yes	all	all	Yes
ag	annual & monthly	yes	all	all	Yes
afdust_adj	annual	yes	week	all	Yes
avefire	daily		all	all	Yes
biog	hourly		n/a	all	Yes

1. Note the annual and monthly “inventory” actually refers to the activity data (VMT and VPOP) for onroad. The actual emissions are computed on an hourly basis.
2. Note the annual and monthly “inventory” actually refers to the activity data (VMT and VPOP) for onroad_rfl. The actual emissions are computed on an hourly basis.

See Section 3.3.5 for more details on the temporalization and inventory resolution of specific sectors.

In addition to the resolution, temporal processing includes a ramp-up period for several days prior to January 1, 2007, which is intended to mitigate the effects of initial condition concentrations. The ramp-up period was 10 days (December 22-31, 2006). For most non-EGU sectors, our approach used the emissions from

December 2007 to fill in surrogate emissions for the end of December 2006. In particular, we used December 2007 emissions (representative days) for December 2006. For biogenic emissions, we processed December 2006 emissions using 2006 meteorology.

3.3.1 FF10 format and inventory resolution

The Flat File 2010 format (FF10) inventory format for SMOKE provides a more consolidated format for monthly, daily, and hourly emissions inventories than previous formats supported. Previously, to process monthly inventory data required the use of 12 separate inventory files. With the FF10 format, a single inventory file can contain emissions for all 12 months and the annual emissions in a single record. This helps simplify the management of numerous inventories. Similarly, daily and hourly FF10 inventories contain individual records with data for all days in a month and all hours in a day, respectively.

SMOKE 3.5 prevents the application of temporal profiles on top of the "native" resolution of the inventory. For example, a monthly inventory should not have annual to month temporalization applied to it; rather, it should only have month-to-day and diurnal temporalization. This becomes particularly important when specific sectors have a mix of annual, monthly, daily, and/or hourly inventories (e.g. the nonpt sector). The flags that control temporalization for a mixed set of inventories are discussed in the SMOKE documentation. The modeling platform sectors that make use of monthly values in the FF10 files are nonroad, onroad, and the ag burning inventory within the nonpt sector.

3.3.2 Ptipm Temporalization

The approach for temporalization of the ptipm sector (EGUs) has not changed from the 2005 v4.3 platform, and is consistent with the method described in the 2007v5 TSD. However, the importance of this sector warrants a restating of the methodology.

Daily emissions were computed from the annual emissions using a structured query language (SQL) program and state-average CEM data. To allocate the annual emissions to each month, state-specific, three-year averages of 2006-2008 CEM data were created. These average annual-to-month factors were assigned to sources by state. To allocate the monthly emissions to each day, the 2007 CEM data was used to compute state-specific month-to-day factors, averaged across all units in each state. The factors were applied to the annual emissions to calculate the daily emissions outside of SMOKE, and the resulting daily inventories were used as inputs to SMOKE.

The daily-to-hourly allocation was performed in SMOKE using diurnal profiles. The state-specific and pollutant-specific diurnal profiles were created by using the 2007 CEM data to create state-specific, day-to-hour factors, averaged over the whole year and all units in each state. The diurnal factors were calculated for SO_2 emissions, NO_X emissions, and heat input. The SO_2 and NO_X-specific factors were used to temporally allocate those pollutants, and the factors created from the hourly heat input data were used to allocate all other pollutants. The resulting profiles were assigned by state and pollutant. The same procedures and factors were used to allocate the base and future year emissions.

3.3.3 Meteorologically-based temporalization

A significant improvement over previous platforms was the introduction of meteorologically-based temporalization. There are many factors that impact the timing of when emissions occur. The benefits of considering meteorology in support of temporalization are: (1) a meteorological dataset consistent with the one used by the AQ model is available (e.g., outputs from WRF); (2) the meteorological model data is highly resolved in terms of spatial resolution; and (3) the meteorological variables vary at hourly resolution and can therefore be translated into hour-specific temporalization. Because the WRF output data for this study was from a different run than that described in the 2007v5 platform TSD, any meteorologically-based temporalization factors, adjustments, and other meteorological effects were recomputed for the Tier 3 runs. This included updating the BIOSEASON file used for biogenic emissions.

The SMOKE program GenTPRO provides a method for developing meteorology-based temporalization. Currently, the program can utilize three types of temporal algorithms: annual-to-day temporalization for residential wood combustion (RWC), month-to-hour temporalization for agricultural livestock ammonia, and a generic meteorology-based algorithm for other situations. For the 2011 platform, meteorological-based temporalization was used for portions of the rwc sector and for livestock within the ag sector. GenTPRO reads in gridded meteorological data (output from MCIP) along with spatial surrogates, and uses the specified algorithm to produce a new temporal profile that can be input into SMOKE. The meteorological variables and the resolution of the generated temporal profile (hourly, daily, etc.) depend on the selected algorithm and the run parameters. For more details on the development of these algorithms and running GenTPRO, see the GenTPRO documentation and the SMOKE documentation at http://www.cmascenter.org/smoke/documentation/3.1/GenTPRO_TechnicalSummary_Aug2012_Final.pdf

For the RWC algorithm, GenTPRO uses the daily minimum temperature to determine the temporal allocation of emissions to days. We ran GenTPRO so that it created annual-to-day temporal profiles for the RWC sources within the nonpt sector. These generated profiles distribute the annual RWC emissions to the coldest days of the year. On days where the minimum temperature does not drop below a user defined threshold, RWC emissions are zero. Conversely, the program temporally allocates the largest percentage of emissions to the coldest days. Similar to other temporal allocation profiles, the total annual emissions do not change, only the distribution of the emissions within the year is affected. The default 50 ˚F threshold was used for the majority of the states, and a 60 ˚F threshold for the following states: Alabama, Arizona, California, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas.

For the agricultural livestock NH_3 algorithm, the GenTPRO algorithm is based on an equation derived by Jesse Bash of EPA ORD based on the Zhu, Henze, et al. (2013) empirical equation. This equation was updated from that described in the 2007v5 TSD, and is based on observations from the TES satellite instrument with the GEOS-Chem model and its adjoint to estimate diurnal NH3 emission variations from livestock as a function of ambient temperature, aerodynamic resistance, and wind speed. The equations are:

$$E_{i,h} = [161500/T_{i,h} \times e^{(-1380/T_{i,h})}] \times AR_{i,h}$$

$$PE_{i,h} = E_{i,h} / \mathrm{Sum}(E_{i,h})$$

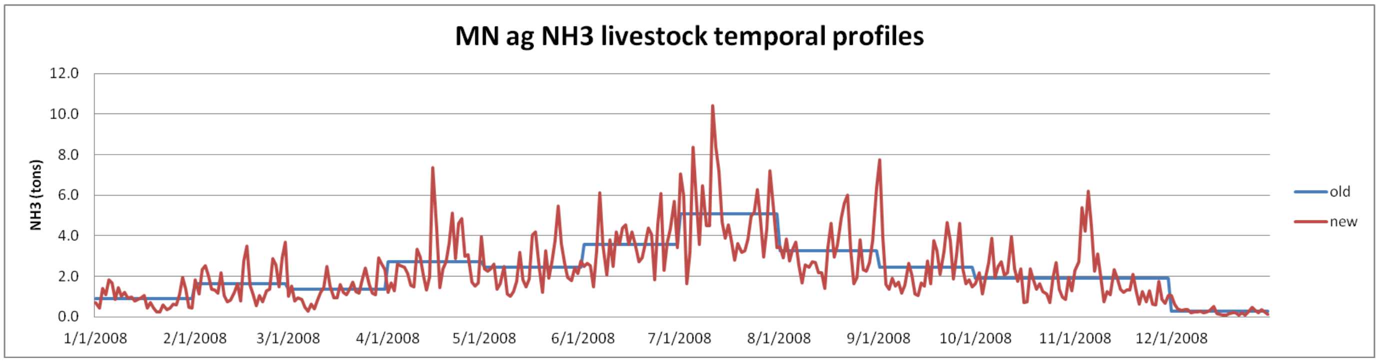
where

- $PE_{i,h}$ = Percentage of emissions in county *i* on hour *h*
- $E_{i,h}$ = Emission rate in county *i* on hour *h*
- $T_{i,h}$ = Ambient temperature (Kelvin) in county *i* on hour *h*
- $V_{i,h}$ = Wind speed (meter/sec) in county *i* (minimum wind speed is 0.1 meter/sec)
- $AR_{i,h}$ = Aerodynamic resistance in county *i*

GenTPRO was run using the “BASH_NH3” profile method to create month-to-hour temporal profiles for these sources. Because these profiles distribute to the hour based on monthly emissions, the monthly emissions are obtained from a monthly inventory, or from an annual inventory that has been temporalized to the month[26].

Figure 3-2 compares the daily emissions for Minnesota from the "old" approach (i.e., uniform monthly profiles) with the "new" approach (i.e., GenTPRO generated month-to-hour profiles). Although the GenTPRO profiles show daily (and hourly variability), the monthly total emissions are the same between the two approaches.

Figure 3-2. Example of new animal NH_3 emissions temporalization approach, summed to daily emissions



For the afdust sector, meteorology is not used in the development of the temporal profiles, but it is used to reduce the total emissions based on meteorological conditions. These adjustments are applied through sector-specific scripts, beginning with the application of land use-based gridded transport fractions and then subsequent zero-outs for hours during which precipitation occurs or there is snow cover on the ground. The land use data used to reduce the NEI emissions explains the amount of emissions that are subject to transport. This methodology is discussed in (Pouliot, et. al., 2010, http://www.epa.gov/ttn/chief/conference/ei19/session9/pouliot_pres.pdf, and in Fugitive Dust Modeling for the 2008 Emissions Modeling Platform (Adelman, 2012). The precipitation adjustment is applied to remove all emissions for days where measureable rain occurs. Therefore, the afdust emissions vary day-to-day based on the precipitation and/or snow cover for that grid cell and day. Both the transport fraction and meteorological adjustments are based on the gridded resolution of the platform; therefore, somewhat different emissions will result from different grid resolutions. Application of the transport fraction and meteorological adjustments prevents the overestimation of fugitive dust impacts in the grid modeling as compared to ambient samples.

3.3.4 Onroad and Onroad_rfl Temporalization

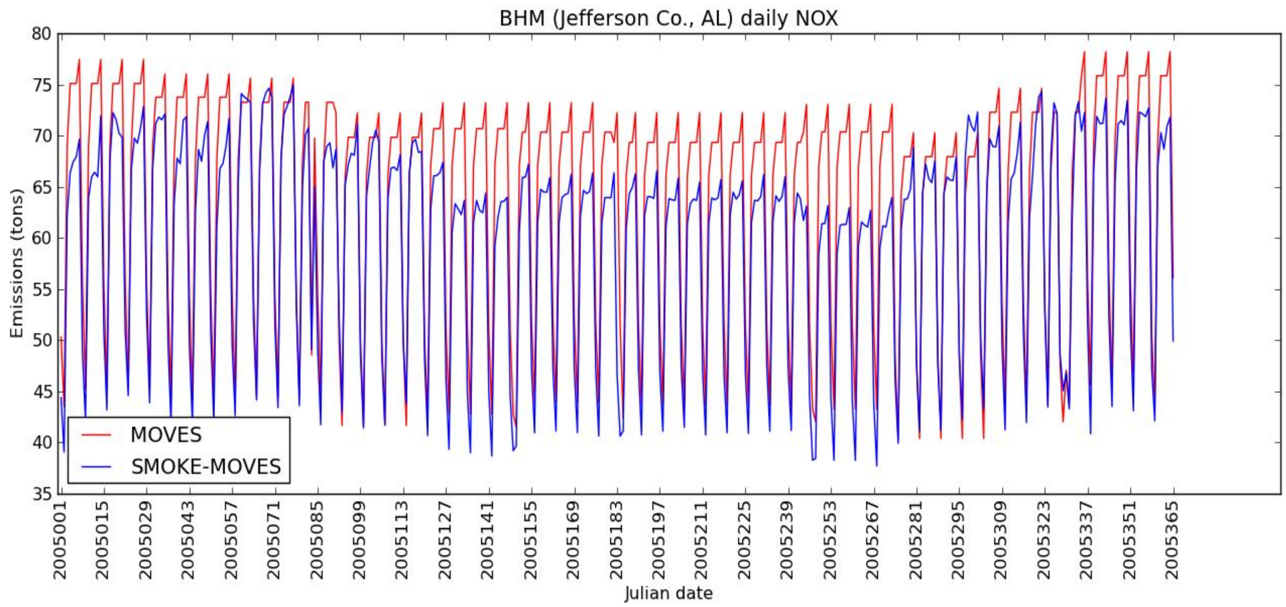
For the onroad and onroad_rfl sectors, meteorology was not used in the development of the temporal profiles; rather, meteorology impacts the actual calculation of the hourly emissions through the program Movesmrg. The result is that the emissions vary at the hourly level by grid cell. More specifically, the on-network (RPD) and the off-network (RPV) exhaust, evaporative, and evaporative permeation modes use the gridded meteorology (MCIP) directly. Movesmrg determined the temperature for that hour and grid cell and used it to select the appropriate EF for that SCC/pollutant/mode. For the off-network RPP, Movesmrg used the Met4moves output for SMOKE (daily minimum and maximum temperatures by county) to determine the appropriate EF for that hour and SCC/pollutant. The result was that the emissions varied hourly by county.

[26] SMOKE v3.5.1 will correctly read in a monthly inventory and apply GenTPRO ag NH3 month-to-hour temporalization. When the emissions were developed for this sector, we were using SMOKE v3.1 beta that incorrectly applied an annual-to-month temporal profile on top of a monthly inventory when temporalizing with GenTPRO ag NH_3 profiles. As an interim solution, a flat monthly profile was applied to the states with a monthly ag NH3 inventory.

The combination of these three processes (RPD, RPV, and RPP) is the total onroad emissions, while the combination of the two processes (RPD, RPV) for the refueling mode only is the total onroad_rfl emissions. Both sectors show a strong meteorological influence on their temporal patterns (see Sections 2.5.1.2 and **Error! Reference source not found.** for more details).

Figure 3-3 illustrates the difference between temporalization of the onroad sector used in previous platforms and that from SMOKE-MOVES. In the plot, the "MOVES" inventory is a monthly inventory that is temporalized by SCC to day-of-week and hour. Similar temporalization is done for the VMT in SMOKE-MOVES, but the meteorologically varying EFs add an additional variable signal on top of the temporalization. Note how the MOVES emissions have a repeating pattern within the month, while the SMOKE-MOVES shows day-to-day (and hour-to-hour) variability. In addition to tracking the meteorological influence, SMOKE-MOVES does not show the artificial jumps between the months.

Figure 3-3. Example of SMOKE-MOVES temporal variability of NO_X emissions



For the onroad and onroad_rfl sectors, the "inventories" referred to in The following values are used in **Error! Not a valid bookmark self-reference.**: the value "all" means that hourly emissions computed for every day of the year and that emissions potentially have day-of-year variation. The value "week" means that hourly emissions computed for all days in one "representative" week, representing all weeks for each month. This means emissions have day-of-week variation, but not week-to-week variation within the month. The value "mwdss" means hourly emissions for one representative Monday, representative weekday (Tuesday through Friday), representative Saturday, and representative Sunday for each month. This means emissions have variation between Mondays, other weekdays, Saturdays and Sundays within the month, but not week-to-week variation within the month. The value "aveday" means hourly emissions computed for one representative day of each month, meaning emissions for all days within a month are the same. Special situations with respect to temporalization are described in the following subsections.

Table 3-9 are actually the activity data inventories. For RPP and RPV processes, the VPOP inventory is annual and does not need temporalization. For RPD, the VMT inventory is monthly and is temporalized to day of the week and then to hourly VMT through temporal profiles. In addition, the RPD processes used a speed profile (SPDPRO) that had vehicle speed by hour for typical weekday and weekend. In addition, RPD, RPV, and RPP all have additional temporal variability due to the meteorological based emissions calculated through Movesmrg.

3.3.5 Additional sector specific details

For a discussion of additional sector-specific details related to temporalization, see Section 3.3.4 of the 2007v5 platform TSD. The topics discussed include updates made in the 2007 platform to agricultural burning and residential wood combustion diurnal profiles.

3.4 *Spatial Allocation*

The methods used to perform spatial allocation for the 2007 platform are summarized in this section. For the 2007 platform, spatial factors are typically applied by country and SCC. As described in Section 3.1, spatial allocation was performed for national 12-km and 36-km domains**.** To do this, SMOKE used national 12-km and 36-km spatial surrogates and a SMOKE area-to-point data file. For the U.S., the surrogates were updated to use 2010-based data wherever possible. For Mexico, we used the same spatial surrogates as were used for the 2005 platform. For Canada we used a set of Canadian surrogates provided by Environment Canada, also unchanged from the 2005v4.3 platform. The U.S., Mexican, and Canadian 12-km surrogates cover the entire CONUS domain 12US1 shown in Figure 3-1. When SMOKE runs, it windows the surrogates to the area needed, such as the 12US2 domain. For the original 2007v5 platform, SMOKE was run on the 12US1 grid and windowed to 12US2 prior to air quality modeling. For the Tier 3 runs, SMOKE was actually run on the 12US2 domain. The remainder of this subsection provides further detail on the origin of the data used for the spatial surrogates and the area-to-point data.

3.4.1 Spatial Surrogates for U.S. emissions

There are 69 spatial surrogates available for spatially allocating U.S. county-level emissions to the 12-km grid cells used by the air quality model. As described in Section 3.4.2, an area-to-point approach overrides the use of surrogates for some sources. Table 3-10 lists the codes and descriptions of the surrogates.

Table 3-10. U.S. Surrogates available for the 2007 platform.

Code	Surrogate Description	Code	Surrogate Description
N/A	Area-to-point approach (see 3.3.1.2)	520	Commercial plus Industrial plus Institutional
100	**Population**	525	Golf Courses + Institutional +Industrial + Commercial
110	**Housing**	527	Single Family Residential
120	**Urban Population**	530	Residential - High Density
130	**Rural Population**	535	Residential + Commercial + Industrial + Institutional + Government
137	**Housing Change**	540	Retail Trade
140	**Housing Change and Population**	545	Personal Repair
150	**Residential Heating - Natural Gas**	550	Retail Trade plus Personal Repair
160	**Residential Heating – Wood**	555	Professional/Technical plus General Government
165	**0.5 Residential Heating - Wood plus 0.5 Low Intensity Residential**	560	Hospital
170	**Residential Heating - Distillate Oil**	565	Medical Office/Clinic
180	**Residential Heating – Coal**	570	Heavy and High Tech Industrial
190	**Residential Heating - LP Gas**	575	Light and High Tech Industrial
200	**Urban Primary Road Miles**	580	Food, Drug, Chemical Industrial
210	**Rural Primary Road Miles**	585	Metals and Minerals Industrial
220	**Urban Secondary Road Miles**	590	Heavy Industrial

Code	Surrogate Description	Code	Surrogate Description
230	**Rural Secondary Road Miles**	595	Light Industrial
240	**Total Road Miles**	596	Industrial plus Institutional plus Hospitals
250	**Urban Primary plus Rural Primary**	600	**Gas Stations**
255	**0.75 Total Roadway Miles plus 0.25 Population**	650	Refineries and Tank Farms
260	**Total Railroad Miles**	675	Refineries and Tank Farms and Gas Stations
270	**Class 1 Railroad Miles**	680	Oil & Gas Wells, IHS Energy, Inc. and USGS
280	**Class 2 and 3 Railroad Miles**	700	Airport Areas
300	**Low Intensity Residential**	710	Airport Point
310	**Total Agriculture**	720	Military AIports
312	**Orchards/Vineyards**	**800**	**Marine Ports**
320	**Forest Land**	**801**	**NEI Ports**
330	**Strip Mines/Quarries**	**802**	**NEI Shipping Lanes**
340	**Land**	**807**	**Navigable Waterway Miles**
350	**Water**	810	Navigable Waterway Activity
400	**Rural Land Area**	850	Golf Courses
500	Commercial Land	860	Mines
505	Industrial Land	870	Wastewater Treatment Facilities
510	Commercial plus Industrial	**880**	**Drycleaners**
515	Commercial plus Institutional Land	890	Commercial Timber

The surrogates in bold have been updated with 2010-based data, including 2010 census data at the block group level, 2010 American Community Survey Data for heating fuels, 2010 TIGER/Line data for railroads and roads, and 2010 National Transportation Atlas Data for ports and navigable waterways. Not all of the available surrogates are used to spatially allocate sources in the 2007 platform; that is, some surrogates shown in Table 3-10 were not assigned to SCCs used in the 2007 platform. Alternative surrogates for ports (801) and shipping lanes (802) were developed from the 2008 NEI shapefiles: Ports_032310_wrf and ShippingLanes_111309FINAL_wrf. These new surrogates were used in the 2007 platform for c1 and c2 commercial marine emissions instead of the standard 800 and 810 surrogates, respectively. Note that the 800 surrogate was used for nonpoint SCCs starting with 250502, which are related to the storage and transfer of petroleum products.

Specific updates made to the surrogates for the Tier 3 runs include updating of the land use-based 300-series surrogates, gas stations (600), construction and mining (861), and dry cleaners (880). Updates to the oil and gas surrogates (689-699) were made as described below, and updated surrogates were used for Mexico.

The creation of surrogates and shapefiles for the U.S. was generated via the Surrogate Tool. The tool and updated documentation for it is available at http://www.ie.unc.edu/cempd/projects/mims/spatial/ and http://www.cmascenter.org/help/documentation.cfm?MODEL=spatial_allocator&VERSION=3.6&temp_id=99999. Note that the surrogate methodology "gapfills" surrogates with less spatial coverage in terms of counties with surrogates that have more spatial coverage. This helps ensure no emissions are dropped during SMOKE processing. Because the land use-based surrogates were updated and are used to gapfill many other surrogates, there were some changes to most of the remaining 500 and 600 series surrogates in terms of using new gapfiling values.

For the onroad sector, the on-network (RPD) emissions were spatially allocated to roadways, which the off-network (RPP and RPV) emissions were allocated to parking areas. For the onroad_rfl sector, the emissions were spatially allocated to gas station locations.

For the oil and gas sources in the nonpt sector, the WRAP Phase III sources have detailed basin-specific spatial surrogates shown in Table 3-11. The remaining oil and gas sources used the 2005-based surrogate "Oil & Gas Wells, IHS Energy, Inc. and USGS" (680) developed for oil and gas SCCs. The surrogates in Table 3-11 were applied for the counties listed in Table 3-12. For the Tier 3 runs, surrogate data for the Permian basin was added.

Table 3-11. Spatial Surrogates for WRAP Oil and Gas Data

Country	Code	Surrogate Description
USA	699	Gas production at CBM wells
USA	698	Well count - gas wells
USA	697	Oil production at gas wells
USA	696	Gas production at gas wells
USA	695	Well count - oil wells
USA	694	Oil production at Oil wells
USA	693	Well count - all wells
USA	692	Spud count
USA	691	Well count - CBM wells
USA	690	Oil production at all wells
USA	689	Gas production at all wells

Table 3-12. Counties included in the WRAP Dataset

FIPS	State	County
08001	CO	Adams
08005	CO	Arapahoe
08007	CO	Archuleta
08013	CO	Boulder
08014	CO	Broomfield
08029	CO	Delta
08031	CO	Denver
08039	CO	Elbert
08043	CO	Fremont
08045	CO	Garfield
08051	CO	Gunnison
08059	CO	Jefferson
08063	CO	Kit Carson
08067	CO	La Plata
08069	CO	Larimer
08073	CO	Lincoln
08075	CO	Logan
08077	CO	Mesa
08081	CO	Moffat
08087	CO	Morgan
08095	CO	Phillips
08097	CO	Pitkin

FIPS	State	County
08103	CO	Rio Blanco
08107	CO	Routt
08115	CO	Sedgwick
08121	CO	Washington
08123	CO	Weld
08125	CO	Yuma
30003	MT	Big Horn
30075	MT	Powder River
35005	NM	Chaves
35015	NM	Eddy
35015	NM	Lea
35031	NM	Mc Kinley
35039	NM	Rio Arriba
35041	NM	Roosevelt
35043	NM	Sandoval
35045	NM	San Juan
48003	TX	Andrews
48033	TX	Borden
48079	TX	Cochran
48081	TX	Coke
48103	TX	Crane
48105	TX	Crockett

FIPS	State	County
48107	TX	Crosby
48109	TX	Culberson
48115	TX	Dawson
48125	TX	Dickens
48135	TX	Ector
48141	TX	El Paso
48151	TX	Fisher
48165	TX	Gaines
48169	TX	Garza
48173	TX	Glasscock
48219	TX	Hockley
48227	TX	Howard
48229	TX	Hudspeth
48235	TX	Irion
48263	TX	Kent
48269	TX	King
48301	TX	Loving
48303	TX	Lubbock
48305	TX	Lynn
48317	TX	Martin
48329	TX	Midland
48335	TX	Mitchell

FIPS	State	County
48353	TX	Nolan
48371	TX	Pecos
48383	TX	Reagan
48389	TX	Reeves
48413	TX	Schleicher
48415	TX	Scurry
48431	TX	Sterling
48435	TX	Sutton
48445	TX	Terry
48451	TX	Tom Green
48461	TX	Upton
48475	TX	Ward
48495	TX	Winkler
48501	TX	Yoakum

FIPS	State	County
49007	UT	Carbon
49009	UT	Daggett
49013	UT	Duchesne
49015	UT	Emery
49019	UT	Grand
49043	UT	Summit
49047	UT	Uintah
56001	WY	Albany
56005	WY	Campbell
56007	WY	Carbon
56009	WY	Converse
56011	WY	Crook
56013	WY	Fremont
56019	WY	Johnson

FIPS	State	County
56023	WY	Lincoln
56025	WY	Natrona
56027	WY	Niobrara
56033	WY	Sheridan
56035	WY	Sublette
56037	WY	Sweetwater
56041	WY	Uinta
56045	WY	Weston

3.4.2 Allocation method for airport-related sources in the U.S.

There are numerous airport-related emission sources in the 2008 NEI, such as aircraft, airport ground support equipment, and jet refueling. The 2007 platform includes the aircraft emissions as point sources. For the 2007 platform, the SMOKE "area-to-point" approach was used for airport ground support equipment (nonroad sector) and jet refueling (nonpt sector). The approach is described in detail in the 2002 platform documentation: http://www.epa.gov/scram001/reports/Emissions%20TSD%20Vol1_02-28-08.pdf.

The ARTOPNT file that lists the nonpoint sources to locate using point data was unchanged from the 2005-based platform.

3.4.3 Surrogates for Canada and Mexico emission inventories

The Mexican spatial surrogates were updated from the 207v5 platform to use the surrogates shown in Table 3-13. The same surrogates for Canada were used to spatially allocate the 2006 Canadian emissions as were used for the 2005v4.2 platform. The spatial surrogate data came from Environment Canada, along with cross references. The surrogates they provided were outputs from the Surrogate Tool (previously referenced). Per Environment Canada, the surrogates are based on 2001 Canadian census data. The Canadian surrogates used for this platform are listed in Table 3-14. We added the leading "9" to the surrogate codes to avoid duplicate surrogate numbers with U.S. surrogates.

Table 3-13. Spatial Surrogates for Mexico

Srg code	Description
22	MEX Total Road Miles
10	MEX Population
12	MEX Housing
14	MEX Residential Heating - Wood
16	MEX Residential Heating - Distillate Oil

20	MEX Residential Heating - LP Gas
22	MEX Total Road Miles
24	MEX Total Railroads Miles
26	MEX Total Agriculture
28	MEX Forest Land
32	MEX Commercial Land
34	MEX Industrial Land
36	MEX Commercial plus Industrial Land
38	MEX Commercial plus Institutional Land
40	Residential (RES1-4)+Comercial+Industrial+Institutional+ Government
42	MEX Personal Repair (COM3)
44	MEX Airports Area
46	MEX Marine Ports
48	Brick Kilns - Mexico
50	Mobile sources - Border Crossing - Mexico

Table 3-14. Canadian Spatial Surrogates for 2007-based platform Canadian Emissions

Code	Description	Code	Description
9100	Population	9493	Warehousing and storage
9101	Total dwelling	9494	Total Transport and warehouse
9102	Urban dwelling	9511	Publishing and information services
9103	Rural dwelling	9512	Motion picture and sound recording industries
9104	Total Employment	9513	Broadcasting and telecommunications
9106	ALL_INDUST	9514	Data processing services
9111	Farms	9516	Total Info and culture
9113	Forestry and logging	9521	Monetary authorities - central bank
9114	Fishing hunting and trapping	9522	Credit intermediation activities
9115	Agriculture and forestry activities	9523	Securities commodity contracts and other financial investment activities
9116	Total Resources	9524	Insurance carriers and related activities
9211	Oil and Gas Extraction	9526	Funds and other financial vehicles
9212	Mining except oil and gas	9528	Total Banks
9213	Mining and Oil and Gas Extract activities	9531	Real estate
9219	Mining-unspecified	9532	Rental and leasing services
9221	Total Mining	9533	Lessors of non-financial intangible assets (except copyrighted works)
9222	Utilities	9534	Total Real estate
9231	Construction except land subdivision and land development	9541	Professional scientific and technical services
9232	Land subdivision and land development	9551	Management of companies and enterprises

Code	Description	Code	Description
9233	Total Land Development	9561	Administrative and support services
9308	Food manufacturing	9562	Waste management and remediation services
9309	Beverage and tobacco product manufacturing	9611	Education Services
9313	Textile mills	9621	Ambulatory health care services
9314	Textile product mills	9622	Hospitals
9315	Clothing manufacturing	9623	Nursing and residential care facilities
9316	Leather and allied product manufacturing	9624	Social assistance
9321	Wood product manufacturing	9625	Total Service
9322	Paper manufacturing	9711	Performing arts spectator sports and related industries
9323	Printing and related support activities	9712	Heritage institutions
9324	Petroleum and coal products manufacturing	9713	Amusement gambling and recreation industries
9325	Chemical manufacturing	9721	Accommodation services
9326	Plastics and rubber products manufacturing	9722	Food services and drinking places
9327	Non-metallic mineral product manufacturing	9723	Total Tourism
9331	Primary Metal Manufacturing	9811	Repair and maintenance
9332	Fabricated metal product manufacturing	9812	Personal and laundry services
9333	Machinery manufacturing	9813	Religious grant-making civic and professional and similar organizations
9334	Computer and Electronic manufacturing	9814	Private households
9335	Electrical equipment appliance and component manufacturing	9815	Total other services
9336	Transportation equipment manufacturing	9911	Federal government public administration
9337	Furniture and related product manufacturing	9912	Provincial and territorial public administration (9121 to 9129)
9338	Miscellaneous manufacturing	9913	Local municipal and regional public administration (9131 to 9139)
9339	Total Manufacturing	9914	Aboriginal public administration
9411	Farm product wholesaler-distributors	9919	International and other extra-territorial public administration
9412	Petroleum product wholesaler-distributors	9920	Total Government
9413	Food beverage and tobacco wholesaler-distributors	9921	Commercial Fuel Combustion
9414	Personal and household goods wholesaler-distributors	9922	TOTAL DISTRIBUTION AND RETAIL
9415	Motor vehicle and parts wholesaler-distributors	9923	TOTAL INSTITUTIONAL AND GOVERNEMNT
9416	Building material and supplies wholesaler-distributors	9924	Primary Industry
9417	Machinery equipment and supplies wholesaler-distributors	9925	Manufacturing and Assembly

Code	Description	Code	Description
9418	Miscellaneous wholesaler-distributors	9926	Distribution and Retail (no petroleum)
9419	Wholesale agents and brokers	9927	Commercial Services
9420	Total Wholesale	9928	Commercial Meat cooking
9441	Motor vehicle and parts dealers	9929	HIGHJET
9442	Furniture and home furnishings stores	9930	LOWMEDJET
9443	Electronics and appliance stores	9931	OTHERJET
9444	Building material and garden equipment and supplies dealers	9932	CANRAIL
9445	Food and beverage stores	9933	Forest fires
9446	Health and personal care stores	9941	PAVED ROADS
9447	Gasoline stations	9942	UNPAVED ROADS
9448	clothing and clothing accessories stores	9943	HIGHWAY
9451	Sporting goods hobby book and music stores	9944	ROAD
9452	General Merchandise stores	9945	Commercial Marine Vessels
9453	Miscellaneous store retailers	9946	Construction and mining
9454	Non-store retailers	9947	Agriculture Construction and mining
9455	Total Retail	9950	Intersection of Forest and Housing
9481	Air transportation	9960	TOTBEEF
9482	Rail transportation	9970	TOTPOUL
9483	Water Transportation	9980	TOTSWIN
9484	Truck transportation	9990	TOTFERT
9485	Transit and ground passenger transportation	9993	Trail
9486	Pipeline transportation	9994	ALLROADS
9487	Scenic and sightseeing transportation	9995	30UNPAVED_70trail
9488	Support activities for transportation	9996	Urban area
9491	Postal service	9997	CHBOISQC
9492	Couriers and messengers	9991	Traffic

4 Development of Future Year Emissions

This section describes the methods used for developing the emissions for the 2018 and 2030 future-year scenarios. Within the 2018 and 2030 cases, the future year emissions for the Tier 3 FRM "reference" and "control" cases are the same for all stationary sources. For 2018 and 2030, the Tier 3 FRM control case emissions include Tier 3 engine and fuel controls that impact emissions for onroad mobile and nonroad mobile sources. EPA analyzed emission impacts of the Tier 3 vehicle emissions and fuel standards by comparing projected emissions for future years without the Tier 3 rule (reference scenario) to projected emissions for future years with the Tier 3 standards in place (control scenario). For more details on the differences between the reference and control scenarios, see the onroad and nonroad sections (Section 4.3.1 and 4.3.2, respectively).

The future scenarios' projection methodologies vary by sector. The 2018 and 2030 reference scenarios represent predicted emissions in the absence of any further controls beyond those Federal and State measures already promulgated, or under reconsideration before emissions processing began in March, 2013. The future base-case scenario reflects projected economic changes and fuel usage for EGU and mobile sectors. The 2020 (used as a surrogate for 2018) and 2030 EGU projected inventories represent demand growth, fuel resource availability, generating technology cost and performance, and other economic factors affecting power sector behavior. It also reflects the expected 2020 and 2030 emissions effects due to environmental rules and regulations, consent decrees and settlements, plant closures, control devices updated since 2007, and forecast unit construction through the calendar year 2020 and 2030. In this analysis, the projected EGU emissions include the Final Mercury and Air Toxics (MATS) rule announced on December 21, 2011, the Clean Air Interstate Rule issued on March 10, 2005, including impacts of electric vehicle penetration resulting from the Light-duty Greenhouse Gas (LDGHG) Rule.

For the other mobile sources (c1c2rail and c3marine sectors), all national measures for which data were available at the time of modeling have been included.

For nonEGU point (ptnonipm sector) and nonpoint stationary sources (nonpt, ag, and afdust sectors), local control programs are generally not included in the future base-case projections for most states unless information was provided by the states. One exception are some NO_X and VOC reductions associated with the New York, Virginia, and Connecticut State Implementation Plans (SIP), that were added as part of a larger effort to start including more local control information on stationary non-EGU sources; this is described further in Section 4.2. The following bullets summarize the projection methods used for sources in the various sectors, while additional details and data sources are given in the following subsections and Table 4-1. For information on control/growth strategies that are not different from the 2007v5 platform, please reference the 2007v5 TSD, available at:
http://epa.gov/ttn/chief/emch/2007v5/2007v5_2020base_EmisMod_TSD_13dec2012.pdf

- IPM sector (ptipm): Unit-specific estimates from IPM, version 4.10 Final MATS with CAIR and the penetration of electric vehicles anticipated due to the LDGHG rule.
- Non-IPM sector (ptnonipm): Projection factors and percent reductions reflect Cross-State Air Pollution Rule (CSAPR) comments and emission reductions due to national rules, control programs, plant closures, consent decrees and settlements, and 1997 and 2001 ozone State Implementation Plans in NY, CT, and VA. Also used projection approaches for corn ethanol and biodiesel plants, refineries and upstream impacts from the Energy Independence and Security Act of 2007 (EISA). Terminal area forecast (TAF) data aggregated to the national level were used for aircraft to account for projected changes in landing/takeoff activity.

- Average fires sector (avefire): No growth or control.
- Agricultural sector (ag): Projection factors for livestock estimates based on expected changes in animal population from 2005 Department of Agriculture data, updated based on personal communication with EPA experts in July 2012; fertilizer application NH_3 emissions projections include upstream impacts EISA.
- Area fugitive dust sector (afdust): Projection factors for dust categories related to livestock estimates based on expected changes in animal population and upstream impacts from EISA.
- Remaining Nonpoint sector (nonpt): Projection factors that implement Cross State Air Pollution Rule comments and reflect emission reductions due to control programs. Residential wood combustion projections are based on growth in lower-emitting stoves and a reduction in higher emitting stoves. PFC projection factors reflecting impact of the final Mobile Source Air Toxics (MSAT2) rule. Upstream impacts from EISA, including post-2007 cellulosic ethanol plants are also reflected.
- Nonroad mobile sector (nonroad): Other than for California, this sector uses data from a run of NMIM that utilized NONROAD2008b, using future-year equipment population estimates and control programs to the year 2018 and 2030 and using national level inputs. Fuels are consistent with the onroad sector. Final controls from the final locomotive-marine and large spark ignition OTAQ rules are included. California-specific data were provided by CARB.
- Locomotive, and non-Class 3 commercial marine sector (c1c2rail): For all states except California, projection factors for Class 1 and Class 2 commercial marine and locomotives which reflect final locomotive-marine controls. California projected year-2017 (used for 2018) and 2030 inventory data were provided by CARB. Additional RFS2-related county-level emissions adjustments were applied to reflect different fuel volume characteristics from increased ethanol fuel transport on rail and commercial marine vessels.
- Class 3 commercial marine vessels (c3marine): Base-year 2007 emissions grown and controlled to 2018 and 2030, incorporating controls based on Emissions Control Area (ECA) and International Marine Organization (IMO) global NO_X and SO_2 controls.
- Onroad mobile, not including refueling (onroad): focus of the rule, see Section 4.3.1.
- Onroad refueling mode (onroad_rfl): Uses the same projection approach as the onroad sector and processing as described in Section 2.5.2.
- Other onroad (othar): No growth or control for Canada because data are not available from Canada. Mexico inventory data were grown from 1999 to years 2018 and 2030.
- Other nonroad/nonpoint (othon): No growth or control for Canada. Mexico inventory data were grown from 1999 to years 2018 and 2030.
- Other point (othpt): No growth or control for Canada and offshore oil. Mexico inventory data were grown from 1999 to years 2018 and 2030.
- Biogenic: 2007 emissions used for all future-year scenarios.

Table 4-1 summarizes the control strategies and growth assumptions by source type that were used to create the U.S. 2018 and 2030 scenario emissions from the 2007 base-case inventories. The control, closures, projection packets (datasets) used to create stationary non-EGU and c1c2rail sector 2018 and 2030 future years scenario inventories from the 2007 base case are described in the following sections. These datasets (i.e., “packets”) were processed through the EPA Control Strategy Tool (CoST) to create future year inventories. CoST is described here: http://www.epa.gov/ttnecas1/cost.htm.

The remainder of this section is organized either by source sector or by specific emissions category within a source sector for which a distinct set of data were used or developed for the purpose of projections for the 2018 and 2030 scenarios. This organization allows consolidation of the discussion of the emissions categories that are contained in multiple sectors, because the data and approaches used across the sectors are consistent and do not need to be repeated. Sector names associated with the emissions categories are provided in parentheses. If a strategy is identical to the 2007v5 platform, it is noted in the Section as "2007v5" and is documented in the 2007v5 TSD.

Table 4-1. Control strategies and growth assumptions for creating the 2018 and 2030 emissions inventories from the 2007 base case

Control Strategies and/or growth assumptions (grouped by standard and approach used to apply to the inventory)	**CAPs affected**	**Section**
Non-EGU Point (ptnonipm sector) Controls and Growth Assumptions		
Ethanol plants that account for increased ethanol production due to EISA mandate	All	**Error! Reference source not found.**
Biodiesel plants producing 1.6 billion gallons of production due to EISA mandate	All	4.2.1.2
Ethanol distribution vapor losses adjustments due to EISA mandate	VOC	0
Refinery upstream adjustments from EISA mandate	All	4.2.1.7
Livestock emissions growth from year 2008 to 2018 and 2030, also including upstream RFS2 impacts on agricultural-related activities such as pesticide and fertilizer production	All	4.2.2
Reciprocating Internal Combustion Engines (RICE) NESHAP with reconsiderations	NO_X, CO, PM, SO_2	2007v5
State fuel sulfur content rules for fuel oil – as of July, 2012, effective only in Maine, Massachusetts, New Jersey, New York and Vermont	SO_2	4.2.3
Industrial/Commercial/Institutional Boilers and Process Heaters MACT with Reconsideration Amendments	CO, PM, SO_2, VOC	2007v5
NESHAP: Portland Cement (09/09/10) – plant level based on Industrial Sector Integrated Solutions (ISIS) policy emissions in 2013. The ISIS results are from the ISIS-Cement model runs for the NESHAP and NSPS analysis of July 28, 2010 and include closures.	All	4.2.4
Future baseline inventory improvements received from a 2005 platform NODA and comments from the CSAPR proposal, including local controls, fuel switching, unit closures and consent decrees	All	4.2.5
Facility and unit closures obtained from various sources such as states, industry and web posting, EPA staff and post-2008 inventory submittals: effective prior to spring 2012	All	2007v5
Aircraft growth via Itinerant (ITN) operations at airports to 2018 and 2030	All	4.2.6.1
Emission reductions resulting from controls put on specific boiler units (not due to MACT) after 2008, identified through analysis of the control data gathered from the Information Collection Request (ICR) from the Industrial/Commercial/Institutional Boiler NESHAP.	SO_2	2007v5
New York ozone SIP controls	NO_X	2007v5
Boat Manufacturing MACT rule, VOC: national applied by SCC	VOC	2007v5
Lafarge and Saint Gobain consent decrees	NO_X, PM, SO_2	2007v5
Consent decrees on companies (based on information from the Office of Enforcement and Compliance Assurance – OECA) apportioned to plants owned/operated by the companies	CO, NO_X, PM, SO_2, VOC	2007v5
Refinery Consent Decrees: plant/unit controls	NO_X,	2007v5

Control Strategies and/or growth assumptions (grouped by standard and approach used to apply to the inventory)	CAPs affected	Section
	SO_2	
Commercial and Industrial Solid Waste Incineration (CISWI) revised NSPS	PM, SO_2	2007v5
Hazardous Waste Incineration (HWI), Phase I and II	PM	2007v5
Nonpoint (afdust, ag and nonpt sectors) Controls and Growth Assumptions		
MSAT2 and RFS2 impacts on portable fuel container growth and control from 2007 to 2018 and 2030	VOC	0
Cellulosic ethanol and diesel emissions from EISA mandate	All	4.2.1.4
Ethanol transport working losses inventory from EISA mandate	VOC	0
Ethanol distribution vapor losses adjustments due to EISA mandate	VOC	0
Livestock emissions growth from year 2008 to 2018 and 2030, also including upstream RFS2 impacts on agricultural-related activities such as pesticide and fertilizer production	All	4.2.2
Reciprocating Internal Combustion Engines (RICE) NESHAP with reconsiderations	NO_X, CO, PM, SO_2	2007v5
State fuel sulfur content rules for fuel oil –as of July, 2012, effective only in Maine, Massachusetts, New Jersey, New York and Vermont	SO_2	4.2.3
Residential wood combustion growth and change-outs from year 2008 to 2018	All	2007v5
Future baseline inventory improvements received from a 2005 platform NODA and comments from the CSAPR proposal, reflecting local controls	NO_X, VOC	4.2.5
New York ozone SIP controls	NO_X	2007v5**Error! Reference source not found.**
Texas oil and gas projections to year 2018	All	4.2.6.2
Onroad Mobile Controls (All national in-force regulations are modeled. The list includes key recent mobile control strategies but is not exhaustive.)		
National Onroad Rules: All onroad control programs finalized as of the date of the model run, including most recently: Light-Duty Greenhouse Gas Rule: October, 2012 Heavy (and Medium)-Duty Greenhouse Gas Rule: September, 2011 Renewable Fuel Standard: March, 2010 Light Duty Greenhouse Gas Rule: May, 2010 Corporate-Average Fuel Economy standards for 2008-2011, April, 2010 2007 Onroad Heavy-Duty Rule: February, 2009 Final Mobile Source Air Toxics Rule (MSAT2): February, 2007 Tier 2 Rule: Signature date February, 2000 National Low Emission Vehicle Program (NLEV): March, 1998	All	4.3
Local Onroad Programs: California LEVIII Program Ozone Transport Commission (OTC) LEV Program: January,1995 Inspection and Maintenance programs Fuel programs (also affect gasoline nonroad equipment) Stage II refueling control programs	VOC	4.3
Nonroad Mobile Controls (All national in-force regulations are modeled. The list includes recent key mobile control strategies but is not exhaustive.)		
National Nonroad Controls: All nonroad control programs finalized as of the date of the model run, including most recently:	All	4.3.2

Control Strategies and/or growth assumptions (grouped by standard and approach used to apply to the inventory)	CAPs affected	Section
Emissions Standards for New Nonroad Spark-Ignition Engines, Equipment, and Vessels: October, 2008 Control of Emissions from Nonroad Large Spark-Ignition Engines, and Recreational Engines (Marine and Land-Based), November 8, 2002[27] Clean Air Nonroad Diesel Final Rule – Tier 4: June, 2004[28]		
Locomotives: Control of Emissions of Air Pollution from Locomotives and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder: March, 2008 Clean Air Nonroad Diesel Final Rule – Tier 4: May, 2004	All	4.3.3
Commercial Marine: Category 3 marine diesel engines Clean Air Act and International Maritime Organization standards: April, 2010 Control of Emissions of Air Pollution from Locomotives and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder: March, 2008 Clean Air Nonroad Diesel Final Rule – Tier 4: May, 2004	All	4.3.4

The ancillary input data in the future-year scenarios are very similar to those used in the 2007 base case except for the speciation profiles used for gasoline-related sources, which change in the future to account for increased ethanol usage in gasoline (see Section 3.2.1.4 for details).

4.1 *Stationary source projections: EGU sector (ptipm)*

The future-year data for the ptipm sector used in the air quality modeling were created by the Integrated Planning Model (IPM) version 4.10 (v4.10) Final MATS (Mercury and Air Toxics Standards) http://www.epa.gov/airmarkets/progsregs/epa-ipm/toxics.html). IPM is a multiregional, dynamic, deterministic linear programming model of the U.S. electric power sector. IPM 4.10 was updated from the previous version to include adjustments to assumptions regarding the performance of acid gas control technologies, new costs imposed on fuel-switching (e.g., bituminous to sub-bituminous), correction of lignite availability to some plants, incorporation of planned retirements, implementation of a scrubber upgrade option, and the availability of a scrubber retrofit to waste-coal fired fluidized bed combustion units without an existing scrubber.

The scenario used for this modeling represents CAIR, MATS, and the penetration of electric vehicles anticipated due to the LDGHG rule. IPM v4.10 Final MATS originally included the Cross-State Air Pollution Rule (CSAPR), but the rule was stayed by the D.C. circuit court pending judicial review. Therefore, the original CAIR rule was included in the run for this project. Electric vehicle penetration expected from the Light-duty Greenhouse Gas Rule was also included.

The Boiler MACT reconsideration was not represented in the 2020 IPM dataset because the rule was not final at the time the IPM modeling was performed. Further details on the future-year EGU emissions inventory used for this rule can be found in the incremental documentation of the IPM v.4.10 platform, available at http://www.epa.gov/airmarkets/progsregs/epa-ipm/transport.html. .

While NO_x, SO_2, and mercury are specific outputs from IPM, directly emitted PM emissions (i.e., $PM_{2.5}$ and PM_{10}) from the EGU sector are computed via a post processing routine that applies emission factors to the

[27] https://www.federalregister.gov/articles/2002/11/08/02-23801/control-of-emissions-from-nonroad-large-spark-ignition-engines-and-recreational-engines-marine-and
[28] http://www.epa.gov/otaq/nonroad-diesel.htm

IPM-estimated fuel throughput based on fuel, configuration and controls to compute the filterable and condensable components of PM.

4.2 *Stationary source projections: non-EGU sectors (ptnonipm, nonpt, ag, afdust)*

To project U.S. stationary sources other than the ptipm sector, EPA applied growth factors and/or controls to certain categories within the ptnonipm, nonpt, ag and afdust platform sectors. This subsection provides details on the data and projection methods used for these sectors. In estimating future-year emissions, EPA assumed that emissions growth does not track with economic growth for many stationary non-IPM sources. This "no-growth" assumption is based on an examination of historical emissions and economic data. For more details on the projection methodology and justification for the approaches, see the 2007v5 TSD.

Year-specific projection factors (PROJECTION packets) for year 2018 and 2030 were used for creating the scenarios unless noted otherwise. The contents of these projection packets (and control reductions) are provided in the following sections where feasible. However, some sectors used growth or control factors that varied geographically and their contents could not be provided in the following sections (e.g., facilities and units subject to the Boiler MACT reconsideration has thousands of records). If the growth or control factors for a sector are not provided in a table in this document, they are available as a "projection", "control", or "closures" packet for input to SMOKE on the 2007v5 platform website. This document only summarizes the impact of controls and projections that differ between Tier 3 and the previous modeling for PM NAAQS (2007v5 platform). The following projection, control or closure packets had identical or nearly identical impact in 2018 (as well as 2030) for Tier 3 as in 2020 of PM NAAQS modeling and are detailed in the 2007v5 TSD:

- RICE NESHAP
- Industrial Boiler MACT reconsideration
- Residential wood combustion growth
- Remaining non-EGU plant closures
- Boiler reductions not associated with the MACT rule
- NY Ozone SIP controls
- Boat manufacturing MACT
- Lafarge and St Gobain settlements
- OECA consent decrees
- Refinery consent decrees
- CISWI/HWI controls

This section is divided into several subsections that are summarized in Table 4-2. Note that for some sources, future year inventories were used rather than projection or control packets.

Table 4-2. Summary of non-EGU stationary projections subsections

Subsection	Title	Sector(s)	Brief Description
4.2.1	RFS2 upstream future year inventories and adjustments	nonpt ptnonipm	1) Point and non-point inventories received from OTAQ that account for the upstream impact of the RFS2 and the EISA mandate. 2) Point and non-point adjustment factors that we apply to the 2007 inventory to reflect RFS2
4.2.2	Agricultural and livestock adjustments, including RFS2	afdust, ag, nonpt, ptnonipm	Adjustment factors to all ag-related sources that also reflect upstream RFS2 impacts on ag-related processes impacted by increased ethanol use
Error! Reference source not found.	Fuel sulfur rules	nonpt ptnonipm	Control packet reflecting state and local fuel sulfur rules, including ULSD
4.2.3	Portland cement NESHAP projections	ptnonipm	Year-2013 ISIS policy case reflecting closures, controls at existing kilns and an inventory containing new kilns constructed after 2008 that account for shifting capacity from some closed units to open units
Error! Reference source not found.	CSAPR and NODA comments	nonpt ptnonipm	Post-2008 controls, adjustments, and closures received in response to preparing the 2005 NEI for a future year baseline. These are not reflective of CSAPR; but rather of non-EGU future year information received from comments.
4.2.4	All other PROJECTION and CONTROL packets	nonpt ptnonipm	All other non-EGU stationary source PROJECTION and CONTROL packets not covered in previous subsections.

4.2.1 RFS2 upstream future year inventories and adjustments (nonpt, ptnonipm)

EPA incorporated adjustments for some stationary source categories to account for impacts of the Energy Independence and Security Act (EISA) renewable fuel standards mandate in the Renewable Fuel Standards Program (RFS2; EPA, 2010a)), as estimated by Annual Energy Outlook (AEO) 2013, as well as impacts of recent 2017-2025 light duty vehicle greenhouse gas emission standards and heavy-duty greenhouse gas standards. These mandates not only impact emissions associated with highway vehicles and nonroad engines, but also emissions associated with point and nonpoint sources. The "upstream" emission impacts of the renewable fuels mandate are associated with all stages of biofuel production and distribution, including biomass production (agriculture, forestry), fertilizer and pesticide production and transport, biomass transport, biomass refining (corn or cellulosic ethanol production facilities), biofuel transport to blending/distribution terminals, and distribution of finished fuels to retail outlets. These impacts are accounted for in the 2018 and 2030 inventories. A portion of these impacts are discussed in this section, with additional impacts due to transport discussed in the onroad and c1c2rail sectors (see Section 4.3.1.1 and 4.3.3, respectively). There are also impacts on domestic crude emissions upstream of petroleum refineries, due to displacement of gasoline and diesel fuel with biofuels, but these are not accounted for in these projections as these data were not available. Greenhouse gas standards also affect production and distribution of gasoline and diesel fuels, but the impacts of these rules will be very small in 2018 and were not accounted for. Where it was feasible, EPA included the impact of these greenhouse gas standards in the 2030 estimates.

EPA assumed that an unadjusted 2018 inventory, which does not account for the impacts of the EISA renewable fuel mandate, would have comparable ethanol volumes to 2007, approximately 6.9 billion gallons. However, analyses done to support the RFS2 rule (EPA, 2010a) suggest a significant increase in renewable fuel volumes in 2018 and 2030 (see Table 4-3). Adjustments applied to the inventories (described in the following subsections) reflect the impacts on emissions due to the difference between the 2007 ethanol volumes and the renewable fuel volumes shown in Table 4-3. In 2018, EPA assumed 1 Bgal (billion gallons) of ethanol would be used as E85, 10 Bgal as E10, and about 4 Bgal as E15. In 2030, EPA assumed 1.4 Bgal of ethanol would be used as E85, 6.8 Bgal as E10, and 6.5 Bgal as E15.

Table 4-3. Renewable Fuel Volumes Assumed for Stationary Source Adjustments.

Renewable Fuel	2018 Volume (Bgal)	2030 Volume (Bgal)
Corn Ethanol	14.7	14.4
Cellulosic Ethanol	0.235	0.235
Imported Ethanol	1.061	0.707
Biodiesel	1.887	1.887
Renewable Diesel	0.236	1.179
Cellulosic Diesel	0.290	0.915

4.2.1.1 Corn Ethanol plants inventory (ptnonipm)

Future year inventories: “ethanol_plants_2018_NEI” and “ethanol_plants_2018_OTAQ_revised”

As discussed in Section 2.1.2, EPA supplemented the 2007 NEI with corn ethanol plants that EPA/OTAQ developed. The 2007 emissions were projected to account for the increased domestic corn ethanol production assumed in this modeling, specifically an increase from 6.9 Bgal in 2007 to approximately 15 Bgal in 2018 and 2030. An industry characterization (EPA, 2012b) was also used to project the 2007 inventory to future years, based on new plants, changes in production capacity since 2007, or changes in progress. Table 4-4 provides the summaries of estimated emissions for the corn ethanol plants in year 2007 and 2018[29]. Note, EPA estimated the same amount of ethanol plant production in the future years for 2018 and 2030 and assumed that the control scenarios would have limited to no impact on the ethanol production.

Table 4-4. 2007 and 2018/2030 corn ethanol plant emissions [tons]

pollutant	2007	2018/2030
1,3-Butadiene	0.0015	0.0021
Acrolein	30	70
Formaldehyde	31	65
Benzene	13	26
Acetaldehyde	746	857
Naphthalene	0.028	0.030
CO	12,821	21,811
NH3	1,036	1,072
NOX	13,403	25,618
PM10	11,468	21,054
PM2.5	4,452	7,827
SO2	16,930	20,235

[29] The 2007 emissions are the sum of the NEI and OTAQ facilities. The same is true for 2018.

VOC	19,271	41,146

4.2.1.2 Biodiesel plants inventory (ptnonipm)

New Future year inventory: "Biodiesel_Plants_2018_ff10"

EPA/OTAQ developed an inventory of biodiesel plants for 2018 and 2030. Plant location and production volume data came from the Tier 3 proposed rule.[30,31] The total volume of biodiesel came from the AEO 2013 early release, 1.3 BG for 2018 and 2030. To reach the total volume of biodiesel, plants that had current production volumes were assumed to be at 100% production and the remaining volume was split among plants with planned production. These emission factors in Table 4-5 are in tons per million gallons (Mgal) and were obtained from EPA's spreadsheet model for upstream EISA impacts developed for the RFS2 rule (EPA, 2010a). Inventories were modeled as point sources with Google Earth and web searching validating facility coordinates and correcting state-county FIPS. Table 4-6 provides the 2018 and 2030 biodiesel plant emissions estimates. Emissions in 2007 are assumed to be near zero, and HAP emissions in 2018 and 2030 are nearly zero. Note, EPA estimated the same amount of biodiesel plant production in the future years for 2018 and 2030 and assumed that the control scenarios would have limited to no impact on the biodiesel production.

Table 4-5. Emission Factors for Biodiesel Plants (Tons/Mgal)

Pollutant	Emission Factor
VOC	4.3981E-02
CO	5.0069E-01
NO_X	8.0790E-01
PM_{10}	6.8240E-02
$PM_{2.5}$	6.8240E-02
SO_2	5.9445E-03
NH_3	0
Acetaldehyde	2.4783E-07
Acrolein	2.1290E-07
Benzene	3.2458E-08
1,3-Butadiene	0
Formaldehyde	1.5354E-06
Ethanol	0

Table 4-6. 2018/2030 biodiesel plant emissions [tons]

Pollutant	2018/2030
CO	649
NO_X	1048
PM_{10}	89
$PM_{2.5}$	89
SO_2	8

[30] US EPA 2013. Draft Regulatory Impact Analysis for Tier 3 Vehicle Emission and Fuel Standards Program. EPA-420-D-13-002.
[31] Cook, R. 2012. Development of Air Quality Reference Case Upstream and Portable Fuel Container Inventories for Tier 3 Proposal. Memorandum to Docket EPA-HQ-OAR-2010-0162.

VOC	57

4.2.1.3 Portable fuel container inventory (nonpt)

Future year inventories: "2018_PFC_inventory_FF10_revision2", "2030_PFC_inventory_FF10_revision2"

EPA used future-year VOC emissions from Portable Fuel Containers (PFCs) from inventories developed and modeled for the EPA's MSAT2 rule (EPA, 2007a). The 10 PFC SCCs are summarized below (note that the full SCC descriptions for these SCCs include "Storage and Transport; Petroleum and Petroleum Product Storage" as the beginning of the description).

- 2501011011 Residential Portable Fuel Containers: Permeation
- 2501011012 Residential Portable Fuel Containers: Evaporation
- 2501011013 Residential Portable Fuel Containers: Spillage During Transport
- 2501011014 Residential Portable Fuel Containers: Refilling at the Pump: Vapor Displacement
- 2501011015 Residential Portable Fuel Containers: Refilling at the Pump: Spillage
- 2501012011 Commercial Portable Fuel Containers: Permeation
- 2501012012 Commercial Portable Fuel Containers: Evaporation
- 2501012013 Commercial Portable Fuel Containers: Spillage During Transport
- 2501012014 Commercial Portable Fuel Containers: Refilling at the Pump: Vapor Displacement
- 2501012015 Commercial Portable Fuel Containers: Refilling at the Pump: Spillage

The large majority of spillage emissions occur when refueling equipment, and this is already included in the nonroad equipment inventory. Thus we did not include these emissions in the PFC inventory for this rule. Vapor displacement for nonroad equipment container refueling was also subtracted from vapor displacement in the PFC inventory to avoid double counting these emissions. The future-year emissions reflect projected increases in fuel consumption, state programs to reduce PFC emissions, standards promulgated in the MSAT2 rule, and impacts of the EISA on gasoline volatility. OTAQ provided year 2018 and 2030 PFC emissions that include estimated Reid Vapor Pressure (RVP) and oxygenate impacts on VOC emissions, and more importantly, large increases in ethanol emissions from EISA. Because the future year PFC inventories contain ethanol in addition to benzene, EPA developed a VOC E-profile that integrated ethanol and benzene; see Section 3.2.1.1 and Section 3.2.1.4for more details. Emissions for 2007, 2018, and 2030 are provided in Table 4-7.

Table 4-7. PFC emissions for 2007, 2018, and 2030 [tons]

pollutant	2007	2018	2030
Benzene	1,049	645	829
Naphthalene	0.6	7.1	9.3
Ethanol		3,719	4,969
VOC	220,472	29,119	37,947

4.2.1.4 Cellulosic fuel production inventory (nonpt)

New Future year inventories: "2018_cellulosic_inventory", "2030_cellulosic_inventory"

Depending on available feedstock, cellulosic plants are likely to produce fuel through either a biochemical process or a thermochemical process. OTAQ developed county-level inventories for biochemical and thermochemical cellulosic fuel production for 2018 and 2030 to reflect AEO2013 (early release) renewable fuel volumes. Emissions factors for each cellulosic biofuel refinery reflect the fuel production technology used rather than the fuel produced. Emission rates in Table 4-8 and Table 4-9 were used to develop cellulosic plant inventories. Criteria pollutant emission rates are in tons per RIN gallon. Emission factors from the cellulosic diesel work in the Tier 3 NPRM were used as the emission factors for the thermochemical plants in the FRM modeling. Cellulosic ethanol VOC and related HAP emission factors from the Tier 3 NPRM were used as the biochemical VOC and related HAP emission factors. Because the future year cellulosic inventory contains ethanol, we developed a VOC E-profile that integrated ethanol, see Sections 3.2.1.1 and 3.2.1.3 for more details.

Plants were treated as area sources spread across the entire area of whatever county they were considered to be located in. Cellulosic biofuel refinery siting was based on utilizing the lowest cost feedstock, accounting for the cost of the feedstock itself as well as feedstock storage and the transportation of the feedstock to the cellulosic biofuel refinery. The total number of cellulosic biofuel refineries was projected using volumes from AEO2013 (early release). The methodology used to determine most likely plant locations is described in Section 1.8.1.3 of the RFS2 RIA (EPA, 2010a). Table 4-10 provides the 2018 and 2030 cellulosic plant emissions estimates.

Table 4-8. Criteria Pollutant Emission Factors for Cellulosic Plants (Tons/RIN gallon)

Cellulosic Plant Type	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	NH_3
Thermochemical	5.92E-07	8.7E-06	1.31E-05	1.56E-06	7.81E-07	1.17E-06	1.44E-10
Biochemical	1.82E-06	1.29E-05	1.85E-05	3.08E-06	1.23E-06	6.89E-07	0

Table 4-9. Toxic Emission Factors for Cellulosic Plants (Tons/RIN gallon)

Plant Type	Acetaldehyde	Acrolein	Benzene	1,3-Butadiene	Formaldehyde	Ethanol
Thermochemical	2.95E-08	1.27E-09	9.61E-10	0	5.07E-09	2.09E-07
Biochemical	3.98E-07	1.11E-08	1.39E-08	0	2.28E-08	6.41E-07

Table 4-10. 2018 and 2030 cellulosic plant emissions [tons]

pollutant	2018	2030
Acrolein	0.9	3.1
Formaldehyde	3.5	10.3
Benzene	0.7	2.9
Acetaldehyde	20.6	86.1
CO	6,087	15,196
Ethanol	146	397
NH3	0.1	0.2
NOX	9,199	22,867
PM10	1,088	2,792
PM2.5	547	1,372
SO2	819	1,941
VOC	414	1,125

4.2.1.5 Ethanol working loss inventory (nonpt)

New Future year inventories: "Ethanol_transport_vapor_2018rg_ref", "Ethanol_transport_vapor_2030rg_ref"

These inventories were provided by OTAQ to represent upstream impacts of loading and unloading at ethanol terminals. Emissions are entirely evaporative and were computed by county for truck, rail and waterway loading and unloading and intermodal transfers (e.g., highway to rail). Inventory totals are summarized in Table 4-11. The leading descriptions are "Industrial Processes; Food and Agriculture; Ethanol Production" for each SCC.

Table 4-11. 2018 and 2030 VOC working losses (Emissions) due to ethanol transport [tons]

SCC	description	2018	2030
30205031	Denatured Ethanol Storage Working Loss	23,420	22,396
30205052	Ethanol Loadout to Truck	14,425	13,794
30205053	Ethanol Loadout to Railcar	10,484	10,025

4.2.1.6 Vapor losses from Ethanol transport and distribution (nonpt, ptnonipm)

Packets: "PROJECTION_2008_2018_distribution_upstream_OTAQ_Tier3FRM", "PROJECTION_2008_2030_distribution_upstream_OTAQ_Tier3FRM"
OTAQ developed county-level inventories for ethanol transport and distribution for 2018 and 2030 to account for losses for the processes such as truck, rail and waterways loading/unloading and intermodal transfers such as highway-to-rail, highways-to-waterways, and all other possible combinations of transfers. These emissions are entirely evaporative and therefore limited to VOC and HAPs in VOC.

2018 and 2030 inventories which included EISA impacts were developed by adjusting the 2007 platform inventory. Impacts of the light-duty greenhouse gas rule are small enough to ignore for 2018. EISA adjustments were made using an updated version of EPA's spreadsheet model for upstream emission impacts, developed for the RFS2 rule[32]. The development of emission factors and fuel volumes to make these adjustments with the RFS2 impacts spreadsheet are described below.

Vapor loss VOC emission factors (EFs) for gasoline were first developed, based on inventory estimates from the 2005 NEI (EPA, 2009a). Total volume of gasoline was based on gasoline sales as reported by the Energy Information Administration (2006). Emissions were partitioned into refinery to bulk terminal (RBT), bulk plant storage (BPS), and bulk terminal to gasoline dispensing pump (BTP) components. Emissions for the BTP component are greater than the RBT and BPS components.

Total nationwide emissions for these components were divided by the energy content of the total volume of gasoline distributed in 2005 to obtain emission factors in grams per million metric British Thermal Units (g/mmBTU). Total volume of gasoline was based on gasoline sales as reported by the Energy Information Administration.[33] In addition to gasoline VOC emission factors for the RBT/BPS components, emission factors were developed for the BTP component, for 10% ethanol, 15% ethanol, and 85% ethanol. Emission factors were calculated by applying adjustment factors to the gasoline EFs. The BTP adjustment factors were based on an algorithm from the 1994 On-Board Refueling Vapor Recovery Rule (EPA, 1994):

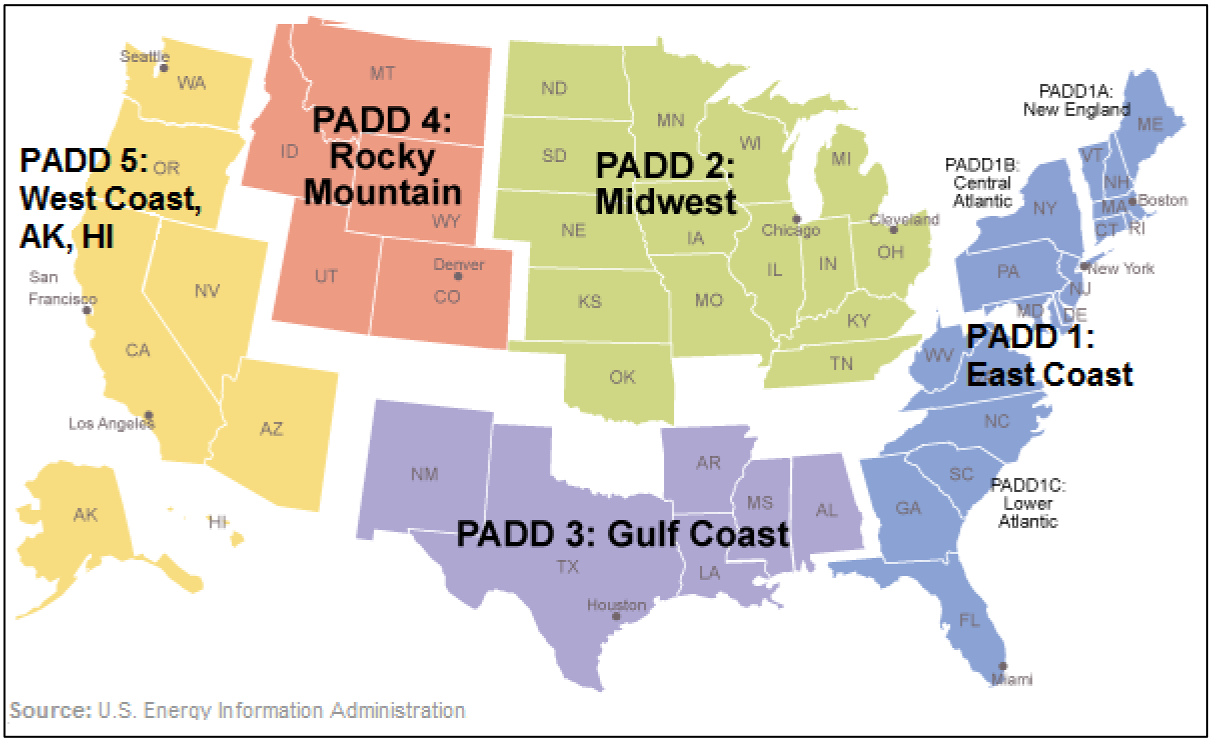
$$EF\ (g/gal) = \exp[-1.2798 - 0.0049(\Delta T) + 0.0203(Td) + 0.1315(RVP)]$$

Here delta T is the difference in temperature between the fuel in the tank and the fuel being dispensed, and Td is the temperature of the gasoline being dispensed. We assumed delta T is zero, and the temperature of the fuel being dispensed averages 60 ºF over the year.

[32] U.S. EPA. 2013. Spreadsheet "upstream_emissions_rev T3.xls.
[33] Source: Energy Information Administration. 2006. Annual Energy Outlook 2006. Report #:DOE/EIA-0383(2006) Available at <http://www.eia.gov/oiaf/archive/aeo06/aeoref_tab.html>

Average summer RVPs at the Petroleum Administration for Defense Districts (PADD) level was used to calculate adjustments. The U.S. is broken into five PADDs for petroleum products data collection purposes via the U.S. Energy Information Administration; see: http://www.eia.gov/oog/info/twip/padddef.html. These PADD regions are shown in Figure 4-1.

Figure 4-1. Map of Petroleum Administration for Defense Districts (PADD)



All counties within a PADD received the same adjustment for BTP emissions. Volumes for each fuel type and summer RVPs for 2018 with EISA impacts are provided in Table 4-12 while volumes without EISA are in Table 4-13. Volumes with and without EISA for 2030 are provided in Table 4-14 and Table 4-16. These volumes and RVPs were obtained from analyses done for the Tier 3 rule. These two sets of volumes were used to estimate emissions using an updated version of the RFS2 impacts spreadsheet (EPA, 2013a).

Table 4-12. RVPs Assumed for 2018 ethanol and gasoline volumes with EISA

PADD	Total Fuel Volume	Gasoline Volume	Ethanol Volume	E10 Only Volume	E15 Only Volume	E85(74) Only Volume	Weighted RVP	Weighted E10 RVP	Weighted E15 RVP	Weighted E85 RVP
1	4.50E+10	3.99E+10	5.18E+09	3.71E+10	7.43E+09	4.73E+08	8.536	8.651	8.056	7
2	3.46E+10	3.03E+10	4.25E+09	2.31E+10	1.11E+10	3.63E+08	9.051	9.35	8.493	7
3	2.14E+10	1.89E+10	2.48E+09	1.72E+10	3.95E+09	2.25E+08	8.399	8.515	7.973	7
4	5.07E+09	4.48E+09	5.89E+08	4.06E+09	9.53E+08	5.33E+07	9.322	9.536	8.536	7
5	2.35E+10	2.08E+10	2.71E+09	1.91E+10	4.13E+09	2.47E+08	7.906	7.974	7.645	7
Total	**1.30E+11**	**1.14E+11**	**1.52E+10**	**1.01E+11**	**2.75E+10**	**1.36E+09**	**8.567**	**8.696**	**8.175**	**7**

Table 4-13. RVPs Assumed for 2018 ethanol and gasoline volumes without EISA

PADD	Total Fuel Volume	Ethanol Volume	Gasoline Volume	E0 Only Volume	E10 Only Volume	Weighted RVP	Weighted E0 RVP	Weighted E10 RVP
1	4.42E+10	2.47E+09	4.17E+10	1.95E+10	2.47E+10	8.63	8.301	8.883
2	3.38E+10	1.92E+09	3.19E+10	1.47E+10	1.92E+10	9.48	8.925	9.907
3	2.09E+10	1.02E+09	1.99E+10	1.07E+10	1.02E+10	8.77	8.391	9.166
4	4.96E+09	2.54E+08	4.71E+09	2.43E+09	2.54E+09	9.18	8.674	9.674
5	2.30E+10	1.27E+09	2.17E+10	1.03E+10	1.27E+10	7.77	7.602	7.911
Total	**1.27E+11**	**6.93E+09**	**1.20E+11**	**5.76E+10**	**6.93E+10**	**8.75**	**8.372**	**9.059**

Table 4-14. RVPs Assumed for 2030 ethanol and gasoline volumes with EISA

PADD	Total Fuel Volume	Gasoline Volume	Ethanol Volume	E10 Only Volume	E15 Only Volume	E85(74) Only Volume	Wtd. RVP	Wtd. E10 RVP	Wtd. E15 RVP	Wtd. E85 RVP
1	3.92E+10	3.41E+10	5.02E+09	2.43E+10	1.43E+10	6.02E+08	8.444	8.763	7.962	7
2	2.97E+10	2.58E+10	3.91E+09	1.62E+10	1.31E+10	4.56E+08	8.942	9.333	8.525	7
3	1.95E+10	1.68E+10	2.63E+09	9.32E+09	9.85E+09	2.98E+08	8.245	8.644	7.905	7
4	4.69E+09	4.08E+09	6.14E+08	2.64E+09	1.98E+09	7.20E+07	9.063	9.524	8.524	7
5	2.05E+10	1.81E+10	2.47E+09	1.60E+10	4.24E+09	3.17E+08	7.884	7.93	7.774	7
Total	**1.14E+11**	**9.89E+10**	**1.46E+10**	**6.84E+10**	**4.34E+10**	**1.75E+09**	**8.464**	**8.716**	**8.126**	**7**

Table 4-15. RVPs Assumed for 2030 ethanol and gasoline volumes without EISA

PADD	Total Fuel Volume	Ethanol Volume	Gasoline Volume	E0 Only Volume	E10 Only Volume	Weighted RVP	Weighted E0 RVP	Weighted E10 RVP
1	3.83E+10	2.47E+09	3.59E+10	1.36E+10	2.47E+10	8.68	8.301	8.883
2	2.90E+10	1.92E+09	2.71E+10	9.88E+09	1.92E+10	9.57	8.925	9.907
3	1.89E+10	1.02E+09	1.79E+10	8.78E+09	1.02E+10	8.81	8.391	9.166
4	4.57E+09	2.54E+08	4.32E+09	2.04E+09	2.54E+09	9.23	8.674	9.674
5	2.02E+10	1.27E+09	1.89E+10	7.48E+09	1.27E+10	7.80	7.602	7.911
Total	**1.11E+11**	**6.93E+09**	**1.04E+11**	**4.18E+10**	**6.93E+10**	**8.80**	**8.372**	**9.059**

A benzene g/mmgal emission factor for 2018 and 2030 was based on benzene inventory projections used in the 2011 Cross-State Air Pollution Rule and projected gasoline volumes obtained from the Annual Energy Outlook 2011 Early Release Overview. This emission factor was used to estimate g/mmBTU emission factors based on the energy content of E0, E10, and E15 gasoline. Aside from energy content, we did not account for the effect of other fuel parameters on emission rates for E0, E10, and E15 blends. Thus, the E10 emission rate is slightly higher than the E0 rate due to the lower energy content of E10, and the E15 emission rate is higher still. The E85 emission rate was estimated for the RFS2 rule. Emission factors are summarized in Table 4-16.

Table 4-16. Storage and Transport Vapor Loss Emission Factors (g/mmBtu)

Process	**Fuel**	**Benzene**
BTP	E0	0.250
	E10	0.259
	E15	0.264
	E85	0.023
RBT/BPS	E0	0.059

These emission factors for VOC and benzene were used in conjunction with an updated version of EPA's spreadsheet model for upstream emission impacts, developed for the RFS2 rule, to estimate PADD-level inventory changes of the changes in gasoline volume in 2018 with 2007 ethanol volumes versus projected volumes with EISA. VOC inventory changes were used to develop nationwide adjustment factors that were applied to modeling platform inventory SCCs associated with storage and transport processes (see Table 4-17). Benzene emission estimates were obtained either by application of the adjustments in Table 4-17 or through speciation of VOC in SMOKE.

A similar approach was used to develop adjustment factors for 2030. However, in addition to the impacts of EISA, the 2017-2025 light-duty greenhouse gas rule will significantly reduce gasoline production. The impact of this rule was small enough to ignore for 2018, but quite significant in 2030. To account for impacts of this rule in 2030, an additional scalar of 0.7916 was applied.

Ethanol emissions were estimated in SMOKE by applying the ethanol to VOC ratios from headspace profiles to VOC emissions for E10 and E15, and an evaporative emissions profile for E85. These ratios are 0.065 for E10, 0.272 for E15, and 0.61 for E85. The E10 and E15 profiles were obtained from an ORD analysis of fuel samples from the EPAct exhaust test program[34] and have been submitted for incorporation into EPA's SPECIATE database. The E85 profile was obtained from data collected as part of the CRC E-80 test program (Environ, 2008) and has also been submitted for incorporation into EPA's SPECIATE database. For more details on the change in speciation profiles between 2007 and the future years, see Section 3.2.1.4**Error! Reference source not found.**.

After developing emissions for 2018 with EISA volumes versus 2018 without EISA volumes, and 2030 with EISA and the light-duty greenhouse gas rule versus 2030 without those rules, EPA created ratios of these two cases to apply against the 2007 platform emissions. From this, EPA created 2018 and 2030 reference cases.

[34] U.S. EPA. 2011. Hydrocarbon Composition of Gasoline Vapor Emissions from Enclosed Fuel Tanks. Office of Research and Development and Office of Transportation and Air Quality. Report No. EPA-420-R-11-018. EPA Docket EPA-HQ-OAR-2011-0135.

Table 4-17. Adjustment factors applied to storage and transport emissions

Year	Process	PADD	Pollutant	Adjustment Factor
2018	BTP	1	VOC	0.9515
			benzene	0.9905
		2	VOC	0.9619
			benzene	0.9882
		3	VOC	0.9778
			benzene	0.9879
		4	VOC	0.8983
			benzene	0.9885
		5	VOC	0.9430
			benzene	0.9901
	RBT/BPS	All	VOC	0.9553
			benzene	0.9893
2030	BTP	1	VOC	0.8005
			benzene	0.7871
		2	VOC	0.8436
			benzene	0.7865
		3	VOC	0.8318
			benzene	0.7824
		4	VOC	0.7905
			benzene	0.7840
		5	VOC	0.7700
			benzene	0.7888
	RBT/BPS	All	VOC	0.8114
			benzene	0.7863

It should be noted that these adjustment factors are based on summer RVP, but applied to emissions for the whole calendar year. However, higher RVPs in winter corresponding to lower temperatures result in roughly the same vapor pressure of the fuel and roughly the same propensity to evaporate. Significant evaporative emissions are not expected from storage and transport of biodiesel, renewable or cellulosic diesel fuel due to their low volatility. The cumulative impacts are a reduction in VOC emissions from 2007 levels (see Table 4-18). See 2007v5 TSD, Appendix B for the complete cross-walk between SCC, and state-SCC for BTP components, and each type of petroleum transport and storage.

Table 4-18. Impact of VOC losses from reduced gasoline production due to EISA

Sector	2018 Reductions	2030 Reductions
ptnonipm	2,039	7,884
nonpt	22,082	97,030
Total	24,121	104,914

4.2.1.7 Pipeline and Refinery EISA adjustments (ptnonipm)

Packets: "PROJECTION_2018rg_ref_pipelines_refineries", "PROJECTION_2030rg_ref_pipelines_refineries"

Pipeline usage, refinery, and bulk terminal emissions were adjusted for changes in fuels due to EISA and reductions in gasoline and diesel volumes due to greenhouse gas emission standards. These adjustments were developed by EPA/OTAQ and impact processes such as process heaters, catalytic cracking units, blowdown systems, wastewater treatment, condensers, cooling towers, flares and fugitive emissions.

Calculation of the emission inventory impacts of decreased gasoline and diesel production, due to EISA and greenhouse gas rules, on nationwide refinery emissions was done in the updated version of EPA's spreadsheet model for upstream emission impacts. Emission inventory changes reflecting EISA and greenhouse gas rules implementation were used to develop adjustment factors that were applied to inventories for each petroleum refinery in the U.S. (Table 4-19 and Table 4-20). These impacts of decreased production were assumed to be spread evenly across all U. S. refineries. Toxic emissions were estimated in SMOKE by applying speciation to VOC emissions. It should be noted that the adjustment factors in Table 4-19 are estimated relative to that portion of refinery emissions associated with gasoline and diesel fuel production. Production of jet fuel, still gas and other products also produce emissions. If these emissions were included, the adjustment factors would not be as large. The impact of the EISA and greenhouse gas rules is shown in

Table 4-21.

Table 4-19. 2018 adjustment factors applied to petroleum pipelines and refinery emissions associated with gasoline and diesel fuel production.

Pollutant	**Pipelines**	**Refineries**	**Both**
CO	0.996	0.978	0.974
NO_X	0.982	0.987	0.969
PM_{10}	0.997	0.984	0.981
$PM_{2.5}$	0.998	0.979	0.977
SO_2	0.998	0.978	0.976
NH_3	n/a	0.952	n/a
VOC	0.999	0.972	0.971

Table 4-20. 2030 adjustment factors applied to petroleum pipelines and refinery emissions associated with gasoline and diesel fuel production.

Pollutant	**Pipelines**	**Refineries**	**Both**
CO	0.981	0.773	0.763
NO_X	0.890	0.781	0.695
PM_{10}	0.985	0.779	0.767
$PM_{2.5}$	0.989	0.775	0.766
SO_2	0.986	0.774	0.763
NH_3	n/a	0.750	n/a
VOC	0.994	0.769	0.764

Table 4-21. Impact of refinery adjustments on 2007 emissions [tons]

pollutant	reductions 2018	reductions 2030
CO	2,148	19,952
NH3	111	572
NOX	2,884	28,116
PM10	515	6,185
PM2.5	555	5,503
SO2	3,401	33,913
VOC	1,891	15,341

4.2.2 Upstream agricultural and Livestock adjustments (afdust, ag, nonpt, ptnonipm)

Packets: "PROJECTION_2008_2018_ag_including_upstream_OTAQ";
"PROJECTION_2008_2030_ag_including_upstream_OTAQ"

Inventory adjustments were previously developed for 2030 as part of final RFS2 rule modeling[35]. For the Tier 3 proposal, adjustments for 2017 were scaled by the ratio of 2017 renewable fuel volumes versus 2030 volumes. Although 2018 was modeled for this rule rather than 2017, EPA continued to use the 2017 adjustments. Impacts on farm equipment emissions were not accounted for, however. Emission rates from the GREET model (fertilizer and pesticide production)[36] or based on the 2002 National Emissions Inventory (fertilizer and pesticide application, agricultural dust, livestock waste) were combined with estimates of agricultural impacts from FASOM (Forest and Agricultural Section Optimization Model). Since FASOM modeling used a reference case of 13.2 billion gallons of ethanol, impacts used in the modeling for this rule are underestimates.

Adjustment factors are provided in

[35] U. S. Environmental Protection Agency. 2010. Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis. Assessment and Standards Division, Office of Transportation and Air Quality, Ann Arbor, MI. Report No. EPA-420-R-10-006, February, 2010. Available at <http://www.epa.gov/otaq/fuels/renewablefuels/regulations.htm>.

[36] GREET, version 1.8c. Available at < http://greet.es.anl.gov/>.

Table 4-22. These adjustments were applied equally to all counties having any of the affected sources. This is an area of uncertainty in the inventories, since there would likely be variation from one county to another depending on how much of the predicted agricultural changes occurred in which counties. By using percent change adjustments rather than attempting to calculate absolute ton changes in each county, EPA attempted to minimize the inventory distortions that could occur if the calculated change for a given county was out of proportion to the reference case emissions for that county. For instance, a different approach could estimate reductions that were larger than the reference case NEI emissions, since there was no linkage between the NEI inventories and the FASOM modeling. The specific sources (SCCs) and affected pollutants that these adjustments were applied to are listed in a docket reference[37].

[37] U. S. EPA. 2011. Spreadsheet "agricultural sector adjustments.xls." Docket EPA–HQ–OAR–2011–0135.

Table 4-22. Adjustments to modeling platform agricultural emissions for the Tier 3 reference case

Source Description	2018 Adjustment	2030 Adjustment
Nitrogen Fertilizer Application	1.0242	1.0573
Fertilizer Production	1.0603	1.0603
Pesticide Production	0.9544	0.9954
Tilling/Harvesting Dust	1.0079	1.0265
Agricultural Burning	1.0000	1.0000
Livestock Dust	0.9868	0.9983
Livestock Waste	0.9901	0.9983

For the animal waste sources, EPA also estimated animal population growth in ammonia (NH_3) and dust (PM_{10} and $PM_{2.5}$) emissions from livestock in the ag and afdust and ptnonipm sectors. Therefore, a composite set of projection factors is needed for animal operations that also reflect the minor 0.99% decrease resulting from the EISA mandate. These composite projection factors by animal category are provided in Table 4-23. As discussed below, Dairy Cows and Turkeys are assumed to have no growth in animal population, and therefore the projection factor for these animals is the same as the upstream agriculture-related projection factor. The PROJECTION packet used for these sources, including the cross-reference to the animal categories listed in Table 4-23 and the source categories in

Table 4-22.

Table 4-23. Composite NH_3 projection factors to year 2018 and 2030 for animal operations

Animal Category	2018 Factors	2030 Factors
Dairy Cow	0.9901	0.9983
Beef	0.9927	0.9460
Pork	1.0798	1.1614
Broilers	1.1399	1.1795
Turkeys	0.9050	0.8953
Layers	1.0974	1.1281
Poultry Average	1.0865	1.1149
Overall Average	1.0428	1.0505

Except for dairy cows and turkey production, the animal projection factors are derived from national-level animal population projections from the U.S. Department of Agriculture (USDA) and the Food and Agriculture Policy and Research Institute (FAPRI). This methodology was initiated in 2005 for the 2005 NEI, but was updated on July 24, 2012 in support of the 2007v5 platform (EPA, 2012). For dairy cows, EPA assumed that there would be no growth in emissions based on little change in U.S. dairy cow populations from year 2007 through 2030 according to linear regression analyses of the FAPRI projections. This assumption was based on an analysis of historical trends in the number of such animals compared to production rates. Although productions rates have increased, the number of animals has declined. Based on this analysis, EPA concluded that production forecasts do not provide representative estimates of the future number of cows and turkeys; therefore, EPA did not use these forecasts for estimating future-year emissions from these animals. In particular, the dairy cow population is projected to decrease in the future as it has for the past few decades; however, milk production will be increasing over the same period. Note that the ammonia emissions from dairies are not directly related to animal population but also nitrogen excretion. With the cow numbers going down and the production going up, the excretion value will likely change, but EPA assumed no change because of the lack of a quantitative estimate. Appendix H of the 2007v5 platform TSD provides the animal population data and regression curves used to derive the growth factors.

4.2.3 Fuel sulfur rules (nonpt, ptnonipm)

Packets: CONTROL_SULF_2020_2007v5; CONTROL_SULF_2030_2007v5

Fuel sulfur rules that were signed by July, 2012 are limited to Maine, Massachusetts, New Jersey, New York and Vermont. The fuel limits for these states are incremental starting after year 2012, but are fully implemented by year 2018 in all of these states. In 2030, New York City had additional controls implemented, mandating that all sources burn ULSD (15 ppm). For more details on these rules, see the 2007v5 TSD.A summary of the sulfur rules by state, with emissions reductions is provided inTable 4-24.

Table 4-24. Summary of fuel sulfur rules by state

State/ Metro	Fuel	% reduction 2018	% reduction 2030	2008 Emissions	2018 Emissions	2018 Reductions	2030 Emissions	2030 Reductions
ME	Distillate	99.5	99.5	12,076	1,056	11,021	1,056	11,021
ME	Residual	75	75					
MA	Distillate	99.5	99.5	17,265	86	17,178	86	17,178
NJ	Distillate	99.5	99.5	7,285	45	7,240	45	7,240
NJ	Kerosene	96.25	96.25					
NY	Distillate	99.5	99.5	54,093	655	53,439	274	53,819

NYC	Residual	75	99.25					
VT	Distillate	99.5	99.5	2,018	10	2,008	10	2,008

4.2.4 Portland Cement NESHAP projections (ptnonipm)

As indicated in Table 4-1, the Industrial Sectors Integrated Solutions (ISIS) model (EPA, 2010b) was used to project the cement industry component of the ptnonipm emissions modeling sector to 2013. This approach provided reductions of criteria and hazardous air pollutants, including mercury (Hg). The ISIS cement emissions were developed in support for the Portland Cement NESHAPs and the NSPS for the Portland cement manufacturing industry.

The ISIS model produced a Portland Cement NESHAP policy case of multi-pollutant emissions for individual cement kilns (emission inventory units) that were relevant for years 2013 through 2017; however, no additional policy case scenario for later future years (i.e., 2018) are available. Therefore, the 2013 policy case is used for the 2018 and 2030 base case. These ISIS-based emissions are reflected using CoST packets and a cement inventory for new kilns:

1) Inventory: "cement_newkilns_ISIS2013_2007v5_POINT_ff10"
   Contains information on new cement kilns constructed after year 2008. This inventory was accidentally not included in projections for all future year scenarios.
2) Packet: "CLOSURES_cement_ISIS_2007v5_2013policy"
   Contains facility and unit-level closures,
3) Packet: "PROJECTION_ISIS2013_cement_2007v5"
   Contains updated policy case emissions at existing cement kilns which we include via projection factors. The units that opened or closed before 2010 were included in the 2020 base case.

The ISIS model results for the future show a continuation of the recent trend in the cement sector of the replacement of lower capacity, inefficient wet and long dry kilns with bigger and more efficient preheater and precalciner kilns. Multiple regulatory requirements such as the NESHAP and NSPS currently apply to the cement industry to reduce CAP and HAP emissions. Additionally, state and local regulatory requirements might apply to individual cement facilities depending on their locations relative to ozone and $PM_{2.5}$ nonattainment areas. The ISIS model provides the emission reduction strategy that balances: 1) optimal (least cost) industry operation, 2) cost-effective controls to meet the demand for cement, and 3) emission reduction requirements over the time period of interest. Table 4-25 shows the magnitude of the ISIS-based cement industry reductions in the future-year emissions that represent 2018 and 2030, and the impact that these reductions have on total stationary non-EGU point source (ptnonipm) emissions. The impact of accidentally not including the inventory of new kilns in future year modeling is quantified below. This error has the most significant impact on NO_X emissions; however, nationally, NO_X from cement kilns would still decrease from 2008 by over 50% had these new kilns been included in the future year scenarios.

Table 4-25. ISIS-based cement industry change (tons/yr)

Pollutant	Cement Industry emissions in 2008	Cement Industry projected emissions in 2018 & 2030	New cement kilns erroneously dropped from inventory	% decrease in Cement projections
CO	46,317	8,713	0	81%
NH_3	270	77	0	71%
NO_X	156,579	57,477	17,699	63%
PM_{10}	6,621	1,005	2	85%
$PM_{2.5}$	3,689	800	1	78%

SO_2	98,277	22,287	1,543	77%
VOC	6,954	1,131	135	84%

4.2.5 Controls, Closures and consent decrees from CSAPR and NODA Comments (nonpt, ptnonipm)

EPA released a Notice of Data Availability (NODA) after the CSAPR proposal to seek comments and improvements from states and outside agencies. The goal was to improve the future baseline emissions modeling platform prior to processing the Final CSAPR. EPA received several control programs and other responses that were used for future year projections. However, this effort was performed on a version of the 2005 modeling platform, which used the NEI2005v2 as a base year starting point for future year projections. Now with the 2007 platform using the 2008 NEI for most non-EGU point and nonpoint sources, many of these controls and data improvements were removed from this 2007 base case projection. But for those controls, closures and consent decree information that are implemented after 2008, EPA used these controls/data after mapping them to the correct SCCs and/or facilities in the 2008 NEI. This subsection breaks down the controls used for the nonpt and ptnonipm sectors separately, and also describes the consent decrees separately. EPA used July 1, 2008 as the cut-off date for assuming whether controls were included in the 2007 modeling platform (2008 NEI). For example, if a control had a compliance date of December 2008 it was assumed that the 2008 NEI emissions did not reflect this control and would need to reflect this control in our 2018 or 2030 scenarios. It is important to note that these controls are not comprehensive for all state/counties and source categories. These only represent post-year 2008 controls for those areas and categories where EPA received usable feedback from the CSAPR comments and related 2005 platform NODA.

Nonpoint controls: packet “CONTROL_CSAPR_nonpoint_2018_2007v5”
The remaining nonpt sector CSAPR comments controls with compliance dates after 2008 are limited to state-level Ozone Transport Commission (OTC) VOC controls in Connecticut and local controls around Richmond Virginia. These controls target many of the same sources in the previously-discussed NY SIP ozone control packet: AIM coating, Mobile Equipment Repair and Refinishing, Adhesives and Sealants and Consumer Products. Cumulatively, these controls reduce VOC by approximately 1,400 tons. This control packet also impacts Texas oil and gas drill rigs (SCC 2310000220), were though factors for these emissions were available through year 2021, EPA only projected these to 2018. The impact in TX is a reduction of NO_X by 17,244 tons, $PM_{2.5}$ by 1,158 tons and VOC by 1,470 tons with minor reductions for other pollutants. The control packet is used for both 2018 and 2030 and has the same impact in both years.

Ptnonipm controls: packet “CONTROL_CSAPR_ptnonipm_2020_2007v5”
EPA created a CONTROL packet for the ptnonipm sector that contains reductions needed to achieve post year-2008 emissions values from the CSAPR response to comments. These reductions reflect fuel switching, cleaner fuels, and permit targets via specific information on control equipment and unit and facility zero-outs in the following states: California, Delaware, Georgia, New Hampshire, New York and Virginia. Cumulatively, these controls reduce NO_X about 1,000 tons and SO_2 by approximately 4,100 tons. The control packet is used for both 2018 and 2030 and has the same impact in both years.

Ptnonipm closures: packet “CLOSURES_TR1_2008NEIv2”
This packet contains observed unit and facility-level closures based on CSAPR comments. This packet includes only units that reported by states as closed prior to receipt of the CSAPR comments in year 2012 or sooner. EPA found a couple of units in the 2008 NEI-based inventory that were reported as closed in year 2007; therefore, the compliance dates in this packet range from 2007 to 2012. EPA also retained all year-2007 closures to allow for this packet to potentially be used on RPO year-2007 point inventories. All

closures were provided for the 2005 NEI facility and unit identifier codes. EPA matched these units/facilities to the 2008 NEI using the "agy_facility_id" and "agy_point_id" codes in the NEI and searching the EIS for closure information. Overall, these facility and unit closures reduced NO_X, SO_2 and $PM_{2.5}$ emissions by approximately 8,800, 1,300 and 50,000 tons respectively distributed amongst the following states: Alabama, Arkansas, Delaware, Georgia, Illinois, Maine, Massachusetts, Missouri, New Hampshire, South Carolina, Texas, Virginia and West Virginia. The closure packet is used for both 2018 and 2030 and has the same impact in both years.

Ptnonipm projection: packet "PROJECTION_CSAPR_WVunit_ptnonipm_2020_2007v5"
This packet contains the only post-2008 unit-level growth projection resulting from CSAPR comments. The Sunoco Chemicals Neal Plant in Wayne County West Virginia replaced a 155MM Btu/hour coal-fired boiler with a 96.72 MM Btu/hour natural gas-fired unit in 2010. The shutdown of the coal boiler was included in the CLOSURES_TR1_2008NEIv2" packet just discussed and simply added the emissions from the new natural gas unit to an existing unit by computing the new cumulative total from the new and old natural gas units. The closing of the coal-fired boiler removed 51 tons of NO_X and 234 tons of SO_2 while this packet resulted in only 28 more tons of NO_X and minimal emissions from PM and SO_2. The projection packet is used for both 2018 and 2030 and has the same impact in both years.

Consent decrees (ptnonipm): packet "CONTROLS_CSAPR_consent_2008NEIv2"
These controls reflect consent decree and settlements that were identified in our preparation of the Final CSAPR emissions modeling platform. These controls generally consist of one or more facilities and target future year reductions. After removing all consent decrees with compliance dates prior to late-2008, EPA matched the remaining controls to the 2008 NEI using a combination of EIS facility codes, "agy_facility_id", "agy_point_id" and searching the EIS. Then, the percent reductions were recomputed such that the future year emissions would match those for facilities originally projected from the 2005 platform. EPA did not retain consent decree controls if the emissions in 2007 (2008 NEI) were less than the controlled future year emissions based on the 2005 platform. The remaining consent decree controls are in sixteen states (AL, CA, IN, KS, KY, LA, MI, MS, MO, OH, OK, TN, TX, UT, WI, WY) and accounted for 3,835 tons of NO_X and 37,368 tons of SO_2 cumulative reductions in 2018 and approximately 3,411 tons of NO_X and 36,878 tons of SO_2 cumulative reductions in 2030. The control packet is used for both 2018 and 2030, but compliance dates for 2 facilities are in late-2018; therefore these controls were not applied in 2018 but were applied for 2030.

4.2.6 All other PROJECTION and CONTROL packets (ptnonipm, nonpt)

This section describes all remaining non-EGU stationary sources not already discussed. These control packets and projection packets generally have lesser national-level impact on future year projections than those items above. However, some of the consent decrees discussed below have significant local impacts.

4.2.6.1 Aircraft growth (ptnonipm)

Packets: "PROJECTION_2008_2018_aircraft"; "PROJECTION_2008_2030_aircraft"

Aircraft emissions are contained in the ptnonipm inventory. These 2008 point-source emissions are projected to future years by applying activity growth using data on itinerant (ITN) operations at airports. The ITN operations are defined as aircraft take-offs whereby the aircraft leaves the airport vicinity and lands at another airport, or aircraft landings whereby the aircraft has arrived from outside the airport vicinity. We used projected ITN information available from the Federal Aviation Administration's (FAA) Terminal Area Forecast (TAF) System: http://www.apo.data.faa.gov/main/taf.asp (publication date March, 2012). This information is available for approximately 3,300 individual airports, for all years up to 2030. EPA aggregated and applied this information at the national level by summing the airport-specific (U.S. airports only) ITN operations to national totals by year and by aircraft operation, for each of the four available operation types: commercial, general, air taxi, military. Growth factors were computed for each operation type by dividing future-year 2018 and 2030 ITN by 2008-year ITN. EPA assigned factors to inventory SCCs based on the operation type.

The methods that the FAA used for developing the ITN data in the TAF are documented in: http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/taf_reports/media/TAF_summary_report_FY20112040.pdf. Table 4-26 provides the national growth factors for aircraft; all factors are applied to year 2008 emissions. For example, year 2018 commercial aircraft emissions are 7.5% higher than year 2008 emissions.

None of the aircraft emission projections account for any control programs. EPA considered the NO_X standard adopted by the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) in February 2004, which is expected to reduce NO_X by approximately 3% in 2020. However, this rule has not yet been adopted as an EPA (or U.S.) rule; therefore, the effects of this rule were not included in the future-year emissions projections.

Table 4-26. Factors used to project 2008 base-case aircraft emissions to 2020

SCC	Description	2018	2030
2270008005	Commercial Aircraft: Diesel Airport Ground Support Equipment, Air Ground Support Equipment	1.0750	1.3502
2275000000	All Aircraft Types and Operations	1.0750	1.3502
2275001000	Military Aircraft, Total	1.0620	1.0623
2275020000	Commercial Aviation, Total	1.0750	1.3502
2275050000	General Aviation, Total	0.9206	0.9709
2275050011	General Aviation, Piston	0.9206	0.9709
2275050012	General Aviation, Turbine	0.9206	0.9709
2275060000	Air Taxi, Total	0.9381	1.0965
2275060011	Air Taxi, Total: Air Taxi, Piston	0.9381	1.0965
2275060012	Air Taxi, Total: Air Taxi, Turbine	0.9381	1.0965
2275070000	Commercial Aircraft: Aircraft Auxiliary Power Units, Total	1.0750	1.3502
27501014	Military aircraft: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Military; Jet Engine: JP-4	1.0620	1.0623
27501015	Military aircraft, This SCC is in 2005v2: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Military; Jet Engine: JP-5	1.0620	1.0623
27502001	Commercial Aircraft, Total, This SCC is in 2005v2 NEI: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Commercial; Piston Engine: Aviation Gas	1.0750	1.3502
27502011	Commercial Aircraft, Total, This SCC is in 2005v2 NEI: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Commercial; Jet Engine: Jet A	1.0750	1.3502
27505001	General Aviation Total. This SCC is in 2005v2 NEI: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Civil; Piston Engine: Aviation Gas	0.9206	0.9709
27505011	General Aviation Total. This SCC is in 2002 NEI: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Civil; Jet Engine: Jet A	0.9206	0.9709
27601014	Military aircraft: Internal Combustion Engines; Rotary Wing Aircraft L & TO Exhaust; Military; Jet Engine: JP-4	1.0620	1.0623
27601015	Military aircraft: Internal Combustion Engines; Rotary Wing Aircraft L & TO Exhaust; Military; Jet Engine: JP-5	1.0620	1.0623
27602011	Commercial aircraft: Internal Combustion Engines; Rotary Wing Aircraft L & TO Exhaust; Commercial; Jet Engine: Jet A	1.0750	1.3502

4.2.6.2 Oil and gas projections in TX, and non-California WRAP states (nonpt)

EPA used a suite of intermediate-year projected WRAP Phase III oil and gas emissions for all future year scenarios. These intermediate-year inventories are 2008 for the Permian basin, and 2010, 2012 or 2015 for the remaining WRAP area basins. These point and nonpoint inventories are discussed in the 2007 base case Sections 2.1.2 and 2.2.3, respectively. Summaries of these mid-term projections are posted on the WRAP Phase III oil and gas project website: http://www.wrapair2.org/PhaseIII.aspx. As discussed in Section 4.2.6.2, for drilling rig operations in the remaining counties in Texas (non-Permian basin), EPA applied year-2018 projections from a TCEQ report (http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/5820783985FY0901-20090715-ergi-Drilling_Rig_EI.pdf).

4.3 *Mobile source projections*

EPA analyzed emission impacts of the Tier 3 vehicle emissions and fuel standards by comparing projected emissions for future years without the Tier 3 rule (reference scenario) to projected emissions for future years with the Tier 3 standards in place (control scenario). Table 4-27 presents an overview of the reference and control scenarios for calendar years 2018 and 2030. Both scenarios reflect the renewable fuel volumes and market fractions projected by the Annual Energy Outlook 2013 Report ("AEO2013")[38]

[38] U.S. Energy Information Administration, Annual Energy Outlook 2013 (April 15, 2013)

Table 4-27. Overview of Reference and Control Scenarios

	Reference Scenario	**Control Scenario**
2018	Renewable Fuels: AEO 2013[a] 17.5 B gallons renewable fuels (18.3 B ethanol-equivalent gallons): 16.0 B gallons ethanol: E10 [b], E15[c], E85[d] Fuel Sulfur Level: 30 ppm (10 ppm California) Fleet: [e] 96 percent Tier 2 and older vehicles 4 percent LEV III vehicles	Renewable Fuels: AEO 2013[a] 17.5 B gallons renewable fuels (18.3 B ethanol-equivalent gallons): 16.0 B gallons ethanol: E10 [b], E15[c], E85[d] Fuel Sulfur Level: 10 ppm Fleet: [e] 86 percent Tier 2 and older vehicles 14 percent Tier 3/LEV III vehicles
2030	Renewable Fuels: AEO 2013[a] 17.6 B gallons renewable fuels (18.6 B ethanol-equivalent gallons): 15.3 B gallons ethanol: E10 [b], E15[c], E85[d] Fuel Sulfur Level: 30 ppm (10 ppm California) Fleet: [e] 76 percent Tier 2 and older vehicles 24 percent LEV III vehicles	Renewable Fuels: AEO 2013[a] 17.6 B gallons renewable fuels (18.6 B ethanol-equivalent gallons): 15.3 B gallons ethanol: E10 [b], E15[c], E85[d] Fuel Sulfur Level: 10 ppm Fleet: [e] 21 percent Tier 2 and older vehicles 79 percent Tier 3/LEV III vehicles

[a] U.S. Energy Information Administration, Annual Energy Outlook 2013 (April 15, 2013)
[b] Gasoline containing 10 percent ethanol by volume
[c] Gasoline containing 15 percent ethanol by volume
[d] Gasoline containing up to 85 percent ethanol by volume (74 percent nominal used in this analysis)
[e] Fraction of the vehicle population

The reference scenarios assumed an average fuel sulfur level of 30 ppm in accordance with the Tier 2 gasoline sulfur standards. Under the Tier 3 program, federal gasoline will contain no more than 10 ppm sulfur on an annual average basis by January 1, 2017, and therefore EPA assumed a nationwide fuel sulfur level of 10 ppm for both future year control cases.

EPA assumed a continuation of the existing Tier 2 standards for model years 2017 and later in modeling emissions for the reference scenario, with the exception of California and Section 177 states that have adopted the LEV III program. The Tier 3 control scenario modeled the suite of exhaust and evaporative emission standards for light-duty vehicles (LDVs), light duty trucks (LDTs: 1-4), medium passenger vehicles (MDPVs) and large pick-ups and vans (Class 2b and 3 trucks) including:

- Fleet average Federal Test Procedure (FTP) NMOG+NO_X standards of 30 mg/mi for LDVs, LDTs and MDPVs, phasing in from MYs 2017 to 2025 for the light-duty fleet under 6,000 lbs. GVWR and phasing in from MYs 2018 to 2025 for the light-duty fleet over 6,000 lbs. GVWR, and MDPVs
- Fleet average Supplemental Federal Test Procedure (SFTP) NMOG+NO_X standards of 50 mg/mi for LDVs, LDTs and MDPVs, phasing in from MYs 2017 to 2025 for the light-duty fleet under 6,000 lbs. GVWR and phasing in from MYs 2018 to 2025 for the light-duty fleet over 6,000 lbs. GVWR, and MDPVs
- Per-vehicle FTP PM standard of 3 mg/mi for LDVs, LDTs and MDPVs, phasing in from MYs 2017 to 2022 for the light-duty fleet under 6,000 lbs. GVWR and phasing in from MYs 2018 to 2022 for the light-duty fleet over 6,000 lbs. GVWR, and MDPVs

- Per-vehicle US06-only PM standard of 10 mg/mi for LDVs, LDTs and MDPVs through MY2021 and of 6 mg/mi for MY2022 and later model years
- New standards for Class 2b and 3 trucks phasing in by MY 2022 including NMOG+NO_X declining fleet average, and more stringent PM standards
- More stringent evaporative emission standards for diurnal plus hot soak emissions, a new canister bleed test and emission standard, and new requirements addressing evaporative leaks on in-use vehicles.
- New refueling emission control requirements for all complete HDGVs equal to or less than 14,000 lbs GVWR (i.e., Class 2b/3 HDGVs), starting in the 2018 model year, and for all larger HDGVs by the 2022 model year

Implementation of the Tier 3 standards is aligned with the model year 2017-2025 Light-Duty GHG standards[39] to achieve significant criteria pollutant and GHG emissions reductions while providing regulatory certainty and compliance efficiency to the auto and oil industries. Accordingly, the analyses for the Tier 3 rule include the final LD GHG standards in both the reference and control scenarios, and thus account for their impacts on the future vehicle fleet and future fuel consumption.

The analysis described here accounts for the following national onroad rules:
- Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements (65 FR 6698, February 10, 2000)
- Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements (66 FR 5002, January 18, 2001)
- Mobile Source Air Toxics Rule (72 FR 8428, February 26, 2007)
- Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program (75 FR 14670, March 26, 2010)
- Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for 2012-2016 (75 FR 25324, May 7, 2010)
- Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (76 FR 57106, September 15, 2011)
- 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards (77 FR 62623, October 15, 2012)

In addition, the modeling accounts for state and local rules including local fuel standards, Inspection/Maintenance programs, Stage II refueling controls, the National Low Emission Vehicle Program (NLEV), and the Ozone Transport Commission (OTC) LEV Program. Furthermore, the Tier 3 emissions modeling for both the national inventory and air quality analysis includes California's LEV III program and its associated emission reductions from both California and the states that adopted the LEV III program, in the baseline scenario.

Onroad mobile sources are comprised of several components and are discussed in the next subsection (4.3.1). Monthly nonroad mobile emission projections are discussed in subsection 4.3.2. Locomotives and Class 1 and Class 2 commercial marine vessel (C1/C2 CMV) projections are discussed in subsection 4.3.3, and Class 3 (C3) CMV projected emissions are discussed in subsection 4.3.4.

[39] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule (77 FR 62623–63200), October 2012.

4.3.1 Onroad mobile (onroad and onroad_rfl)

The onroad emissions for 2018 and 2030 use the same SMOKE-MOVES system as for the base year (see Sections 2.5.1 and 2.5.2). Meteorology, speed, spatial and temporal surrogates, representative counties, and fuel months were the same as for 2007, discussed above.

4.3.1.1 VMT and vehicle population

EPA estimates of total national Vehicle Miles Travelled (VMT) in 2018 and 2030 came from DOE's Annual Energy Outlook (AEO) 2013 early release (http://www.eia.gov/forecasts/aeo/). The VMT was allocated between vehicle types using a version of MOVES2010b that had been modified with VMT growth factors from the AEO and with historical data from FHWA (http://www.fhwa.dot.gov/policyinformation/statistics.cfm). The growth rates by SCC were applied to the VMT values from the 2007 base year in each county to generate the future year VMT estimates. These VMT values were normalized such that the total national VMT from the growth calculations matched the total VMT estimates in the AEO for 2018 and 2030. Vehicle populations by county, month and vehicle type were estimated by dividing annual VMT by national estimates of annual VMT per vehicle.

Tank trucks are used to transport ethanol mandated by EISA from production facilities to bulk terminals and from terminals to bulk plants and dispensing facilities. Impacts of this activity on emissions from tank trucks transporting ethanol (Class 8 trucks) are accounted for in these inventories by adjusting VMT used in SMOKE-MOVES. The VMT adjustments were derived from an Oak Ridge National Laboratory analysis of ethanol transport (Oak Ridge National Laboratory, 2009), scaled to account for the difference in ethanol volume for AEO 2013 future year projections versus the 2007 platform volume of 8.7 billion gallons. It should be noted that the Oak Ridge analysis only addressed ethanol transport and did not account for impacts of other biofuels on transportation activity. Impacts from the 2017-2025 light duty vehicle GHG emission standards were assumed to be negligible in 2018 and were accounted for with a 0.997 scalar in 2030.

4.3.1.2 Set up and Run MOVES to create EF

Emission factor tables were created by running SMOKE-MOVES using the same procedures and models as 2007 (see Section 2.5.1 and the 2007v5 TSD). The same meteorology and the same representative counties were used. Changes between 2007, 2018, and 2030 are predominantly VMT, fuels, national and local rules, and the model-year distribution of the fleet, which is built into MOVES. Fleet turnover resulted in a greater fraction of newer vehicles meeting stricter emission standards.

A detailed list of the differences between the runs for each case are described in

Table 4-28.

Table 4-28. Comparison of MOVES runs

Year	2007	2018	2018	2030	2030
Case	base	ref	ctl	ref	Ctl
Version	20130130	20130609	20130610	20130603	20130604
Run Name	abs2007base_20130130	tier3frm2018ref_20130609	tier3frm2018ctl_20130610	tier3frm2030ref_20130603	tier3frm2030ctl_20130604
MOVES code	moves20121002f	moves20121002f	moves20121002f	moves20121002f	moves20121002f
MOVES default database	movesdb20121002f	movesdb20121002k_truncatedgfre	movesdb20121002k_truncatedgfre	movesdb20121002k_truncatedgfre	movesdb20121002k_truncatedgfre
CDBs	2007PFCdb146RepCnties20120402	2018PM146Counties20120724	2018PM146Counties20120724	2030146Counties20130312	2030146Counties20130312
Early NLEV	early_nlev	N/A	N/A	N/A	N/A
LEV rates	tier3_lev_standards_YYYY	lev3_standards_SS_20130603	lev3_standards_SS_20130603	lev3_standards_SS_20130603	lev3_standards_SS_20130603
VMT and VPOP	nationaldefaultvmtpop_20120410	nationaldefaultvmtpop_20120410	nationaldefaultvmtpop_20120410	nationaldefaultvmtpop_20120410	nationaldefaultvmtpop_20120410
GFRE	N/A	non-LEV: tier3frm3030gfre LEV: tier3frm3010gfre_053013	tier3frm3010gfre_053013	non-LEV: tier3frm3030gfre LEV: tier3frm3010gfre_053013	tier3frm3010gfre_053013
hcspeciation	N/A	tier3frm_ref2018_hcspec_M_rvpB	tier3frm_ref2018_hcspec_M_rvpB	tier3frm_ref2030_hcspec_M_rvpB	tier3frm_ref2030_hcspec_M_rvpB
Fuels	2007_Baseline_09062012	tier3frm2018reffuels_02252013	tier3frm2018ctrlfuels_03152013	tier3frm2030reffuels_03072013	tier3frm2030ctrlfuels_03152013
Tier 3 control rates	N/A	N/A	tier3ctldbs_060313	N/A	tier3ctldbs_060313

The following states were modeled as having adopted the California LEV II and LEV III programs (see Table 4-29)

Table 4-29. CA LEVIII program states

FIPS	**State Name**
06	California
09	Connecticut
10	Delaware
23	Maine
24	Maryland
25	Massachusetts
34	New Jersey
36	New York
41	Oregon
42	Pennsylvania
44	Rhode Island
50	Vermont
53	Washington

Early NLEV refers to states which adopted the California "low emission vehicle" (LEV) standards in the 1990's "early", since the California LEV standards were adopted nationally (NLEV) starting in 2001. The following states were modeled as using the early NLEV program in 2007 (see Table 4-30).

Table 4-30. Early NLEV states

FIPS	State Name
09	CONNECTICUT
10	DELAWARE
11	DISTRICT OF COLUMBIA
23	MAINE
24	MARYLAND
33	NEW HAMPSHIRE
34	NEW JERSEY
42	PENNSYLVANIA
44	RHODE ISLAND
50	VERMONT
51	VIRGINIA

The following table indicates when the LEV states adopted the LEV2 standards and lists the emission standards databases used in the 2007 base run (see Table 4-31)

Table 4-31. LEV2 states and MOVES databases

FIPS	State Name	Database
6	CALIFORNIA	tier3_lev_standards_1994
9	CONNECTICUT	tier3_lev_standards_2008
10	DELAWARE	tier3_lev_standards_2014
23	MAINE	tier3_lev_standards_2001
24	MARYLAND	tier3_lev_standards_2011
25	MASSACHUSETTS	tier3_lev_standards_1995
34	NEW JERSEY	tier3_lev_standards_2009
35	NEW MEXICO	tier3_lev_standards_2016
36	NEW YORK	tier3_lev_standards_1996
41	OREGON	tier3_lev_standards_2009
42	PENNSYLVANIA	tier3_lev_standards_2008
44	RHODE ISLAND	tier3_lev_standards_2008
50	VERMONT	tier3_lev_standards_2000
53	WASHINGTON	tier3_lev_standards_2009

The use of RVP bins for specifying hydrocarbon speciation (HCspeciation) database for January and July for both 2018 and 2030 runs are listed by representative county (see Table 4-32)   Because the hydrocarbon speciation is dependent on the level of RVP, four RVP bins were generated based on RVP of the fuels in each representative county for each month. The HCspeciation database contains hydrocarbon speciation profiles for NMOG and VOC and applies only to fuels containing 70% or more ethanol by volume (i.e., E85).

Table 4-32. RVP bins by representative county

FIPS	Jan	Jul	FIPS	Jan	Jul	FIPS	Jan	Jul	FIPS	Jan	Jul
1073	2	2	23019	2	3	39041	3	4	47163	2	4
4013	2	1	23031	2	2	39049	3	4	48001	2	2
4019	2	4	24005	2	1	39061	3	3	48003	2	4
4021	2	4	24015	2	1	39113	3	3	48005	2	2
6025	2	1	24029	2	1	39119	3	4	48011	2	4
6037	2	1	24033	2	1	39151	3	4	48039	1	1
8031	3	3	24043	2	4	40143	2	4	48047	2	4
8041	3	4	24045	2	4	41005	3	3	48139	2	2
8101	3	4	25017	2	1	41019	3	4	48141	2	1
9003	2	1	26081	3	4	41029	3	4	48143	2	4
10003	2	1	26163	3	2	41037	3	4	48221	2	2
10005	2	1	27003	4	4	41039	3	4	48251	2	2
11001	2	1	27053	4	4	41047	3	3	48439	1	1
12011	2	3	27111	4	4	41051	3	3	49005	3	4
12033	2	4	27137	4	4	41067	3	3	49009	3	4
12086	2	3	27145	4	4	41071	3	4	49011	3	3
13015	2	2	27165	4	4	42003	3	2	49017	3	4
13051	2	4	29095	2	2	42005	3	2	49035	3	3
13121	2	2	29189	2	1	42009	2	4	49043	3	4
16001	3	4	32003	2	4	42017	2	1	49045	3	4
16027	3	4	32005	2	4	42019	3	2	49049	3	4
17031	2	1	32007	2	4	42039	3	4	49057	3	4
17093	2	1	32009	2	4	42043	2	4	50007	2	4
18019	3	3	32027	2	4	42049	3	4	51036	2	1
18089	2	1	32031	2	3	42051	3	2	51041	2	1
18097	3	4	33009	2	4	42055	2	4	51059	2	1
19095	2	4	33015	2	1	42063	3	4	51087	2	1
19133	2	4	34003	2	1	42071	2	4	51107	2	1
19153	2	4	35001	2	4	42073	3	4	51683	2	1
19163	2	4	35013	2	4	42089	2	4	51740	2	1
20091	2	2	36029	2	3	42091	2	1	53033	3	4
21029	2	1	36103	2	1	42101	2	1	53063	3	4
21111	2	1	37051	2	4	42129	3	2	53067	3	4
21117	2	1	37081	2	3	44007	2	1	55025	4	4
22033	2	3	37119	2	3	46099	4	4	55079	2	1
22047	2	3	39023	3	3	47157	3	3	55117	4	4
23005	2	2	39035	3	4						

Fuels were projected into the future using estimates from the AEO2013 (http://www.eia.gov/forecasts/aeo/), release dates April 15th-May 2nd 2013. . The fuel supply used in the Tier 3 FRM varies significantly from that used in the NPRM, including the introduction of a new approach to aggregating fuels by region. For more information regarding this new approach to fuels, please refer to the Tier 3 FRM, Chapter 7.1.3.2. Reference fuels contain E10, E15, and E85 at a market share fraction determined regionally from the AEO2013 report. Additional fuel properties for the reference cases are based on local fuel surveys as well as EPA fuel compliance and certification reports. All sulfur levels were set at 30ppm in the reference cases in order to reduce possible calculation artifacts. Fuel property changes associated with this sulfur adjustment were also calculated appropriately by region. The Tier 3 control cases adjust this sulfur level to 10ppm, as well as adjusting associated fuel properties with this sulfur reduction. Market shares between E10, E15 and

E85 remain unchanged between the reference and the control cases but changed across the years (2018 versus 2030).

4.3.1.3 Long Haul truck adjustments and SMOKE-MOVES

A set of adjustments were calculated for SMOKE-MOVES to estimate 2018 and 2030 emissions in each county to account for extended idle and the use of auxiliary power units (APU). These adjustments use the same approach as was used in 2007 (see Section 2.5.1.3 and the 2011 NEI v1 TSD for details) except for the vehicle population (VPOP) was updated to be consistent with 2018 or 2030. These adjustments are by county, vehicle type (long-haul truck SCCs only), and mode (extended idle or APU only) and impacted the RPV process only. The set of adjustments created for the extended idle mode are identical for APU because it was assumed that the distribution of APU usage and emissions would mirror extended idle activity.

SMOKE-MOVES, specifically Movesmrg, uses the adjustment factor file (CFPRO) for extended idle and APU to estimate 2018 and 2030 emissions that incorporates each of these adjustments.

4.3.2 Nonroad mobile (nonroad)

The nonroad sector includes a wide range of mobile emission sources ranging from construction equipment to hand-held lawn tools. In the nonroad sector, the only emissions that are directly affected by the Tier 3 regulation are the emissions from gasoline-powered equipment such as lawn-mowers, recreational boats and all-terrain vehicles. Their SO_2 emissions are reduced with the decrease in gasoline sulfur levels. As with onroad, reference and control case emissions were generated using the fuel supply inputs reflecting the projected fuel volumes from AEO2013.

Gasoline and land-based diesel nonroad emissions were estimated using EPA's NONROAD2008b model[40], as run by the EPA's consolidated modeling system known as the National Mobile Inventory Model (NMIM).[41] The fuels in the NMIM database, NCD2010201a, were developed from the reference and control fuels used for onroad vehicles, as described in Section 4.3.1.2. Onroad and nonroad gasoline formulations are assumed to be identical for all years. In 2018 and 2030, nonroad equipment is assumed to use E10 only. For all years, the reference case included the higher sulfur reference gasoline and the control case met the sulfur limits.

This sector includes monthly exhaust, evaporative and refueling emissions from nonroad engines (not including commercial marine, aircraft, and locomotives) derived from NMIM for all states except California.

The version of NONROAD models all in-force nonroad controls (see nonroad section under Table 4-1). Not included are voluntary local programs such as encouraging either no refueling or evening refueling on Ozone Action Days.

<u>California nonroad emissions</u>

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[40] This version of NONROAD is very similar to the publicly released version, but it can model ethanol blends up to E20. The NMIM version is NMIM20090504d, which has the same results as the publicly-released NMIM version NMIM20090504a. The underlying National County Database (NCD) is NCD20101201a, but with 2007 meteorology inserted into the countymonthhour table. NCD20101201a includes state inputs for the 2008 NEI.

[41] U.S. EPA. 2005 EPA's National Inventory Model (NMIM), A Consolidated Emissions Modeling System for MOBILE6 and NONROAD; EPA420-R-05-024; Office of Transportation and Air Quality, Ann Arbor, MI. http://www.epa.gov/otaq/models/nmim/420r05024.pdf

Similar to the 2007 base nonroad mobile, NMIM was not used to generate future-year nonroad emissions for California, other than for NH_3. EPA used NMIM for California future nonroad NH_3 emissions because CARB did not provide these data for any nonroad vehicle types. For the rest of the pollutants, EPA converted the CARB-supplied 2017 (surrogate for 2018) and 2030 nonroad annual inventories to monthly emissions values by using the NMIM monthly inventories to compute monthly ratios by pollutant and SCC. Some adjustments to the CARB inventory were needed to convert the provided TOG to VOC and to augment the HAPs. See Section 3.2.1.3 for details on speciation of California nonroad data. The CARB nonroad emissions include nonroad rules reflected in the December 2010 Rulemaking Inventory (http://www.arb.ca.gov/regact/2010/offroadlsi10/offroadisor.pdf) and those in the March 2011 Rule Inventory, the Off-Road Construction Rule Inventory for "In-Use Diesel".

4.3.3 Locomotives and Class 1 & 2 commercial marine vessels (c1c2rail)

Recall from Section 2.5.4 that there are several non-NEI components to the c1c2rail sector in the 2007 base case. There are three distinct approaches used to craft year 2018 and 2030 inventories from the 2007 base case. The first component of the 2018 and 2030 c1c2rail inventories is the non-California data projected from the 2007 base case. The second component is the CARB-supplied year 2017 (used for 2018 scenarios) and year 2030 data for California. The third component is a set of OTAQ-provided county-specific emissions adjustments that account for different fuel transport characteristics resulting from the EISA (RFS2) mandate. Specifically, these adjustments reduce finished petroleum-based fuel transport by rail and barge (CMV) and add ethanol-based finished fuel transport by rail and barge.

Step 1: Project non-California CMV and rail emissions

Packet: "PROJECTION_2008_2018_c1c2rail"; "PROJECTION_2008_2030_c1c2rail"

In this step, a projection packet creates an intermediate set of year 2018 and year 2030 emissions, respectively, for all states except California. This packet does not reflect emission impacts from ethanol volume impacts from the EISA (RFS2) mandate; the EISA impacts are applied for all states in Step 3. This packet consists of national projection factors by SCC and pollutant between 2007 and 2018 and 2030 that reflect the May 2004 "Tier 4 emissions standards and fuel requirements" (http://www.epa.gov/otaq/documents/nonroad-diesel/420r04007.pdf) as well as the March 2008 "Final locomotive-marine rule" controls (http://www.epa.gov/otaq/regs/nonroad/420f08004.pdf).

Projection factors are based on year 2008 rather than year 2007 for a couple of reasons. First, many states with large c1c2rail emissions utilize the 2008 NEI emissions; Texas is one example. Second, the year 2007 emissions are mostly lower than the 2008 RIA summaries, and these emissions generally decrease in the future. By choosing year 2008, the projections are unlikely to overly-reduce emissions by years 2018 and 2030. In addition, the 2007 platform emissions are often much different than the RIA emissions for any year. EPA OTAQ experts determined that the 2007 platform estimates were more up-to date and likely more reliable than the RIA estimates in 2007/2008 and 2018 and 2030. However, the controls and hence the relative reductions in the RIA are expected to be fairly close to what would be expected from the 2007 platform. Therefore, EPA simply apply the ratio of the RIA 2018 or 2030 to 2008 emissions to project the 2007 platform emissions. These projection ratios are provided in

Table 4-33.

Table 4-33. Non-California year 2018 and 2030 Projection Factors for locomotives and Class 1 and Class 2 Commercial Marine Vessel Emissions

SCC	Description	Pollutant	2018	2030
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	CO	0.9284	0.9506
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	NO_X	0.7042	0.3931
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	PM_{10}	0.6429	0.3696
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	$PM_{2.5}$	0.6429	0.3696
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	SO_2	0.1213	0.0647
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	VOC	0.7529	0.4065
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	CO	1.1720	1.4180
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	NO_X	0.7523	0.4426
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	PM_{10}	0.6168	0.2939
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	$PM_{2.5}$	0.6168	0.2939
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	SO_2	0.0334	0.0405
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	VOC	0.5453	0.2914
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	CO	1.1709	1.4174
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	NO_X	1.1092	1.1014
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	PM_{10}	1.0700	1.0250
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	$PM_{2.5}$	1.0722	1.0206
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	SO_2	0.0349	0.0349
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	VOC	1.1740	1.4189
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	CO	1.0832	1.1915
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	NO_X	0.5292	0.2723
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	PM_{10}	0.5457	0.1926
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	$PM_{2.5}$	0.5445	0.1908
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	SO_2	0.0286	0.0343
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	VOC	0.4735	0.1527
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	CO	1.0832	1.1918
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	NO_X	0.5292	0.2723
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	PM_{10}	0.5444	0.1918
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	$PM_{2.5}$	0.5446	0.1906
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	SO_2	0.0335	0.0335
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	VOC	0.4730	0.1535
2285002010	Railroad Equipment;Diesel;Yard Locomotives	CO	1.1720	1.4180
2285002010	Railroad Equipment;Diesel;Yard Locomotives	NO_X	0.9948	0.7533
2285002010	Railroad Equipment;Diesel;Yard Locomotives	PM_{10}	0.9562	0.7271
2285002010	Railroad Equipment;Diesel;Yard Locomotives	$PM_{2.5}$	0.9567	0.7269
2285002010	Railroad Equipment;Diesel;Yard Locomotives	SO_2	0.0337	0.0404
2285002010	Railroad Equipment;Diesel;Yard Locomotives	VOC	0.9511	0.6851

The future-year locomotive emissions account for increased fuel consumption based on Energy Information Administration (EIA) fuel consumption projections for freight rail, and emissions reductions resulting from emissions standards from the Final Locomotive-Marine rule (EPA, 2009d). This rule lowered diesel sulfur content and tightened emission standards for existing and new locomotives and marine diesel emissions to lower future-year PM, SO_2, and NO_X, and is documented at: http://www.epa.gov/otaq/marine.htm#2008final.

EPA applied HAP factors for VOC HAPs by using the VOC projection factors to obtain 1,3-butadiene, acetaldehyde, acrolein, benzene, and formaldehyde. C1/C2 CMV diesel emissions (SCC = 2280002100 and 2280002200) were projected based on the Final Locomotive Marine rule national-level factors provided in Table 4-33. Similar to locomotives, VOC HAPs were projected based on the VOC factor.

Step 2: Intermediate California year 2018 and year 2030 inventories

Obtained from CARB, the locomotive, and class 1 and 2 commercial marine emissions used for California reflect year 2017 and year 2030 and include nonroad rules reflected in the December 2010 Rulemaking Inventory (http://www.arb.ca.gov/regact/2010/offroadlsi10/offroadisor.pdf), those in the March 2011 Rule Inventory, the Off-Road Construction Rule Inventory for "In-Use Diesel", cargo handling equipment rules in place as of 2011 (see http://www.arb.ca.gov/ports/cargo/cargo.htm), and the 2007 and 2010 regulations to reduce emissions diesel engines on commercial harbor craft operated within California waters and 24 nautical miles of the California baseline.

The C1/C2 CMV emissions for both 2017 and 2030 were obtained from the CARB nonroad mobile dataset "ARMJ_RF#2002_ANNUAL_MOBILE.txt". These emissions were developed using Version 1 of the CEPAM which supports various California off-road regulations. The locomotive emissions were obtained from the CARB trains dataset "ARMJ_RF#2002_ANNUAL_TRAINS.txt". Documentation of the CARB offroad methodology, including c1c2rail sector data, is provided here: http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles. EPA converted the CARB inventory TOG to VOC by dividing the inventory TOG by the available VOC-to-TOG speciation factor. Note there was no attempt to modify year 2017 CARB emissions to year 2018 via linear interpolation or other schemes. EPA simply assigned year 2018 emissions as the 2017 CARB submittal with these medications as well as those discussed next in step 3.

Step 3: Adjusting intermediate year 2018 and 2030 c1c2rail emissions to reflect the EISA mandate and LD GHG emission standards

Rail category 1 and commercial marine activity are impacted by both the EISA mandate and the 2017-2025 light-duty vehicle greenhouse gas emission standards. The inventories were adjusted to account for both.

Inventories were adjusted to account for (a) differences in C1/C2 CMV and rail emission rates in 2018 and 2030 versus 2007, (b) the difference in ethanol volume impacts for AEO 2013 future year projections versus the 2007 platform volume of 8.7 billion gallons and (c) impacts on gasoline production and distribution from the 2017-2025 light duty vehicle GHG emissions standards (EPA, 2013b). Adjustments to C1/C2 CMV and rail emission rates were calculated using ton/ton-mile emission factors that were obtained from the Tier 3 proposed rule inventory and AEO 2013 projected domestic shipping estimates (EPA, 2013c; Energy Information Administration, 2013). The ethanol volume impacts were allocated to individual counties using factors developed from the ORNL analysis (ORNL, 2013). Impacts on C1/C2 CMV and rail emissions from the 2017-2025 light duty vehicle GHG emission standards were calculated using the RFS2 impacts spreadsheet. Impacts from the 2017-2025 light duty vehicle GHG emission standards were assumed to be negligible in 2018 but were accounted for by the scalars in Table 4-34 and Table 4-35 for 2030.

Table 4-34. Scalars Applied to Rail Combustion Emissions in 2030 to account for 2017-2025 LDGHG emission standards

Pollutant	Scalar
CO	0.998
NO_X	0.998
$PM_{2.5}$	0.997
PM_{10}	0.996
SO_2	0.997
VOC	0.997

Table 4-35. Scalars Applied to C1/C2 Combustion Emissions in 2030 to account for 2017-2025 LDGHG emission standards

Pollutant	Scalar
CO	0.996
NO_X	0.993
$PM_{2.5}$	0.994
PM_{10}	0.993
SO_2	0.991
VOC	0.978

These emissions from updated ethanol volumes via RFS/EISA and LDGHG are not included in the previously-discussed non-California loco-marine rule-based projections (Step 1) and CARB 2017 and 2030 inventories (Step 2). Nationally, these adjusted emissions are modest.

On average, for year 2018 rail emissions, the impact of the adjustment for transporting more ethanol is an increase in emissions by 1.24%, and the adjustment for transporting less gasoline is -0.04%, leaving a small increase in rail emissions in year 2018. For year 2030 rail emissions, the impact of the adjustment for transporting more ethanol is an increase in emissions by 0.92%, and the adjustment for transporting less gasoline is -0.06%, and the adjustment for the LD GHG rule is a reduction of 0.24%, leaving a small increase in emissions in year 2030. These small increases in rail emissions are evident in Table 4-36. For CMV emissions in year 2018, the impact of transporting more ethanol by 0.21% is offset by the adjustment for transporting less gasoline by -1.32%. For 2030, as shown in the "2030 Error" column in Table 4-36, we erroneously misapplied these RFS2 as well as LDGHG decreasing emissions adjustments: increased ethanol by 0.19%, decreased gasoline by 2.05% and LDGHG rule reductions of -0.78%. In short, in year 2030, national total NO_X emissions from C1/C2 CMV are 2,678 tons larger than intended, a 0.6% error for C1/C2 CMV nationally.

Table 4-36. Cumulative RFS2 and LDGHG adjustments to c1c2rail sector emissions

Pollutant	Source	2018 Adjustment	Final 2018	2030 Applied adjustment	Final 2030	Intended 2030	2030 Error
CO	cmv	-855	88,226	0	92,593	90,360	2,233
CO	rail	1,715	152,424	1,296	185,916	185,916	0
NH_3	cmv	-2	218	0	225	221	4
NH_3	rail	5	358	5	357	357	0
NO_X	cmv	-3,635	343,725	0	197,537	192,590	4,947
NO_X	rail	8,346	683,017	2,678	430,577	430,577	0
PM_{10}	cmv	-139	11,584	0	7,060	6,869	192
PM_{10}	rail	198	18,530	31	9,672	9,672	0
$PM_{2.5}$	cmv	-155	11,102	0	6,773	6,504	269
$PM_{2.5}$	rail	-10	16,857	-36	8,826	8,826	0
SO_2	cmv	-296	5,380	0	4,249	3,870	379
SO_2	rail	80	482	-7	478	478	0
VOC	cmv	-136	11,452	0	7,484	7,293	191
VOC	rail	357	28,272	91	17,143	17,143	0

4.3.4 Class 3 commercial marine vessels (c3marine)

As discussed in Section 2.5.5, the c3marine sector emissions data were developed for year 2002 and projected to year 2007 for the 2007 base case. The ECA-IMO project provides pollutant and geographic-specific projection factors to year 2007, and also projection factors to years 2018 and 2030 that reflect assumed growth and final ECA-IMO controls. The ECA-IMO rule, published in December 2009, applies to Category 3 (C3) diesel engines (engines with per cylinder displacement at or above 30 liters) installed on U.S. vessels. The ECA-IMO rule includes an implementation of Tier 2 and Tier 3 NO_X limits for C3 engines beginning in 2011 and 2016, respectively. The ECA-IMO rule also imposes fuel sulfur limits of 1,000 ppm (0.1%) by 2015 in the ECA region -generally within 200 nautical miles of the U.S. and Canadian coastlines, as well as 5,000 ppm (0.5%) for "global" areas –those areas outside the ECA region. For comparison, with the exception of some local areas, year 2007 sulfur content limits are as high as 15,000 ppm (1.5%) in U.S. waters and 45,000 ppm (4.5%) in global areas. More information on the ECA-IMO rule can be found in the Category 3 marine diesel engines Regulatory Impact Assessment: http://www.epa.gov/otaq/oceanvessels.htm.

Projection factors for creating the year 2018 and year 2030 c3marine inventories from the 2007 base case are provided in Table 4-37. Background on the region and EEZ FIPS is provided in the discussion on the c3marine inventory for 2007 –Section 2.5.5. The impact of the Tier 2 and Tier 3 NO_X engine standards is less noticeable because of the inevitable delay in fleet turnover for these new engines; however, the immediate and drastic cuts in fuel sulfur content are obvious. VOC and CO are mostly unaffected by the engine and fuel standards, thus providing an idea on how much these emissions would have grown without ECA-IMO controls. VOC HAPs are assigned the same growth rates as VOC.

Table 4-37. Growth factors to project the 2007 ECA-IMO inventory to 2018 and 2030

Region	EEZ FIPS	Year	NO_X	PM_{10}	$PM_{2.5}$	VOC	CO	SO_2
East Coast (EC)	85004	2018	1.166	0.221	0.219	1.623	1.623	0.058
		2030	0.900	0.373	0.373	2.752	2.752	0.098
Gulf Coast (GC)	85003	2018	0.984	0.187	0.186	1.370	1.370	0.049
		2030	0.633	0.264	0.265	1.930	1.930	0.069
North Pacific (NP)	85001	2018	1.061	0.197	0.196	1.429	1.429	0.055
		2030	0.773	0.293	0.297	2.128	2.126	0.082
South Pacific (SP)	85002	2018	1.255	0.241	0.239	1.731	1.730	0.068
		2030	1.009	0.456	0.457	3.290	3.254	0.128
Great Lakes (GL)	n/a	2018	1.023	0.159	0.158	1.204	1.204	0.043
		2030	1.013	0.195	0.195	1.474	1.474	0.052
Outside ECA	98001	2018	1.401	1.606	1.606	1.606	1.606	1.606
		2030	2.083	0.612	0.606	2.778	2.778	0.506

4.4 *Canada, Mexico, and Offshore sources (othar, othon, and othpt)*

Emissions for Canada and offshore sources were not projected to future years, and are therefore the same as those used in the 2007 base case. Canada did not provide future-year emissions that were consistent with the base year emissions. The Mexico emissions are based on year 1999 but projected to years 2018 and 2030. A background on the development of year-2018 and year-2030 Mexico emissions from the 1999 inventory is available at: http://www.wrapair.org/forums/ef/inventories/MNEI/index.html.

5 Emission Summaries

The following tables summarize the emissions for the 2007 base case, 2018 reference and control cases, and the 2030 reference and control cases. These summaries are provided for the contiguous U.S. and for the portions of Canada and Mexico inside the smaller 12km domain (12US2) discussed in Section 3.1. The afdust sector emissions represent the summaries after application of both the land use (transport fraction) and meteorological adjustments (see Section 2.2.1); therefore, this sector is called "afdust-adj" in these summaries. The onroad and onroad refueling (onroad_rfl) sector totals are post-SMOKE-MOVES totals, representing air quality model-ready emission totals. Biogenic emissions totals are only given within the United States. The "c3marine-US" sector represents c3marine sector emissions with U.S. FIPS only; these extend to roughly 3-5 miles offshore and include all U.S. waters in the Great Lakes along with all U.S. ports. The Offshore c3marine represents all non-U.S. c3marine emissions outside of U.S. state waters. The c3marine sector is discussed in Section 2.5.5. The "Off-shore othpt" sector is the non-Canada, non-Mexico component of the othpt sector, i.e., the offshore oil platform emissions from the 2008 NEI.

National emission totals by air quality model-ready sector are provided for all CAP emissions for the 2007 base case and 2007 evaluation case in Table 5-1. The total of all U.S. emissions in all sectors is provided. The lower portion of the table provides the non-U.S. emissions including subtotals for Canada, Mexico, and all non-U.S. emissions. Tables 5-2 through 5-5 provide similar CAP emission totals by sector for the 2018 reference case, 2018 control case, 2030 reference case, and 2030 control case, respectively.

Table 5-6 provides total emissions for CO by state for all five cases: 2007 base case, 2018 reference and control cases, and 2030 reference and control cases. Tables 5-7 through 5-12 provide the same summaries for NH_3, NO_X, $PM_{2.5}$, PM_{10}, SO_2 and VOC, respectively. Note that all of these tables use average fire emissions and do not include biogenic emissions. Emission totals by state for each modeling platform sector, for CAPs and air quality model species, can be found in these spreadsheets available in the docket: 2007rg_state_totals.xlsx, 2018rg_ref2_state_totals.xlsx, 2018rg_ctl_state_totals.xlsx, 2030rg_ref_state_totals.xlsx, and 2030rg_ctl_state_totals.xlsx.

Table 5-1. National and non-U.S. CAP emissions by sector for 2007 base case

US Totals

Sector	CO	NH3	NOX	PM10	PM25	SO2	VOC
afdust				6,124,268	863,738		
ag		3,595,613					
biogenic	6,522,111		1,049,976				40,283,861
c1c2rail	218,827	557	1,338,134	43,832	41,015	48,805	61,547
nonpt	4,329,593	155,297	1,199,385	768,986	677,339	406,290	6,529,064
nonroad	17,834,128	1,915	1,877,955	187,707	178,342	100,652	2,517,282
onroad	38,519,970	140,897	7,612,080	365,017	282,304	40,008	4,273,876
avefire	18,347,571	300,999	243,561	1,860,459	1,576,667	135,806	4,326,863
ptipm	703,760	25,427	3,357,349	437,210	329,585	9,136,112	38,071
ptnonipm	2,963,103	67,997	2,136,694	582,397	406,476	1,586,719	1,101,615
c3marine	12,724		138,033	12,476	11,452	104,822	4,902
Total	**89,451,787**	**4,288,703**	**18,953,168**	**10,382,352**	**4,366,917**	**11,559,214**	**59,137,081**

Non-US Totals

Country/Sector	CO	NH3	NOX	PM10	PM2.5	SO2	VOC*
Canada othar	2,809,975	386,148	463,154	810,685	248,902	61,190	932,086
Canada othon	1,207,227	6,123	150,856	6,402	5,199	3,679	94,610
Canada othpt	571,728	15,546	338,967	65,952	39,787	831,669	155,906
Canada Subtotal	4,588,930	407,816	952,977	883,039	293,889	896,539	1,182,601
Mexico othar	410,176	109,861	171,735	71,082	47,115	53,424	450,935
Mexico othon	2,685,132	14,114	326,165	11,805	9,115	5,462	192,045
Mexico othpt	100,075	0	343,480	120,802	89,358	731,675	77,255
Mexico Subtotal	3,195,383	123,975	841,380	203,690	145,588	790,560	720,235
Offshore othpt	82,133	0	74,277	780	769	1,021	60,756
Canada c3marine	2,607		31,870	2,633	2,402	19,504	1,109
Offshore c3marine	55,599		674,615	55,891	51,386	417,293	23,635
Total	7,924,652	531,791	2,575,119	1,146,033	494,033	2,124,917	1,988,337

Table 5-2. National and non-U.S. CAP emissions by sector for 2018 reference case

US Totals:

Sector	CO	NH3	NOX	PM10	PM25	SO2	VOC
afdust				6,139,289	866,710		
ag		3,717,417					
biogenic	6,522,111		1,049,976				40,283,861
c1c2rail	236,042	567	1,008,203	29,525	27,390	5,693	39,272
nonpt	4,613,119	157,772	1,185,288	808,719	715,966	317,310	6,423,764
nonroad	12,702,891	2,276	1,067,481	106,715	100,588	2,670	1,408,935
onroad*	16,144,911	80,053	2,495,021	191,678	111,049	26,089	1,800,164
avefire	18,347,571	300,999	243,561	1,860,459	1,576,667	135,806	4,326,863
ptipm	857,784	40,255	1,941,441	295,290	233,699	2,131,278	46,057
ptnonipm	2,639,792	68,053	2,010,662	536,133	368,215	957,178	1,013,798
c3marine	18,960		151,489	2,530	2,304	5,734	7,290
Total	**62,083,182**	**4,367,393**	**11,153,123**	**9,970,338**	**4,002,588**	**3,581,760**	**55,350,004**

Non-US Totals

Country/Sector	CO	NH3	NOX	PM10	PM2.5	SO2	VOC*
Canada othar	2,809,975	386,148	463,154	810,685	248,902	61,190	932,086
Canada othon	1,207,227	6,123	150,856	6,402	5,199	3,679	94,610
Canada othpt	571,728	15,546	338,967	65,952	39,787	831,669	155,906
Canada Subtotal	4,588,930	407,816	952,977	883,039	293,889	896,539	1,182,601
Mexico othar	527,942	109,840	226,387	70,937	47,201	19,287	577,084
Mexico othon	2,572,443	15,225	304,436	13,185	10,317	3,177	178,219
Mexico othpt	148,760	0	544,711	170,913	127,736	1,066,523	94,351
Mexico Subtotal	3,249,146	125,065	1,075,534	255,035	185,254	1,088,987	849,654
Offshore othpt	82,133	0	74,277	780	769	1,021	60,756
Canada c3marine	3,750		34,364	518	469	1,054	1,595
Offshore c3marine	87,463		807,580	32,180	29,537	190,969	37,173
Total	8,011,422	532,881	2,944,732	1,171,552	509,917	2,178,569	2,131,779

Table 5-3. National and non-U.S. CAP emissions by sector for 2018 control case

US Totals:

Sector	CO	NH3	NOX	PM10	PM25	SO2	VOC
afdust				6,139,289	866,710		
ag		3,717,417					
biogenic	6,522,111		1,049,976				40,283,861
c1c2rail	236,042	567	1,008,203	29,525	27,390	5,693	39,272
nonpt	4,613,119	157,772	1,185,288	808,719	715,966	317,310	6,423,764
nonroad	12,702,891	2,276	1,067,481	106,715	100,588	1,912	1,408,935
onroad*	15,893,583	80,053	2,248,595	191,209	110,617	11,493	1,757,359
avefire	18,347,571	300,999	243,561	1,860,459	1,576,667	135,806	4,326,863
ptipm	857,784	40,255	1,941,441	295,290	233,699	2,131,278	46,057
ptnonipm	2,639,792	68,053	2,010,662	536,133	368,215	957,178	1,013,798
c3marine	18,960		151,489	2,530	2,304	5,734	7,290
Total	**61,831,854**	**4,367,393**	**10,906,697**	**9,969,869**	**4,002,157**	**3,566,405**	**55,307,199**

Non-US Totals

Country/Sector	CO	NH3	NOX	PM10	PM2.5	SO2	VOC*
Canada othar	2,809,975	386,148	463,154	810,685	248,902	61,190	932,086
Canada othon	1,207,227	6,123	150,856	6,402	5,199	3,679	94,610
Canada othpt	571,728	15,546	338,967	65,952	39,787	831,669	155,906
Canada Subtotal	4,588,930	407,816	952,977	883,039	293,889	896,539	1,182,601
Mexico othar	527,942	109,840	226,387	70,937	47,201	19,287	577,084
Mexico othon	2,572,443	15,225	304,436	13,185	10,317	3,177	178,219
Mexico othpt	148,760	0	544,711	170,913	127,736	1,066,523	94,351
Mexico Subtotal	3,249,146	125,065	1,075,534	255,035	185,254	1,088,987	849,654
Offshore othpt	82,133	0	74,277	780	769	1,021	60,756
Canada c3marine	3,750		34,364	518	469	1,054	1,595
Offshore c3marine	87,463		807,580	32,180	29,537	190,969	37,173
Total	8,011,422	532,881	2,944,732	1,171,552	509,917	2,178,569	2,131,779

Table 5-4. National and non-U.S. CAP emissions by sector for 2030 reference case

US Totals:

Sector	CO	NH3	NOX	PM10	PM25	SO2	VOC
afdust				6,174,969	873,719		
ag		3,784,658					
biogenic	6,522,111		1,049,976				40,283,861
c1c2rail	273,741	574	617,480	16,392	15,270	4,633	24,372
nonpt	4,622,228	157,772	1,198,956	809,404	716,460	318,053	6,353,099
Nonroad	13,926,036	2,702	715,617	68,626	63,839	3,045	1,182,812
onroad*	14,434,283	84,796	1,367,429	175,639	82,137	22,310	1,260,883
Avefire	18,347,571	300,999	243,561	1,860,459	1,576,667	135,806	4,326,863
Ptipm	1,064,259	49,461	1,997,303	300,645	238,259	2,188,169	52,061
Ptnonipm	2,693,137	67,596	2,022,539	532,186	364,598	935,044	1,001,777
c3marine	29,906		116,493	3,972	3,654	9,104	11,479
Total	**61,913,273**	**4,448,559**	**9,329,353**	**9,942,292**	**3,934,603**	**3,616,164**	**54,497,206**

Non-US Totals

Country/Sector	CO	NH3	NOX	PM10	PM2.5	SO2	VOC*
Canada othar	2,809,975	386,148	463,154	810,685	248,902	61,190	932,086
Canada othon	1,207,227	6,123	150,856	6,402	5,199	3,679	94,610
Canada othpt	571,728	15,546	338,967	65,952	39,787	831,669	155,906
Canada Subtotal	4,588,930	407,816	952,977	883,039	293,889	896,539	1,182,601
Mexico othar	794,133	109,861	326,219	75,903	51,815	9,909	798,874
Mexico othon	2,673,052	17,507	293,017	17,129	13,873	3,499	180,518
Mexico othpt	222,044	0	812,593	249,006	185,682	1,552,126	119,095
Mexico Subtotal	3,689,230	127,368	1,431,829	342,038	251,370	1,565,534	1,098,487
Offshore othpt	82,133	0	74,277	780	769	1,021	60,756
Canada c3marine	5,650		26,704	780	718	1,584	2,405
Offshore c3marine	146,574		784,389	23,561	21,600	83,949	62,442
Total	8,512,517	535,184	3,270,176	1,250,198	568,346	2,548,627	2,406,691

Table 5-5. National and non-U.S. CAP emissions by sector for 2030 control case

US Totals:

Sector	CO	NH3	NOX	PM10	PM25	SO2	VOC
afdust				6,174,969	873,719		
ag		3,784,658					
biogenic	6,522,111		1,049,976				40,283,861
c1c2rail	273,741	574	617,480	16,392	15,270	4,633	24,372
nonpt	4,622,228	157,772	1,198,956	809,404	716,460	318,053	6,353,099
nonroad	13,926,036	2,702	715,617	68,626	63,839	2,176	1,182,812
onroad*	10,780,871	84,796	1,018,962	166,388	73,619	10,040	1,079,042
avefire	18,347,571	300,999	243,561	1,860,459	1,576,667	135,806	4,326,863
ptipm	1,064,259	49,461	1,997,303	300,645	238,259	2,188,169	52,061
ptnonipm	2,693,137	67,596	2,022,539	532,186	364,598	935,044	1,001,777
c3marine	29,906		116,493	3,972	3,654	9,104	11,479
Total	**58,259,861**	**4,448,559**	**8,980,886**	**9,933,042**	**3,926,085**	**3,603,025**	**54,315,365**

Non-US Totals

Country/Sector	CO	NH3	NOX	PM10	PM2.5	SO2	VOC*
Canada othar	2,809,975	386,148	463,154	810,685	248,902	61,190	932,086
Canada othon	1,207,227	6,123	150,856	6,402	5,199	3,679	94,610
Canada othpt	571,728	15,546	338,967	65,952	39,787	831,669	155,906
Canada Subtotal	4,588,930	407,816	952,977	883,039	293,889	896,539	1,182,601
Mexico othar	794,133	109,861	326,219	75,903	51,815	9,909	798,874
Mexico othon	2,673,052	17,507	293,017	17,129	13,873	3,499	180,518
Mexico othpt	222,044	0	812,593	249,006	185,682	1,552,126	119,095
Mexico Subtotal	3,689,230	127,368	1,431,829	342,038	251,370	1,565,534	1,098,487
Offshore othpt	82,133	0	74,277	780	769	1,021	60,756
Canada c3marine	5,650		26,704	780	718	1,584	2,405
Offshore c3marine	146,574		784,389	23,561	21,600	83,949	62,442
Total	8,512,517	535,184	3,270,176	1,250,198	568,346	2,548,627	2,406,691

Table 5-6. CO emissions (tons/yr) for each case and state

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Alabama	1,924,241	1,360,917	1,351,229	1,355,227	1,255,631
Arizona	1,466,047	957,043	944,935	1,011,463	871,117
Arkansas	1,600,242	1,212,877	1,206,827	1,205,866	1,154,433
California	6,868,040	5,236,858	5,217,036	5,027,026	5,027,026
Colorado	1,190,074	809,875	792,847	872,740	763,605
Connecticut	574,605	357,385	354,137	333,723	332,897
Delaware	162,704	105,413	104,551	93,324	93,129
District of Columbia	60,932	35,900	35,291	36,923	30,370
Florida	5,022,400	3,138,544	3,105,671	3,230,725	2,815,295
Georgia	3,792,250	2,457,784	2,438,401	2,418,199	2,227,785
Idaho	1,953,101	1,772,944	1,767,029	1,772,829	1,738,622
Illinois	2,288,411	1,436,945	1,421,535	1,493,876	1,330,020
Indiana	1,860,666	1,204,836	1,191,445	1,214,686	1,095,670
Iowa	906,397	498,846	492,379	498,959	455,151
Kansas	1,085,160	754,279	748,374	757,743	706,892
Kentucky	1,313,600	920,767	913,119	919,051	844,092
Louisiana	1,901,576	1,443,889	1,436,282	1,461,086	1,378,073
Maine	417,956	251,190	248,837	230,967	230,019
Maryland	1,054,787	708,961	704,541	666,789	666,962
Massachusetts	876,162	604,516	598,218	578,757	577,788
Michigan	2,970,746	1,688,062	1,668,056	1,628,993	1,486,651
Minnesota	2,785,008	2,148,692	2,137,462	2,094,983	2,011,938
Mississippi	1,170,077	835,928	829,347	836,297	765,258
Missouri	2,144,179	1,422,916	1,411,751	1,422,427	1,311,400
Montana	1,330,031	1,214,531	1,210,079	1,213,708	1,193,598
Nebraska	531,194	310,062	306,155	316,475	283,905
Nevada	724,335	518,145	513,004	542,295	490,562
New Hampshire	304,620	209,280	206,548	215,511	194,314
New Jersey	1,352,241	902,273	893,855	867,908	865,761
New Mexico	677,284	453,892	448,885	445,239	413,092
New York	2,641,178	1,649,663	1,632,656	1,615,599	1,608,909
North Carolina	3,273,181	1,954,088	1,932,231	1,907,338	1,749,607
North Dakota	293,318	209,600	208,195	206,779	195,525
Ohio	3,087,510	1,726,198	1,703,457	1,707,663	1,536,234
Oklahoma	1,686,238	1,214,110	1,204,794	1,221,253	1,133,433
Oregon	2,201,777	1,749,839	1,740,219	1,670,492	1,665,955

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Pennsylvania	2,460,443	1,440,750	1,427,500	1,353,066	1,350,221
Rhode Island	151,235	106,761	105,767	101,731	101,681
South Carolina	1,424,534	898,530	890,759	906,112	822,767
South Dakota	321,482	236,051	234,446	234,663	220,361
Tennessee	1,788,332	1,035,150	1,022,408	1,012,970	898,967
Texas	5,466,088	3,430,870	3,388,430	3,632,059	3,119,557
Utah	824,426	589,517	580,111	590,348	538,323
Vermont	188,782	147,145	145,493	140,898	140,486
Virginia	1,837,272	1,146,294	1,134,028	1,174,277	1,039,507
Washington	2,215,115	1,341,308	1,322,137	1,175,059	1,166,307
West Virginia	655,801	432,831	429,529	427,734	401,919
Wisconsin	1,396,496	919,043	910,135	957,000	861,066
Wyoming	656,091	562,905	559,282	562,888	546,433
TOTAL	82,878,364	55,764,204	55,269,404	55,361,723	51,708,312

Table 5-7. NH_3 emissions (tons/yr) for each case and state

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Alabama	78,589	84,806	84,806	86,662	86,662
Arizona	41,818	41,331	41,331	42,090	42,090
Arkansas	135,328	142,800	142,800	145,796	145,796
California	393,315	390,595	390,595	395,474	395,474
Colorado	74,561	74,495	74,495	74,938	74,938
Connecticut	5,158	4,612	4,612	4,691	4,691
Delaware	14,044	15,331	15,331	15,764	15,764
District of Columbia	366	281	281	308	308
Florida	63,410	60,707	60,707	62,042	62,042
Georgia	116,050	123,001	123,001	125,862	125,862
Idaho	130,482	130,704	130,704	130,326	130,326
Illinois	119,703	122,450	122,450	126,561	126,561
Indiana	98,051	101,698	101,698	104,955	104,955
Iowa	301,952	316,176	316,176	327,804	327,804
Kansas	161,525	162,607	162,607	162,849	162,849
Kentucky	60,996	62,786	62,786	63,724	63,724
Louisiana	84,106	85,334	85,334	86,389	86,389
Maine	7,264	7,353	7,353	7,482	7,482
Maryland	31,585	32,929	32,929	34,163	34,163
Massachusetts	7,229	6,421	6,421	6,700	6,700
Michigan	69,890	69,713	69,713	71,021	71,021
Minnesota	210,960	214,414	214,414	220,096	220,096
Mississippi	68,874	73,643	73,643	75,479	75,479
Missouri	139,500	142,734	142,734	145,793	145,793
Montana	72,677	73,473	73,473	74,049	74,049
Nebraska	179,531	182,275	182,275	182,928	182,928
Nevada	10,483	10,706	10,706	10,761	10,761
New Hampshire	2,303	2,214	2,214	2,266	2,266
New Jersey	11,949	11,042	11,042	11,530	11,530
New Mexico	43,094	42,928	42,928	43,343	43,343
New York	51,428	48,036	48,036	49,238	49,238
North Carolina	187,827	198,254	198,254	206,640	206,640
North Dakota	86,696	88,085	88,085	89,930	89,930
Ohio	111,991	114,657	114,657	117,372	117,372
Oklahoma	112,918	116,127	116,127	118,004	118,004
Oregon	64,640	65,193	65,193	65,684	65,684
Pennsylvania	80,223	81,438	81,438	83,198	83,198
Rhode Island	1,135	1,097	1,097	1,123	1,123
South Carolina	39,330	40,054	40,054	41,038	41,038
South Dakota	134,157	136,513	136,513	139,008	139,008

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Tennessee	42,899	43,506	43,506	43,838	43,838
Texas	320,410	323,482	323,482	326,720	326,720
Utah	42,676	43,006	43,006	42,859	42,859
Vermont	8,404	8,395	8,395	8,507	8,507
Virginia	51,371	51,793	51,793	52,776	52,776
Washington	53,330	53,641	53,641	54,200	54,200
West Virginia	16,526	17,102	17,102	17,436	17,436
Wisconsin	120,740	120,384	120,384	122,140	122,140
Wyoming	26,768	26,877	26,877	26,851	26,851
TOTAL	4,288,260	4,367,201	4,367,201	4,448,408	4,448,408

Table 5-8. NO_X emissions (tons/yr) for each case and state

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Alabama	419,234	229,845	224,086	194,697	186,751
Arizona	321,030	166,137	162,417	131,427	123,261
Arkansas	244,131	156,429	152,943	134,335	129,259
California	1,013,990	534,773	534,207	401,302	401,302
Colorado	316,568	193,930	188,903	169,439	160,990
Connecticut	100,231	47,836	45,256	35,480	33,745
Delaware	47,738	22,292	21,481	16,641	16,142
District of Columbia	14,360	6,129	5,797	4,603	3,930
Florida	924,488	415,734	396,122	307,302	278,307
Georgia	648,360	309,555	295,898	232,426	215,596
Idaho	97,617	68,588	66,444	58,280	55,122
Illinois	706,849	374,954	364,591	308,293	291,621
Indiana	578,412	303,868	296,821	253,053	242,065
Iowa	277,985	181,738	178,314	147,307	142,454
Kansas	313,735	187,508	184,433	153,618	149,064
Kentucky	423,640	210,206	205,730	179,350	172,780
Louisiana	547,743	386,244	382,129	313,834	307,329
Maine	73,939	45,873	44,558	38,031	37,127
Maryland	244,074	110,763	106,299	86,801	84,079
Massachusetts	184,511	98,027	94,083	78,391	75,973
Michigan	596,927	322,122	312,688	274,422	260,185
Minnesota	436,436	251,574	245,143	203,733	195,604
Mississippi	264,622	152,848	148,935	128,683	123,054
Missouri	484,132	250,506	242,841	197,412	186,391
Montana	150,854	90,351	88,666	75,197	72,858
Nebraska	232,064	154,028	152,036	114,138	111,001
Nevada	113,273	68,916	66,421	56,506	52,503
New Hampshire	53,845	28,002	26,788	24,553	21,983
New Jersey	279,205	156,200	150,033	126,532	122,477
New Mexico	242,966	214,189	211,475	193,579	189,554
New York	512,170	288,870	278,693	233,250	225,541
North Carolina	470,574	240,195	229,296	189,772	174,568
North Dakota	158,552	109,343	108,580	90,989	89,772
Ohio	780,928	380,073	367,931	308,996	292,899
Oklahoma	422,925	276,827	271,902	246,670	239,147
Oregon	191,065	117,844	114,051	71,781	69,227
Pennsylvania	649,142	382,391	373,752	323,768	318,208
Rhode Island	24,475	13,179	12,437	9,836	9,418
South Carolina	260,234	147,083	142,073	126,278	119,008
South Dakota	72,894	47,905	47,011	36,593	35,209

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Tennessee	453,075	196,382	188,871	151,166	140,425
Texas	1,643,416	1,049,545	1,027,205	915,168	877,443
Utah	217,960	159,486	156,268	142,187	137,588
Vermont	23,019	13,139	12,430	10,261	9,800
Virginia	409,546	233,194	225,015	186,346	171,417
Washington	338,856	195,727	189,118	120,291	115,573
West Virginia	283,713	133,980	132,031	118,343	115,759
Wisconsin	313,623	181,705	176,143	161,856	152,732
Wyoming	245,053	202,613	201,270	185,500	183,713
TOTAL	17,824,174	10,108,647	9,849,620	8,268,417	7,919,951

Table 5-9. $PM_{2.5}$ emissions (tons/yr) for each case and state

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Alabama	108,906	106,546	106,536	105,571	105,391
Arizona	74,270	69,748	69,738	68,653	68,436
Arkansas	108,112	104,947	104,941	104,175	104,073
California	399,796	378,847	378,829	373,435	373,435
Colorado	59,418	58,602	58,625	57,615	57,347
Connecticut	11,334	10,251	10,243	9,806	9,803
Delaware	6,098	4,945	4,943	4,762	4,761
District of Columbia	1,606	1,283	1,282	1,173	1,156
Florida	167,089	140,539	140,509	137,516	136,937
Georgia	167,573	160,387	160,368	158,003	157,632
Idaho	149,633	148,313	148,322	147,911	147,826
Illinois	114,168	103,352	103,280	101,102	100,555
Indiana	111,294	91,698	91,658	91,207	90,845
Iowa	65,220	57,874	57,863	56,419	56,278
Kansas	114,378	110,828	110,820	109,983	109,854
Kentucky	76,841	76,393	76,371	75,463	75,273
Louisiana	148,650	136,251	136,244	132,771	132,630
Maine	13,644	12,574	12,570	12,117	12,116
Maryland	33,292	24,795	24,770	24,009	23,994
Massachusetts	24,024	21,679	21,663	20,663	20,656
Michigan	92,529	89,602	89,545	87,489	86,974
Minnesota	182,166	176,876	176,837	174,485	174,123
Mississippi	67,639	63,514	63,507	62,644	62,521
Missouri	113,722	104,744	104,718	102,905	102,623
Montana	114,123	115,121	115,126	113,412	113,360
Nebraska	54,712	52,061	52,055	50,565	50,466
Nevada	47,003	47,297	47,291	46,785	46,684
New Hampshire	11,396	11,424	11,418	11,329	11,251
New Jersey	32,028	24,540	24,520	23,033	23,023
New Mexico	73,249	73,117	73,111	72,514	72,402
New York	67,804	59,517	59,483	56,787	56,772
North Carolina	131,243	109,172	109,152	107,654	107,324
North Dakota	45,406	47,772	47,767	46,969	46,914
Ohio	130,887	93,624	93,558	91,451	90,922
Oklahoma	119,448	113,347	113,336	112,259	112,075
Oregon	136,821	134,681	134,692	133,082	133,101
Pennsylvania	121,002	73,505	73,474	71,428	71,413
Rhode Island	3,551	3,283	3,280	3,154	3,153
South Carolina	67,530	54,106	54,098	53,836	53,683
South Dakota	34,265	32,640	32,636	32,079	32,023

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Tennessee	70,324	62,282	62,261	60,406	60,155
Texas	304,810	287,235	287,156	280,355	279,426
Utah	42,657	43,349	43,361	42,052	41,932
Vermont	8,798	10,084	10,081	9,934	9,933
Virginia	56,025	51,254	51,225	50,234	49,896
Washington	81,218	74,509	74,529	72,302	72,341
West Virginia	55,146	37,131	37,124	36,655	36,583
Wisconsin	52,086	53,545	53,507	53,172	52,783
Wyoming	88,542	83,455	83,459	82,734	82,690
TOTAL	4,361,473	4,002,642	4,001,882	3,934,060	3,925,542

Table 5-10. PM_{10} emissions (tons/yr) for each case and state

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Alabama	183,182	178,922	178,911	178,468	178,272
Arizona	221,304	216,564	216,553	216,217	215,981
Arkansas	213,094	209,261	209,254	209,464	209,354
California	767,701	746,021	746,001	741,688	741,688
Colorado	167,205	166,169	166,194	166,316	166,024
Connecticut	14,555	13,095	13,085	12,687	12,683
Delaware	8,759	8,981	8,979	8,814	8,813
District of Columbia	2,263	1,917	1,916	1,814	1,796
Florida	293,334	267,282	267,250	266,055	265,425
Georgia	293,557	280,599	280,578	279,207	278,803
Idaho	255,419	253,805	253,814	253,162	253,069
Illinois	360,962	349,384	349,306	349,836	349,241
Indiana	249,264	232,131	232,088	233,654	233,260
Iowa	231,578	223,006	222,994	223,494	223,341
Kansas	431,017	427,337	427,329	429,770	429,630
Kentucky	127,958	127,539	127,514	127,013	126,807
Louisiana	213,933	198,283	198,275	195,160	195,006
Maine	18,899	17,372	17,368	16,930	16,928
Maryland	47,375	37,502	37,474	36,883	36,867
Massachusetts	50,126	47,953	47,935	47,152	47,144
Michigan	183,520	179,905	179,843	178,640	178,081
Minnesota	379,202	370,541	370,499	369,565	369,172
Mississippi	135,088	130,000	129,992	129,689	129,555
Missouri	313,634	301,513	301,485	300,857	300,552
Montana	240,329	242,981	242,987	241,375	241,319
Nebraska	244,975	242,296	242,290	242,488	242,380
Nevada	207,718	208,009	208,002	207,635	207,525
New Hampshire	13,604	13,375	13,369	13,332	13,247
New Jersey	42,034	34,824	34,801	33,564	33,554
New Mexico	499,439	499,598	499,591	499,279	499,157
New York	110,972	100,461	100,425	98,415	98,399
North Carolina	188,502	162,820	162,799	161,721	161,362
North Dakota	184,477	187,463	187,458	188,449	188,389
Ohio	228,328	190,228	190,156	189,335	188,760
Oklahoma	395,287	387,332	387,320	387,718	387,518
Oregon	202,601	200,067	200,080	198,682	198,702
Pennsylvania	155,601	104,914	104,881	103,180	103,163
Rhode Island	4,623	4,348	4,345	4,248	4,246
South Carolina	126,413	110,963	110,955	111,480	111,314
South Dakota	120,429	119,324	119,319	119,870	119,809

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Tennessee	112,667	104,066	104,043	102,637	102,364
Texas	1,214,912	1,197,608	1,197,521	1,195,116	1,194,108
Utah	134,321	134,782	134,795	133,513	133,383
Vermont	11,723	13,032	13,028	12,912	12,912
Virginia	89,603	83,362	83,330	82,778	82,411
Washington	155,262	148,701	148,723	147,304	147,346
West Virginia	71,742	52,483	52,475	52,054	51,975
Wisconsin	125,130	123,545	123,504	124,019	123,597
Wyoming	328,164	316,276	316,281	315,609	315,562
TOTAL	10,371,781	9,967,938	9,967,113	9,939,248	9,929,998

Table 5-11. SO_2 emissions (tons/yr) for each case and state

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Alabama	532,060	120,900	120,556	127,284	127,008
Arizona	95,311	63,737	63,547	65,920	65,743
Arkansas	96,013	53,257	53,084	56,039	55,890
California	63,232	47,581	47,579	49,907	49,907
Colorado	74,021	24,643	24,328	25,224	24,933
Connecticut	20,638	13,765	13,603	14,143	14,013
Delaware	45,503	8,554	8,506	8,286	8,248
District of Columbia	1,685	906	882	898	879
Florida	405,072	102,249	100,910	108,181	107,040
Georgia	698,480	135,516	134,826	132,415	131,818
Idaho	28,009	23,180	23,072	23,168	23,073
Illinois	409,821	187,550	186,932	189,244	188,731
Indiana	815,212	227,783	227,371	237,607	237,259
Iowa	189,267	78,977	78,817	81,301	81,157
Kansas	138,105	48,411	48,244	49,836	49,688
Kentucky	417,969	174,597	174,335	179,587	179,376
Louisiana	252,229	146,547	146,284	138,417	138,188
Maine	24,257	6,038	5,953	6,056	5,987
Maryland	312,223	49,690	49,385	50,476	50,225
Massachusetts	84,476	13,227	12,908	13,390	13,126
Michigan	427,357	200,680	200,117	211,957	211,496
Minnesota	129,765	83,686	83,355	88,071	87,797
Mississippi	95,879	37,150	36,918	38,561	38,366
Missouri	418,246	189,346	188,954	191,943	191,609
Montana	38,639	20,432	20,369	18,784	18,729
Nebraska	77,017	57,286	57,181	58,990	58,894
Nevada	18,667	14,363	14,206	14,387	14,245
New Hampshire	51,031	9,421	9,342	9,791	9,723
New Jersey	61,773	15,013	14,554	14,664	14,279
New Mexico	34,258	25,728	25,580	26,093	25,967
New York	240,983	58,409	57,631	58,321	57,641
North Carolina	440,967	116,993	116,434	116,411	115,949
North Dakota	149,603	32,717	32,676	32,833	32,797
Ohio	1,111,660	206,919	206,273	211,543	211,001
Oklahoma	148,867	75,536	75,257	72,933	72,688
Oregon	31,045	26,354	26,152	13,415	13,244
Pennsylvania	1,102,035	189,787	189,263	200,627	200,180
Rhode Island	4,576	3,727	3,674	3,733	3,689
South Carolina	217,175	66,623	66,343	67,591	67,357
South Dakota	13,097	14,981	14,932	15,638	15,595

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Tennessee	297,935	63,903	63,502	64,567	64,236
Texas	651,329	236,570	235,013	207,330	205,952
Utah	35,663	28,388	28,232	26,626	26,490
Vermont	4,173	2,346	2,292	2,426	2,379
Virginia	258,286	72,522	72,082	74,142	73,757
Washington	36,638	16,137	15,781	16,421	16,106
West Virginia	422,049	85,518	85,418	91,986	91,910
Wisconsin	207,922	53,394	53,044	60,050	59,760
Wyoming	115,330	51,648	51,596	49,837	49,794
TOTAL	11,545,544	3,582,687	3,567,299	3,617,050	3,603,918

Table 5-12. VOC emissions (tons/yr) for each case and state

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Alabama	394,478	312,021	311,865	295,361	290,621
Arizona	299,405	226,453	229,150	219,068	212,501
Arkansas	367,862	314,065	313,618	301,947	299,537
California	1,493,672	1,203,729	1,214,353	1,155,135	1,151,387
Colorado	359,741	265,489	265,909	259,229	254,687
Connecticut	91,124	56,030	55,574	49,410	49,018
Delaware	30,272	19,775	19,737	17,633	17,506
District of Columbia	11,564	7,841	7,783	7,516	7,224
Florida	970,251	685,446	685,391	630,355	610,660
Georgia	731,394	580,549	578,596	541,521	532,475
Idaho	491,700	465,738	465,639	458,300	456,974
Illinois	490,297	358,934	357,262	340,282	332,759
Indiana	348,813	264,712	263,731	247,129	241,765
Iowa	189,536	142,561	141,889	132,241	130,142
Kansas	238,892	199,124	198,562	189,268	186,925
Kentucky	284,125	224,140	223,611	210,998	207,531
Louisiana	502,713	427,256	427,040	406,847	402,894
Maine	80,956	56,005	55,813	48,750	48,542
Maryland	172,580	111,856	111,432	101,205	100,363
Massachusetts	180,220	128,399	127,673	118,733	117,986
Michigan	565,194	398,966	397,029	357,995	351,667
Minnesota	622,926	515,939	514,442	481,519	477,844
Mississippi	267,564	213,246	213,264	199,541	196,050
Missouri	423,126	323,326	322,071	302,292	297,093
Montana	293,547	276,893	276,801	272,858	272,065
Nebraska	105,934	82,394	81,972	75,541	74,071
Nevada	152,771	132,532	134,495	132,199	129,597
New Hampshire	57,530	39,034	38,770	35,049	33,985
New Jersey	261,426	177,994	177,196	164,288	163,145
New Mexico	311,387	280,189	280,751	273,093	271,173
New York	535,040	337,635	336,195	307,325	305,271
North Carolina	620,323	474,236	473,183	440,230	432,671
North Dakota	64,768	52,510	52,365	49,120	48,609
Ohio	479,576	317,531	315,292	283,813	276,248
Oklahoma	512,690	450,517	449,649	435,508	431,452
Oregon	435,314	387,230	386,735	367,051	366,503
Pennsylvania	455,475	336,441	337,248	312,623	311,092
Rhode Island	27,159	18,437	18,318	16,762	16,627
South Carolina	292,949	220,191	219,953	205,620	201,702
South Dakota	81,613	70,455	70,331	67,162	66,511

State	2007rg	2018rg_ref	2018rg_ctl	2030rg_ref	2030rg_ctl
Tennessee	354,294	256,459	255,849	235,103	229,819
Texas	2,414,946	2,158,320	2,155,608	2,108,224	2,083,716
Utah	297,616	287,999	288,306	279,249	276,992
Vermont	30,384	22,924	22,977	20,511	20,367
Virginia	360,687	265,016	264,007	247,344	240,525
Washington	353,447	277,515	276,658	239,200	238,165
West Virginia	117,626	88,643	88,413	82,210	81,028
Wisconsin	337,259	241,006	240,083	222,276	217,957
Wyoming	251,477	260,241	260,208	256,390	255,740
TOTAL	18,813,646	15,013,942	15,002,796	14,201,023	14,019,183

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United States Environmental Protection Agency	Office of Air Quality Planning and Standards Air Quality Assessment Division Research Triangle Park, NC	Publication No. EPA-454/R-14-003 February, 2014