Technical Support Document (TSD)

Preparation of Emissions Inventories for the Version 5.0, 2007 Emissions Modeling Platform

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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 (2010b) -- 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

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1 Introduction

The U.S. Environmental Protection Agency (EPA) developed a year 2007, 2008-NEIv2-based air quality modeling platform. The air quality modeling platform consists of all the emissions inventories and input ancillary files, along with the meteorological, initial condition, and boundary condition files needed to run the air quality model. This platform uses all Criteria Air Pollutants (CAPs) and the following select Hazardous Air Pollutants (HAPs): chlorine (Cl), hydrogen chloride (HCl), benzene, acetaldehyde, formaldehyde and methanol. The latter four HAPs are also denoted BAFM. This platform is called the "CAP-BAFM 2007-Based Platform, Version 5" platform because it is primarily a CAP platform with BAFM included. "Version 5" denotes the evolution from the 2005-based platform, version 4, with substantial improvements using newer data and methods. Many emissions inventory components of this "2007v5" air quality modeling platform are based on the Version 2 of the 2008 National Emissions Inventory, hereafter referred to as the "2008 NEI". This document describes only the emissions modeling component of the 2007 platform, which includes the emission inventories and the ancillary data and approaches used to transform inventories for use in air quality modeling. This document is available from the Emissions Modeling Clearinghouse website, http://www.epa.gov/ttn/chief/emch/, under the section entitled "CAP-BAFM 2007-Based Platform, Version 5".

From this point on, we refer to this emissions modeling platform as simply the "2007 platform" or "2007v5". Later updates to the 2007 platform will include a version qualifier such as "2007 Platform V5.1" and so on. The first use of the 2007 platform is for the Regulatory Impact Assessment of the 2012 Final National Ambient Air Quality Standards (NAAQS) for particulate matter less than 2.5 microns ($PM_{2.5}$), hereafter referred to as the "PM NAAQS". The air quality model used for the PM NAAQS is the Community Multiscale Air Quality (CMAQ) model (http://www.epa.gov/AMD/CMAQ/), version 4.7.1. 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 ($PM_{2.5}$). In addition, 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 BAFM and includes anthropogenic HAP emissions of HCl and Cl. Applications of the 2007v5 platform to-date have used CMAQ v4.7.1. EPA is currently evaluating the 2007 platform with CMAQ v5.0. The platform's emissions processing methods develop emissions that can be used with either CMAQ v4.7.1 or CMAQ v5.0, since extra species are created that are needed by CMAQ v5.0, but that earlier versions of CMAQ can ignore.

The emissions and modeling effort for the 2007 platform consists of three 'complete' emissions cases: 2007 base case, 2007 evaluation case and the 2020 base 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 baseline, control and sensitivity cases for the 2012 PM NAAQS. For regulatory applications, the 2007 base case is used with the outputs from the 2020 base case in the relative response factor (RRF) calculations to identify future areas of nonattainment. For more information on the use of RRFs, please see the PM NAAQS Air Quality Modeling Final Rule TSD. More information on the use of RRFs and air quality modeling for the PM NAAQS are provided in the Final PM NAAQS Regulatory Impact Analysis.

Table 1-1. List of base cases run in the 2007 (Version 5) Emissions Modeling Platform

Case Name	Internal EPA Abbreviation	Description
2007 base case	2007re_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 2020 scenario(s).
2007 evaluation case	2007ee_v5	2007 case created for air quality model performance evaluation that uses actual 2007 continuous emissions monitoring (CEM) data for EGUs and actual wild and prescribed fire data.
2020 base case	2020re_v5	2020 "base case" scenario, representing the best estimate for the future year without implementation of controls needed to attain current $PM_{2.5}$ annual and 24-hour (35 ppm and 15 ppm respectively) and Ozone 8-hour (75 ppb) standards.

There are a couple of differences between the 2007 evaluation and 2007 base cases. The evaluation case uses 2007-specific wildfires and prescribed burning emissions and 2007 hour-specific continuous emissions monitoring (CEM) data for electric generating units (EGUs). The 2007 base case uses an "average year" scenario for wildfires and a spatially and temporally-smoothed year 2008 prescribed burning emissions. Discussed in Section 2.3.2, the recently-developed Fire Averaging Tool (FAT), was used to create the average year day-specific county-level wildfires and prescribed burning inventory. For EGUs, the base case uses an illustrative (rather than year-specific) temporal allocation approach for EGUs to allocate annual 2007 emissions to days and hours. This approach to temporal allocation of EGU emissions is described in Section 3.3.2 and is used for both the 2007 base and 2020 base cases to provide temporal consistency between the years. It is intended to be a conceivable representation of temporal allocation of the emissions without tying the approach to a single year. For example, each year has different days and different locations with large fires, unplanned EGU shutdowns, and periods of high electricity demand. By using a base-case approach such as the one used here in the 2007 base case, the temporal and spatial aspects of the inventory for these sources are maintained into the future-year modeling. This avoids potentially spurious year-specific artifacts in the air quality modeling estimates.

This base case EGU temporalization, and many other components in the 2007 platform, are following similar methodological techniques as the latest (Version 4.2) 2005-based platform: http://www.epa.gov/ttn/chief/emch/index.html#final. We will not refer to the 2005 platform TSDs in this TSD but much of what we describe in this TSD will be similar; we repeat the documentation of unchanged components here.

The underlying 2007 inventories used are most significantly defined by: 1) for point and nonpoint sources: the 2008 NEI, 2) for onroad mobile sources: year 2007 Motor Vehicle Emissions Simulator with database corrections for diesel toxics (MOVES2010b) (http://www.epa.gov/otaq/models/moves/index.htm), 3) for nonroad mobile sources: year 2007 National Mobile Inventory Model (NMIM) EPA-estimated emissions, and 4) numerous year 2007 stationary non-EGU sources from regional planning organizations (RPOs).

The primary emissions modeling tool used to create the air quality model-ready emissions was the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system (http://www.smoke-model.org/index.cfm). We used SMOKE version 3.1 beta to create emissions files for a 12-km national grid.

This document contains five sections and several appendices. Section 2 describes the 2007 inventories input to SMOKE for both the evaluation case and base case. Section 3 describes the emissions modeling and the ancillary files used with the emission inventories. Section 4, describes the development of the 2020 inventory (projected from 2007). Data summaries comparing the 2007 base case and 2020 base case are provided in Section 5. Section 6 provides references. The Appendices provide additional details about specific technical methods.

Electronic copies of the data used with SMOKE for the 2007 Platform are available from the Emissions Modeling Clearinghouse website, http://www.epa.gov/ttn/chief/emch/.

2 2007 Emission Inventories and Approaches

This section describes the 2007 emissions data created for input to SMOKE that is part of the 2007 platform; year 2020 emissions data development is discussed in Section 4. The starting point for the 2007 stationary source emission inputs is the 2008 National Emission Inventory, version 2 (2008 NEI).

There are many similarities between the 2008 NEI version 2 approaches and past versions of the NEI -2008, 2005 and earlier. The 2008 NEI version 2 draft Technical Support Document is available at 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 a voluntary component. New for the 2008 NEI is the use of the Emissions Inventory System (EIS) to compile the NEI. The EIS includes hundreds of automated QA checks to help improve data quality, and also supports release point (stack) coordinates separately from facility coordinates. Improved EPA collaboration with S/L/T agencies prevented duplication between point and nonpoint source categories such as industrial boilers. For onroad mobile sources, the 2008 NEI used the MOVES model for the first time, where emissions were computed based on hourly meteorology rather than monthly averages used in the MOBILE6 (http://www.epa.gov/oms/m6.htm) model that was used to develop 2008 NEI version 1 and prior years of the NEI.

For fires, EPA used the SMARTFIRE2 (SF2) system for the first time in 2008 NEI. SF2 was the first system to assign all fires as either prescribed burning or wildfire categories and includes improved emission factor estimates for prescribed burning.

As reflected in the 2008 NEI Technical Support Document, in general, NO_X, SO_2, VOC and PM emissions decrease from values in the 2005 NEI, with a couple of notable exceptions: 1) increased onroad NO_X and PM associated with the change to the MOVES model, 2) increased NO_X from metals processing and petroleum and related industries, 3) increased PM from agricultural tilling and paved road dust, and 4) increased agricultural NH_3 from livestock and fertilizer application.

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 Technical Support Document generally uses 60 sectors to further describe the emissions. In addition to the NEI data, 2007 biogenic emissions, emissions from the Canadian and Mexican inventories, and numerous other non-NEI data are included in the 2007 platform. As we explain below, the non-NEI emissions component to the 2007 platform reflects primarily year-2007 onroad mobile and nonroad mobile emissions, a computed average fires inventory and data received from some regional planning organizations (RPOs).

The RPOs focused on addressing visibility impairment from a regional perspective and we relied on a few of these RPOs to obtain year 2007 inventories to improve the 2007 platform over the 2008 NEI inventories. A map of these RPOs can be found here: http://www.epa.gov/visibility/regional.html. The RPOs that were most involved in providing data are listed here:

- 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/

Virginia year 2007 inventories were provided from both MARAMA and SESARM. Analyses of the RPO emissions data and conversations with RPOs indicated that MARAMA inventories were preferable to SESARM inventories in Virginia for most source categories with the exception of Residential Wood Combustion (RWC), in which case, we used SESARM RWC emissions.

For the purposes of preparing the air quality model-ready emissions, we split the 2007 emissions inventory into "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 then combines the sector-specific gridded, speciated and 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. As discussed in greater detail in Table 2-2, the emissions in many of these sectors were significantly modified for the 2007 platform. 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. We did not use all sectors for all modeling cases. In particular, the ptfire sector is only used in the 2007 evaluation case; conversely, the avefire sector is only used in the 2007 and 2020 base cases.

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 mapped to the Integrated Planning Model (IPM) model using the National Electric Energy Database System (NEEDS) version 4.10. Hourly emissions replaced with 2007 CEM values of NO_X and SO_2 for 2007 evaluation case only. Other pollutants are scaled from 2008 NEI using heat input. For 2007 and 2020 base cases, year-2007 CEM data total daily emissions created for input into SMOKE. Non-CEM sources are 2008 NEI for all cases. 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. This sector is processed separately to allow for the application of a land use based transport fraction and precipitation zero-out.
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.

Platform Sector: ***abbreviation***	**2008NEI Sector**	**Description and resolution of the data input to SMOKE**
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", usually 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, evaporative, permeation, and brake and tire wear. For all states except California, based on monthly Motor Vehicle Emissions Simulator (MOVES) emissions tables. For California, based on Emission Factor (EMFAC).
Onroad non-refueling: ***onroad_rfl***	Mobile: onroad	Onroad mobile gasoline and diesel vehicle refueling emissions for all states. Based on monthly MOVES emissions tables.
Point source fires: ***ptfire***	Fires	Point source day-specific wildfires and prescribed fires for 2007. This sector used only for the 2007 evaluation case.
Average-fire: ***avefire***	N/A	Average-year wildfire and prescribed fire emissions, county and daily resolution. This sector is used in the 2007 base and 2020 base cases, but not for the 2007 evaluation case.
Other point sources not from the NEI: ***othpt***	N/A	Point sources from Canada's 2006 inventory and Mexico's Phase III 2008 inventory, annual resolution. Mexico's inventory is grown from year 1999. Also includes annual U.S. offshore oil 2008 NEI point source emissions.
Other non-NEI nonpoint and nonroad: ***othar***	N/A	Annual year 2006 Canada (province resolution) and year 2008 (grown from 1999) Mexico Phase III (municipio resolution) nonpoint and nonroad mobile inventories.
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 2007 emissions platform and the 2008 NEI. Every modeling sector is different from the 2008 NEI to some degree. For some sectors, such as ptnonipm (non-EGU point), these changes are very minor and local. In contrast, other sectors such as nonroad mobile are either completely replaced (2007 NMIM versus 2008 NEI) or have significant and detailed edits based on review of available alternative data. The specific by-sector updates to the 2007 platform are described in greater detail later in this section under each by-sector subsection. Figure 2-1 shows how the 2007 platform relates to the underlying 2008 NEI.

The emission inventories in SMOKE input format for the 2007 base case are available at the Emissions Modeling Clearinghouse website http://www.epa.gov/ttn/chief/emch/index.html. The inventories "readme" file indicates the particular zipped files associated with each platform sector.

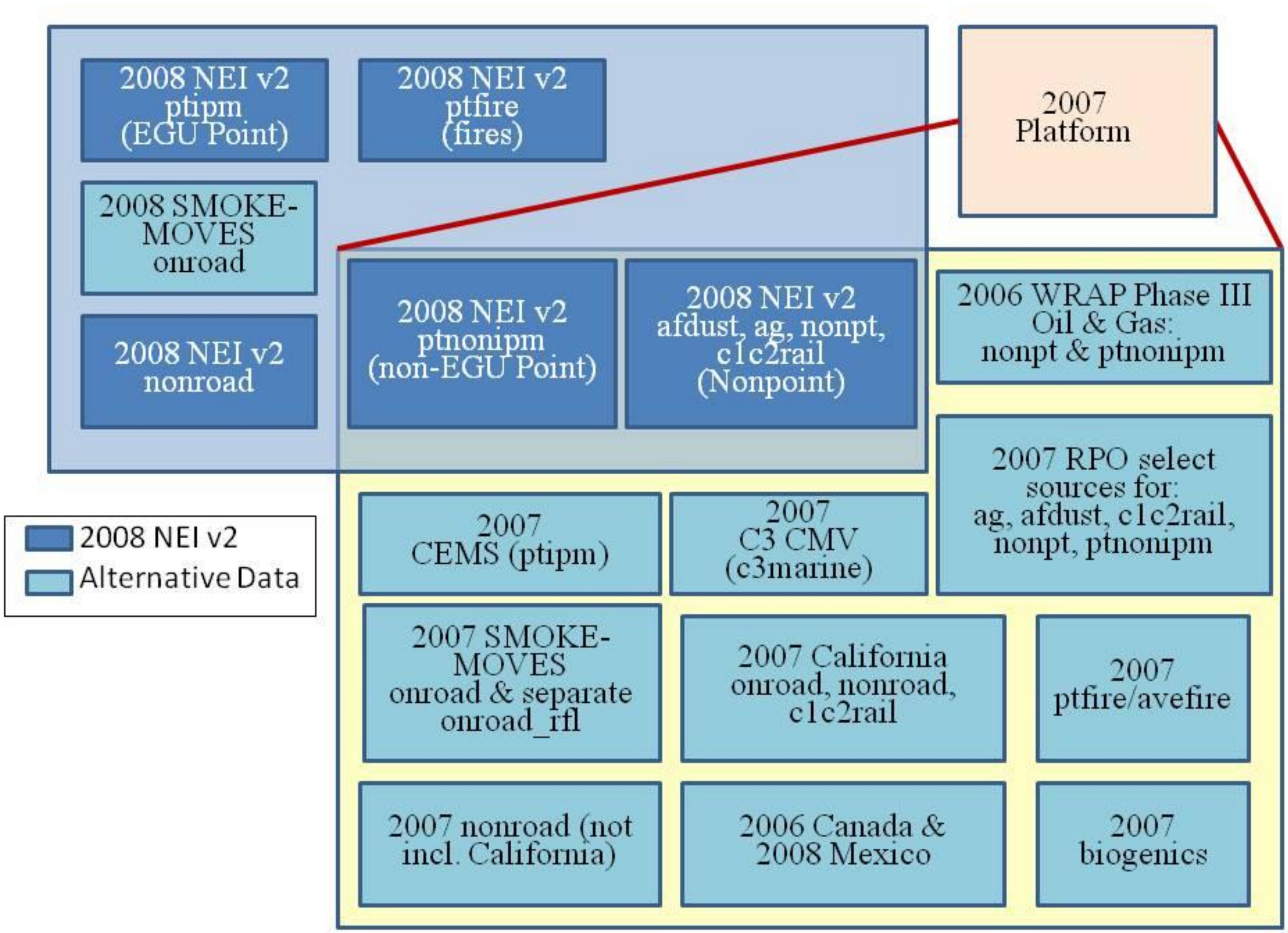
The remainder of Section 2 provides details about the data contained in each of the 2007 platform sectors. Different levels of detail are provided for different sectors depending on the availability of reference information for the data, the degree of changes or manipulation of the data needed to prepare it for input to SMOKE, and whether the 2007 platform emissions are significantly different from the 2008 NEI.

Table 2-2. Summary of significant changes between 2007 platform and 2008 NEI by sector

Platform Sector	Summary of Significant Inventory Differences of 2007 Platform vs. 2008 NEI
IPM sector: ***ptipm***	1) Replaced all NO_X and SO_2 emissions with 2007 CEM data that were confirmed to be for the entire year. Other pollutants for these CEM units were scaled from 2008 NEI values based on 2008 and 2007 heat input ratios. 2) Emission release point type and missing or invalid stack parameters corrected for several units based on analyses of significant emitters and comparison to 2005 NEI. 3) Added or changed ORIS Boiler IDs to some units with missing or incorrect values, and for a subset of these, recomputed annual emissions of NO_X, SO_2 or both using 2007 CEM data. Only replaced emissions if 2007 CEM data were confirmed to be for the entire year (since some CEMs only run for the summer season). 4) Moved several stacks and units from the ptnonipm sector, assigning ORIS facility and boiler codes and matching stack parameters to those provided in the future-year IPM emissions. These edits ensure future-year EGUs are not double counted and that base year and future-year stack parameters are similar. 5) Deleted units from the inventory that were found to be either double counts, closed or not operational in 2007.
Non-IPM sector: ***ptnonipm***	1) Moved several sources to the ptipm sector. This edit prevents double counting of EGU emissions in the future years. 2) Removed onroad refueling for the handful of states that included them; refueling sources are processed consistently nation-wide in the onroad_rfl sector. 3) Moved a large California PM source to the afdust sector to allow for transport factor and meteorology-based reductions. 4) Deleted several units from the inventory that were found to be either double counts or closed. 5) Corrected miscellaneous SCCs in New Jersey with appropriate values. 6) Updated missing or invalid stack parameters. 7) Replaced oil and gas emissions with Western Regional Air Partnership (WRAP) Phase III year 2006 emissions in select oil and gas basins. 8) Included plants submitted by Utah and Virginia missing in 2008 NEI 9) Included 2005 South Dakota emissions –not submitted in the 2008 NEI. 10) Included 2008 ethanol plant facilities from EPA's Office of Transportation and Air Quality (OTAQ) that were not already in the 2008 NEI.
Agricultural: ***ag***	1) Corrected one New Mexico significant overestimate in NEI. 2) Replaced emissions with monthly-resolution 2007 estimates for states in the MWRPO.
Area fugitive dust: ***afdust***	1) Added a large California PM source from the NEI point inventory. 2) Replaced some emissions with year-2007 estimates for states in 3 RPOs. 3) These emissions are adjusted to reflect land use (transport) and meteorological effects that significantly reduce PM emissions input to the air quality model. These adjusted emissions are known as the afdust_adj emissions.

Platform Sector	Summary of Significant Inventory Differences of 2007 Platform vs. 2008 NEI
Remaining nonpoint sector: ***nonpt***	1) Area fugitive dust, agricultural NH_3 and c1c2rail sources separated out for processing in different sectors. 2) C3marine removed –see c3marine description. 3) Replaced agricultural fires with daily inventory (aggregated to monthly) from the SMARTFIRE tool. 4) Replaced oil and gas emissions with WRAP Phase III year 2006 emissions in select oil and gas basins. 5) Apparent double-counting of EPA and state estimates removed 6) Removed onroad refueling; these are now processed consistently nation-wide in the onroad_rfl sector. 7) Applied reductions to RWC outdoor hydronic heaters (OHH) based on analysis of methodology used to create OHH in NEI. 8) Replaced a portion of RWC for states in 3 RPOs with 2007 data. 9) Replaced open burning emissions in select states with RPO 2007 data.
Class 1 & 2 CMV and locomotives: ***c1c2rail***	1) Removed rail yard emissions for counties that reported them in the point inventory to remove duplicates. 2) Replaced Texas-reported (NEI) rail emissions with EPA estimates. 3) Replaced all emissions with year-2007 estimates for states in 3 RPOs. 4) Replaced California estimates with year-2007 CARB estimates.
C3 commercial marine: ***c3marine***	Not NEI-based, but rather year-2007 as projected from 2002 from the ECA-IMO project with the following modifications: 1) Canada defined as part of the ECA rather than an "outside the ECA" region, using region-specific growth rates. For example, British Columbia emissions were projected the same as "North Pacific" growth and control used in Washington state. 2) Updated Delaware emissions with data provided by Delaware in Cross-State Air Pollution Rule (CSAPR) comments. 3) Redefined the spatial extent of state boundaries off-shore from up to 200 nautical miles to under 10 miles based on Mineral Management Service (MMS) state-federal water boundaries data. This item did not change emissions but it drastically reduces areas that are assigned to states.
Nonroad sector: ***nonroad***	1) Non-California: replaced with 2007 NMIM monthly data. 2) California: replaced with annual 2007 CARB data apportioned to months using 2007 NMIM.
Onroad non-refueling: ***onroad***	1) For all states except California: Year 2007 emissions for all pollutants and modes (exhaust, tire and brake wear) from all vehicle types are based on MOVES2010b monthly emission factor tables. Processed with 2007 meteorology using new SMOKE-MOVES routine (discussed later). 2) For California: merged in year-2007 CARB data to post-adjust SMOKE-MOVES data via county/pollutant ratios.
Onroad non-refueling: ***onroad_rfl***	For all states including California: Year 2007 emissions for all pollutants and modes (exhaust, tire and brake wear) from all vehicle types are based on MOVES2010b monthly emission factor tables. Processed with 2007 meteorology using new SMOKE-MOVES routine (discussed later). Replaces all NEI point (ptnonipm) and nonpoint (nonpt) data.
Point source fires: ***ptfire***	Used year-2007 SMARTFIRE (V1)-based emissions

Figure 2-1. Emissions Components of the 2007 Platform



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, we 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), and Cl (code = 7782505). We did not utilize BAFM from these sectors because we chose to speciate VOC without any use (i.e., integration) of VOC HAP pollutants from the inventory (VOC integration is discussed in detail in Section 3.2.1.1).

The ptnonipm emissions were provided to SMOKE as annual emissions. The ptipm emissions used in 2007 were different for the model evaluation case and for the base case. First, annual NO_X and SO_2 emissions for units that match CEM data were replaced with year 2007 CEM data so that there were no changes in total emissions of CEM pollutants in the base and evaluation cases. Next, annual emissions for other pollutants at CEM-matched units were scaled to year 2007 using CEMs heat input ratios between year 2008 and year 2007.

For the model evaluation case, those ptipm sources with CEM data (that we could match to the NEI) used year 2007 hourly NO_X and SO_2 emissions and for all other pollutants annual emissions were adjusted via 2007-2008 heat input ratios. The hourly data also contained heat input, which was used to allocate the annual emissions to hourly values. For the non-CEM sources, we created daily emissions using an approach described in Section 2.1.1, and we applied state-specific diurnal profiles to create hourly emissions. For the 2007 base case, all sources (both CEM and non-CEM) used the daily emissions and diurnal profiles approach

There are several changes made to the ptipm and ptnonipm sectors from the 2008 NEI for the 2007 platform that were briefly discussed in Table 2-2. One of these changes involved splitting the stacks, units and facilities into the ptnonipm and ptipm sectors. Sources were placed in the ptipm sector when it was determined that these sources were reflected in the future-year IPM output data. These changes and other updates in the ptipm and ptnonipm sectors for the 2007 platform are discussed in the following sections.

2.1.1 IPM sector (ptipm)

The ptipm sector contains emissions from EGUs in the 2008 NEI point inventory that we were able match to the units found in the year 2007 NEEDS database. We used a May 2012 version 4.10 of NEEDS to split out the ptipm sector for the 2007 platform: (http://www.epa.gov/airmarkets/progsregs/epa-ipm/BaseCasev410.html#needs). The IPM provides future-year emission inventories for the universe of EGUs contained in the NEEDS database. As described below, 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 2008 NEI point source inventory contains emissions estimates for both EGU and non-EGU sources. IPM is used to predict the future year emissions for the EGU sources. The remaining non-EGU point sources are projected by applying projection and control factors to the base year emissions. It was therefore necessary to identify and separate into two sectors: (1) all sources that are projected via the IPM and (2) those that are not. While CEM-matched units use year 2007 emissions for NO_X and SO_2, those sources not matched to CEMs use the 2008 NEI EGU emissions as-is. In addition, all stack parameters, coordinates and SCCs use values from the 2008 NEI. The SCC value may be important if a source changed fuel types between year 2007 and 2008 because speciation of inventory VOC and $PM_{2.5}$ might differ, but these potential differences were not accounted for in this version of the platform.

The 2008 NEI point inventory includes EGU ORIS facility IDs and EPA's Clean Air Markets Division (CAMD) Boiler IDs for most EGUs. However, many smaller emitter's in CAMD's hourly CEM programs are not identified with ORIS facility or boiler IDs in the NEI due to uncertainties in source identification and inconsistencies in the way a unit is defined between the NEI and CAMD datasets. In addition, the NEEDS database includes a larger universe of many smaller emitting EGUs, which are not included in the CAMD hourly CEM programs.

Methodology to split the EGU from non-EGU sources

Several analytical steps were performed to better link the NEEDS units to the NEI sources that might potentially be IPM/NEEDS units. The steps described in the 2008 NEI document only detail how IPM and non-IPM sources were assigned and estimates in the year 2008 inventory. Next we discuss the steps needed to refine the ptipm/ptnonipm splits and emissions for the 2007 platform.

Ptipm updates from the 2008 NEI used in creating the 2007 platform

- We started with the ptipm/ptnonipm split as determined by the value of the SMOKE input file variable "IPM_YN", which is determined based on the EIS alternative facility identifier. The SMOKE input was exported from EIS into the SMOKE Flat File 10 (FF10) format described here: http://www.smoke-model.org/version3.1/html/ch08s02s10.html#d0e44497. Some IPM_YN values in the SMOKE input file were updated based on units that had previously been matched to IPM units in past modeling platforms, but for which the alternative facility IDs in EIS did not yet include a code for IPM matching.
- For NEI units that matched NEEDS units, we recomputed annual emissions for SO_2 and NO_X using the year 2007 CEMS data available at the EPA's data and maps website: http://camddataandmaps.epa.gov/gdm/index.cfm?fuseaction=emissions.wizard. For other pollutants at these matched units, we scaled 2008 NEI emissions based on the ratio of 2007 to 2008 heat inputs (i.e., 2007 emissions = 2008 emissions × 2007 annual CEM heat input / 2008 annual CEM heat input).
- Based on NEI and NEEDS analyses we: 1) removed duplicate emissions for the SIGECO facility in Indiana (FIPS=18173, facility ID=8183011), 2) reassigned units as EGU (ptipm) from the non-EGU (ptnonipm) sector, and 3) manually inserted new inventory EGU records for units that existed in the 2007 CEM data but not in the 2008 NEI. The 3rd item listed here made sense in retrospect because of the temporary and permanent unit closures between 2007 and 2008 due to regulations and the recession. The importance of reclassifying sources as ptipm versus ptnonipm is that it prevents

potential double-counting of future year EGU emissions because these ptipm emissions are replaced by the IPM inventory in future years while ptnonipm emissions are projected from the platform sector.

- Reassigned New Jersey SCCs from 39999999 (miscellaneous) to more-specific values based on inventory processes from a 2008 state inventory provided by New Jersey. This fix impacts only two NJ stacks at "North Jersey Energy Assoc": FIPS=34023, facility ID=6719711 and process IDs = 19650514 and 19650814.
- We updated stack parameters for some units with missing or invalid parameter assignments in the annual inventory. In addition, the emissions release point type flag (SMOKE variable ERPTYPE) was analyzed for all stacks with any CAP or HAP exceeding 1,000 tons. We found numerous EGU and non-EGU stacks with an ERPTYPE value indicating a fugitive release (ERPTYPE="1"). These stacks were reassigned as vertical stacks (ERPTYPE="2") and assigned sensible stack parameters from the 2005 NEI when the 2008NEIv2 parameters were invalid or missing.

Creation of temporally resolved emissions for the ptipm sector

Another reason we separated the ptipm sources from the other sources was due to the difference in the temporal resolution of the data input to SMOKE. For the year 2007 evaluation case, hourly CEM NO_X and SO_2 data are directly used for sources that match the CEM data. For other pollutants, hourly CEM heat input data are used to allocate the NEI annual values. For sources not matching CEM data ("non-CEM" sources), we computed daily emissions from the NEI annual emissions using state-average CEM data. See Section 3.3.2 for more details on the temporalization approach. For the future-year scenarios, there are no CEM data available for specific units. Therefore, to keep the base and future year cases consistent, we use the same procedures as for the "non-CEM" sources to compute daily emissions for the 2007 base case and future year ptipm sources.

2.1.2 Non-IPM sector (ptnonipm)

With several notable exceptions, the non-IPM (ptnonipm) sector contains the remaining 2008 NEI point sources that we did not include 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.

The ptnonipm sector contains a very small amount of fugitive dust PM emissions from vehicular traffic on paved or unpaved roads at industrial facilities or coal handling at coal mines. In previous versions of the platform, we would reduce these emissions prior to input to SMOKE. However, in the 2007 platform we do not make this reduction because of a new methodology used to reduce PM dust. This is discussed further in Section 2.2.1.

There are numerous modifications between the published 2008 NEI and the 2007 ptnonipm inventory we used for modeling. More details on some of these items will follow; however, these 2007 platform modifications are summarized here:

Ptnonipm updates from the 2008 NEI used in creating the 2007 platform

- Removed sources with state/county FIPS code ending with "777". These sources represent mobile (temporary) asphalt plants that are only reported for some states, and are generally in a fixed location for only a part of the year and are therefore difficult to allocate to certain days for modeling, and would not be expected to in the same location(s) in any future year projection.

- Reassigned FIPS code for "Lane Construction Corp" facility ID=7945311 from 23009 to 23027.
- Reassigned New Jersey SCCs from 39999999 (miscellaneous) to more-specific values based on inventory processes from a 2008 inventory provided by New Jersey.
- Moved PM emissions at three California (FIPS=06071) stacks from "US Army National Training Center" facility ID=706411 to the area fugitive dust sector (afdust sector discussed in Section 2.2.1) and reassigning SCC from 20200905 (kerosene combustion) to unpaved road dust (2296000000). These emissions aggregate to 2,072 tons of $PM_{2.5}$.
- Removed all offshore oil records as reflected by FIPS=85000. These sources are processed in the othpt sector and discussed in Section 2.6.
- Added South Dakota non-EGU emissions from the 2005 NEI. South Dakota did not submit emissions for the 2008 NEI.
- Added 2008 ethanol facilities provided by EPA's OTAQ that were not already included in the 2008 NEI.
- Removed oil and gas emissions for counties that are included in the WRAP Phase III inventories: http://www.wrapair2.org/PhaseIII.aspx.
- Removed onroad refueling emissions. As discussed in Section 2.5.2, these emissions are now provided by OTAQ's MOVES model and processed in the onroad_rfl sector.
- Added the "Meadwestvaco Packaging" facility in Virginia (FIPS=51580) for year 2007 that was missing in the 2008 NEI.
- Added HAP emissions (HCl and Chlorine) for the "US Magnesium LLC: Rowley Plant" in Utah (FIPS=49045) that was inadvertently dropped from the 2008 NEI.
- Corrected stack parameters for some units with missing or invalid parameter assignments.
- As discussed in Section 2.1.1, several sources in the 2008 ptnonipm inventory were found to be EGU emissions. Therefore, we reassigned these known EGU emissions to the ptipm sector.

<u>Reassigning New Jersey SCCs</u>
It was found that 569 stacks (process IDs) in New Jersey were accidentally assigned as "…Miscellaneous Industrial Processes" with an SCC=39999999 in the 2008 NEI. Of these incorrect SCC assignments, only two are for EGUs (discussed in Section 2.1.1) and the remaining SCCs are non-EGUs. The correct SCCs were included in the earlier draft version (1.7) of the 2008 NEI based on a prior submission of data from New Jersey. These correct SCCs were (re)-applied to the (v2) 2008 NEI by inventory process ID (stack).

<u>South Dakota non-EGU emissions</u>
As noted in the 2008 NEI documentation (EPA, 2012a), South Dakota did not provide point source emissions. Therefore we included South Dakota emissions from the last working version (4.2) of the 2005 platform. These emissions are included in the 2007v5 website as a separate FF10-format inventory for HAPs and CAPs.

<u>Ethanol facilities from OTAQ</u>
We added a subset of the ethanol facilities that EPA's OTAQ provided for year 2008. Several of the OTAQ facilities were already included in the 2008 NEI, and the OTAQ duplicates were removed prior to including in the 2007 platform. Locations and FIPS codes for these ethanol plants were verified using web searches and Google Earth. These emissions are included in the 2007v5 website as a separate FF10-format inventory for HAPs and CAPs.

The inventory estimates provided by OTAQ were all for corn ethanol plants. Emission rates were obtained from EPA's spreadsheet model for upstream impacts developed for the Renewable Fuel Standard (RFS2) rule (EPA, 2010a). 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 VOC emission rates in Table 2-3. For air toxics except 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 and 2020 (via 2017 emission factors) based on analyses done for the industry characterization described in Chapter 1 of the RFS2 final rule regulatory impact analysis.

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

<u>WRAP Phase III oil and gas emissions</u>

The Western Regional Air Partnership (WRAP) RPO created year 2006 "Phase III" oil and gas sector point and non-point format emissions for several major basins in Colorado and Montana, New Mexico, Utah and Wyoming. These basins are listed here: Denver-Julesburg, Uinta, San Juan (North and South), Piceance, Southwest Wyoming (Green River), Powder River and Wind River. A map showing the geographic area of these basins is provided at: http://www.wrapair.org/forums/ogwg/documents/2008-08_Phase_III_O&G_Basin_Map_&_Source_List.pdf

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, we removed all oil and gas emissions from the 2008 NEI for counties that comprise the 7 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.

Onroad refueling emissions

Most onroad refueling emissions in the 2008 NEI are in the nonpoint sector; however a few states included (some) gas station point inventory estimates for onroad refueling. These NEI emissions (point and nonpoint) include VOC and some HAPs and were removed from the ptnonipm sector. These onroad refueling emissions are now replaced with county-month emission factor estimates from the Motor Vehicle Emissions Simulator (MOVES2010b) model: http://www.epa.gov/otaq/models/moves/index.htm. These onroad refueling emissions are processed as a new platform sector "onroad_rfl", described in detail in Section 2.5.2.

Corrected stack parameters

Stacks parameters in the 2008 NEI were analyzed for missing or invalid values. A list of stacks with invalid parameters was developed and alternative values were substituted based on available data from the 2005 NEI or EIS queries. In addition, similar to the ptipm inventory discussed earlier, emissions release point type flag corrections and stack parameters reassignments were made to the ptnonipm sector.

2.2 2007 nonpoint sources (afdust, ag, nonpt)

The 2007 platform nonpoint sectors use the 2008 NEI as a starting point. We 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.

We removed the nonpoint tribal-submitted emissions to prevent possible double counting with the county-level emissions and also because we did not have spatial surrogates for tribal data. Because the tribal nonpoint emissions are small, we do not anticipate these omissions having an 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 2007 platform emissions modeling sector inventories are initialized with the 2008 NEI by SCC and sometimes also by pollutant. However, prior to this, we removed several source categories from the 2008 NEI. These sources are dropped from the 2007 platform for a couple of potential reasons: 1) these sources are only reported by a couple of states or agencies, 2) these sources are 'atypical' and small, and/or 3) we have other data that we believe to be more accurate. Table 2-5 provides these 2008 NEI SCCs, justification for removal and national annual NO_X, VOC and NH_3 emission totals.

Table 2-5. 2008 NEI nonpoint sources removed from the 2007 platform

SCC	Description	Reason for Removal	NO_X	VOC	NH_3
2280003100	Marine Vessels, Commercial; Residual; Port emissions	Replaced with OTAQ ECA-IMO dataset -see Section 2.5.5	70,044	2,412	64
2280003200	Marine Vessels, Commercial; Residual; Underway emissions		813,907	28,711	323
2294000000	Paved Roads; All Paved Roads; Total: Fugitives	Replaced with emissions NOT reduced via precipitation			
2294010000	Paved Roads; All Other Public Paved Roads; Total: Fugitives				
2501060100	Gasoline Stage 2 refueling: Total	Replaced with MOVES2010b-based estimates – see Section 2.5.2		165,389	
2501060101	Gasoline Stage 2 refueling: Displacement Loss/Uncontrolled			20,116	
2501060102	Gasoline Stage 2 refueling: Displacement Loss/Controlled			3,169	
2501060103	Gasoline Stage 2 refueling: Spillage			6,276	
2801500600	Agricultural Field Burning; Forest Residues Unspecified	Replaced with SMARTFIRE estimates -see Section 2.2.3	3	116	7
2810005001	Managed Burning, Slash (Logging Debris);Pile Burning	Replaced with SMARTFIRE estimates -see Section 2.3	145	420	
2810005002	Managed Burning, Slash (Logging Debris);Broadcast Burning		3	5	
2810020000	Prescribed Rangeland Burning; Unspecified				41
2810090000	Open Fire; Not categorized		210	1,274	0
2275087000	Aircraft; In-flight (non-Landing-Takeoff cycle);Total	Atypical and sparsely-reported category with small emissions			
2806010000	Domestic Animals Waste Emissions; Cats; Total				2,994
2806015000	Domestic Animals Waste Emissions; Dogs; Total				8,227
2807020001	Wild Animals Waste Emissions; Bears; Black Bears				3
2807020002	Wild Animals Waste Emissions; Bears; Grizzly Bears				0
2807025000	Wild Animals Waste Emissions; Elk; Total				1,268
2807030000	Wild Animals Waste Emissions; Deer; Total				3,366
2807040000	Wild Animals Waste Emissions; Birds; Total				0
2810003000	Cigarette Smoke; Total		39	171	4
2810010000	Human Perspiration and Respiration; Total				10,882
2830000000	Catastrophic/Accidental Releases; All; Total		0	473	0
2830010000	Catastrophic/Accidental Releases; Transportation Accidents; Total			0	
2862000000	Swimming Pools; Total (Commercial, Residential, Public);Total				

We discuss in each of the following subsections how we separated the remaining portion of the 2008 NEI nonpoint inventory into 2007v5 modeling platform sectors, and also the changes we made to the NEI data.

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. This sector is separated from other nonpoint sectors to allow for the application of "transport fraction," and meteorology/precipitation ("MET") 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 MET 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 MET adjustments reduces the overestimation of fugitive dust impacts in the grid modeling as compared to ambient samples.

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.

We created the afdust sector from the 2008 NEI based on SCCs and pollutant codes (i.e., PM_{10} and $PM_{2.5}$) that are considered "fugitive". The SCCs included in the 2008 NEI nonpoint inventory that comprise the 2007 platform afdust sector are provided in Table 2-6.

Table 2-6. SCCs in the afdust platform sector

SCC	SCC Description
2275085000	Mobile Sources; Aircraft; Unpaved Airstrips; Total
2294000000	Mobile Sources; Paved Roads; All Paved Roads; Total: Fugitives
2296000000	Mobile Sources; Unpaved Roads; All Unpaved Roads; Total: Fugitives
2296005000	Mobile Sources; Unpaved Roads; Public Unpaved Roads; Total: Fugitives
2311000000	Industrial Processes; Construction: SIC 15 - 17;All Processes; Total
2311010000	Industrial Processes; Construction: SIC 15 - 17;Residential;Total
2311020000	Industrial Processes; Construction: SIC 15; Industrial/Commercial/Institutional; Total
2311030000	Industrial Processes; Construction: SIC 15; Road Construction; Total
2325000000	Industrial Processes; Mining and Quarrying: SIC 14;All Processes; Total
2801000000	Miscellaneous Area Sources; Agriculture Production - Crops; Agriculture - Crops; Total
2801000002	Miscellaneous Area Sources; Agriculture Production - Crops; Agriculture - Crops; Planting
2801000003	Miscellaneous Area Sources; Agriculture Production - Crops; Agriculture - Crops; Tilling
2801000005	Miscellaneous Area Sources; Agriculture Production - Crops; Agriculture - Crops; Harvesting
2801000008	Miscellaneous Area Sources; Agriculture Production - Crops; Agriculture - Crops; Transport
2805000000	Miscellaneous Area Sources; Agriculture Production - Livestock; Agriculture - Livestock; Total
2805001000	Miscellaneous Area Sources; Agriculture Production - Livestock; Beef cattle - finishing operations on feedlots (drylots);Dust Kicked-up by Hooves

A limitation of the transportable fraction approach is the lack of monthly variability, which would be expected due to seasonal changes in vegetative cover. And while wind speeds are not accounted for, the variability due to soil moisture, snow cover and precipitation is accounted for in the subsequent MET adjustment.

Several modifications were included in the 2007 platform after the initial sector emissions were created from the 2008 NEI. The 2007 platform afdust emissions differ from the 2008 NEI as follows:

- The NEI paved road inventory includes a built-in precipitation reduction. We replaced these emissions with a paved road emissions inventory not including this MET reduction, thereby allowing the entire sector to be processed consistently with the same grid-specific transport fractions and MET adjustments

- A large source of fugitive dust in the 2008 NEI point inventory in California was moved to the afdust sector to allow transport fraction and MET reductions. This source contains over 2,000 tons of annual $PM_{2.5}$ and is discussed in Section 2.1.2. We did not use the SMOKE area-to-point (ARTOPNT) function (http://www.smoke-model.org/version3.1/html/ch08s10.html#sect_input_artopnt) to assign this source to the correct coordinates. Therefore, these emissions were spatially allocated to numerous grid cells via the "Rural Population" surrogate in a large California (San Bernardino) county. We will fix this in later versions of the platform.
- NEI data were replaced with year 2007 RPO inventories for several states and select sources. The justification for using RPO inventories is that these data are what the RPOs are using for their modeling and that where different and reasonable, they were used in our 2007 platform.

The 2008 NEI also includes a non-removable precipitation adjustment for unpaved roads and road construction dust. Therefore, it is possible that there is some double-counting of the MET-based emissions reductions for these sources. However, air quality modeling shows that in general, we are continuing to overestimate "dust" in our modeling.

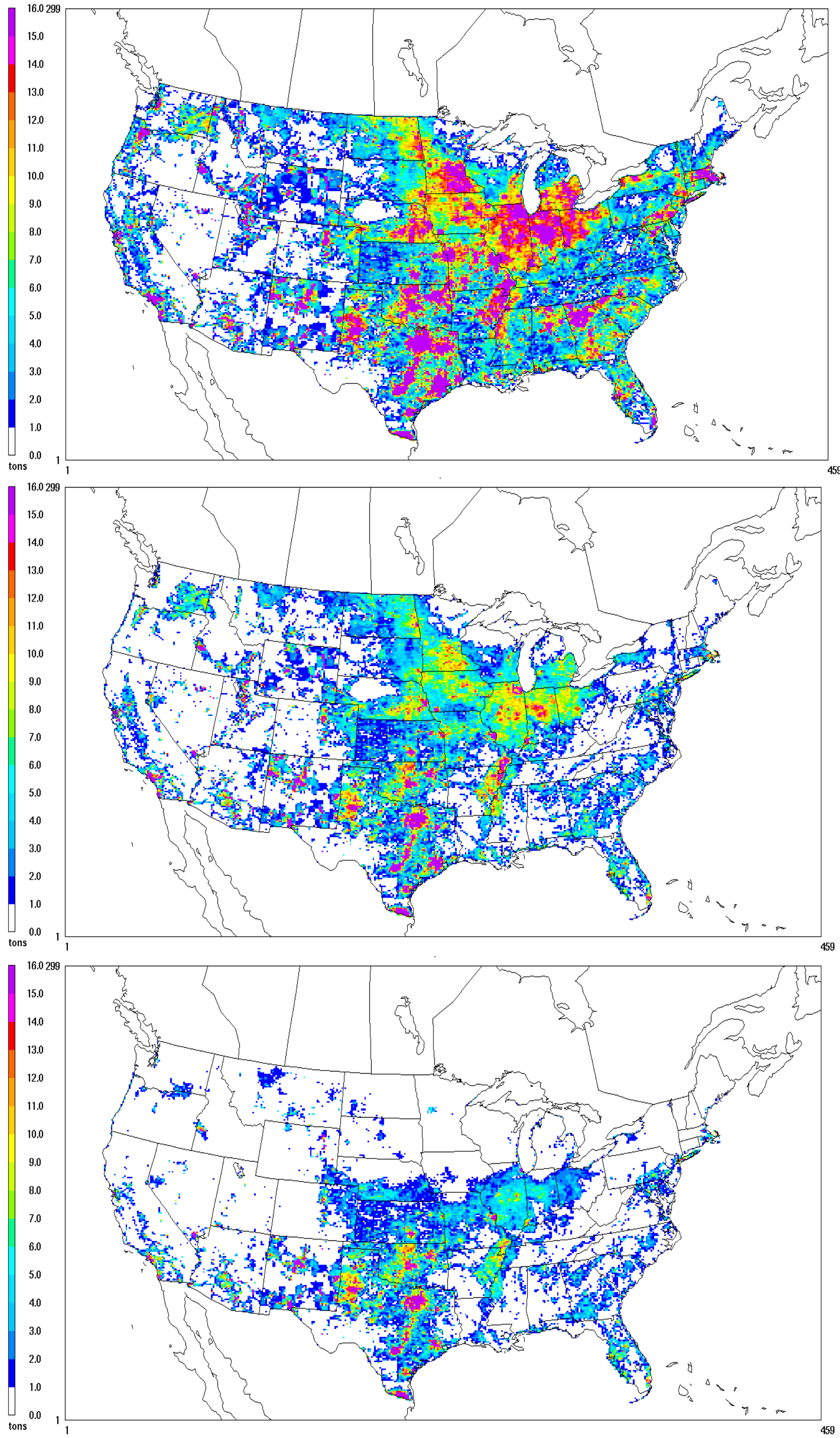
RPO afdust emissions replaced NEI data in the MARAMA and SESARM states with the following exceptions:

- We retained 2008 NEI "mining and quarrying" (SCC beginning with 2325x) because for many states in both RPOs we noticed that county emissions were the same in every county. Emissions in the NEI varied as expected.
- We retained "unpaved" (SCCs beginning with 2296x) road dust because RPO emissions often appeared to have a built-in transport and/or MET reduction.
- Similarly, as discussed above, we retained our year-2008 "paved" (SCCs beginning with 2294x) road dust emissions based on 2008 NEI but without transportable fraction or MET-adjustment built-in.
- Massachusetts and North Carolina RPO emissions were missing; therefore 2008 NEI emissions were used.
- New York "agriculture production, crops" (SCCs beginning with 2801000x) RPO emissions were missing; therefore 2008 NEI emissions were used.
- Delaware provided more resolved SCCs for "agriculture production, crops" (12 versus 2 NEI SCCs); however, the county totals were small and we did not find it worthwhile to replace the 2008 NEI emissions with these more refined but similar totals from the MARAMA inventory.

The impacts of the transport fraction and MET adjustments in January are shown in Figure 2-2. The raw 2008 NEI afdust $PM_{2.5}$ emissions –prior to transport fraction or MET adjustments- are shown at the top of Figure 2-2. These afdust emissions after the application of the transport fraction, but prior to MET adjustments are shown in the middle of Figure 2-2. Finally, the post-MET, and post-transport fraction, afdust emissions are shown at the bottom of Figure 2-2.

The top and middle plots in Figure 2-2 shows how the transport fraction has a larger reduction effect in the east where less barren and more forested areas are more effective at reducing PM transport than many western areas. The bottom versus middle plots show how the MET impacts of precipitation, and especially snow cover in the north, further reduce these emissions.

Figure 2-2. January $PM_{2.5}$ afdust emissions: raw 2008 NEI (top), after application of transport fraction (middle) and final post-MET adjusted (bottom)



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. In building this sector we included livestock and fertilizer emissions based on only the SCCs listed in Table 2-7 and Table 2-8.

Table 2-7. Livestock SCCs extracted from the 2008 NEI to create the ag sector

SCC	SCC Description*
2805001100	Beef cattle - finishing operations on feedlots (drylots);Confinement
2805001200	Beef cattle - finishing operations on feedlots (drylots);Manure handling and storage
2805001300	Beef cattle - finishing operations on feedlots (drylots);Land application of manure
2805002000	Beef cattle production composite;Not Elsewhere Classified
2805003100	Beef cattle - finishing operations on pasture/range;Confinement
2805007100	Poultry production - layers with dry manure management systems;Confinement
2805007300	Poultry production - layers with dry manure management systems;Land application of manure
2805008100	Poultry production - layers with wet manure management systems;Confinement
2805008200	Poultry production - layers with wet manure management systems;Manure handling and storage
2805008300	Poultry production - layers with wet manure management systems;Land application of manure
2805009100	Poultry production - broilers;Confinement
2805009200	Poultry production - broilers;Manure handling and storage
2805009300	Poultry production - broilers;Land application of manure
2805010100	Poultry production - turkeys;Confinement
2805010200	Poultry production - turkeys;Manure handling and storage
2805010300	Poultry production - turkeys;Land application of manure
2805018000	Dairy cattle composite;Not Elsewhere Classified
2805019100	Dairy cattle - flush dairy;Confinement
2805019200	Dairy cattle - flush dairy;Manure handling and storage
2805019300	Dairy cattle - flush dairy;Land application of manure
2805020000	Cattle and Calves Waste Emissions;Milk Total
2805020001	Cattle and Calves Waste Emissions;Milk Cows
2805020002	Cattle and Calves Waste Emissions;Beef Cows
2805020003	Cattle and Calves Waste Emissions;Heifers and Heifer Calves
2805020004	Cattle and Calves Waste Emissions;Steers, Steer Calves, Bulls, and Bull Calves
2805021100	Dairy cattle - scrape dairy;Confinement
2805021200	Dairy cattle - scrape dairy;Manure handling and storage
2805021300	Dairy cattle - scrape dairy;Land application of manure
2805022100	Dairy cattle - deep pit dairy;Confinement
2805022200	Dairy cattle - deep pit dairy;Manure handling and storage
2805022300	Dairy cattle - deep pit dairy;Land application of manure
2805023100	Dairy cattle - drylot/pasture dairy;Confinement
2805023200	Dairy cattle - drylot/pasture dairy;Manure handling and storage
2805023300	Dairy cattle - drylot/pasture dairy;Land application of manure
2805025000	Swine production composite;Not Elsewhere Classified (see also 28-05-039, -047, -053)
2805030000	Poultry Waste Emissions;Not Elsewhere Classified (see also 28-05-007, -008, -009)
2805030001	Poultry Waste Emissions;Pullet Chicks and Pullets less than 13 weeks old
2805030002	Poultry Waste Emissions;Pullets 13 weeks old and older but less than 20 weeks old
2805030003	Poultry Waste Emissions;Layers
2805030004	Poultry Waste Emissions;Broilers
2805030007	Poultry Waste Emissions;Ducks
2805030008	Poultry Waste Emissions;Geese
2805030009	Poultry Waste Emissions;Turkeys
2805035000	Horses and Ponies Waste Emissions;Not Elsewhere Classified
2805039100	Swine production - operations with lagoons (unspecified animal age);Confinement
2805039200	Swine production - operations with lagoons (unspecified animal age);Manure handling and storage
2805039300	Swine production - operations with lagoons (unspecified animal age);Land application of manure
2805040000	Sheep and Lambs Waste Emissions;Total

SCC	SCC Description*
2805045000	Goats Waste Emissions;Not Elsewhere Classified
2805045002	Goats Waste Emissions;Angora Goats
2805045003	Goats Waste Emissions;Milk Goats
2805047100	Swine production - deep-pit house operations (unspecified animal age);Confinement
2805047300	Swine production - deep-pit house operations (unspecified animal age);Land application of manure
2805053100	Swine production - outdoor operations (unspecified animal age);Confinement

* All SCC Descriptions begin "Miscellaneous Area Sources;Agriculture Production – Livestock"

Table 2-8. Fertilizer SCCs extracted from the 2008 NEI for inclusion in the "ag" sector

SCC	SCC Description*
2801700001	Anhydrous Ammonia
2801700002	Aqueous Ammonia
2801700003	Nitrogen Solutions
2801700004	Urea
2801700005	Ammonium Nitrate
2801700006	Ammonium Sulfate
2801700007	Ammonium Thiosulfate
2801700008	Other Straight Nitrate
2801700009	Ammonium Phosphates
2801700010	N-P-K (multi-grade nutrient fertilizers)
2801700011	Calcium Ammonium Nitrate
2801700012	Potassium Nitrate
2801700013	Diammonium Phosphate
2801700014	Monoammonium Phosphate
2801700015	Liquid Ammonium Polyphosphate
2801700099	Miscellaneous Fertilizers

* All descriptions include "Miscellaneous Area Sources; Agriculture Production – Crops; Fertilizer Application" as the beginning of the description.

The "ag" sector includes all of the NH_3 emissions from fertilizer from the NEI. However, the "ag" sector does not include all of the livestock ammonia emissions, as there are also a very small amount of NH_3 emissions –around 38 tons- in California from livestock feedlots in the point source inventory that we retained from the 2008 NEI.

A significant error in the 2008 NEI was corrected in the 2007 platform ag sector. A fertilizer application source "N-P-K (multi-grade nutrient fertilizers)" (SCC=2801700010) in Luna county New Mexico (FIPS=35025), was 6,953 tons of NH_3 in the 2008 NEI. However, this source was corrected by a factor of 1,000 to be 6.953 tons in the 2007 platform.

Monthly ag sector NH_3 RPO emissions replaced NEI ag sector emissions in the MWRPO (LADCO) states due to the improved temporal resolution. RPO ag sector emissions in the MARAMA and SESARM RPO states were either identical or nearly-so to the 2008 NEI; therefore, 2008 NEI (annual) ag sector emissions were used in all other states. We retained the MWRPO ag sector monthly emissions by creating a SMOKE FF10 nonpoint format with the monthly values populated: http://www.smoke-model.org/version3.1/html/ch08s02s04.html#d0e40584. We will discuss the difference of these monthly MWRPO ag sector emissions versus SMOKE annual-to-month temporal allocation in Section 3.3.4. We also incorporated a new temporal allocation methodology for animal NH_3 (see Section 3.3.3 for more details) that allocates emissions down to the hourly level by taking into account temperature and wind speed.

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. As discussed in the beginning of Section 2, all fire emissions from the 2008 NEI nonpoint inventory were removed and replaced with SMARTFIRE emissions; these are described in Section 2.3. Additionally, locomotives and CMV mobile sources from the 2008 NEI nonpoint inventory are described in Section 2.5.

Below is a summary of changes made to the 2007 platform nonpt sector beyond what is listed in Table 2-2 at the beginning of Section 2. Details on these changes not already-discussed are provided following this summary:

- The 2007 platform replaces 2008 NEI oil and gas emissions (SCCs beginning with "23100") with year 2006 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.
- 2008 NEI nonpoint agriculture burning emissions were replaced with year 2008 SMARTFIRE day-specific county-based emissions aggregated to monthly totals in the 2007 platform.
- Replaced open burning "land clearing" (SCC=2610000500) emissions in Florida and Georgia with SESARM-provided daily point data, but aggregated to county and monthly resolution.
- Replaced all open burning data (SCCs beginning with 261000x) in MARAMA states.
- Replaced, removed and modified much of the residential wood combustion (RWC) emissions in the MARAMA, MWRPO and SESARM states with RPO data and non-RPO corrections, modified the outdoor hydronic heater (OHH) emissions in all states and indoor furnaces in MWRPO states.
- Removed industrial coal combustion emissions (SCC=2102002000) in Tennessee.
- Removed EPA-estimated commercial cooking (SCCs 2302002100 and 2302002200) duplicate PM emissions in California.
- Removed duplicate "Industrial Processes; Food and Kindred Products;…Total" source (SCC=23020000000) in Maricopa county Arizona (FIPS=04013).

The oil and gas changes were discussed in the ptnonipm section. We elaborate on each of the above bullets below.

<u>Ag burning</u>
2008 NEI agricultural burning estimates were replaced with more specific data from the Fire Characteristic Classification System (FCCS) module fuel loadings map in the BlueSky Framework (http://blueskyframework.org/modules/fuel-loading/fccs). Year 2008-specific fire locations from SMARTFIRE version 1 (Sullivan, et al., 2008) were read into the FCCS module and intersected with the FCCS fuel-loading dataset. The module assigned an FCCS code to each fire record that reflects the ecosystem geography and potential natural vegetation based on remote sensing data. Prescribed or unclassified fires having an FCCS code equal to zero (0) were assumed to be agricultural fires. Next, Arc GIS was used to categorize the fires as occurring on rangeland, cropland or other land use via USGS 2006 National Land Cover Database (NLCD). Activity data were analyzed to restrict to cropland fires and assign state and crop-specific emission factors. Emissions were then appropriately weighted based on known statistics about each state's crop mix.

These SMARTFIRE-based ag burning emissions were provided in Excel sheets at 1km point source and day-specific resolution. State-county FIPS codes were assigned using GIS. We aggregated these emissions to county and monthly resolution and converted to SMOKE nonpoint FF10 format. This SMARTFIRE-based ag burning dataset includes emissions for all but these 7 of the lower 48 states: CT, DC, MA, ME, NH, RI and VT. These 7 states did not contain any cropland burning estimates for year 2008 based on this SMARTFIRE approach.

Open burning RPO data

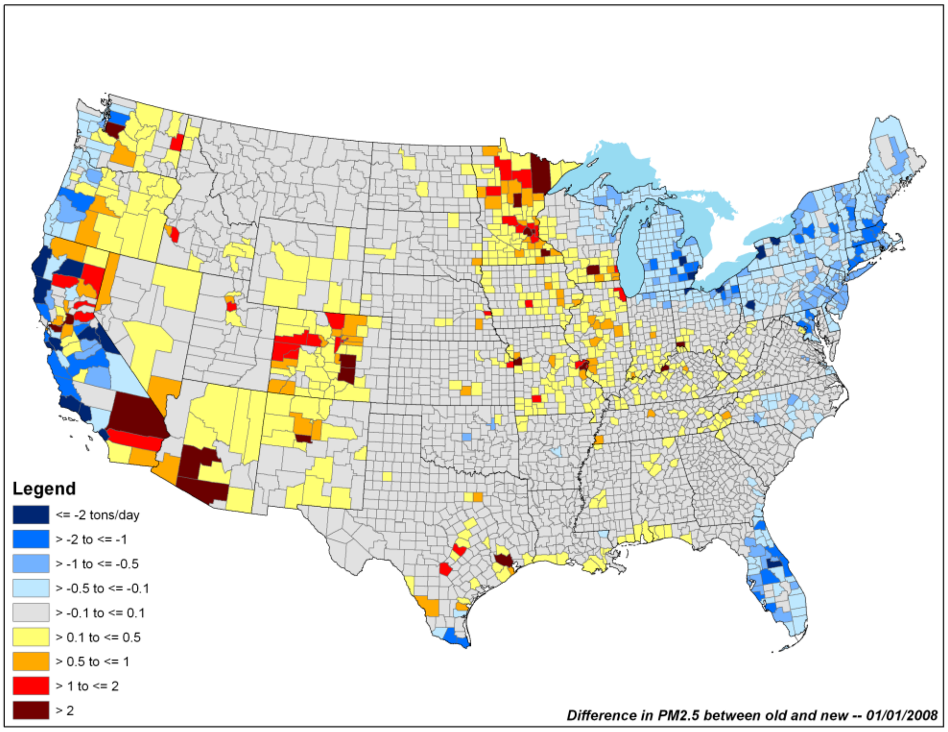
We replaced all 2008 NEI open burning emissions (CAPs only) in the MARAMA states with the 2007 MARAMA open burning inventory. These MARAMA open burning emissions include estimates for household waste (SCC=2610030000), land clearing (2610000500) and yard waste leaf and brush (2610000100 and 2610000400 respectively).

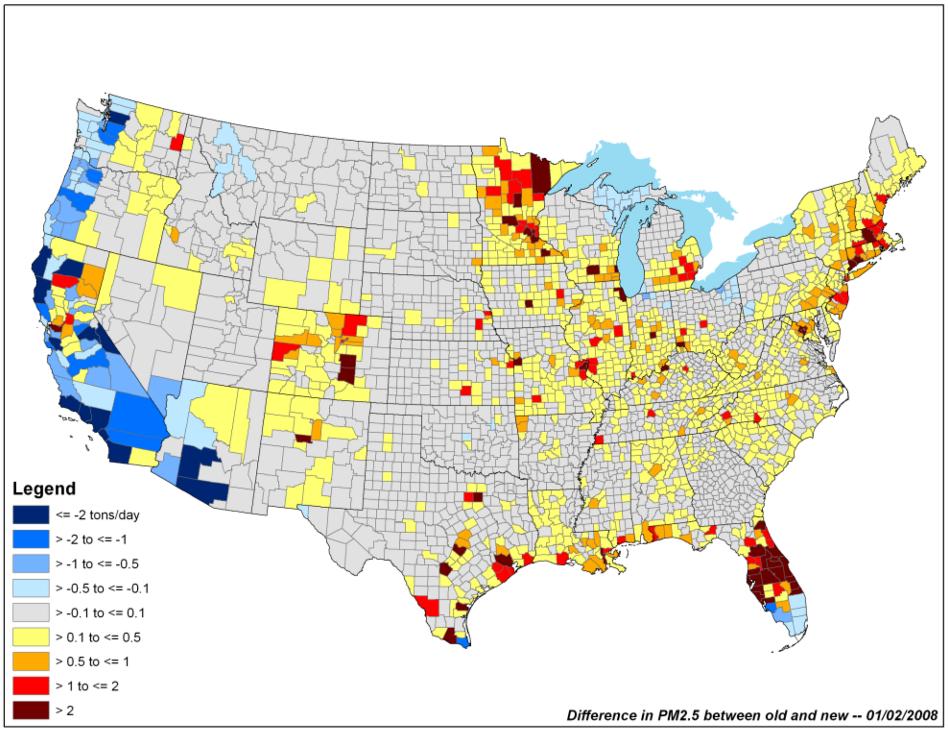
We also replaced 2008 NEI land clearing emissions in Georgia and Florida with SESARM-based year-2007 data. The SESARM land clearing emissions are based on daily point emissions from the CONSUME v3.0 model (SESARM, 2012a). These daily point-format emissions were aggregated to county and monthly resolution as a separate FF10 nonpoint monthly inventory.

Residential Wood Combustion

There are many modifications to the RWC emissions data. We also modified the daily temporalization from monthly uniform (non-varying) to day-of-year specific. We describe this in more detail in Section 3.3.3, but believe it is important to mention here because of the large day-to-day impact this change makes on RWC emissions allocation for some areas. In short, we utilize a new SMOKE program (GenTPRO) to distribute annual RWC emissions to the coldest days of the year, using maximum temperature thresholds by-state and/or by-county. On days where the low temperature does not drop below this threshold, RWC emissions are zero. Conversely, the program temporally allocates the most ***relative*** emissions to the coldest days. An example of the difference between the old method and the new method is reflected in Figure 2-3, where negative values indicate more emissions in this new method. For example, in the top panel, more RWC emissions on January 1st in the new method are shown in the northeast and Florida because of colder (than average) minimum temperatures. However, daily RWC emissions on January 2nd in the bottom panel show less emissions in many of these same areas, which reflects warmer (than average) daily minimum temperatures.

Figure 2-3. Examples of Daily RWC $PM_{2.5}$ emissions changes due to inclusion of new temperature dependency: old method minus new method.





Next, we discuss the modifications to the annual emissions via alternate datasets and in some cases, recalculations for specific RWC sources.

i. SESARM states: AL, FL, GA, KY, MS, NC, SC, TN, VA, WV

The 2008 NEI nonpoint inventory was the starting point; however, we replaced all emissions in the SESARM states, including Virginia, with the SESARM year-2007 inventory (SESARM, 2012b). SESARM updates to the RWC estimates incorporate updated wood burning appliance counts at the sub-MSA (Metropolitan Statistical Area) level as well as a default urban and overall appliance count profile for other areas. Urban area RWC were lower than the NEI estimates partially because of the assumptions about greater penetration of natural gas fireplaces, less access to inexpensive wood supplies and a lower proportion of housing units with wood burning appliances as primary heating units than rural areas. The specific RWC updates are referenced in a report available at: http://projects.pechan.com/EPA/Non-Point_Emission_Estimates/2008_files/Residential_Wood_Combustion_Documentation.zip

Overall, the SESARM RWC estimates are considerably lower than the 2008 NEI estimates for several states, particularly for "uncertified" and "general" wood stoves and insert categories: FL, KY, NC, TN, VA and WV. However, emissions in Mississippi are only slightly reduced and emissions in AL, GA and SC are very similar to those in the 2008NEIv2.

ii. MWRPO states and Minnesota: IL, IL, MI, OH, WI, MN

The Midwest RPO (LADCO) states year-2007 RWC inventory was similar to the 2008 NEI for most source types. However, the pellet stoves (SCC=2104008400), indoor furnaces (2104008510), and outdoor hydronic heater (OHH, SCC=2104008610) estimates were updated to reallocate the indoor furnaces and OHHs to non-MSA counties (LADCO, 2012) for several urban areas. Some double counting of appliances was also fixed in Wisconsin and Michigan. Overall, the MWRPO states totals are very similar to the 2008 NEI; however, emissions are spatially redistributed from urban to rural areas. Therefore, for the MWRPO states, the 2008 NEI emissions were used for all RWC sources except the three aforementioned SCCs that use the 2007 MWRPO data.

iii. MARAMA states: CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT

The MARAMA states year 2007 RWC inventory was either unchanged from the 2008 NEI, or was missing for most states. The exceptions were New York and Pennsylvania which includes significantly revised RWC estimates compared to the 2008 NEI. For New York, the MARAMA estimates were not split out into the refined set of 10 RWC appliance types/SCCs in the NEI. New York only reported "general" fireplaces (SCC=2104008100) and "EPA certified, non-catalytic" woodstoves (SCC=2104008320). However, similar to the SESARM and MWRPO improvements, the MARAMA NY RWC estimates were spatially reallocated from urban to more rural areas and were also lower state-wide than the NEI. For Pennsylvania, MARAMA RWC estimates were not much different state-wide on the aggregate, but were refined by SCC and spatially compared to the 2008 NEI. Therefore, the MARAMA 2007 RWC data is used for New York and Pennsylvania and the 2008 NEI emissions are used for all RWC sources in the rest of the MARAMA states.

iv. Adjustments to specific RWC SCCs

We removed all RWC outdoor wood burning devices such as "fire pits and chimeas" (SCC=2104008700) from the 2007 platform because they were only reported in a couple of states, RPO inventories did not include them for most states and emissions were generally insignificant.

A market research report (Frost and Sullivan, 2010) developed in support of the potential RWC New Source Performance Standard (NSPS) indicated slower sales of outdoor hydronic heaters compared to what was assumed for growth estimates in the 2008 NEI. We therefore recomputed outdoor hydronic heater (OHH) appliance counts and emissions estimates (SCC=2104008610) for all states. OHH appliance count activity in the 2008 NEI was based on Northeast States for Coordinated Air Use Management (NESCAUM) sales survey data in the year 2005 that was extrapolated through year 2008. The Frost and Sullivan report supports a much smaller amount of OHH sales between 2005 and 2008 and hence much lower OHH emissions in 2008. Table 2-9 details how we modified the NEI-assumed OHH sales between 2005 and 2008, and how this reduces OHH units by 51% -from 362,333 units to 176,673 cumulative units. We assume that the 63,728 units in 2003 is a correct estimate, and that the NESCAUM-based 24,560 units sold in 2004 is approximately correct. However, rather than including the sudden spike to 67,546 units sold in year 2005, we assume, only 25,000 units sold each year between 2005 and 2007. This is still probably a conservatively high estimate based on only 13,385 units sold in 2008 according to Frost & Sullivan. We applied this 51% reduction to OHH emissions for all states.

Table 2-9. Recomputed Outdoor Hydronic Heater Sales for the 2007 Platform

Year(s)	2008 NEI OHH Annual Sales	Revised OHH Annual Sales	Source of Info: 2008 NEI	Source of Info: 2007 Platform
1990-2003 total	63,728	63,728	NESCAUM	NESCAUM
2004	+ 24,560	+ 24,560	NESCAUM	NESCAUM
2005	+ 67,546	+ 25,000	NESCAUM	assumed similar to 2004 NESCAUM
2006	+ 68,833	+ 25,000	extrapolated from NESCAUM	assumed similar to 2004 NESCAUM
2007	+ 68,833	+ 25,000	extrapolated from NESCAUM	assumed similar to 2004 NESCAUM
2008	+ 68,833	+ 13,385	extrapolated from NESCAUM	Frost & Sullivan, 2010
Total Units in 2008	**362,333**	**176,673**	sum of 1990-2008	sum of 1990-2008, with revised 2005-2008

We also recomputed the indoor wood fired furnaces (SCC=2104008510) in several MWRPO states based on newer, improved survey data from Minnesota. While we used the MWRPO emissions for indoor furnaces rather than 2008 NEI emissions, as discussed above, the MWRPO emissions primarily redistributed these emissions from urban to rural counties and for most states did not significantly change the underlying assumption of the number of indoor furnace units, and hence state-total emissions. The 2008 NEI for these sources started with an assumption of year 2002 Minnesota wood burning survey data of 38 indoor furnaces per 100 woodstoves for Illinois, Indiana, Michigan, Ohio, and Wisconsin. Each state had some minor tweaks from this ratio. However, the calculation of the furnace per woodstove ratio from the 2002 MN survey did not reflect the number of "combination" devices that were surveyed, such as woodstove/furnace or other combination of 2 or more wood burning devices. This made the indoor wood furnace ratio from the 2002 MN survey too high. More recent year 2007 MN survey data resulted in the much lower ratio of 7.3 indoor furnaces per 100 wood stove units, which, as seen in Table 2-10, is more in line with the 7.6% ratio of indoor furnaces to wood stoves in the 2008 NEI for Minnesota. Therefore, for the other 5 MWRPO states previously listed, we normalize the indoor furnace emissions by forcing the indoor furnace count ratio to wood stoves to match the 7.6% reported value in Minnesota. These adjustment factors reduce the indoor furnace emissions in these states by 67% (Wisconsin) to as much as 83% in Ohio.

Table 2-10. Recomputed Indoor Furnace Units and Emissions Adjustment Factor in MWRPO states

State	2008 NEI Indoor Furnace Appliance Count	2008 NEI Woodstove Appliance Count	Indoor Furnaces as a % of Woodstove	Adj Factor	Revised Indoor Appliance Count
Ohio	60,795	137,848	44.1%	0.17	10,436
Michigan	58,271	236,129	24.7%	0.31	17,877
Wisconsin	39,072	170,615	22.9%	0.33	12,917
Illinois	34,566	75,185	46.0%	0.16	5,692
Indiana	28,714	61,353	46.8%	0.16	4,645
Minnesota	15,167	200,334	7.6%	1	15,167

TN coal combustion

Tennessee nonpoint industrial coal combustion (SCC=2102002000) emissions are significantly overestimated in the 2008 NEI because of incorrect reconciliation with the point source inventory. Nonpoint industrial coal combustion emissions were estimated by subtracting point source emissions rather than activity. By not accounting for controlled sources, remaining activity for nonpoint coal combustion is significantly overestimated. EPA NEI experts determined that it would be more appropriate to completely remove the nonpoint component of this sector than to leave it as-is. The reality for TN industrial coal combustion nonpoint sector emissions is likely much closer to zero than the value in the 2008 NEI because these emissions are accounted for in the point source inventory.

Duplicates removal

Maricopa county Arizona reported the same NH_3 emissions value, 1,678.43 tons, for two different but similar SCCs: 23020000000 “Industrial Processes; Food and Kindred Products: SIC 20; ***All Processes***; Total” and 23020800000 “Industrial Processes; Food and Kindred Products: SIC 20; ***Miscellaneous Food and Kindred Products***; Total”. We confirmed that this was a duplicate and therefore deleted the more broad SCC record 2302000000.

We also found numerous “Commercial Cooking” duplicates for PM in California where the California Air Resources Board (CARB) estimated “Charbroiling Total” emissions (SCC=23020002000 “Industrial Processes; Food and Kindred Products: SIC 20; Commercial Cooking - Charbroiling; ***Charbroiling Total***”) and EPA provided defaults for “…***Conveyorized Charbroiling***” (SCC=23020002100) and “…***Under-fired Charbroiling***” (SCC=23020002200). At first glance, these are not duplicates because they are different SCCs; however, it became clear that EPA emissions were “gap-filling” a source that the CARB submittal already covered for most counties in California and therefore the EPA emission were removed.

2.3 Fires (ptfire, 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. For the 2007 evaluation case, we modeled 2007 year-specific fires using the emissions from the ptfire sector. For the 2007 and 2020 base cases, the ptfire sector was replaced by the avefire sector.

For the 2007v5 platform, the following SCCs in Table 2-11 are considered “fires” – note that the complete SCC description includes “Miscellaneous Area Sources” as the first tier level description.

Table 2-11. 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

Both the ptfire and avefire sectors for the 2007 Platform exclude agricultural burning and other open burning sources, which are included in the nonpt sector. We chose to keep agricultural burning and other open burning sources in the nonpt sector because these categories were not factored into the development of the average fire sector (as described in 2.3.2). 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.

2.3.1 Day-specific point source fires (ptfire)

The ptfire sector includes wildfire and prescribed burning emissions occurring in 2007, which are used in the 2007 model evaluation case and not the 2007 and 2020 base cases. Emissions are day-specific and include satellite derived latitude/longitude of the fire's origin and other parameters associated with the emissions such as acres burned and fuel load, which allow estimation of plume rise.

The point source day-specific emission estimates for 2007 fires rely on Version 1 of the Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation (SMARTFIRE) system (Sullivan, et al., 2008). This system involves the use the National Oceanic and Atmospheric Administration's (NOAA's) Hazard Mapping System (HMS) fire location information as input combined with the CONSUMEv3.0 software application (Joint Fire Science Program, 2009) and the Fuel Characteristic Classification System (FCCS) fuel-loading database to estimate fire emissions from wildfires and prescribed burns on a daily basis. The method involves the reconciliation of ICS-209 reports (Incident Status Summary Reports) with satellite-based fire detections to determine spatial and temporal information about the fires. The ICS-209 reports for each large wildfire are created daily to enable fire incident commanders to track the status and resources assigned to each large fire (100 acre timber fire or 300 acre rangeland fire). The SMARTFIRE system of reconciliation with ICS-209 reports is described in an Air and Waste Management Association report (Raffuse, et al., 2007). While 2007 data from SMARTFIRE version 2 are available now, they were not available for use in this version of the platform.

A functional diagram of the SMARTFIRE process is available in the SMARTFIRE documentation (Raffuse, et al., 2007). Once the fire reconciliation process is completed, the emissions are calculated using the U.S. Forest Service's CONSUMEv3.0 fuel consumption model and the FCCS fuel-loading database in the BlueSky Framework (Ottmar, et. al., 2007),

Fires that could be matched in space and time with an ICS-209 report were designated as wildfires; all other fires were designated as prescribed burning. A limitation of these satellite-based fires compared to ground-based fires is the distinction between wildfire and prescribed burn is not as precise as with ground-based methods. Also, the fire size is based on the number of satellite pixels and a nominal fire size of 100 acres/pixel and is assumed for a significant number of fire detections when the first detections were not matched to ICS 209 reports. This means that the fire size information is not as precise as ground based methods. In addition, because the HMS satellite product from NOAA is based on daily detections, the emission inventory represents a time-integrated emission estimate. For example, a large smoldering fire will show up on satellite for many days and would count as acres burned on a daily basis whereas a ground-based method would count the area burned only once even it burns over many days.

Additional references for this method are provided in (McKenzie, et al., 2007), (Ottmar, et al., 2003), (Ottmar, et al., 2006), and (Anderson et al., 2004).

2.3.2 Average fires (avefire)

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.

The avefire sector contains wildfire and prescribed burning emissions. It excludes agricultural burning and other open burning sources, which are included in the nonpt sector. Generally, their year-to-year impacts are not as variable as wildfires and non-agricultural prescribed/managed burns.

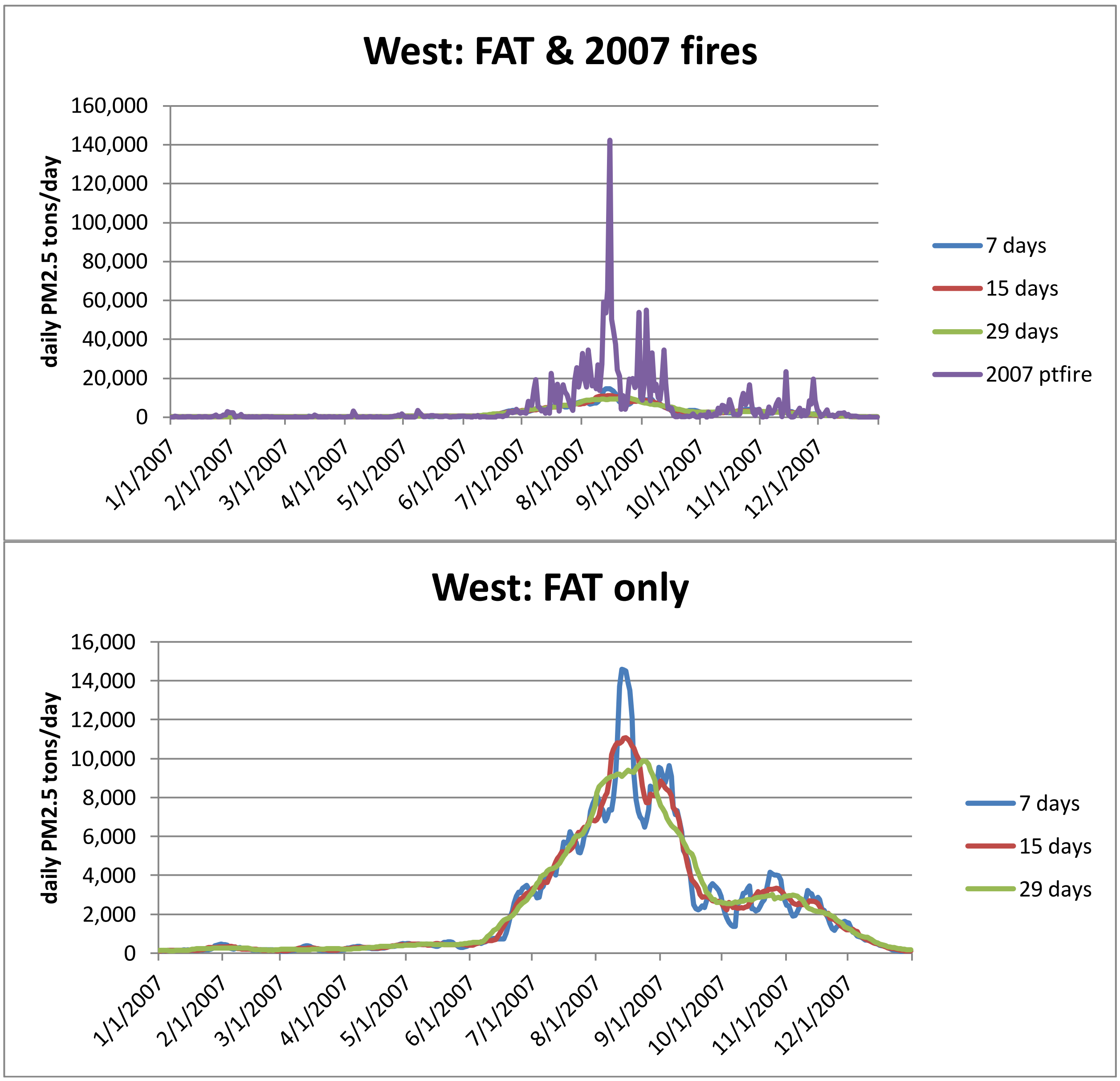
We use this sector for the 2007 base case, and all future-year cases. Emissions are day-specific but aggregated to county-level where spatial surrogates will allocate the fires to forest and crop/pasture land. The creation of the avefire daily nonpoint inventory is distinct for prescribed burning and wildfires. We manually added the pollutant PMC to the avefire inventory prior to processing because the beta version of SMOKE v3.1 did not support SMKINVEN_FORMULA (where PMC = $PM_{10} – PM_{2.5}$) use for FF10 Daily Nonpoint inventories. This bug has since been fixed in the public release of SMOKE v3.1.

For prescribed burning, we used a year-2008 specific SMARTFIRE version 2 (SFv2) approach because of improvements over the SMARTFIRE version 1 approach used in all previous year data. In particular, the unclassified fires (SCC=2811090000) in SFv1 were eliminated in SFv2 and were replaced by either prescribed burning or wildfire classification. In addition, activity data and emission factors for prescribed burning were improved significantly in SFv2. However, the wildfire emissions methodology is more stable between SFv1 and SFv2; therefore, we are comfortable using wildfire data from both SFv1 and SFv2. We also know from state and county emissions summaries that prescribed burning emissions are less variable year-to-year than wildfire emissions. Therefore, we feel comfortable using year 2008 prescribed burning emissions in the 2007 and future year base case scenarios. Year 2007 data from SFv2 is now available, but was not available in time to include in this version of the platform.

The EPA developed a new Fire Averaging Tool (FAT) to create avefire inventories from SMARTFIRE point, day-specific data. The FAT tool is a stand-alone Perl program that reads user options, day-specific one record per line (ORL) point (PTDAY, see http://www.smoke-model.org/version3.1/html/ch08s02s08.html#sect_input_ptday_fireemis) source files and an SCC mapping file to a generate day-specific nonpoint inventory (see http://www.smoke-model.org/version3.1/html/ch08s02s02.html) containing averaged fire emissions. The FAT tool allows setting the averaging period (e.g., one month), the input data years, and the SCC assignments for mapping. The tool calculates the average emissions for each day and county by using the rolling average to select a set of days from each of the input PTDAY files for the years being included. For example, if the selected averaging period is 15 days (+/- 7 days) and the years included were 2006, 2007, and 2008, then for July 15th the tool selects all fires in that county from July 8th – 22nd for 2006, 2007, and 2008 to compute the average emissions for that day. All of the fires in the county are included in the average for that county and day. Because many of those days will have 0 emissions, peaks in the emissions will tend to be smoothed out.

For the 2007 platform, we chose an averaging period of 29 days (+/- 14 days), and included year 2003-2009 wildfires but only year 2008 prescribed burning data. The bottom panel of Figure 2-4 illustrates how the 29-day averaging period used in the 2007 platform (green line) is smoother than shorter periods of 7 and 15 days; the maximums are lower and the minimums are higher. The top panel in Figure 2-4 shows how the use of multiple years of fire data greatly smoothes the year-to-year day-specific variability in the ptfire inventory. The smoothing impact of FAT is seen temporally here, but FAT also smoothes the wildfires spatially by using multiple years of data. The emissions shown in Figure 2-4 are for the western US only and therefore mostly wildfire emissions; note the difference in scale from Figure 2-4. It is important to note that the smoothing of prescribed fires is completely restricted to the 29-day average effect because only year-2008 SFv2 prescribed burning emissions are used for this component.

Figure 2-4. Illustration of various FAT avefire emissions versus year 2007 fires (top), and with year-2007 fires not shown (bottom)



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 inputs to BEIS include:

- Temperature data at 2 meters which were obtained from the meteorological input files to the air quality model,
- Land-use data from the Biogenic Emissions Land use Database, version 3 (BELD3). BELD3 data provides data on the 230 vegetation classes at 1-km resolution over most of North America.

Plots of BEIS outputs for isoprene and NO for July, 2007 are shown in Figure 2-5 and Figure 2-6, respectively.

Figure 2-5. NO emissions output from BEIS 3.14 for July, 2007

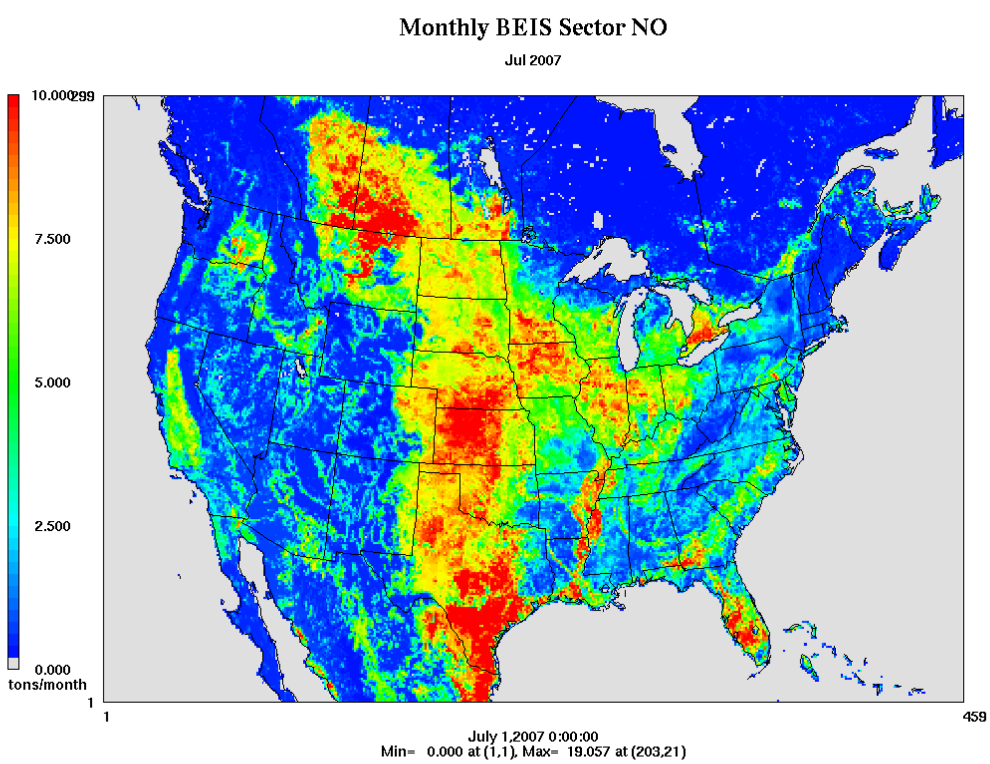
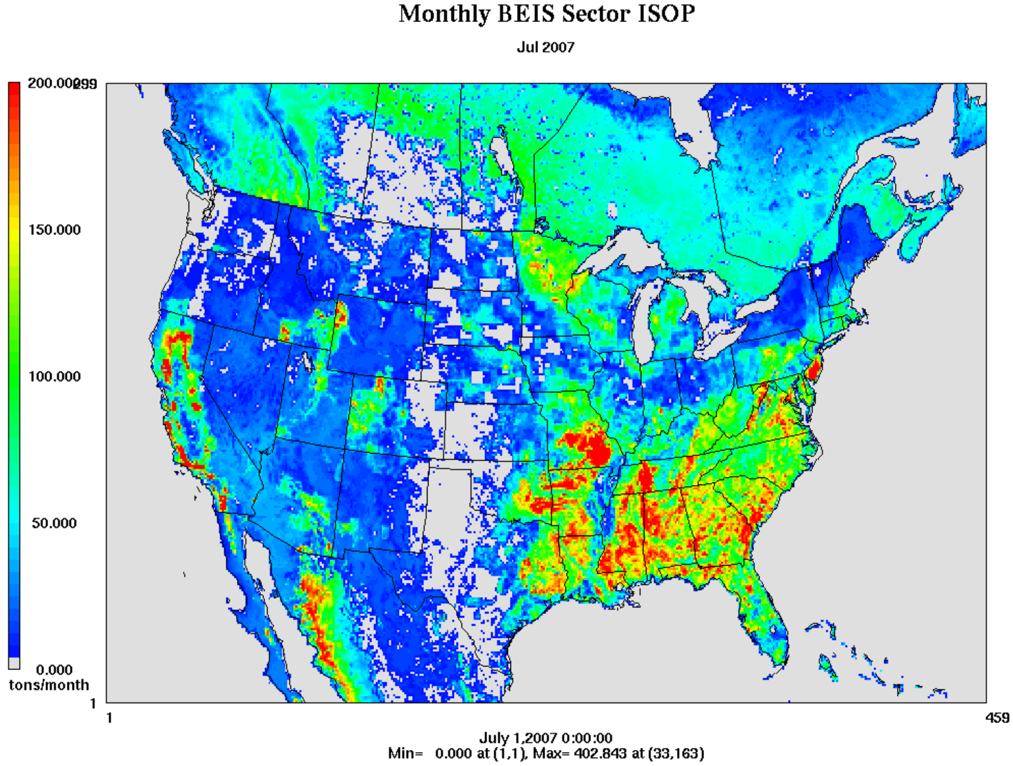


Figure 2-6. Isoprene emissions output from BEIS 3.14 for July, 2007



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

For the 2007 platform, as indicated in Table 2-1, we 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). Except for California, all onroad and onroad refueling emissions are generated using a new SMOKE-MOVES emissions modeling framework that leverages MOVES2010b-generated outputs (http://www.epa.gov/otaq/models/moves/index.htm) and hourly meteorology. California mobile emissions for onroad (including refueling), nonroad and c1c2rail sources were provided by the California Air Resources Board (CARB).

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).

The 2008 NEI c3marine emissions were replaced with a set of approximately 4-km resolution point source format emissions. These data are used for all states, including California, as well as offshore and international emissions within our air quality modeling doming, and are modeled separately as point sources in the "c3marine" sector.

All tribal data from the mobile sectors have been dropped because we do not have spatial surrogate data, and the emissions are small.

2.5.1 Onroad non-refueling (onroad)

For the 2007 platform, EPA estimated emissions for every county in the continental U.S. except for California. We used a modeling framework that took into account the strong temperature sensitivity of the onroad emissions. Specifically, we used county-specific inputs and tools that integrated the MOVES model with the SMOKE[2] 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., EPA used an automated process to run MOVES to produce emission factors by temperature and speed for 146 "representative counties," to which every other county could be mapped, as detailed below. Using the MOVES emission rates, SMOKE selected appropriate emissions rates for each county, hourly temperature, SCC, and speed bin and multiplied the 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).

Using SMOKE-MOVES for creating the 2007 and future year emissions requires numerous steps, as described in the sections below:

- Determine which counties will be used to represent other counties in the MOVES runs (see Section 2.5.1.1)
- Determine which months will be used to represent other month's fuel characteristics (see Section 2.5.1.2)
- Create MOVES inputs needed only for MOVES runs (see Sections 2.5.1.3 and 2.5.1.4). MOVES requires county-specific information on vehicle populations, age distributions, and inspection-maintenance programs for each of the representative counties.
- Create inputs needed both by MOVES and by SMOKE, including a list of temperatures and activity data (see Sections 2.5.1.5 and 2.5.1.6).
- Run MOVES to create emission factor tables (see Section 2.5.1.7).
- Run SMOKE to apply the emission factors to activities to calculate emissions (see Section 2.5.1.8).
- Aggregate the results at the county-SCC level for summaries and quality assurance

The California emissions were post-processed to incorporate both CARB supplied inventories and the SMOKE-MOVES results (see Section 2.5.1.9).

[2] A beta version of SMOKE v3.1 was used for modeling the PM NAAQS. The release version is available at: http://www.smoke-model.org/index.cfm

2.5.1.1 Representative counties

Although EPA compiles county-specific databases for all counties in the nation, actual county-specific data is rare. Instead, much of our "county" data is based on state-wide estimates or national defaults. For the modeling platform, rather than explicitly modeling every county in the nation, we have done detailed modeling for some counties and less detailed estimates for the other counties. This approach dramatically reduces the number of modeling runs required to generate inventories and still takes into account important differences between counties.

In this approach, we group counties that have similar properties that would result in similar emission rates. We explicitly model only one county in the group (the "representative" county) to determine emission rates. These rates are then used in combination with county-specific activity and meteorology data, to generate inventories for all of the counties in the group. The grouping of counties was based on several characteristics as summarized in Table 2-12 below.

Table 2-12. Characteristics for grouping counties

County Grouping Characteristic	Description
PADD	Petroleum Administration for Defense Districts (PADDs). PADD 1 is divided into three sub-PADD groupings and each sub-group is treated as a separate PADD (1a, 1b and 1c). Each state belongs to a PADD and all counties in any state are within the same PADD.
Fuel Parameters	Weighted average gasoline fuel properties for January and July 2008, including RVP, sulfur level, ethanol fraction and percent benzene
Emission Standards	Some states have adopted California highway vehicle emission standards or plan to adopt them. Since implementation of the standards varies, each state with California standards is treated separately.
Inspection/Maintenance Programs	Counties were grouped within a state according to whether or not they had an inspection and maintenance (I/M) program. All I/M programs within a state were considered as a single program, even though each county may be administered separately and have a different program design.
Altitude	Counties were categorized as high or low altitude based on the criteria set forth by EPA certification procedures (4,000 feet above sea level).
Fleet Age	The weighted average age of passenger cars.

The result is a set of 146 county groups with similar fuel, emission standards, altitude, I/M programs and fleet age. For each group, the county with the highest total VMT was chosen as the representative county for the group.

For each county group, SMOKE-MOVES generated a set of emission rates that varied by SCC (vehicle type and road type), fuel, speed, temperature, and humidity; thus, we did not need to consider the fleet mix, fuel, speed, temperature range, or humidity in our grouping characteristics. This greatly increased the number of counties that can be grouped and reduced the number of MOVES runs required.

2.5.1.2 Fuel months

The concept of a fuel month is used to indicate when a particular set of fuel properties should be used in a MOVES simulation. Similar to the reference county, the fuel month reduces the computational time of MOVES by using a single month to represent a set of months. Because there are winter fuels and summer fuels, EPA used January to represent October through April and July to represent May through September. For example, if the grams/mile exhaust emission rates in January are identical to February's rates for a given reference county and temperature (as well as other factors), then we use a single fuel month to represent January and February. In other words, only one of the months needs to be modeled through MOVES. The hour-specific VMT, temperature and other factors for February are still used to calculate emissions in February, but the emission factors themselves do not need to be created since one month can represent the other month sufficiently.

2.5.1.3 Fuels

Although state-submitted NMIM and MOVES input data may have included information about fuel properties, the MOVES runs for the 2007 platform 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 following list provides a step-by-step outline of the process used by EPA to generate the 2007 county fuel properties:

1) Fuel properties from proprietary refinery certification data were compiled on a regional basis (based on typical pipeline delivery areas).

2) Properties within a region for finished fuel batches (e.g. no CBOB, RBOB or OBO fuel batches) produced in 2007, excluding RFG, were averaged to generate non-ethanol conventional gasoline fuel properties within that region, for a given month.

3) RFG fuel properties were based on RFG fuel compliance survey data, and oxygenate levels were assumed to be 10% ethanol (E10, no MTBE).

4) Refinery modeling results generated for the RFS2 rulemaking were used to adjust the regional conventional gasoline fuel properties to account for ethanol blending up to E10, for a given month.

5) Additional adjustments to fuel properties were performed on individual counties within a region, based on refinery modeling, for known local regulatory constraints such as low-RVP or oxygenate level mandates.

6) Appropriate E10 and conventional gasoline fuel market shares were calculated on a regional basis for the level of ethanol produced in 2007, after ethanol required for RFG compliance was taken into account.

7) Gasoline fuel properties and ethanol market shares were applied to each county regionally and accounting for known local regulatory constraints.

8) Diesel properties were assumed to be 15 ppm nationally with no significant biodiesel penetration.

2.5.1.4 Other local MOVES inputs

In addition to fuels and the information also needed by SMOKE (in the following sections), MOVES also required inputs such as age distribution and I/M program descriptions for each of the representative counties. At the county level, these inputs provide an opportunity to assure that the model properly accounts for the most recent available local data. When these data were available from the state-supplied NMIM inputs, we converted the NMIM data (version NCD20101201) for use in MOVES. EPA manually imported the 2008 data from Delaware and Utah into a MOVES format. Only data related to VMT, vehicle populations, speed distributions and age distributions were imported. Fuel data submitted by states was not used for the 2007 platform in order to use the latest EPA estimates and make selecting representing counties easier. Similarly, meteorological data from states were not used, since the NEI calculations used the SMOKE generated meteorological data instead. Other state data from the NMIM data format were not used because of the project schedule and resource constraints.

In the few cases where MOVES input data were provided, we used that data. When state-supplied data were not available, we used MOVES defaults. For the continental U.S., all of these MOVES inputs were organized by representative counties. This means that only the counties used to represent other counties had specific information for the MOVES runs.

2.5.1.5 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.

The 12-km gridded meteorological input data for the entire year of 2007 covering the continental United States were derived from simulations of version 3.1 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 3.6 (http://www.cmascenter.org/help/model_docs/mcip/3.6/ReleaseNotes) was used as the software for maintaining dynamic consistency between the meteorological model, the emissions model, and air quality chemistry model.

We applied the SMOKE-MOVES tool Met4moves to 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. “Temperature profiles” are arrays of 24 temperatures that describe how temperatures change over a day, and they are used by MOVES to estimate vapor venting emissions. The hourly gridded meteorological data (output from MCIP) was also used directly by SMOKE (see Section 2.5.1.8).

The temperature lists were organized based on the representative counties and fuel months as described in Sections 2.5.1.1 and 2.5.1.2, respectively. Temperatures were analyzed for all of the counties that are mapped to the representative counties, i.e., for the county groups, and for all the months that were mapped to the fuel months. We used Met4moves to determine the minimum and maximum temperatures in a county group for the January fuel month and for the July fuel month, and the minimum and maximum temperatures for each hour of the day. Met4moves also generated idealized temperature profiles using the minimum and maximum temperatures and 10 degree intervals. In addition to the meteorological data, the representative counties and the fuel months, Met4moves uses spatial surrogates to determine which grid cells from the meteorological data to collect temperature and relative humidity statistics. For example, if a county had a mountainous area with no roads, this would be excluded from the meteorological statistics.

The treatment of humidity was simpler. Met4moves calculated an average day-time (6 am to 6 pm) relative humidity for the county group for the months mapped to July and for the months mapped to January. The humidity was also averaged over the grid cells intersecting the counties in the county group. When the emission factors are applied by SMOKE (Section 2.5.1.8), the appropriate (July or January) humidity was used for all runs of the county group.

Met4moves can be run in daily or monthly mode for producing SMOKE input. In monthly mode, the temperature range is determined by looking at the range of temperatures over the whole month for that specific county. Therefore, there is one temperature range per county per month. While in daily mode, the temperature range is determined by evaluating the range of temperatures in that county for each day. The output for the daily mode is one temperature range per county per day and is a more detailed approach for modeling the vapor venting (RPP) based emissions. EPA ran Met4moves in daily mode for the 2007 platform.

2.5.1.6 VMT, vehicle population, and speed

SMOKE requires county-specific VMT, vehicle population, and average speed by SCC to calculate the gridded or county emissions. Unlike the other inputs that are needed just for the representative counties, these inputs are needed for every county. In some cases, speeds were provided by states. The state-submitted input data are described in Section 2.5.1.4. If speeds were not provided by states, the average speeds provided to SMOKE for each county were derived from the default national average speed distributions found in the default MOVES2010b database AvgSpeedDistribution table. These average speeds are the average speeds developed for the previous EPA highway vehicle emission factor model, MOBILE6. EPA used the MOVES distribution of average speeds for each hour of the day for each road type to calculate an overall average speed for each hour of the day. These hourly average speeds were weighted together using the default national average hourly VMT distribution found in the MOVES default database HourlyVMTFraction table, to calculate an average speed for each road type. This average speed by road type was provided to SMOKE for each county.

SMOKE requires estimates of VMT by county and SCC. The annual VMT values calculated for calendar year 2007 were estimated using VMT estimates from the Federal Highway Administration (FHWA) for 2007 and 2008, combined with the state-supplied VMT estimates submitted for the 2008 calendar year. The FHWA estimates can be found in the vehicle miles of travel by functional system table (VM-2) and can be obtained from the web at:
http://www.fhwa.dot.gov/policyinformation/statistics/2007/ and
http://www.fhwa.dot.gov/policyinformation/statistics/2008/.

The VMT data in the VM-2 tables are broken out by state and Highway Performance Monitoring System (HPMS) road type. We combined the VMT values from both 2007 and 2008 into a single table (matched on state and road type) and calculated an adjustment factor (2007 VMT / 2008 VMT) for each state and road type.
FHWA VM-2 table includes Puerto Rico, but not the Virgin Islands. We assumed that the adjustment factor for VMT for the Virgin Islands is proportional to the small change in human population (approximately 0.2%).

The VMT used for the 2008 NEI is obtained from the by county and SCC FF10 format file (http://www.smoke-model.org/version3.1/html/ch08s02s04.html#d0e40584) used with SMOKE for Version 2 of the 2008 NEI (VMT_NEI_2008_updated2_18jan2012_v3.csv). These FF10 data do not include VMT for Alaska, Hawaii, Puerto Rico or the Virgin Islands (AK/HI/PR/VI). VMT data for these locations were obtained from the original VMT developed for the 2008 NEI in the National Mobile Inventory Model (NMIM) National County Database (NCD) version NCD20101201. These data were aggregated from the MOBILE6 vehicle classes into the SCC vehicle classes and allocated to months using the MOBILE6 default monthly VMT fractions (NEI2008_VMT_AKHIPRVI_FF10.csv). Finally, rows with zero VMT were removed.

The 2007 VMT values were calculated by applying the adjustment factors calculated from the FHWA tables to the appropriate rows in the 2008 VMT data, matching on state and HPMS road type. This means that the same adjustment was used for all counties in a state and that all SCC vehicle types use the same adjustment for each road type. The resulting 2007 VMT includes VMT estimates by county and SCC for all states, Washington D.C., Puerto Rico and the Virgin Islands.

SMOKE also requires vehicle population estimates for each county by SCC vehicle type. Population estimates for calendar year 2007 were determined by applying the population to VMT ratio obtained from running the MOVES2010b emission factor model for calendar year 2007 with results for annual VMT and population by SCC. These national default values for VMT and vehicle population were used to develop ratios specific to the 12 SCC vehicle types.

Using the 2007 VMT values calculated previously, the ratios were applied to each appropriate SCC vehicle type value aggregated across all road types to calculate a corresponding vehicle population value in each county. The 2007 population results were converted to FF10 format.

2.5.1.7 Run MOVES to create emission factors

EPA used the SMOKE-MOVES driver scripts to run MOVES for each of the representative counties, fuel-months, and the listed temperatures and temperature profiles. The runspec generator created a series of runspecs (MOVES jobs) based on the outputs from Met4moves. Specifically, the script used a 5 degree bin and the minimum and maximum temperature ranges from Met4moves and used the idealized diurnal profiles from Met4moves to generate a series of MOVES runs that captured the full range of temperatures for each representative county. The SMOKE-MOVES driver scripts resulted in three emission factors (EF) tables for each representative county and fuel month: rate per distance (RPD), rate per vehicle (RPV), and rate per profile (RPP). After the MOVES runs were completed, the post-processor Moves2smk converted the MySQL tables into EF files that can be read by SMOKE. For more details, see Section 3.2.2.2 or the SMOKE documentation: http://www.smoke-model.org/version3.1/html/ch05s02s04.html.

2.5.1.8 Run SMOKE to create emissions

Lastly, we generated air quality model ready emissions at a gridded and hourly resolution. The Movemrg SMOKE-MOVES program performs this function by combining activity data, meteorological data, and emission factors to produce gridded, hourly emissions. We ran Movesmrg for each of the three sets of emission factor tables (RPD, RPV, and RPP). During the Movesmrg run, the program used the hourly, gridded temperature (for RPD and RPV) or daily temperature profile (for RPP) to select the proper emissions rates and compute emissions. These calculations were done for all counties and SCCs in the SMOKE inputs, covering the continental U.S.

The emissions process RPD is for modeling the on-network emissions. This includes the following modes: vehicle exhaust, evaporation, evaporative permeation, break wear, and tire wear. For RPD, the activity data is monthly VMT, monthly speed (SPEED), and hourly speed profiles for weekday versus weekend (SPDPRO)[3]. The SMOKE program Temporal takes vehicle and roadtype specific temporal profiles and distributes the monthly VMT to day of the week and hour. Movesmrg reads the speed data for that county and SCC and the temperature from the gridded hourly (MCIP) data and uses these values to look-up the appropriate emission factors (EFs) from the representative county's EF table. It then multiplies this EF by temporalized VMT to calculate the emissions for that grid cell and hour. This is repeated for each pollutant and SCC in that grid cell.

The emission process RPV is for modeling the off-network emissions. This includes the following modes: vehicle exhaust, evaporative, and evaporative permeation. For RPV, the activity data is vehicle population (VPOP). Movesmrg reads the temperature from the gridded hourly data and uses the temperature plus SCC and the hour of the day to look up the appropriate EF from the representative county's EF table. It then multiplies this EF by the VPOP for that SCC and FIPS to calculate the emissions for that grid cell and hour. This repeats for each pollutant and SCC in that grid cell.

The emission process RPP is for modeling the off-network emissions for parked vehicles. This includes the mode vehicle evaporative (fuel vapor venting). For RPP, the activity data is VPOP. Movesmrg reads the county based diurnal temperature range (Met4moves' output for SMOKE). It uses this temperature range to determine a similar idealized diurnal profile from the EF table using the temperature min and max, SCC, and hour of the day. It then multiplies this EF by the VPOP for that SCC and FIPS to calculate the emissions for that grid cell and hour. This repeats for each pollutant and SCC within the county.

The result of the Movesmrg processing is hourly, gridded data suitable for use in air quality modeling as well as daily reports for the three processing streams (RPD, RPV, and RPP). The results include emissions for every county in the continental U.S., rather than just for the representative counties.

After running SMOKE-MOVES for the RPD, RPV and RPP processes have completed, we used the SMOKE program Mrggrid to combine RPD, RPV and RPP model ready outputs into a single onroad model ready output.

2.5.1.9 California emissions

The California 2007 onroad emissions were provided by California Air Resources Board (CARB). The 2007 and 2020 onroad emissions were produced from versions of EMFAC2011-LD and EMFAC2011-HD with default activity assumptions. We did not model the CARB emissions directly because all emissions were reported as occurring on local roads. We also wanted to take advantage of the temperature dependence in the SMOKE-MOVES approach. We developed an approach to merge the CARB data with the SMOKE-MOVES results in order to reflect California's unique rules in the total emissions while leveraging the more detailed SCCs and the highly resolved spatial patterns, temporal patterns, and speciation from SMOKE-MOVES.

The basic steps involved in merging CARB onroad emissions with SMOKE-MOVES were:

- Sum CARB emissions to county/pollutant annual totals across all emission modes (excluding refueling) and SCCs
- Sum SMOKE-MOVES emissions to county/pollutant annual totals across all emission modes (excluding refueling) and SCCs

[3] If the SPDPRO is available, the hourly speed takes precedence over the average speed in the SPEED inventory.

- Create county/pollutant ratios by dividing the CARB emissions (county/pollutant totals) by the appropriate SMOKE-MOVES emissions (county/pollutant totals)[4].
- Distribute the county/pollutant ratios to grid cells by using the land area spatial surrogate to determine which grid cells are completely within one county versus those that overlap multiple counties.[5]
- Determine the grid cells that fall completely within California, i.e. cells that do not overlap Arizona, Oregon, or Nevada.
- Multiply the gridded ratios by the SMOKE-MOVES onroad model-ready files (merged combination of RPD, RPP, RPV but excluding refueling). For all cells that do not fall completely within California, multiply by a ratio of 1

This process created adjusted model-ready files that approximately sum to CARB annual totals but have the temporal and spatial patterns reflecting the highly resolved meteorology and SMOKE-MOVES. After adjusting the California emissions, we call this sector "onroad_adj".

2.5.2 Onroad refueling (onroad_rfl)

Onroad refueling is modeled very similarly to other onroad emissions (see Section 2.5.1.8). MOVES2010b can produce EFs for refueling. These EFs are at the resolution of the onroad SCCs. We ran the refueling EFs separately from the other onroad mobile sources to allow for different spatial allocation. To facilitate this, we first separated out the EFs from the refueling process into RPD refueling and RPV refueling tables[6]. We 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). For California, we use the SMOKE-MOVES generated emissions for onroad refueling without any adjustments because we did not have CARB supplied refueling emissions.

Lastly, we used the Mrggrid SMOKE program to combine 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.

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. We used year-2007 CARB inventories for California after several preprocessing steps discussed below.

<u>NMIM (non-California) nonroad</u>
NMIM ran the publically released version of NONROAD, NR08a, which models all in-force nonroad controls, including the marine spark ignited (SI) and small SI engine final rule, published May 2009 (EPA, 2008). The NMIM version is NMIM20090504d, which has the same results as the publicly-released NMIM version NMIM20090504a. The underlying National County Database (NCD) is NCD20101201, but with 2007 meteorology inserted into the countymonthhour table. NCD20101201 includes state inputs for the 2008 NEI.

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[4] We created these ratios for all matching pollutants. We also duplicated the ratios for all appropriate modeling species. For example, we used the NO_X ratio for NO, NO_2, HONO and use the $PM_{2.5}$ ratio for PEC, PNO_3, POC, PSO_4, and PMFINE (For more details on NO_X and PM speciation, see Sections 3.2.3 and 3.2.2). For VOC model-species, if there was an exact match (e.g. BENZENE), we used that HAP pollutant ratio. For other VOC based model-species that didn't exist in the CARB inventory, we used VOC ratios.

[5] More specifically, for those grid cells that fall completely within one county, the county/pollutant ratios are used without further adjustment. For those grid cells that overlap more than one county, the county specific ratios are weighted according to the % of land area within each county.

[6] The Moves2smk post-processing script has command line arguments that will either consolidate or split out the refueling EF.

The NMIM run, 2007PfBase2007Nr, only includes states in our emission modeling domain; 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 countymap2007pf. The fuels database, regionalfuels_2007_20120323fuelsNMIM, is a conversion to NMIM format of the MOVES fuels.

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/OTAQ ran NMIM to create county-SCC emissions and we removed California emissions because they were replaced with a CARB inventory. Emissions were converted from monthly totals to SMOKE-ready FF10 format (http://www.smoke-model.org/version3.1/html/ch08s02s04.html#d0e40584) monthly average-day based on the number of days in each month. We retained only CAPs and the necessary HAPs: BAFM, HCl, Cl, 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).

We 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. 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.

The starting point for the c1c2rail sector is the 2008 NEI nonpoint inventory. As discussed in Table 2-1 and Table 2-2, the c1c2rail SCCs were extracted from the NEI nonpoint inventory. Table 2-13 lists the NEI SCCs included in this sector.

Table 2-13. 2008 NEI SCCs extracted for the starting point in c1c2rail development

SCC	Description: Mobile Sources prefix for all
2280002100	Marine Vessels; Commercial; Diesel; Port
2280002200	Marine Vessels; Commercial; Diesel; Underway
2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations
2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations
2285002008	Railroad Equipment; Diesel; Line Haul Locomotives: Passenger Trains (Amtrak)
2285002009	Railroad Equipment; Diesel; Line Haul Locomotives: Commuter Lines
2285002010	Railroad Equipment; Diesel; Yard Locomotives

We included several modifications to this sector based on the availability of improved data from other sources and analysis with the NEI point inventory. We describe these modifications here:

<u>Duplicate rail yard emissions removed</u>

The 2008 NEI point inventory contains rail yard emissions for several states and counties. We analyzed the NEI point and nonpoint inventories for counties with significant rail yard emissions in both inventories. We assumed that the point inventory contained more accurate information when both inventories contained rail yard emissions. Therefore, we removed nonpoint rail yards in the c1c2rail sector for the states and counties listed in Table 2-14.

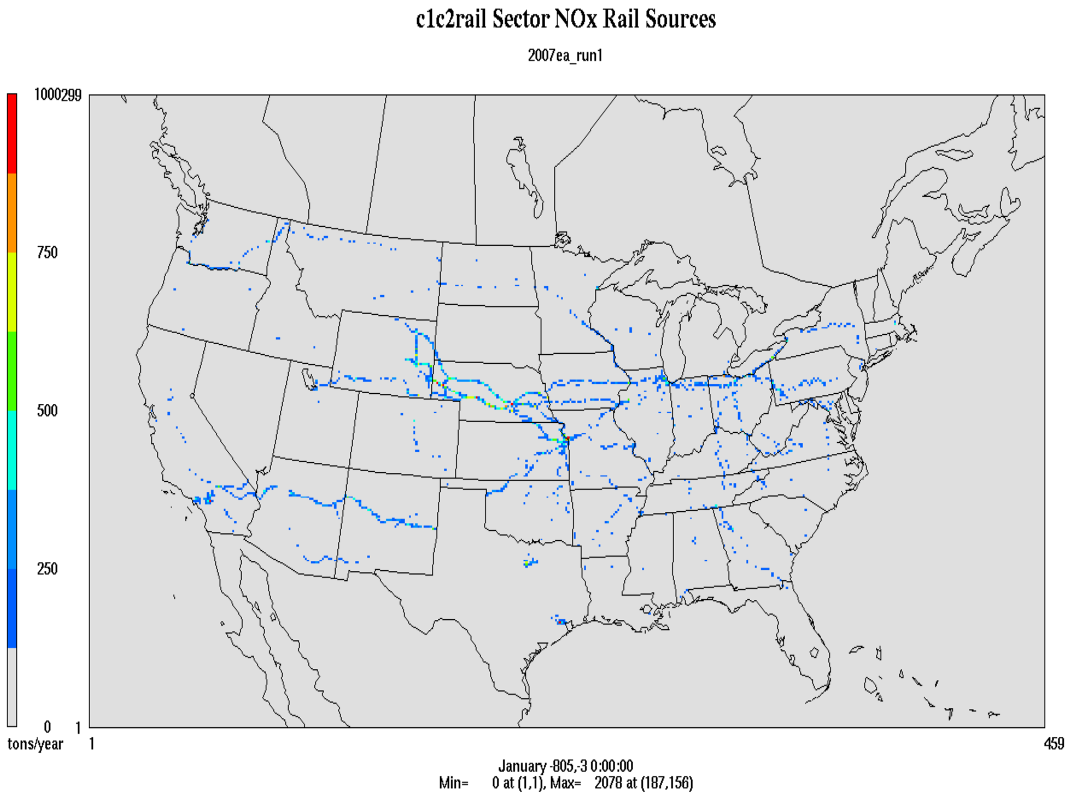
Table 2-14. Counties where c1c2rail sector rail yard emissions were removed

FIPS Code	State	County
04013	Arizona	Maricopa
06001	California	Alameda
06013	California	Contra Costa
06019	California	Fresno
06025	California	Imperial
06029	California	Kern
06037	California	Los Angeles
06061	California	Placer
06063	California	Plumas
06067	California	Sacramento
06071	California	San Bernardino
06077	California	San Joaquin
06085	California	Santa Clara
06099	California	Stanislaus
24001	Maryland	Allegheny
24021	Maryland	Frederick
24043	Maryland	Washington
24510	Maryland	Baltimore
41017	Oregon	Deschutes
41035	Oregon	Klamath
41039	Oregon	Lane
41043	Oregon	Linn
41051	Oregon	Multnomah
41059	Oregon	Umatilla
41061	Oregon	Union

Replaced Texas Class I and Class II/III Operations emissions

Analysis of the total rail emissions in the 2008 NEI showed what appeared to be missing rail line emissions in Texas. We found that line haul emissions from Texas were essentially zero because of challenges faced in using EIS for the first time in 2008. This error is reflected in Figure 2-7 where rail line emissions are missing in Texas. Therefore, we removed all line haul emissions from the 2008 NEI (which are zero for most records) and added information from an EPA default dataset of Texas line haul emissions. These EPA line haul emissions are restricted to the Class I and Class II/III operations and add approximately 52,000 tons of NO_X to Texas that would otherwise be missing. We consulted Texas on this change and it was agreed that this was the best solution.

Figure 2-7. NO_X rail emissions in 2008 NEI



Replaced Texas C1/C2 CMV emissions with improved dataset

For several Texas counties, the C1/C2 CMV emissions in the 2008 NEI included EPA gap filled values where shape IDs were not populated on submittal. The intended Texas submittal was often much smaller than the EPA-estimated default value for several counties. An example of this is Harris county (FIPS=48201) where the Texas submittal was approximately 1,200 tons of NO_X for port and underway emissions but not all shape IDs were included. The NEI methodology used EPA emissions where Texas did not provide estimates and the resulting double count and overestimate of this top-down method resulted in over 49,000 tons of NO_X in the 2008 NEI in Harris county, Texas. Therefore, we went back to the original Texas submittal, did not append any EPA emissions, and summed up port and underway for our modeling files to the county level. Corrections to c1c2rail emissions in places where errors similar to this occurred may be released in a future version of the 208 NEI. Other states were impacted by this error in the 2008 NEI but for many of these states, alternative data were used as discussed below.

Replaced all California C1/C2 CMV and rail data with CARB data

As discussed in Section 2.5.3, the California Air Resources Board (CARB) provided year 2007 emissions for all mobile sources, including C1/C2 CMV and rail. California year 2007 emissions were provided by CARB and are documented in a staff report available at: http://www.arb.ca.gov/regact/2010/offroadlsi10/offroadisor.pdf.

The C1/C2 CMV emissions were obtained from the CARB nonroad mobile dataset that includes the 2007 regulations to reduce emissions from diesel engines on commercial harbor craft operated within California waters and 24 nautical miles of the California baseline. These emissions were developed using Version 1 of the CEPAM that 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 mobile methodology, including c1c2rail sector data, are provided here: http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles. We converted the CARB inventory TOG to VOC by dividing the inventory TOG by the available VOC-to-TOG speciation factor. See Section 3.2.1.3 for more details on c1c2rail speciation.

The RPO and CARB inventories did not include HAPs; therefore, we processed all non-NEI source emissions in the c1c2rail sector using VOC speciation.

Replaced all C1/C2 CMV and rail data for states in 3 RPOs

As discussed in Section 2.2, we received year-2007 inventories for many sectors from three RPOs: MARAMA, MWRPO and SESARM. We used the RPO emissions in these areas and removed all 2008 NEI c1c2 CMV and rail emissions for states in these three RPOs to prevent double counting. We used the emissions data from the MARAMA rather than SESARM dataset for Virginia because the SESARM data included some rather large emissions for Commuter Lines (SCC=2285002009) that were not reflected in either the 2008 NEI or the MARAMA dataset. We were unable to confirm that these emissions were reliable and not potentially reflected in other rail SCCs.

The MWRPO year-2007 c1c2rail data were obtained from a subset of their version 7 emissions modeling file "nrinv.mwrpo_alm.baseCv7.annual.orl.txt", where MWRPO NEI Inventory Format (NIF)-formatted data were converted to SMOKE ORL format. The MARAMA dataset was obtained from a subset of their version 3.3 January 27, 2012 vintage file "ARINV_2007_MAR_Jan2012.txt". The SESARM dataset was obtained from a subset of the file "nrinv.alm.semap.base07.v093010.orl.txt" developed for the Southeastern Modeling, Analysis, and Planning (SEMAP) project. All RPO datasets were edited to remove non-c1c2rail sources. The background and contact information for these RPO datasets can be found via the web links and contacts provided at the beginning of Section 2.

We made several modifications to the RPO c1c2rail data. We changed the county FIPS code field in the MARAMA RPO dataset from Clifton Forge (FIPS=51560) to Allegheny county (FIPS=51005) because Clifton Forge is no longer its own county in our SMOKE ancillary input files. We also corrected a misclassified SCC in several Virginia counties. MARAMA reported an unknown SCC 2283000000 in Massachusetts that we changed to "diesel-military" (SCC=2280002040) based on analyses of sources in other counties. We also removed likely duplicate C1/C2 CMV emissions in four New York counties where a broad SCC (2280002000) was reported alongside more specific SCCs reflecting port (2280002100) and/or underway (2280002200) processes in the same inventory. These four New York counties (and FIPS) are: Nassau (36059), Queens (36081), Richmond (36085) and Suffolk (36103).

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. An overview of the C3 ECA Proposal to the International Maritime Organization (EPA-420-F-10-041, August 2010) project and future-year goals for reduction of NO_X, SO_2, and PM C3 emissions can be found at: http://www.epa.gov/oms/regs/nonroad/marine/ci/420r09019.pdf. The resulting ECA-IMO coordinated strategy, including emission standards under the Clean Air Act for new marine diesel engines with per-cylinder displacement at or above 30 liters, and the establishment of Emission Control Areas is at: http://www.epa.gov/oms/oceanvessels.htm. We converted the ECA-IMO emissions data to SMOKE point-source ORL input format as described in http://www.epa.gov/ttn/chief/conference/ei17/session6/mason.pdf.

As described in the paper, the ASCII raster dataset was converted to latitude-longitude, mapped to state/county FIPS codes that extended up to 200 nautical miles (nm) from the coast, assigned stack parameters, and monthly ASCII raster dataset emissions were used to create monthly temporal profiles. Counties were assigned as extending up to 200nm from the coast because this was the distance to the edge of the U.S. Exclusive Economic Zone (EEZ), a distance that defines the outer limits of ECA-IMO controls for these vessels.

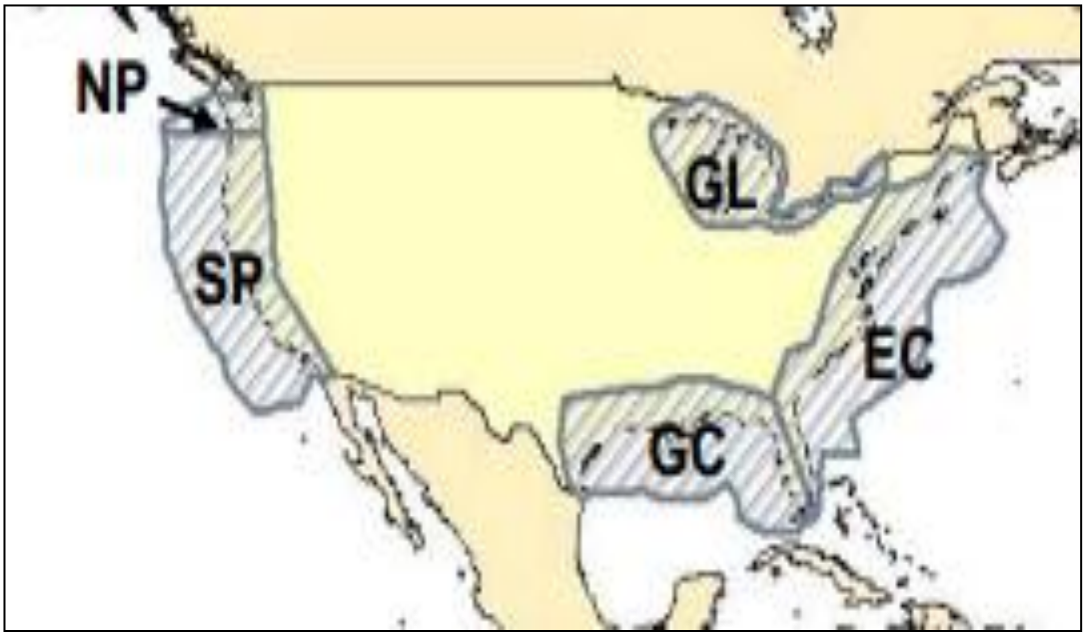
The base year ECA inventory is 2002 and consists of these CAPs: PM_{10}, $PM_{2.5}$, CO, CO_2, NH_3, NO_X, SO_X (assumed to be SO_2), and Hydrocarbons (assumed to be VOC). The EPA developed regional growth (activity-based) factors that we applied to create the 2007v5 inventory from the 2002 data. These growth factors are provided in Table 2-15. The geographic regions listed in the table are shown in Figure 2-8. The East Coast and Gulf Coast regions were divided along a line roughly through Key Largo (longitude 80° 26' West).

We assigned Canadian near-shore emissions to province-level FIPS codes and paired those to region classifications for British Columbia (North Pacific), Ontario (Great Lakes) and Nova Scotia (East Coast). The assignment of U.S. FIPS was also restricted to state-federal water boundaries data from the Mineral Management Service (MMS) that extended only (approximately) 3 to 10 miles off shore. Emissions outside the 3 to 10 mile MMS boundary but within the approximately 200 nm EEZ boundary in Figure 2-8 were projected to year 2007 using the same regional adjustment factors as the U.S. emissions; however, the FIPS codes were assigned as "EEZ" FIPS. Note that state boundaries in the Great Lakes are an exception, extending through the middle of each lake such that all emissions in the Great Lakes are assigned to a U.S. county or Ontario. The classification of emissions to U.S. and Canadian FIPS codes is primarily needed only for inventory summaries and is irrelevant for air quality modeling except potentially for source apportionment of states contributions to transport.

Table 2-15. Growth factors to project the 2002 ECA-IMO inventory to 2007

		2007 Adjustments Relative to 2002					
Region	**EEZ FIPS**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**VOC (HC)**	**CO**	**SO_2**
East Coast (EC)	85004	1.191	1.258	1.260	1.259	1.258	1.258
Gulf Coast (GC)	85003	1.087	1.149	1.146	1.148	1.149	1.149
North Pacific (NP)	85001	1.131	1.188	1.172	1.188	1.188	1.188
South Pacific (SP)	85002	1.221	1.292	1.290	1.284	1.282	1.295
Great Lakes (GL)	n/a	1.076	1.099	1.099	1.100	1.099	1.099
Outside ECA	98001	1.165	1.230	1.230	1.230	1.230	1.230

Figure 2-8. Illustration of regional modeling domains in ECA-IMO study



We converted the emissions to SMOKE point source ORL format, allowing for the emissions to be allocated to modeling layers above the surface layer. We also corrected FIPS code assignments for one county in Rhode Island. All non-US emissions (i.e., in waters considered outside of the 200 nm EEZ, and hence out of the U.S. and Canadian ECA-IMO controllable domain) are simply assigned a dummy state/county FIPS code=98001 and thus projected to year 2007 via the "Outside ECA" factors in Table 2-15. The SMOKE-ready data have also been cropped from the original ECA-IMO entire northwestern quarter of the globe to cover only the large continental U.S. 36-km "36US1" air quality model domain, the largest domain we currently use.

Other modifications to the original ECA-IMO c3marine dataset include updated Delaware county total emissions that reflect comments received during the Cross-State Air Pollution Rule (CSAPR) emissions modeling platform development: http://www.epa.gov/ttn/chief/emch/index.html#final. The original ECA-IMO inventory also did not delineate between ports and underway (or other C3 modes such as hoteling, maneuvering, reduced-speed zone, and idling) emissions; however, we used a U.S. ports spatial surrogate dataset to assign the ECA-IMO emissions to ports and underway SCCs - 2280003100 and 2280003200, respectively. This has no effect on temporal allocation or speciation because all C3 emissions, unclassified/total, port and underway, share the same temporal and speciation profiles. See Section 3.2.1.3 for more details on c3marine speciation.

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 Canada we use year-2006 Canadian emissions but applied several modifications to the inventories:

i. We did not include wildfires, or prescribed burning because Canada does not include these inventory data in their modeling.
ii. We did not include in-flight aircraft emissions because we do not include these for the U.S. and we do not have a finalized approach to include in our modeling.
iii. We applied a 75% reduction ("transport fraction") to PM for the road dust, agricultural, and construction emissions in the Canadian "afdust" inventory. This approach is more simplistic than the county-specific approach used for the U.S., but a comparable approach was not available for Canada.
iv. We did not include speciated VOC emissions from the ADOM chemical mechanism because we use speciated emissions from the CB5 chemical mechanism that Canada also provided.
v. Residual fuel CMV (C3) SCCs (22800030X0) were removed because these emissions are included in the c3marine sector, which covers not only emissions close to Canada but also emissions far at sea. Canada was involved in the inventory development of the c3marine sector emissions.
vi. Wind erosion (SCC=2730100000) and cigarette smoke (SCC=2810060000) emissions were removed from the nonpoint (nonpt) inventory; these emissions are also absent from our U.S. inventory.
vii. Quebec $PM_{2.5}$ emissions (2,000 tons/yr) were removed for one SCC (2305070000) for Industrial Processes, Mineral Processes, Gypsum, Plaster Products due to corrupt fields after conversion to SMOKE input format. This error should be corrected in a future inventory.
viii. Excessively high CO emissions were removed from Babine Forest Products Ltd (British Columbia SMOKE plantid='5188') in the point inventory. This change was made at our discretion because the value of the emissions was impossibly large.
ix. The county part of the state/county FIPS code field in the SMOKE inputs were modified in the point inventory from "000" to "001" to enable matching to existing temporal profiles.

For Mexico we used emissions for year 2008 that are projections of their 1999 inventory originally developed by Eastern Research Group Inc., (ERG, 2006) as part of a partnership between Mexico's Secretariat of the Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales-SEMARNAT) and National Institute of Ecology (Instituto Nacional de Ecología-INE), the U.S. EPA, the Western Governors' Association (WGA), and the North American Commission for Environmental Cooperation (CEC). This inventory includes emissions from all states in Mexico. A background on the development of year-2008 Mexico emissions from the 1999 inventory is available at: http://www.wrapair.org/forums/ef/inventories/MNEI/index.html.

The offshore emissions include point source offshore oil and gas drilling platforms. We used emissions from the 2008 NEI point source inventory. The offshore sources were provided by the Mineral Management Services (MMS).

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. The pre-processing steps involving temporal allocation, spatial allocation, pollutant speciation, and vertical allocation of point sources are referred to as emissions modeling.

As seen in Section 2, the temporal resolution of the emissions inventories input to SMOKE for the 2007 platform varies across sectors, and may be hourly, monthly, or annual total emissions. The spatial resolution, which also can be different for different sectors, may be individual point sources or county totals with province totals for Canada and municipio totals for Mexico. This section provides some basic information about the tools and data files used for emissions modeling as part of the 2007 platform. Since we devoted Section 2 to describing the emissions inventories, we have limited the descriptions of data in this section to the ancillary data SMOKE uses to perform the emissions modeling steps. Note that all SMOKE inputs for the 2007v5 platform emissions are available at the 2007v5 website (see Section 1).

We used SMOKE version 3.1 beta to pre-process the raw emissions to create the emissions inputs for CMAQ. We utilized the feature in SMOKE to create combination speciation profiles that could vary by state/county FIPS code and by month; we used this approach for some mobile sources as described in Section 0. For sectors that have plume rise, we used the in-line emissions capability of the air quality model for plume rise, and therefore created source-based emissions files rather than the much larger 3-dimensional files. Emissions totals by specie for the entire model domain are output as reports that are then compared to reports generated by SMOKE to ensure mass is not lost or gained during this conversion 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 for 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: "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 (further described in Section3.4.2). The "Speciation" column indicates that all sectors use the SMOKE speciation step, though biogenics speciation is done within BEIS3 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 which will have 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 ptfire sectors are the only sectors with only "in-line" emissions, meaning that all of the emissions are placed in aloft layers and thus there are no emissions for those sectors in the two-dimensional, layer-1 files created by SMOKE.

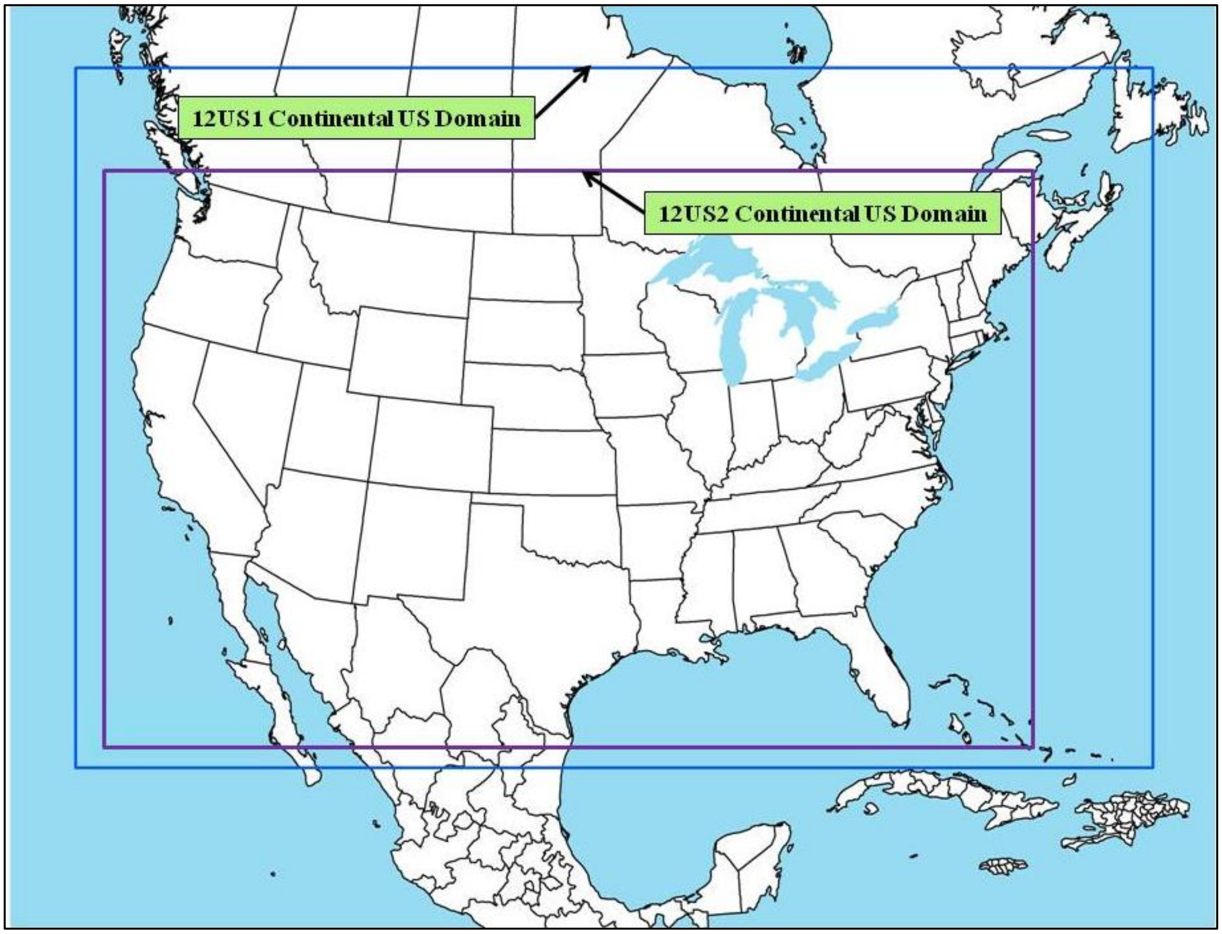
Table 3-1. Key emissions modeling steps by sector.

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

In addition to the above settings, we used the PELVCONFIG file, which can be optionally used to group sources so that they are treated as a single stack by SMOKE when computing plume rise. For the 2007v5 platform we chose to have no grouping because grouping done for "in-line" processing will not give identical results as "offline" (i.e., processing whereby SMOKE creates 3-dimensional files). The only way to get the same results between in-line and offline is to choose to have no grouping.

We ran SMOKE for the large12-km CONtinental United States "CONUS" modeling domain for boundary conditions in the 2007 evaluation case and windowed emissions down to the smaller CONUS US 12-km modeling domain (12US2) shown in Figure 3-1.

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 describes the grids for the two domains.

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 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 2005 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.

The approach for speciating $PM_{2.5}$ emissions supports both CMAQ 4.7.1 and CMAQ 5.0, which includes additional speciation of $PM_{2.5}$ into a larger set of PM model species than is listed above (see Section 3.2.2.1 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) which is the EPA's repository of TOG and PM speciation profiles of air pollution sources. However, a few of the profiles we used in the v5 platform will be published in later versions of the SPECIATE database after the release of this documentation.

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 $PM_{2.5}$.

Table 3-3. Model species produced by SMOKE for CB05 with SOA for CMAQ4.7.1 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	ALD2	Acetaldehyde
	ALDX	Propionaldehyde and higher aldehydes
	BENZENE	Benzene (not part of CB05)
	CH4	Methane[7]
	ETH	Ethene
	ETHA	Ethane
	ETOH	Ethanol
	FORM	Formaldehyde
	IOLE	Internal olefin carbon bond (R-C=C-R)
	ISOP	Isoprene
	MEOH	Methanol
	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
$PM_{2.5}$	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)	PCL	Particulate chloride
	PNA	Particulate sodium

*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, and CMAQ PMFINE= CAM_X FPRM

[7] 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.

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, we 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 below) 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. We believe that generally, the HAP emissions from the NEI are more representative of emissions of these compounds than their generation via VOC speciation.

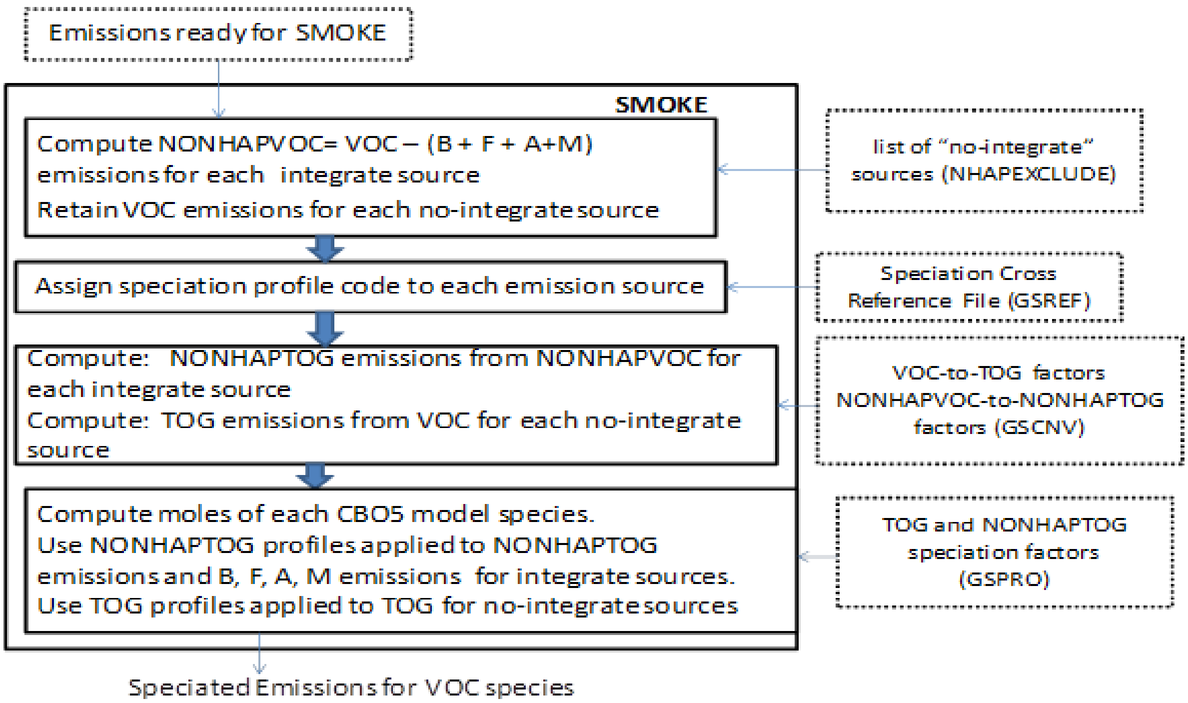
We chose the HAPs benzene, acetaldehyde, formaldehyde and methanol (BAFM) because, with the exception of BENZENE, they are the only explicit VOC HAPs in the base version of CMAQ 4.7.1 (CAPs only with chlorine chemistry) model. By "explicit VOC HAPs," we mean model species that participate in the modeled chemistry using the CB05 chemical mechanism. We denote the use of these HAP emission estimates along with VOC as "HAP-CAP integration". BENZENE was chosen because it was added as a model species in the base version of CMAQ 4.7.1, and there was a desire to keep its emissions consistent between multi-pollutant and base versions of CMAQ.

For specific sources, especially within the onroad and onroad_rfl sectors, we included ethanol in our integration. To differentiate when a source was integrating BAFM versus EBAFM (ethanol in addition to BAFM), the speciation profiles which do not include ethanol are referred to as an "E-profile", for example E10 headspace gasoline evaporative speciation profile 8763 where ethanol is speciated from VOC, versus 8763E where ethanol is obtained directly from the inventory.

The integration of HAP VOC with VOC is a feature available in SMOKE for all inventory formats other than PTDAY (the format used for the ptfire sector). SMOKE allows the user to specify the particular HAPs to integrate and the particular sources to integrate. The particular HAPs to integrate are specified in the INVTABLE file, and the particular sources to integrate are based on the NHAPEXCLUDE file (which actually provides the sources that are *excluded* from integration[8]). For the "integrate" sources, SMOKE subtracts the "integrate" HAPs from the VOC (at the source level) to compute emissions for the new pollutant "NONHAPVOC." The user provides NONHAPVOC-to-NONHAPTOG factors and NONHAPTOG speciation profiles. SMOKE computes NONHAPTOG and then applies the speciation profiles to allocate the NONHAPTOG to the other air quality model VOC species not including the integrated HAPs. After determining if a sector is to be integrated, if all sources have the appropriate HAP emissions, then the sector is considered fully integrated (full integrate) and does not need a NHAPEXCLUDE file. If on the other hand, certain sources do not have the necessary HAPs, then one needs to construct a NHAPEXCLUDE file based on the evaluation of each source's pollutant mix. The process of partial integration for BAFM is illustrated in Figure 3-2. Note that we did not need to remove BAFM from any sources in a partially integrated sector, which is different from previous platforms.

[8] In SMOKE version 3.1, the options to specify sources for integration are expanded so that a user can specify the particular sources to include or exclude from integration, and there are settings to include or exclude all sources within a sector.

Figure 3-2. Process of integrating BAFM with VOC for use in VOC Speciation



For EBAFM integration, this process would be identical to the above figure except for the addition of ethanol (E) to the list of subtracted HAP pollutants. For full integration, the process would be very similar except that the NHAPEXCLUDE file would not be used and all sources in the sector would be integrated.

We considered CAP-HAP integration for all sectors and developed "integration criteria" for some of them (see Section 3.2.1.3 for details)

We prepared two different types of INVTABLE files to use with different sectors of the platform. For sectors in which we chose no integration across the entire sector (see Table 3-4), we created a "no HAP use" INVTABLE in which the "KEEP" flag is set to "N" for BAFM pollutants. Thus, any BAFM pollutants in the inventory input into SMOKE are dropped. This approach both avoids double-counting of these species and assumes that the VOC speciation is the best available approach for these species for the sectors using the approach. The second INVTABLE, used for sectors in which one or more sources are integrated, causes SMOKE to keep the BAFM pollutants and indicates that they are to be integrated with VOC (by setting the "VOC or TOG component" field to "V" for all four HAP pollutants. We further differentiate this integrate INVTABLE into those that integrate BAFM versus those that integrate EBAFM (for example for the onroad and onroad_rfl 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	No integration
avefire	No integration
ag	N/A – sector contains no VOC
afdust	N/A – sector contains no VOC
nonpt	Partial integration (BAFM and EBAFM)
nonroad	For other than California: Partial integration (BAFM). 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 I
othon	No integration

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

3.2.1.2 County specific profile combinations (GSPRO_COMBO)

We 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).

We 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.

For the c1c2rail sector, we 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, we processed all non-NEI source emissions in the c1c2rail sector as no integrate. For California, we converted the CARB inventory TOG to VOC by dividing the inventory TOG by the available VOC-to-TOG speciation factor.

For the c3marine sector, we computed HAPs directly from the CAP inventory; therefore, the entire sector utilizes CAP-HAP VOC integration 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 emissions are derived from the following equations:

$$\text{Benzene} = \text{VOC} * 9.795\text{E-}06$$
$$\text{Acetaldehyde} = \text{VOC} * 2.286\text{E-}04$$
$$\text{Formaldehyde} = \text{VOC} * 1.5672\text{E-}03$$

For the onroad and onroad_rfl sectors, there are series of unique speciation issues. First, we are using SMOKE-MOVES (see Section 2.5.1.7 and Section 2.5.1.8) which means that both the MEPROC and INVTABLE files are involved in controlling which pollutants are ingested and speciated. Second, we speciate directly from TOG rather than VOC. Third, for the gasoline sources, we use full integration of EBAFM (i.e. we use E-profiles). For the diesel sources, we use full integration of BAFM. Fourth, for the onroad sector we utilize 5 different modes for speciation: exhaust, evaporative, permeation (gasoline vehicles only), brake wear, and tire wear. For the onroad_rfl sector, we utilize a sixth mode, refueling. Fifth, for California we apply gridded ratios to the SMOKE-MOVES model-ready files to produce California adjusted model-ready files (see Section 2.5.1.9 for details). By applying the ratios to the model-ready file, we are essentially speciating the CARB inventory to match the SMOKE-MOVES speciation grid cell by grid cell.

For the nonroad sector, we did not integrate CNG or LPG sources (SCC beginning with 2268 or 2267) because NMIM computed only VOC and not any HAPs for these SCCs. All other nonroad sources were integrated. For California, we 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.

For the ptnonipm sector, the 2007 and 2020 runs were no integrate. This was an oversight— it should have been partial integration because the 2007 ethanol inventory (SCC 30125010) includes BAFM. In the future year, we should also have partial integration because both the ethanol and biodiesel inventories (SCC 30125010) provided by OTAQ include BAFM. For aircraft emissions, we use the profile 5565b which is chemically equivalent to 5565 (aircraft exhaust) in SPECIATE 4.3 database. We differentiate the profile numbers internally because a draft version of 5565 was used in previous modeling platforms.

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 3-5 lists the basin and gas composition specific profiles used for the WRAP Phase III inventory.

Table 3-5. 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
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

For the biog sector, the speciation profiles for use with BEIS are not included in SPECIATE. The 2007 platform uses BEIS3.14, which includes a new species (SESQ) that was mapped to the model species SESQT. The profile code associated with BEIS3.14 profiles for use with CB05 uses the same as in the 2005 platform: “B10C5.”

For the nonpt sector, we integrated sources where VOC emissions were greater than or equal to BAFM and BAFM was not zero. For portable fuel containers (PFCs) and fuel distribution operations associated with the bulk-plant-to-pump (BTP) distribution, ethanol may be mixed into the fuels; therefore, we used county- and month-specific COMBO speciation (via the GSPRO_COMBO file). Refinery to bulk terminal (RBT) fuel distribution and bulk plant storage (BPS) speciation are considered upstream from the introduction of ethanol into the fuel; therefore a single profile is sufficient for these sources. We had no refined information on potential VOC speciation differences between cellulosic diesel and cellulosic ethanol sources. Therefore, we summed up cellulosic diesel and cellulosic ethanol sources and used the same SCC (30125010: Industrial Chemical Manufacturing, Ethanol by Fermentation production) for VOC speciation as was used for corn ethanol plants. For future year PFC and the cellulosic inventory, we integrated EBAFM (i.e. we used E-profiles) because ethanol was in those inventories.

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.

We used 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 Section 2.5.1.3. For 2007, we used "COMBO" profiles to model combinations of profiles for E0 and E10 fuel use. For 2020, we used "COMBO" profiles to model combinations of E10 and E85 fuel use. The speciation of onroad exhaust VOC additionally accounts for a portion of the vehicle fleet meeting Tier 2 standards; different exhaust profiles are available for pre-Tier 2 versus Tier 2 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 Tier 2 vehicles 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, we would expect speciation changes 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.
Table 3-6 summarizes the different profiles utilized for the fuel-related sources in each of the sectors for 2007 and the future year case. This table indicates when "E-profiles" were used instead of BAFM integrated profiles. The term "COMBO" indicates that a combination of the profiles listed were used to speciate that subcategory using the GSPRO_COMBO file. Note, the speciation for the PM NAAQS 2020 control case is identical to the 2020 base case.

Table 3-6. Select VOC profiles 2007 versus 2020

Sector	Subcategory	2007		2020	
onroad	gasoline exhaust	COMBO:		COMBO:	
		8750E	Pre-Tier 2 E0 exhaust	8751E	Pre-Tier 2 E10 exhaust
		8751E	Pre-Tier 2 E10 exhaust	8757E	Tier 2 E10 Exhaust
		8756E	Tier 2 E0 Exhaust	8855E	Tier 2 E85 Exhaust
		8757E	Tier 2 E10 Exhaust		
onroad	gasoline evaporative	COMBO:		8754E	E10 Evap
		8753E	E0 Evap		
		8754E	E10 Evap		
onroad	gasoline permeation	COMBO:		8769E	E10 evap perm
		8766E	E0 evap perm		
		8769E	E10 evap perm		

Sector	Subcategory	2007		2020	
onroad_rfl	gasoline refueling	COMBO: 8869E 8870E	 E0 Headspace E10 Headspace	8870E	E10 Headspace
onroad	diesel exhaust	8774	Pre-2007 MY HDD exhaust	877P0	WTD Pre & Post 2007 MY HDD exh for 2020
onroad	diesel evaporative	4547	Diesel Headspace	4547	Diesel Headspace
onroad_rfl	diesel refueling	4547	Diesel Headspace	4547	Diesel Headspace
nonroad	gasoline exhaust	COMBO: 8750 8751	 Pre-Tier 2 E0 exhaust Pre-Tier 2 E10 exhaust	8751	Pre-Tier 2 E10 exhaust
nonroad	gasoline evaporative	COMBO: 8753 8754	 E0 evap E10 evap	8754	E10 evap
nonroad	gasoline refueling	COMBO: 8869 8870	 E0 Headspace E10 Headspace	8870	E10 Headspace
nonroad	diesel exhaust	8774	Pre-2007 MY HDD exhaust	8774	Pre-2007 MY HDD exhaust
nonroad	diesel evaporative	4547	Diesel Headspace	4547	Diesel Headspace
nonroad	diesel refueling	4547	Diesel Headspace	4547	Diesel Headspace
nonpt/ptnonipm	PFC	COMBO: 8869 8870	 E0 Headspace E10 Headspace	8870E	E10 Headspace
nonpt/ptnonipm	BTP	COMBO: 8869 8870	 E0 Headspace E10 Headspace	8870	E10 Headspace
nonpt/ptnonipm	BPS/RBT	8869	E0 Headspace	8869	E0 Headspace

3.2.2 PM speciation

3.2.2.1 AE5 versus AE6 speciation

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, 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 3-7). Because PMFINE is used in CMAQ4.7.1 and not in CMAQ 5.0, we were able to speciate $PM_{2.5}$ so that it included both AE5 and AE6 PM model species without causing a double count. Therefore, the emissions could be modeled with either CMAQ 4.7.1 or CMAQ 5.0[9].

Table 3-7. 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
PNA	sodium	N	Y
PCL	chloride	N	Y
PH2O	water	N	Y
PMOTHR	unspeciated $PM_{2.5}$	N	Y

Although we produced AE6 speciation of $PM_{2.5}$, due to historical data in our GSREF and GSPRO, the profile numbers are not consistent with SPECIATE 4.3. The profile numbers we used are the 920XX series which are draft versions of the AE5 speciation. The updated profile numbers are the 911XX series which are the updated AE6 speciation. Although our profile numbers are inconsistent, the actual profiles themselves (namely the percentage of AE6 components) are consistent with the updated AE6 profiles (911XX series). Due to this confusion, we have provided a table that maps our inconsistent profile numbers to the actual SPECIATE 4.3 AE6 profiles (see Appendix C).

3.2.2.2 Onroad PM speciation

Unlike other sectors, the onroad sector has pre-speciated PM. This speciated PM comes from the MOVES model and is processed through the SMOKE-MOVES system (see Section 2.5.1). Unfortunately, the MOVES2010b speciated PM does not map 1-to-1 to the AE5 speciation (nor AE6 speciation) needed for CMAQ modeling. Table 3-8 shows the relationship between MOVES2010b exhaust $PM_{2.5}$ related species and CMAQ AE5 PM species.

[9] For PM NAAQS modeling we used CMAQ 4.7.1, therefore only the AE5 species were needed.

Table 3-8. MOVES exhaust PM species versus AE5 species

MOVES2010b Pollutant Name	Variable name for Equations	Relation to AE5 model species
Primary Exhaust PM2.5 – Total	PM25_TOTAL	
Primary $PM_{2.5}$ - Organic Carbon	PM25OM	Sum of POC, PNO3 and PMFINE
Primary $PM_{2.5}$ - Elemental Carbon	PM25EC	PEC
Primary $PM_{2.5}$ - Sulfate Particulate	PM25SO4	PSO4

MOVES species are related as follows:

$$PM25\_TOTAL = PM25EC + PM25OM + PSO4$$

The five CMAQ AE5 species also sum to total $PM_{2.5}$:

$$PM_{2.5} = POC+PEC+PNO3+PSO4+PMFINE$$

The basic problem is to differentiate MOVES species "PM25OM" into the component AE5 species (POC, PNO3 and PMFINE). The Moves2smkEF post-processor script takes the MOVES2010b species (EF tables) and calculates the appropriate AE5 $PM_{2.5}$ species and converts them into a format that is appropriate for SMOKE (see http://www.smoke-model.org/version3.1/html/ch05s02s04.html for details on the Moves2smkEF script). For a more detailed discussion of the derivation of these equations, see Appendix D.

For brake wear and tire wear PM, total $PM_{2.5}$ (not speciated) comes directly from MOVES2010b. These PM modes are speciated by SMOKE. PMFINE from onroad exhaust is further speciated by SMOKE into the component AE6 species.

3.2.3 NO_X speciation

NO_X can be speciated into NO, NO2, and/or HONO. For the non-mobile sources, we use a single profile "NHONO" to split NO_X into NO and NO_2. For the mobile sources except for onroad (including nonroad, c1c2rail, c3marine, othon sectors) and for specific SCCs in othar and ptnonipm, the profile "HONO" splits NO_X into NO, NO_2, and HONO. Table 3-9 gives the split factor for these two profiles.

Table 3-9. NO_X speciation profiles

profile	pollutant	species	split factor
HONO	NOX	NO2	0.092
HONO	NOX	NO	0.9
HONO	NOX	HONO	0.008
NHONO	NOX	NO2	0.1
NHONO	NOX	NO	0.9

The onroad sector does not use the "HONO" profile to speciate NO_X. MOVES2010b produces speciated NO, NO_2, and HONO by source, including emission factors for these species in the emission factor tables used by SMOKE-MOVES. Within MOVES, the HONO fraction is a constant 0.008 of NO_X. The NO fraction varies by heavy duty versus light duty, fuel type, and model year. The NO_2 fraction = 1 – NO – HONO. For more details on the NO_X fractions within MOVES, see http://www.epa.gov/otaq/models/moves/documents/420r12022.pdf. The SMOKE-MOVES system models these species directly without further speciation.

3.3 Temporal Allocation

Temporal allocation or 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. Typically, emissions inventories are annual or monthly in nature. Temporalization takes these annual emissions and distributes them to the month, the monthly emissions to the day, and the daily emissions to the hour. This process is typically done by applying temporal profiles—monthly, day of the week, and diurnal—to the inventories.

The monthly, weekly, and diurnal temporal profiles and associated cross references used to create the 2007 hourly emissions inputs for the air quality model were similar to those used for the 2005v4.3 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. Table 3-10 summarizes the temporal aspects of emissions modeling by comparing the key approaches used for temporal processing across the sectors. We control the temporal aspects of SMOKE processing 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 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 not "all", then the SMOKE merge step runs only for representative days, which could include holidays as indicated by the right-most column. The values given are the values of the SMOKE M_TYPE setting.

Table 3-10. 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 & hourly		all	all	yes
ptnonipm	annual	yes	mwdss	mwdss	yes
ptfire	daily		all	all	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.

The following values are used in the above table: 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.

See Section 3.3.4 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) is a new inventory format for SMOKE. It provides a more consolidated format for monthly, daily, and hourly emissions inventories. Previously, if we were going to process a monthly inventory we would have 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, individual records contain data for all days in a month and all hours in a day in the daily and hourly FF10 inventories, respectively.

SMOKE 3.1 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; 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.

3.3.2 Ptipm Temporalization

Although the approach for temporalization of the ptipm sector (EGUs) has not changed from the 2005 v4.3 platform, the importance of this sector warrants a restating of the methodology.

For the year 2007 evaluation case (2007ee), hourly CEM NO_X and SO_2 data are directly used for sources that match CEMs. For other pollutants, hourly CEM heat input data are used to allocate the NEI annual values. For sources not matching CEM data ("non-CEM" sources), we computed daily emissions from the NEI annual emissions using a structured query language (SQL) program and state-average CEM data. To allocate annual emissions to each month, we created state-specific, three-year averages of 2006-2008 CEM data. These average annual-to-month factors were assigned to non-CEM sources by state. To allocate the monthly emissions to each day, we used the 2007 CEM data to compute state-specific month-to-day factors, averaged across all units in each state. These daily emissions are calculated outside of SMOKE and the resulting daily inventory is used as an input into SMOKE.

The daily-to-hourly allocation was performed in SMOKE using diurnal profiles. We updated the state-specific and pollutant-specific diurnal profiles for use in allocating the day-specific emissions for non-CEM sources in the ptipm sector. We used the 2007 CEM data to create state-specific, day-to-hour factors, averaged over the whole year and all units in each state. We calculated the diurnal factors using CEM SO_2 and NO_X emissions and heat input. We computed SO_2 and NO_X-specific factors from the CEM data for these pollutants. All other pollutants used factors created from the hourly heat input data. We assigned the resulting profiles by state and pollutant.

For the 2007 base case (2007re), year-specific CEM data are not used. For future-year scenarios, there are no CEM data available for specific units. Thus, for the base and future-year cases, we used the same procedures as for "non-CEM" sources to compute daily emissions for input to SMOKE for all ptipm sources.

3.3.3 Meteorologically based temporalization

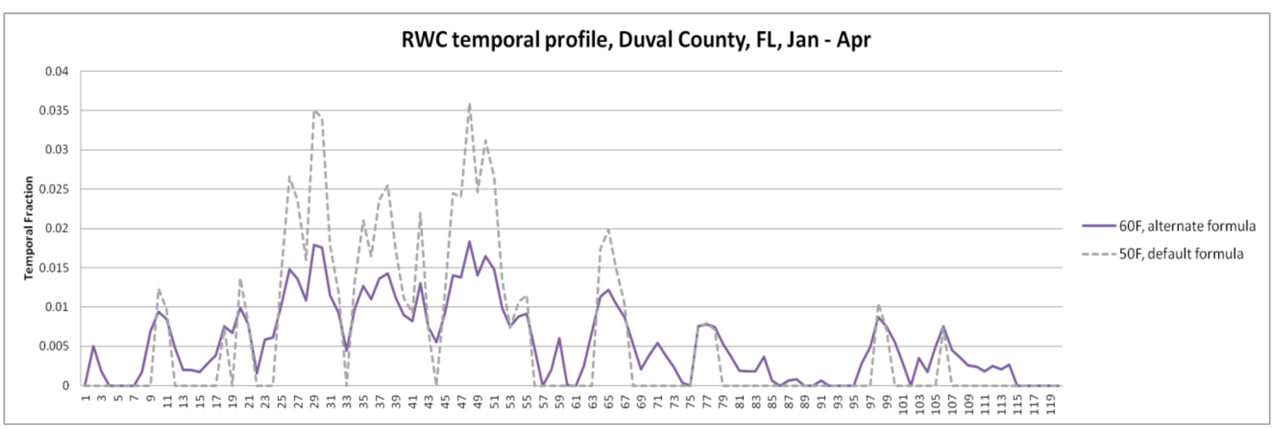
A significant improvement over previous platforms is the introduction of meteorologically based temporalization. We recognize that there are many factors that impact the timing of when emissions occur. The benefits of utilizing meteorology as method of temporalizing are: (1) we already have consistent meteorological dataset that is used by the AQ model (e.g. WRF); (2) the meteorological model data is highly resolved in terms of spatial resolution; and (3) the meteorological variables vary at hourly resolution which can translate to hour specific temporalization.

The SMOKE program GenTPRO provides a method for developing meteorology based temporalization. Currently, the program can utilize three types of temporal algorithms: RWC, agricultural livestock ammonia, and a generic meteorology based algorithm. For the 2007 platform, we used the RWC and ag NH_3 GenTPRO generated profiles. GenTPRO reads in gridded meteorology data (MCIP) and 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 algorithm and the run parameters. For more details on the development of these algorithms and running GenTPRO, see the GenTPRO documentation http://www.smoke-model.org/version3.1/GenTPRO_TechnicalSummary_Aug2012_Final.pdf and SMOKE documentation http://www.smoke-model.org/version3.1/html/ch05s03s07.html.

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 an annual-to-day temporal profile for the RWC sources within the nonpt sector. These generated profiles will distribute 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, just the distribution of the emissions within the year. Initially, we ran the RWC algorithm with the default temperature threshold of 50 ˚F. For most of the country, this produced a reasonable distribution of emissions, but for a few Southern counties all of the emissions were compressed into a few days creating excessively high daily emissions. We made two modifications to GenTPRO to support this work. First, we added an optional input that defines a county/state specific alternative temperature threshold. Second, we created an alternative RWC algorithm which avoided negative RWC emissions when the daily minimum temperature was greater than 53.3 ˚F. For the 2007 platform, we used the alternative RWC algorithm for the whole country, the default 50 ˚F threshold 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.

Figure 3-3 illustrates the impact of changing the temperature threshold for a warm climate county. The plot shows the temporal fraction by day for Duval County, Florida for the first four months of the year. The default 50 ˚F threshold creates large spikes while the 60 ˚F threshold dampens these spikes and distributes a small amount of emissions to the days that have a minimum temperature between 50 and 60 ˚F.

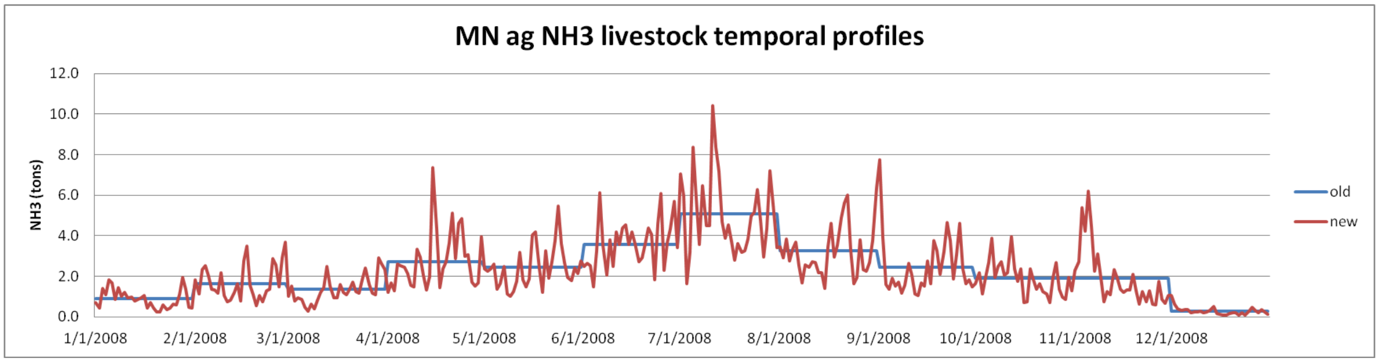
Figure 3-3. Example of RWC temporalization using a 50 versus 60 ˚F threshold



For the agricultural livestock NH_3 algorithm, GenTPRO algorithm is based on the Russel and Cass (1986) equation. This algorithm uses county-average hourly temperature and wind speed to calculate the temporal profile. We ran GenTPRO so that it created month-to-hour temporal profiles for these sources. Because these profiles distribute to the hour based on monthly emissions, the emissions will either start from a monthly inventory or from an annual inventory that has been temporalized already to the month[10].

Figure 3-4 compares the daily emissions for Minnesota from the "old" approach (uniform monthly profile) with the "new" approach (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 3-4. Example of new animal NH_3 emissions temporalization approach, summed to daily emissions

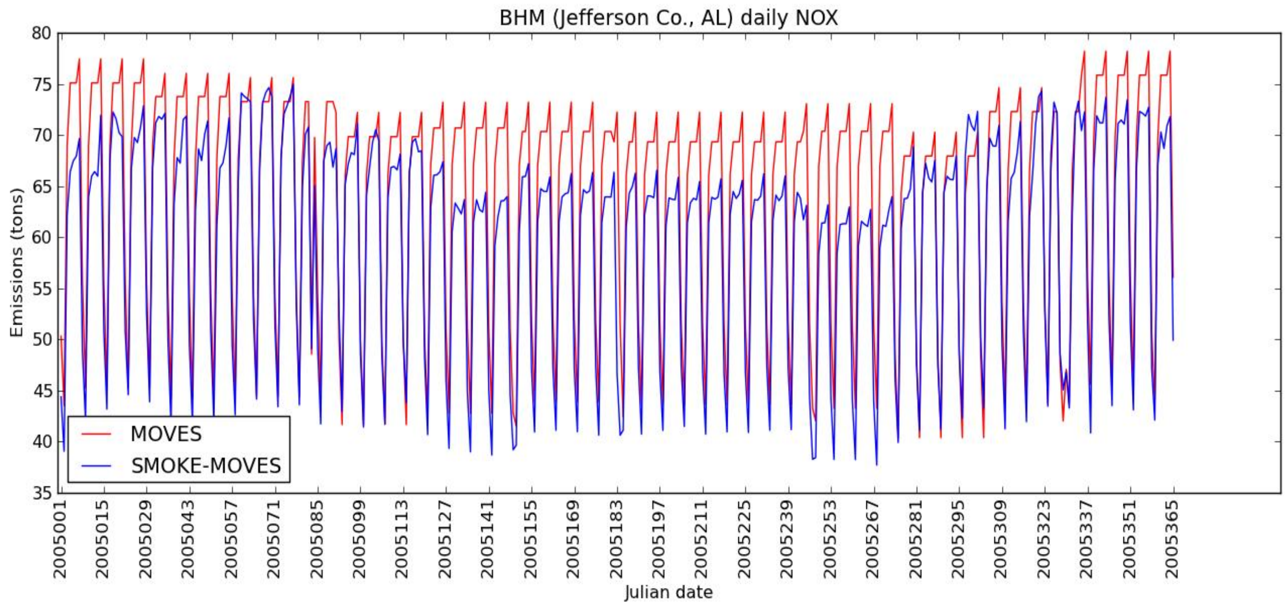


For the onroad and onroad_rfl sectors, we are technically not using meteorology in the development of the temporal profiles; rather, meteorology impacts the actual calculation of the hourly emissions through the program Movesmrg. The result is that the emissions will vary at the hourly level by grid 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 will determine the temperature for that hour and grid cell and use it to select the appropriate EF for that SCC/pollutant/mode. For the off-network RPP, Movesmrg uses 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 is that the emissions will vary hourly by county. 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 will show a strong meteorological influence on their temporal patterns (see Sections 2.5.1.5 and 2.5.1.8 for more details).

Figure 3-5 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.

[10] SMOKE v3.1 will correctly read in a monthly inventory and apply GenTPRO ag NH3 month-to-hour temporalization. When we developed the emissions 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, we applied a flat monthly profile to the states with a monthly ag NH3 inventory.

Figure 3-5. Example of SMOKE-MOVES temporal variability of NO_X emissions



For the afdust sector, we are technically not using meteorology in the development of the temporal profiles; rather, we are reducing the total emissions by a meteorological factor. 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. Therefore, the afdust emissions will vary day-to-day based on the precipitation and/or snow cover for that grid cell and day. Both the transport fraction and MET 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 MET adjustments prevents the overestimation of fugitive dust impacts in the grid modeling as compared to ambient samples.

3.3.4 Additional sector specific details

For the ptfire and avefire sectors, ptfire inventories are in the daily point fire format PTDAY and avefire inventories are in the FF10 daily nonpoint format. The ptfire sector is only used in the evaluation case (2007ee), while the avefire sector is used in the 2007 base case (2007re) and future case.

For the ptipm sector, the evaluation case (2007ee) uses a combination of CEM data and daily inventories. The 2007 base case (2007re) and the future case uses daily inventories (see Section 3.3.2 for more details).

For the ag sector, the 2008 NEI is annual. We supplemented this with a MWRPO inventory that was monthly. Only the 2008 NEI portion of the inventory had annual-to-month temporalization. For all livestock sources, we used the GenTPRO month-to-hour temporalization described in Section 3.3.3.

For the onroad and onroad_rfl sectors, the "inventories" referred to in Table 3-10 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 we temporalized it to day of the week and then to hourly VMT through temporal profiles. In addition, the RPD processes used a speed profile

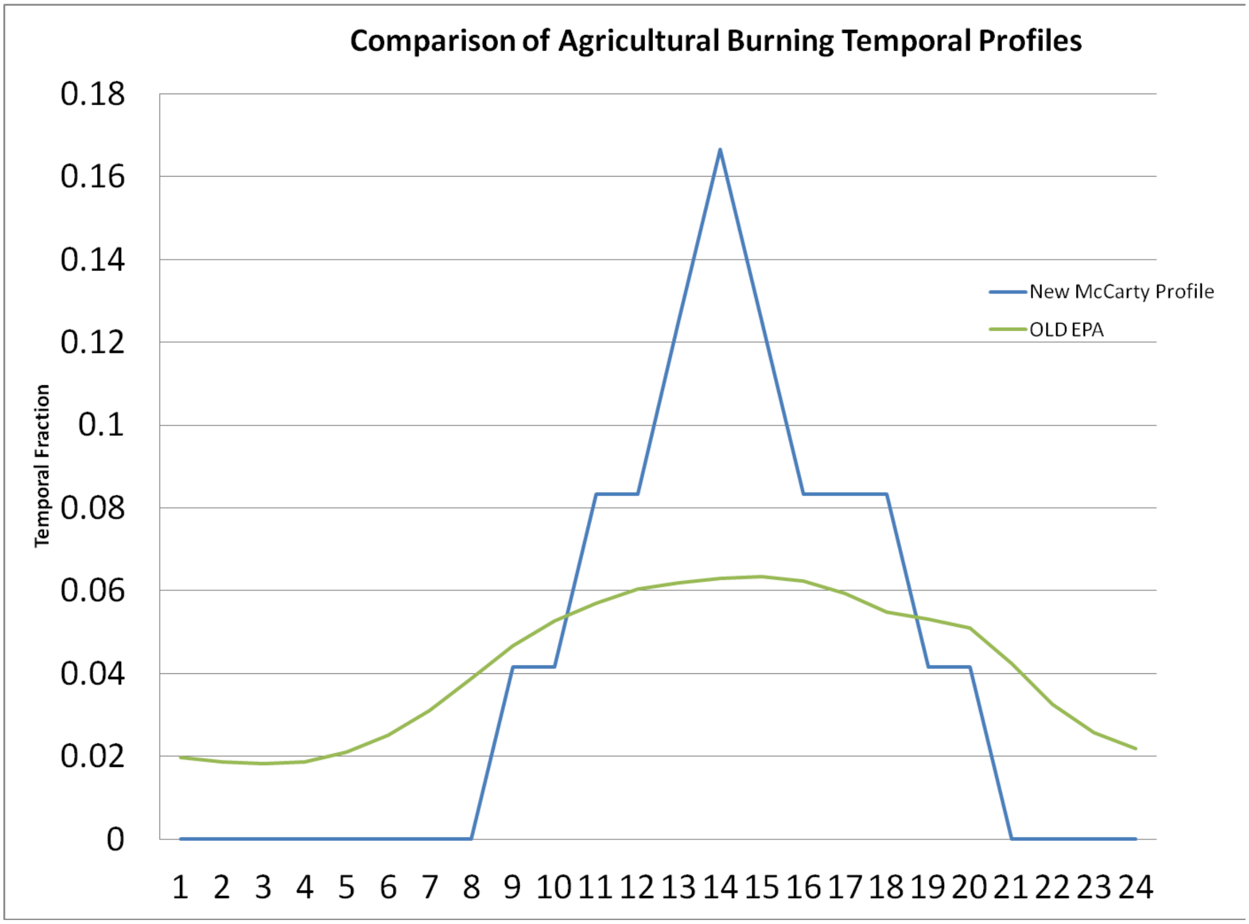
(SPDPRO) that had vehicle speed by hour for typical weekday and weekend. In addition, RPD, RPV, and RPP all have additional temporal variability due to the meteorological based emissions calculated through Movesmrg (see Section 3.3.3 for details). For California we applied gridded ratios to the SMOKE-MOVES model-ready files to produce California adjusted model-ready files (see Section 2.5.1.9 for details). By applying the ratios to the model-ready file, we essentially temporalized the CARB annual inventory to match the SMOKE-MOVES temporalization grid cell by grid cell.

For the nonroad sector, we had monthly inventories from NMIM. For California, we created a monthly inventory from CARB's annual inventory by using the EPA estimated NMIM monthly results to compute monthly ratios by pollutant and SCC. For those CARB sources that we did not have an exact match in terms of SCC, we applied a monthly ratio by pollutant and SCC7.

For the afdust_adj sector, we started with the afdust sector's annual inventories which were temporalized to representative week (L_TYPE=week). The resulting afdust model-ready files were post-processed to take into account transport fraction and meteorological adjustment (see Section 3.3.3 for details). The post-processed model-ready files (afdust_adj) vary by day because the meteorology varies by day, hence the M_TYPE=all.

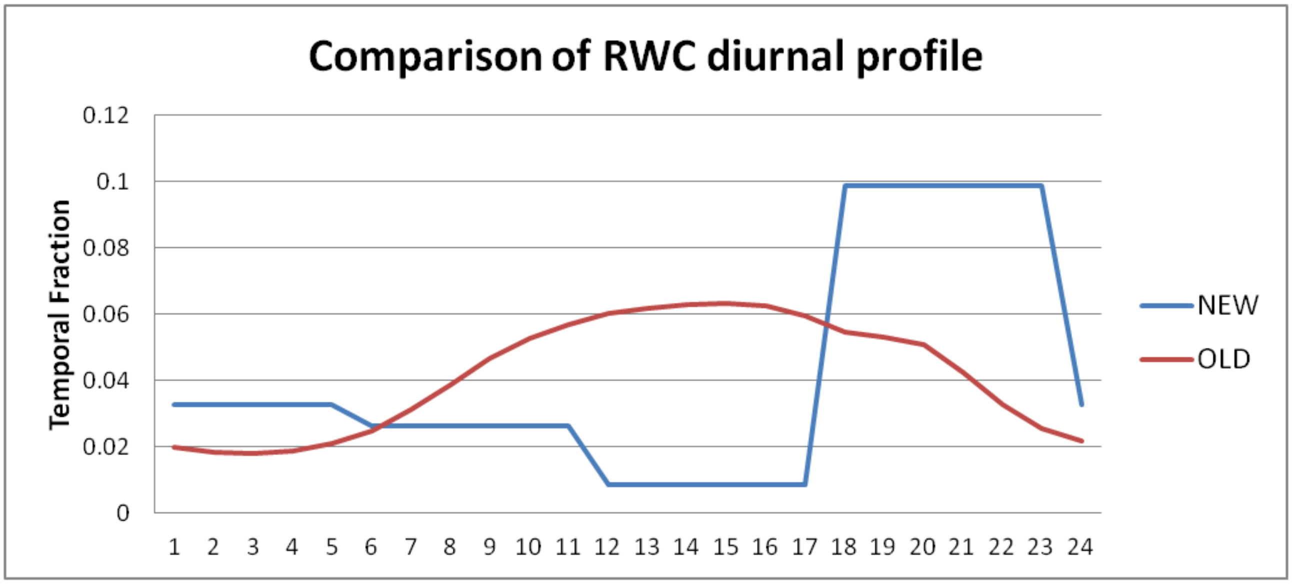
For the nonpt sector, most the inventories are annual except for two monthly inventories: agricultural burning (SCC 2801500000) inventory and a SESARM-provided open burning, land clearing (SCC 2610000500) inventory for Florida and Georgia. These monthly inventories do not need annual-to-month temporalization. For all agricultural burning, we used a new diurnal temporal profile - see Figure 3-6 (McCarty et al., 2009). This puts more of the emissions during the actual work day and suppresses the emissions during the middle of the night. All states used a uniform day of week profile for all agricultural burning emissions, except for the following states that for which we used state-specific day of week profiles: Arkansas, Kansas, Louisiana, Minnesota, Missouri, Nebraska, Oklahoma, and Texas.

Figure 3-6. Agricultural burning diurnal temporal profile



For nonpt RWC sources, we used the GenTPRO annual-to-day temporalization (see Section 3.3.3 for details). We updated the RWC diurnal profile (see Figure 3-7). This placed more of the RWC emissions in the morning and the evening when people are typically using these sources. This new profile is based on a 2004 MANE-VU survey based temporal profiles (see http://www.marama.org/publications_folder/ResWoodCombustion/Final_report.pdf). We took the three indoor and three outdoor temporal profiles from counties in Delaware for RWC and aggregated them into a single RWC diurnal profile. We also compared this new profile to a concentration based analysis of aethalometer measurements in Rochester, NY (Wang *et al.* 2011) for various seasons and day of the week and found that our new RWC profile generally tracked the concentration based temporal patterns.

Figure 3-7. RWC diurnal temporal profile



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, we performed spatial allocation for a national 12-km domain. To do this, SMOKE used national 12-km spatial surrogates and a SMOKE area-to-point data file. For the U.S., we updated surrogates 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. 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 3-11 lists the codes and descriptions of the surrogates. 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 3-11 were not assigned to any SCCs.

Table 3-11. 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
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 Points
310	Total Agriculture	720	Military Airports
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

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.

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.

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 3-12. 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 3-12 were applied for the counties listed in Table 3-13.

Table 3-12. 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 3-13. Counties included in the WRAP Dataset

FIPS	State	County
8001	Colorado	Adams
8005	Colorado	Arapahoe
8007	Colorado	Archuleta
8013	Colorado	Boulder
8014	Colorado	Broomfield
8029	Colorado	Delta
8031	Colorado	Denver
8039	Colorado	Elbert
8043	Colorado	Fremont
8045	Colorado	Garfield
8051	Colorado	Gunnison
8063	Colorado	Kit Carson
8067	Colorado	La Plata
8069	Colorado	Larimer
8073	Colorado	Lincoln
8075	Colorado	Logan
8077	Colorado	Mesa
8081	Colorado	Moffat
8087	Colorado	Morgan
8095	Colorado	Phillips
8103	Colorado	Rio Blanco
8107	Colorado	Routt
8115	Colorado	Sedgwick
8121	Colorado	Washington
8123	Colorado	Weld
8125	Colorado	Yuma
30003	Montana	Big Horn
30075	Montana	Powder River

FIPS	State	County
35031	New Mexico	Mc Kinley
35039	New Mexico	Rio Arriba
35043	New Mexico	Sandoval
35045	New Mexico	San Juan
49007	Utah	Carbon
49009	Utah	Daggett
49013	Utah	Duchesne
49015	Utah	Emery
49019	Utah	Grand
49043	Utah	Summit
49047	Utah	Uintah
56001	Wyoming	Albany
56005	Wyoming	Campbell
56007	Wyoming	Carbon
56009	Wyoming	Converse
56011	Wyoming	Crook
56013	Wyoming	Fremont
56019	Wyoming	Johnson
56023	Wyoming	Lincoln
56025	Wyoming	Natrona
56027	Wyoming	Niobrara
56033	Wyoming	Sheridan
56035	Wyoming	Sublette
56037	Wyoming	Sweetwater
56041	Wyoming	Uinta
56045	Wyoming	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, we used the SMOKE "area-to-point" approach for only 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 single surrogate (population) is the same as was used in the 2005 platform. We used the same surrogates for Canada 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 3-14. 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
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

Code	Description	Code	Description
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
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

Code	Description	Code	Description
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 2020 Base-Case Emissions

This section describes the methods we used for developing the 2020 future-year base-case emissions. The PM NAAQS control case and sensitivity cases are not described in this section, but are discussed in the Regulatory Impact Assessment.

The future base-case projection methodologies vary by sector. With one exception (described below), the 2020 base case represents 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 July, 2012. The future base-case scenario reflects projected economic changes and fuel usage for EGU and mobile sectors. The 2020 EGU projected inventory represents demand growth, fuel resource availability, generating technology cost and performance, and other economic factors affecting power sector behavior. It also reflects the expected 2020 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. In this analysis, the projected EGU emissions include the Final Mercury and Air Toxics (MATS) rule announced on December 21, 2011 and the Final Cross-State Air Pollution Rule (CSAPR) issued on July 6, 2011

For mobile sources (onroad, onroad_rfl, nonroad, c1c2rail and c3marine sectors), all national measures for which data were available at the time of modeling have been included with the exception of the 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule (LDGHG), published October 15, 2012. The LDGHG rule was not included in this analysis because the rule was not signed at the time the modeling was performed, and it is expected to have little impact on particulate matter emissions.

For nonEGU point (ptnonipm sector) and nonpoint stationary sources (nonpt, ag, and afdust sectors), local control programs that might have been necessary for areas to attain the 1997 $PM_{2.5}$ NAAQS annual standard, 2006 PM NAAQS (24-hour) standard, and the 1997 ozone NAAQS are generally not included in the future base-case projections for most 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.

- IPM sector (ptipm): Unit-specific estimates from IPM, version 4.10 with CSAPR and Final MATS.
- 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. We 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 NONROAD2008a, using future-year equipment population estimates and control programs to the year 2020 and using national level inputs. Final controls from the final locomotive-marine and small 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-2020 inventory data were provided by CARB.
- Class 3 commercial marine vessel (c3marine): Base-year 2007 emissions grown and controlled to 2020, 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): MOVES2010b emissions factors for year 2020 were developed using the same representative counties, state-supplied data, meteorology, and procedures that were used to produce the 2007 emission factors described in Section 2.5.1. California-specific data were provided by CARB. Other than California, this sector includes all non-refueling onroad mobile emissions (exhaust, evaporative, evaporative permeation, brake wear and tire wear modes).
- Onroad refueling mode (onroad_rfl): Uses the same projection approach as the onroad sector and processing as described in Section 2.5.2, except for California where we projected using MOVES2010b and did not include CARB data.
- Other onroad (othar): No growth or control for Canada because data are not available from Canada. Mexico inventory data were grown from 1999 to year 2018.
- Other nonroad/nonpoint (othon): No growth or control for Canada. Mexico inventory data were grown from 1999 to year 2018.
- Other point (othpt): No growth or control for Canada and offshore oil. Mexico inventory data were grown from 1999 to year 2018.
- 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. 2020 base-case emissions from the 2007v5 base-case inventories. Lists of the control, closures, projection packets (datasets) used to create 2020 future year base-case scenario inventories from the 2007 base case are provided in Appendix E. These 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. These CoST packets are formatted the same as those needed for SMOKE and are available on the 2007v5 web site: http://www.epa.gov/ttn/chief/emch/. Summaries on the emissions changes resulting from all CoST packets (control programs, projections and closures) can be found in Appendix F.

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 2020 base case. 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.

Table 4-1. Control strategies and growth assumptions for creating the 2020 base-case 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	4.2.1.1
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	4.2.1.6
Refinery upstream adjustments from EISA mandate	All	4.2.1.7
Livestock emissions growth from year 2008 to 2020, 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	4.2.3, Appendix I
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	4.2.4
Industrial/Commercial/Institutional Boilers and Process Heaters MACT with Reconsideration Amendments	CO, PM, SO_2, VOC	4.2.5
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	4.2.6
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	4.2.8
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	4.2.9
Aircraft growth via Itinerant (ITN) operations at airports to 2020	All	4.2.10.1
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	4.2.10.2
New York ozone SIP controls	NO_X	4.2.10.3
Boat Manufacturing MACT rule, VOC: national applied by SCC	VOC	4.2.10.4
Lafarge and Saint Gobain consent decrees	NO_X, PM, SO_2	4.2.10.5
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	4.2.10.6
Refinery Consent Decrees: plant/unit controls	NO_X, SO_2	4.2.10.7
Commercial and Industrial Solid Waste Incineration (CISWI) revised NSPS	PM, SO_2	4.2.10.8
Hazardous Waster Incineration (HWI), Phase I and II	PM	4.2.10.8
Nonpoint (afdust, ag and nonpt sectors) Controls and Growth Assumptions		
MSAT2 and RFS2 impacts on portable fuel container growth and control from 2007 to 2020	VOC	4.2.1.3
Cellulosic ethanol and diesel emissions from EISA mandate	All	4.2.1.4
Ethanol transport working losses inventory from EISA mandate	VOC	4.2.1.5

Control Strategies and/or growth assumptions (grouped by standard and approach used to apply to the inventory)	**CAPs affected**	**Section**
Ethanol distribution vapor losses adjustments due to EISA mandate	VOC	4.2.1.6
Livestock emissions growth from year 2008 to 2020, 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	4.2.3, Appendix I
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	4.2.4
Residential wood combustion growth and change-outs from year 2008 to 2020	All	4.2.7
Future baseline inventory improvements received from a 2005 platform NODA and comments from the CSAPR proposal, reflecting local controls	NO_X, VOC	4.2.8
New York ozone SIP controls	NO_X	4.2.10.3
Texas oil and gas projections to year 2020 –***not applied***	All	4.2.10.9
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: Heavy (and Medium)-Duty Greenhouse Gas Rule: August, 2011 Renewable Fuel Standard: February, 2010 Light Duty Greenhouse Gas Rule: April, 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: 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: Emissions Standards for New Nonroad Spark-Ignition Engines, Equipment, and Vessels: October, 2008 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	4.3.2
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

A list of inventory datasets used for this and all cases is provided in Table G-1 in Appendix G. 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). Table G-2 of Appendix G is a table of differences between these ancillary input data between the 2007 base case and these future-year scenarios. The specific speciation profile changes are discussed in Section 3.2.1.4. Table G-3 in Appendix G also provides the values for the main parameters used in the emissions modeling cases.

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) of (http://www.epa.gov/airmarkt/progsregs/epa-ipm/index.html). The IPM is a multiregional, dynamic, deterministic linear programming model of the U.S. electric power sector. Version 4.10 reflects state rules and consent decrees through December 1, 2010 and incorporates information on existing controls collected through the Information Collection Request (ICR), and information from comments received on the IPM-related Notice of Data Availability (NODA) published on September 1, 2010. IPM v4.10 Final included the addition of over 20 GW of existing Activated Carbon Injection (ACI) reported to the EPA via the MATS Information Collection Request (ICR). Units with SO_2 or NO_X advanced controls (e.g., scrubber, SCR) that were not required to run for compliance with Title IV, New Source Review (NSR), state settlements, or state-specific rules were modeled by IPM to either operate those controls or not based on economic efficiency parameters.

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 both the Cross-State Air Pollution Rule as it was originally finalized in July, 2011, and also the Mercury and Air Toxics Standards. On August 21, 2012, the D.C. Circuit Court of Appeals released an opinion that would vacate CSAPR. However, at the time this document was written, pending a petition to rehear the case, the Court has not issued a mandate making that opinion legally effective. As such, CSAPR is still a final rule but remains subject to a stay imposed by the Court on December 30, 2011. In the interim, the Clean Air Interstate Rule (CAIR) continues to be implemented to address regional transport of air pollution, as directed by the Court. In light of the still-pending litigation proceeding on CSAPR and its current status as a final rule (albeit stayed), EPA does not believe it would be appropriate or possible at this time to adjust emission projections on the basis of speculative alternative emission reduction requirements in 2020.

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/BaseCasev410.html.

Directly emitted PM emissions (i.e., $PM_{2.5}$ and PM_{10}) from the EGU sector are computed via a post processing routine which applies emission factors to the IPM-estimated fuel throughput based on fuel, configuration and controls to compute the filterable and condensable components of PM. This methodology is documented in the IPM TSD.

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

To project U.S. stationary sources other than the ptipm sector, we 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, we 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. While we are working toward improving the projection approach in future emissions platforms, we are still using the no-growth assumption for the 2007 platform. More details on the rationale for this approach can be found in Appendix D of the Regulatory Impact Assessment for the PM NAAQS rule (EPA, 2006b).

For many sources, we applied emissions reduction factors (CONTROL packets) to the 2007 base case emissions for particular sources in the ptnonipm and nonpt sectors to reflect the impact of stationary-source control programs including consent decrees and plant closures (CLOSURE packets). Some of the controls described in this section were obtained from comments on the Cross-State Air Pollution Rule (CSAPR) proposal. Most of the control programs were applied as replacement controls, which means that any existing percent reductions ("baseline control efficiency") reported in the 2008 NEI were removed prior to the addition of the new percent reductions due to these control programs. Exceptions to replacement controls are "additional" controls, which ensure that the controlled emissions match desired reductions regardless of the baseline control efficiencies in the NEI. We used the "additional controls" approach for many permit limits and consent decrees where specific plant and multiple-plant-level reductions/targets were desired.

Here we describe the contents of the controls, local adjustments and closures for the 2020 base case. Detailed summaries of the impacts of all control programs, local adjustments and closures are provided in Appendix F. All CLOSURE, CONTROL and PROJECTION packets are listed in Appendix E, and these data are provided on the 2007v5 website. In addition, we note key packets in the relevant sections below.

Year-specific projection factors (PROJECTION packets) for year 2020 were used for creating the 2020 base case 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 section is divided into several subsections that are summarized in Table 4-2. Note that we used future year inventories rather than projection or control packets for some sources.

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
4.2.3	RICE NESHAP	nonpt ptnonipm	Control packet reflecting RICE NESHAP with reconsideration amendments
4.2.4	Fuel sulfur rules	nonpt ptnonipm	Control packet reflecting state and local fuel sulfur rules, including ULSD
4.2.5	Industrial Boiler MACT reconsideration	ptnonipm	Control packet reflecting ICI Boiler MACT reconsideration reductions
4.2.6	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
4.2.7	Residential wood combustion growth	nonpt	Adjustment factors that reflect the change in RWC emissions by appliance type, including wood stove change-outs and accounting for estimated future sales and replacement rates.
4.2.8	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.
4.2.9	Remaining non-EGU plant closures	ptnonipm	All other plant and unit closures information not covered in previous subsections
4.2.10	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)

We 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). This mandate (EPA, 2010a) not only impacts emissions associated with highway vehicles and nonroad engines using renewable fuels, but also emissions associated with point and nonpoint sources. These "upstream" emission impacts 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 2020 inventories. 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.

Based on the Annual Energy Outlook 2012 (early release) energy use of 14.86 quad (10^{15} BTU) (Department of Energy, 2012), we estimated the 2007 ethanol volume as 8.7 billion gallons (Bgal). We assume that an unadjusted 2020 inventory, which does not account for the impacts of the EISA renewable fuel mandate, would have comparable ethanol volumes to 2007. However, analyses done to support the RFS2 rule (EPA, 2010a) suggest a significant increase in renewable fuel volumes in 2020 (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 in Table 4-3.

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

Renewable Fuel	Volume (Bgal)
Corn Ethanol	15.000
Cellulosic Ethanol	2.536
Imported Ethanol	1.880
Biodiesel	1.280
Renewable Diesel	0.150
Cellulosic Diesel	4.280

We assumed 6.7 Bgal of ethanol would be used in E85 and 8.7 Bgal in E10. While the stationary source projections do reflect the RFS2, they do not reflect the upstream impacts of the recent Heavy-Duty Greenhouse Gas (HDGHG) and Light-Duty Greenhouse Gas (LDGHG) rules (EPA, 2011a and EPA, 2012b).

4.2.1.1 Corn Ethanol plants inventory (ptnonipm)

Future year inventory: "Ethanol_plants_2020_POINT_ff10"

As discussed in Section 2.1.2, for 2007 we supplemented the 2008 NEI with corn ethanol plants that EPA/OTAQ developed. Additional ethanol plants cited for development in support of increased ethanol production for the EISA/RFS2 are the cause for the increased number of facilities and emissions in the future. Table 4-4 provides the summaries of estimated emissions for the corn ethanol plants in year 2007 and 2020.

Table 4-4. 2007 and 2020 corn ethanol plant emissions [tons]

Pollutant	2007	2020
Acrolein	5	34
Formaldehyde	5	35
Benzene	2	16
Acetaldehyde	64	332
CO	1,347	8,038
NO_X	1,944	12,662
PM_{10}	2,067	11,982
$PM_{2.5}$	599	3,082
SO_2	637	1,547
VOC	4,086	26,990

4.2.1.2 Biodiesel plants inventory (ptnonipm)

New Future year inventory: "Biodiesel_plants_2020_POINT_ff10"

EPA/OTAQ developed an inventory of biodiesel plants for 2020 that were sited at existing plant locations in support of producing biodiesel fuels for the EISA mandate. EISA was estimated to result in 1.6 Bgal of biodiesel fuel production in year 2020. Only plants with current production capacities were assumed to be operating in 2020. Total plant capacity at these existing facilities is limited to just over 1 Bgal. There was no attempt to site future year plants to account for the need to match biodiesel production needed for RFS2/EISA. Therefore, OTAQ applied scalar adjustments to each individual biodiesel plant to match the 2020 production levels. Once facility-level production capacities were scaled, emission factors were applied based on soybean oil feedstock. 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 2020 biodiesel plant emissions estimates. Emissions in 2007 are assumed to be near zero, and HAP emissions in 2020 are nearly zero.

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. 2020 biodiesel plant emissions [tons]

Pollutant	2020
CO	801
NO_X	1,293
PM_{10}	109
$PM_{2.5}$	109
SO_2	10
VOC	70

4.2.1.3 Portable fuel container inventory (nonpt)

Future year inventory: "pfc_2020_pmnaaqs"

We 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 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 2020 PFC emissions that include estimated Reid Vapor Pressure (RVP) and oxygenate impacts on VOC emissions, and more importantly, large increases in ethanol emissions from RFS2. These emission estimates also include refueling from the NONROAD model for gas can vapor displacement, changes in tank permeation and diurnal emissions from evaporation. Because the future year PFC inventories contain ethanol in addition to benzene, we developed a VOC E-profile that integrated ethanol and benzene; see Sections 3.2.1.1 and 3.2.1.4 for more details. Emissions for 2007 and 2020 are provided in Table 4-7.

Table 4-7. PFC emissions for 2007 and 2020 [tons]

Pollutant	2007	2020
VOC	220,472	128,588
Benzene	1,049	1,426
Ethanol	0	16,196

4.2.1.4 Cellulosic fuel production inventory (nonpt)

New Future year inventory: "Cellulosic_plants_2020_NONPOINT_ff10"

OTAQ developed county-level inventories for cellulosic diesel and cellulosic ethanol production for 2020 to reflect EISA renewable fuel volumes. 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 Mgal and were obtained from EPA's spreadsheet model for upstream impacts developed for the RFS2 rule (EPA, 2010a). For air toxics emitted from cellulosic diesel production, emission rates were obtained from the spreadsheet model, but for cellulosic ethanol plants, air toxic emission rates were updated from the RFS2 rule using data from five demonstration plants in the 2005 NEI (EPA, 2009a). 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 the types of feedstocks that were determined to be most economical, along with projected volumes from modeling using FASOM. The methodology used to determined most likely plant locations is described in Section 1.8.1.3 of the RFS2 RIA (EPA, 2010a).

Design capacities for 2022 used in the RFS2 rule air quality modeling were adjusted to account for differences with the estimated volumes of cellulosic fuel produced for 2020, using final RFS2 rule data. Since the final RFS2 rule assumed about 57% percent of cellulosic fuel nationwide was cellulosic diesel, with the remainder cellulosic ethanol, we assumed this split would apply to every plant. In reality, however, depending on available feedstocks, plants are likely to produce one fuel or the other. Table 4-10 provides the year 2020 cellulosic plant emissions estimates.

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

Cellulosic Plant Type	Year	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	NH_3
Cellulosic Ethanol	2017-2030	1.82	5.68	8.19	0.941	0.480	0.299	0.00
Cellulosic Biodiesel	2017	1.01	14.79	22.35	2.65	1.33	1.99	0.00
	2030	1.00	14.73	22.24	2.63	1.32	1.99	0.00

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

Cellulosic Plant Type	Acetaldehyde	Acrolein	Benzene	1,3-Butadiene	Formaldehyde	Ethanol
Cellulosic Ethanol	0.398	0.009	0.014	0	0.023	0.645
Cellulosic Biodiesel	0.050	0.002	0.002	0	0.009	0.355

Table 4-10. 2020 cellulosic plant emissions [tons]

Pollutant	Emissions
Acrolein	40
Formaldehyde	111
Benzene	52
Acetaldehyde	1,504
CO	81,876
Ethanol	3,585
NH_3	1
NO_X	122,437
PM_{10}	14,398
$PM_{2.5}$	7,255
SO_2	9,503
VOC	10,204

4.2.1.5 Ethanol working loss inventory (nonpt)

<u>New Future year inventory:</u> "Ethanol_transport_vapor_2017ct_ref_caphap_25jul2011"

This inventory was provided by OTAQ to represent RFS2 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. 2020 VOC working losses (Emissions) due to RFS2 ethanol transport [tons]

SCC	Description	Emissions
30205031	Denatured Ethanol Storage Working Loss	27,763
30205052	Ethanol Loadout to Truck	19,069
30205053	Ethanol Loadout to Railcar	9,610

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

<u>Packet:</u> "PROJECTION_2008_2020_distribution_upstream_OTAQ"

OTAQ developed county-level inventories for ethanol transport and distribution for 2020 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.

To estimate impacts of EISA, 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). In addition to gasoline VOC emission factors for the RBT/BPS components, emission factors were developed for the BTP component, for 10 percent ethanol and 15 percent 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. Nationwide RVPs for different fuel types (E0, E10 and E85) were used to develop the adjustment factors. We assumed delta T is zero, and the temperature of the fuel being dispensed averages 60 °F over the year. RVP was assumed to be 8.1 psi for E0 and E10 and 6.2 for E85. These RVPs are based on 2009 refinery compliance data.

E0 and E10 benzene emission factors for 2020 were based on the benzene inventory used in the 2011 Cross-State Air Pollution Rule (EPA, 2011b) 2020 gasoline volumes were obtained from the Annual Energy Outlook 2011 Early Release Overview (Energy Information Administration, 2010) and used to estimate g/mmBTU emission factors based on the Energy content of E0 and E10 gasoline. Aside from energy content, we did not account for the effect of other fuel parameters on emission rates. Thus, the E10 emission rate is slightly higher than the E0 rate due to the lower energy content of E10. The E85 emission rate was estimated for the RFS2 rule. Emission factors are summarized in Table 4-12.

Table 4-12. Storage and Transport Vapor Loss Emission Factors (g/mmBtu)

Process	Fuel	VOC	Benzene
BTP	E0	25.448	0.260
	E10	26.341	0.264
	E85	26.827	0.023
RBT/BPS	E0	10.532	0.059

Emission factors for VOC and benzene were used in conjunction with EPA's spreadsheet model for upstream emission impacts, developed for the RFS2 rule, to estimate national level inventory changes that reflect EISA implementation (EPA, 2009b, 2012c). VOC inventory changes were used to develop nationwide adjustment factors that were applied to modeling platform inventory SCCs associated with storage and transport processes (Table 4-12). Benzene emission estimates were obtained either by application of the adjustments in Table 4-13 or through speciation of VOC in SMOKE.

Table 4-13. Adjustment Factors Applied to Storage and Transport Emissions

Process	Pollutant	Adjustment Factor
BTP	VOC	1.012
	Benzene	0.967
BPS/RBT	VOC	0.944
	Benzene	0.944

Ethanol emissions were estimated in SMOKE by applying ethanol to VOC ratios to VOC emissions. These ratios, obtained from speciation profiles, are 0.065 for E10 and 0.61 for E85. The E0 profile was obtained from an ORD analysis of fuel samples from the EPAct exhaust test program (EPA, 2009c) and has been submitted for incorporation into EPA's SPECIATE database. The E85 profile was obtained from evaporative emission data for E85 vehicles, collected as part of the Auto/Oil emissions research program in the early 1990's (Environ, 2008). For more details on the change in speciation profiles between 2007 and 2020, see Section 3.2.1.4.

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. Also, although EISA results in vapor losses from transport of ethanol, they were not included in this inventory, as the impact of these emissions would be negligible for the modeling in this action. The cumulative impacts are VOC reductions of approximately 5,415 tons across the nonpt sector and 1,548 tons in the ptnonipm sector in 2020 for these processes. See Appendix B for cross-walk between SCC and each type of petroleum transport and storage.

4.2.1.7 Refinery adjustments (ptnonipm)

Packet: "PROJECTION_2008_2020_refineries_upstream_OTAQ"

Refinery emissions were adjusted for changes in fuels due to the EISA. 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, on nationwide refinery emissions was done in EPA's spreadsheet model for upstream emission impacts (EPA, 2009b). Emission inventory changes reflecting EISA implementation were used to develop adjustment factors that were applied to inventories for each petroleum refinery in the U.S. (Table 4-14). 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 4-14 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.

Table 4-14. Adjustment Factors Applied to Petroleum Refinery Emissions Associated with Gasoline and Diesel Fuel Production.

Pollutant	2020 Adjustment
VOC	0.963
CO	0.971
NO_X	0.983
PM_{10}	0.979
$PM_{2.5}$	0.973
SO_2	0.972
NH_3	0.938

The impact of the EISA-based reductions is shown in Table 4-15.

Table 4-15. Impact of refinery adjustments on 2020 emissions [tons]

Pollutant	Reductions 2020
CO	2,426
NH_3	186
NO_X	1,608
PM_{10}	562
$PM_{2.5}$	649
SO_2	4,094
VOC	2,386

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

Packet: "PROJECTION_2008_2020_ag_including_upstream_OTAQ"

Impacts of the EISA renewable fuel mandate on criteria pollutant and air toxic emissions from agricultural operations were quantified for 2022 as part of the RFS2 RIA. Estimates of agricultural impacts were developed using FASOM (Forest and Agricultural Section Optimization Model). It should be noted that FASOM agricultural impacts were estimated relative to a baseline of 13.2 Bgal of ethanol, whereas we assume a volume of 8.7 Bgal in the unadjusted 2007 modeling platform. Thus, impacts used in the modeling for this study are likely underestimates.

Adjustments for 2020 were scaled by the ratio of 2020 renewable fuel volumes to 2022 volumes assumed in the RFS2 RIA. Impacts on farm equipment emissions were not accounted for, however. Adjustment factors are provided in Table 4-16. 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, we have 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, using absolute ton changes 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.

Table 4-16. Adjustments to Agricultural Emissions for post-EPAct/EISA Cases

Source Description	**Adjustment**
Nitrogen fertilizer application	1.0510
Fertilizer production, mixing/blending	1.0537
Pesticide production	0.9959
Agricultural tilling/loading dust	1.0236
Agricultural burning	1.000
Livestock dust	0.9985
Livestock waste	0.9985

For the animal waste sources, we also estimate 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 0.15% decrease resulting from the EISA mandate. These composite projection factors by animal category are provided in Table 4-17. As we will discuss 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 in Table 4-16. The PROJECTION packet used for these sources, which includes the cross-reference to the animal categories listed in Table 4-17 and the source categories in Table 4-16, is provided on the 2007v5 platform website and is listed in Appendix E.

Table 4-17. Composite Projection factors to year 2020 for Animal Operations

Animal Category	**Projection Factor**
Dairy Cow	0.9985
Beef	0.9926
Pork	1.0712
Broilers	1.1798
Turkeys	0.9985
Layers	1.1283
Poultry Average	1.168
Overall Average	1.0444

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 this 2007v5 platform. For dairy cows and turkeys, we assumed that there would be no growth in emissions based on little change in U.S. dairy cow or turkey populations from year 2007 through 2019 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, we concluded that production forecasts do not provide representative estimates of the future number of cows and turkeys; therefore, we 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 we suspect the excretion value will be changing, but we assumed no change because we did not have a quantitative estimate.

The inventory for livestock emissions used 2008 emissions values for all states except the MWRPO states; therefore, our projection method projected from 2008 rather than from 2007. Appendix H provides the animal population data and regression curves used to derive the growth factors.

4.2.3 RICE NESHAP (nonpt, ptnonipm)

Packet: CONTROL_RICE_incl_SO2_2007v5

There are three rulemakings for National Emission Standards for Hazardous Air Pollutants (NESHAP) for Reciprocating Internal Combustion Engines (RICE). These rules reduce HAPs from existing and new RICE sources. In order to meet the standards, existing sources with certain types of engines will need to install controls. In addition to reducing HAPs, these controls have co-benefits that also reduce CAPs, specifically, CO, NO_X, VOC, PM, and SO_2. In 2014 and beyond, compliance dates have passed for all three rules; thus all three rules are included in the emissions projection. These RICE reductions also reflect the recent (proposed January, 2012) Reconsideration Amendments, which results in significantly less stringent NO_X controls (fewer reductions) than the 2010 final rules.

The rules can be found at http://www.epa.gov/ttn/atw/rice/ricepg.html and are listed below:

- National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final Rule (69 FR 33473) published 06/15/04

- National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final Rule (FR 9648) published 03/03/10

- National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final Rule (75 FR 51570) published 08/20/2010

The difference among these three rules is that they focus on different types of engines, different facility types (major for HAPs, versus area for HAPs) and different engine sizes based on horsepower. In addition, they have different compliance dates. We project CAPs from the 2008 NEI RICE sources, based on the requirements of the rule for existing sources only because the inventory includes only existing sources and the current projection approach does not estimate emissions from new sources.

A complete discussion on the methodology to estimate year 2020 RICE controls, with the new reconsideration amendments, is provided in Appendix I. Impacts of the RICE controls on nonpt and ptnonipm sector emissions are provided in Table 4-18.

Table 4-18. National Impact of RICE Reconsideration Controls on 2020 Non-EGU Projections

Pollutant	2008 Emissions	2020 Emissions	2020 Reductions
CO	424,974	399,112	25,862
NO_X	614,580	604,973	9,608
PM_{10}	6,840	6,065	775
$PM_{2.5}$	5,981	5,280	701
SO_2	58,009	52,741	5,268
VOC	68,092	57,462	10,630

4.2.4 Fuel sulfur rules (nonpt, ptnonipm)

Packet: CONTROL_SULF_2020_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. Several other states in the Northeast and Mid-Atlantic had pending sulfur rules but were not finalized prior to July, 2012 -the completion date of the 2007 platform year-2020 projection. Background on all these enforceable and pending fuel sulfur rules can be found here: http://www.ilta.org/LegislativeandRegulatory/MVNRLM/NEUSASulfur%20Rules_09.2010.pdf. A more recent update to the status of fuel sulfur rules is provided here: http://www.eia.gov/todayinenergy/detail.cfm?id=5890#.

Maine

The Maine Law Legislative Document (LD) 1662 sets a fuel sulfur rule effective January 1, 2014 that reduces sulfur to 15 ppm for distillate fuel, resulting in a 99.5% reduction from 3,000 ppm assumed in year 2008. Maine Law LD 1662 also states that #5 and #6 fuel oils must not exceed 0.5% by weight (500 ppm), which is a 75% reduction from an assumed 2% baseline sulfur content in 2008. These Maine sulfur content reductions are discussed here: http://www.mainelegislature.org/legis/bills/bills_124th/billpdfs/SP062701.pdf.

Massachusetts

The Massachusetts Department of Environmental Protection issued a commitment in their State Implementation Plan (SIP) to adopt Phase 2 ultra low sulfur diesel (ULSD) limits by year 2016. Similar to Maine, this will reduce the sulfur content in distillate fuel to 15 ppm, a 99.5% reduction from the 3,000 ppm baseline. Additional details on the phase-in of ULSD can be found here: http://www.mass.gov/dep/service/online/boilwbk.pdf

New Jersey

The New Jersey Department of Environmental Protection adopted sulfur fuel content rules for kerosene and home heating distillate oil. For distillate oil, the ULSD limit of 15 ppm yields a 99.5% reduction from the 3,000 ppm baseline. For kerosene, the same 15 ppm limit is adopted, resulting in a 96.25% reduction from an assumed 2,000 ppm baseline. More details on these fuel sulfur limits in New Jersey can be found here: http://njtoday.net/2010/09/01/nj-adopts-rule-limiting-sulfur-content-in-fuel-oil/

New York

New York also signed a law requiring ULSD to replace distillate heating oil #2, which results in a fuel sulfur content limit of 15 ppm, a 99.5% reduction from the 3,000 ppm baseline. The ULSD law (A.8642-A/S.1145-C) can be found here: http://switchboard.nrdc.org/blogs/rkassel/governor_paterson_signs_new_la.html and here: http://green.blogs.nytimes.com/2010/07/20/new-york-mandates-cleaner-heating-oil/. New York City also includes limits by year 2015 on #4 and #6 residual oils, where fuel sulfur content must not exceed 0.5% by weight (500 ppm), a 75% reduction from an assumed 2% baseline sulfur content in 2008. By 2030, these sources must burn ULSD (15 ppm). The NYC updated Air Code, updated from the NY DEP is discussed here: http://www.nyc.gov/html/dep/html/news/dep_stories_p3-109.shtml.

Vermont

Vermont ULSD fuel and date requirements for home heating oil are similar to those adopted in Massachusetts: a 99.5% reduction to 15 ppm from the 3,000 ppm baseline.

A summary of the sulfur rules by state, with emissions reductions is provided in Table 4-19.

Table 4-19. Summary of fuel sulfur rules by state

State/ Metro	Fuel	% reduction	2008 Emissions	2020 Emissions	2020 Reductions
ME	Distillate	99.5	12,076	1,056	11,021
ME	Residual	75			
MA	Distillate	99.5	17,265	86	17,178
NJ	Distillate	99.5	7,285	45	7,240
NJ	Kerosene	96.25			
NY	Distillate	99.5	54,093	655	53,442
NYC	Residual	75			
VT	Distillate	99.5	2,018	10	2,008

4.2.5 Industrial Boiler MACT reconsideration (ptnonipm)

Packet: CONTROL_BlrMACT_ptnonipm_2020_2007v5

The Industrial/Commercial/Institutional Boilers and Process Heaters MACT Rule, hereafter simply referred to as the "Boiler MACT" has been proposed and the reconsideration of the final rule is slated for December 31, 2012. A background on the Boiler MACT can be found at: http://www.epa.gov/ttn/atw/boiler/boilerpg.html. The Boiler MACT promulgates national emission standards for the control of HAPs (NESHAP) for new and existing industrial, commercial, and institutional (ICI) boilers and process heaters at major sources of HAPs. The expected cobenefit for CAPs at these facilities is significant and greatest for SO_2 with lesser impacts for direct PM, CO and VOC.

Boiler MACT reductions were computed from a non-NEI database of ICI boilers. As seen in the Boiler MACT Reconsideration RIA (http://www.epa.gov/ttn/atw/boiler/boilersriaproposalrecon111201.pdf), this Boiler MACT Information Collection Request (ICR) dataset computed over 558,000 tons of SO_2 reductions by year 2015. However, the Boiler MACT ICR database and reductions are based on the assumption that if a unit *could* burn oil, it *did* burn oil, and often to capacity. With high oil prices and many of these units also able to burn cheaper natural gas, the NEI2008 inventory has a lot more gas combustion and a lot less oil combustion than the boiler MACT database. For this reason, we decided to target units that potentially could be subject to the Boiler MACT and compute preliminary reductions for several CAPs prior to building a control packet.

Step 1: Extract facilities/sources potentially subject to Boiler MACT

We did not attempt to map each ICR unit to the NEI units, instead choosing to use a more general approach to extract NEI sources that would be potentially subject to, and hence have emissions reduced by the Boiler MACT. The NEI includes a field that indicates whether a facility is a major source of HAPs and/or CAPs. This field in our FF10 point inventory modeling file is called "FACIL_CATEGORY_CODE" and the possible values for that field are shown in Table 4-20. Because the Boiler MACT rule applies to only major sources of HAPs, we restricted the universe of facilities potentially subject to the Boiler MACT to those classified as HAP major or unknown (UNK). The third column indicates whether the facility was a candidate for extraction as being potentially subject to the Boiler MACT.

Table 4-20. Facility types potentially subject to Boiler MACT reductions

Code	Facility Category	Subject to Boiler MACT?	Description
CAP	CAP Major	N	Facility is Major based upon 40 CFR 70 Major Source definition paragraph 2 (100 tpy any CAP. Also meets paragraph 3 definition, but NOT paragraph 1 definition).
HAP	HAP Major	Y	Facility is Major based upon only 40 CFR 70 Major Source definition paragraph 1 (10/25 tpy HAPs).
HAPCAP	HAP and CAP Major	Y	Facility meets both paragraph 1 and 2 of 40 CFR 70 Major Source definitions (10/25 tpy HAPs and 100 tpy any CAP).
HAPOZN	HAP and O3 n/a Major	Y	Facility meets both paragraph 1 and 3 of 40 CFR 70 Major Source definitions (10/25 tpy HAPs and Ozone n/a area lesser tons for NO_X or VOC).
NON	Non-Major	N	Facility's Potential To Emit is below all 40 CFR 70 Major Source threshold definitions without a FESOP.
OZN	O3 n/a Major	N	Facility is Major based upon only 40 CFR 70 Major Source definition paragraph 3 (Ozone n/a area lesser tons for NO_X or VOC).
SYN	Synthetic non-Major	N	Facility has a FESOP which limits its Potential To Emit below all three 40 CFR 70 Major Source definitions.
UNK	Unknown	N	Facility category per 40 CFR 70 Major Source definitions is unknown.

From these facilities we extracted records (process level / release point level emissions) from our modeling file with industrial, commercial, institutional boiler or process heater SCCs. A complete list of these SCCs is provided in Appendix J. The resultant data are the NEI sources potentially subject to the Boiler MACT.

Step 2: Match fuel types and control reductions to the NEI SCCs

After obtaining the subset of NEI sources potentially subject to the Boiler MACT, we assigned each inventory SCC to a fuel type. The reductions are based on the ICR fuel types and associated controls from an April 2010 "Baseline Memo.pdf" memorandum available on the Regulations.gov website (http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2002-0058-0802) under docket # EPA-HQ-OAR-2002-0058-0802. These ICR fuel types and associated default controls were mapped to SCCs in our inventory using the cross-walk provided in Table 4-21. The previously-mentioned Appendix J also maps the complete list of inventory SCCs to these ICR fuel categories.

Table 4-21. Default Boiler MACT fuel percent % reductions by ICR fuel type

ICR Fuel Category	SCC Fuel Category(s)	CO	$PM_{2.5}$	SO_2	VOC
coal	coal, petroleum coke, waste coal	98.9	95.8	95	98.9
gas 1 (other)	gasified coal, hydrogen, liquified petroleum gas (LPG), propane/butane, refinery gas	1	1	1	1
gas 2	digester gas, gas, landfill gas, process gas	99.97	0	95	99.97
bagasse	bagasse	95.3	90	95	95.3
dry biomass	wood	95.8	99.1	95	95.8
gas 1 (natural gas)	natural gas, unknown	1	1	1	1
heavy liquid	coal-based Synfuel, crude oil, liquid waste, methanol, residual oil, waste oil	99.9	98.3	95	99.9
light liquid	distillate oil, gasoline, kerosene, oil, other oil	99.9	93	95	99.9
wet biomass	solid waste, wood/bark waste	85.5	99.2	95	85.5

The impacts of these Boiler MACT reductions on the controllable facilities and units are provided in Table 4-22. Controls were applied as "replacement" controls to prevent over-control of units that had existing controls. However, this assumes that the inventory correctly reflects units with controls, so it is likely that some units that are not recorded as controlled in the 2008 NEI but are actually controlled were reduced more than they should have. Overall, the SO_2, CO and $PM_{2.5}$ reductions are reasonably close to the year-2015 expected reductions in the Boiler MACT Reconsideration RIA: http://www.epa.gov/ttn/atw/boiler/boilersriaproposalrecon111201.pdf. It is worth noting that the SO_2 reductions in the preamble (http://www.epa.gov/ttn/atw/boiler/fr21mr11m.pdf) were estimated at 442,000 tons; the additional SO_2 reductions in the reconsideration are from an additional cobenefit from more stringent HCl controls.

Table 4-22. Summary of Boiler MACT reductions (tons) compared to Reconsideration RIA reductions

Pollutant	2007 Emissions	2020 Emissions	Reductions	RIA Reductions
CO	289,531	69,042	220,489	187,000
$PM_{2.5}$	36,061	10,311	25,749	25,601
SO_2	461,167	37,324	423,843	558,430
VOC	19,925	6,817	13,108	n/a

4.2.6 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., 2020) are available. Therefore, the 2013 policy case is used for the 2020 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,
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 4-23 shows the magnitude of the ISIS-based cement industry reductions in the future-year emissions that represent 2020, and the impact that these reductions have on total stationary non-EGU point source (ptnonipm) emissions.

Table 4-23. ISIS-based cement industry change (tons/yr)

Pollutant	Cement Industry emissions in 2008	Cement Industry emissions in 2020	% decrease in Cement Industry
CO	46,317	8,713	81%
NH_3	270	77	71%
NO_X	156,579	75,176	52%
PM_{10}	6,621	1,007	85%
$PM_{2.5}$	3,689	801	78%
SO_2	98,277	23,830	76%
VOC	6,954	1,265	82%

4.2.7 Residential wood combustion growth (nonpt)

Packet: "PROJECTION_2008_2020_RWC"

We projected residential wood combustion (RWC) emissions to the year 2020 based on expected increases and decreases in various residential wood burning appliances. As newer, cleaner woodstoves replace ***some*** older, higher-polluting wood stoves, there will be an overall reduction of the emissions from older "dirty" stoves but an overall increase in total RWC due to population and sales trends in all other types of wood burning devices such as indoor furnaces and outdoor hydronic heaters (OHH). It is important to note that our RWC projection methodology does not explicitly account for state or local residential wood control programs. There are many state and local rules in place across the country. However, at this time, we do not have enough detailed information to calculate state specific or local area growth rates. We are therefore using national level growth rates for each RWC SCC category. We also do not account for national New Source Performance Standards (NSPS) for RWC, since they are not currently in place.

We began our projection methodology by obtaining estimates for the future year sales of wood burning devices through year 2020[11]. Table 4-24 provides these new units in 2020 as well as the US total appliance counts for similar groups of wood burning devices in the 2008 NEI. For wood burning devices that are not expected to be replaced, the projection factor would simply be the sum total of these new units and existing units from 2008 divided by the number of units in 2008. However, there are exceptions to this simple ratio

[11] The Frost and Sullivan report contained forecasted growth to 2015. Additional growth to 2020 was extrapolated based on the 2008 to 2018 growth rate.

for each wood burning device. The Frost and Sullivan sales for year 2008 are totals for North America. The report estimates that 87% of these units are sold in the U.S. From this beginning point adjustment, future year sales for 2009 to 2020 were summed as they appear in Table 4-24. Specific assumptions were then applied to each of the following types of wood burning equipment:

Fireplaces (2104008100)
The RWC emissions estimates are based on the number of appliances that are actually used to burn wood. Information collected through local surveys, industry marketing research, and other government publications has indicated that approximately 42% of homes with usable fireplaces are never used, either for heating or aesthetic purposes (Kochera, 1997). Therefore the cumulative new units by year 2020 for this category is only 58% of the expected total number of new units, yielding a projection factor of 1.088, or, 8.8% growth between 2008 and 2020. We do not assume any change out of these units in the future.

EPA-certified wood stoves (2104008220, 2104008230, 2104008320, 2104008330)
There is no assumption on the removal of existing units. Therefore, the projection factor for these devices is simply the sum of existing and new units (4,353,690) divided by the number of units in 2008 (2,977,877) = 1.462.

Conventional non-certified woodstoves (2104008210, 2104008310)
EPA NSPS experts assume that 10% of the total new certified wood stoves, inserts and pellet stoves (2,452,995) are used to replace older, more-polluting units. This 10% change out reduces the existing units from 5,221,191 to 4,975,892, yielding a projection factor of 0.953.

Pellet stoves (2104008400)
There is no assumption on the removal of existing units. Therefore, the projection factor for these devices is simply the sum of existing and new units (1,924,113) divided by the number of units in 2008 (846,931) = 2.272.

Indoor Furnaces (2104008510)
We assume that any existing unit in 2008 will be replaced by a new indoor furnace in 2020[12]. This also assumes that every unit sold between 2009 and 2020 will be in use in 2020. The projection factor for these devices is therefore simply the sum of the new units (338,734) divided by the number of units in 2008 (197,362) = 1.716.

Outdoor Hydronic Heaters (2104008610)
EPA NSPS experts assume that 10% of the total new OHH (110,584) will replace existing units in 2008 (176,673). This yields a projection factor of 1.563 = 276,199 / 176,673.

[12] This is based on the assumption that wood fired furnaces will have a relatively short lifetime. All existing furnaces in 2008 will be more than 12 years old in 2020.

Table 4-24. Worksheet for computing national RWC projection factors to 2020

SCC(s)	Description	US total appliance count NEI2008	New units in 2020 with fireplace 58% usage assumed	US total units in 2020	US total 2020 with: 1) 10% change out woodstoves & OHH 2) 100% 2008 indoor furnaces replaced by 2020	Ratio 2020/2008 w/ 10% change out for non-certified woodstoves & OHH, and 100% indoor furnaces replaced
2104008100	Fireplace: general	9,789,251	862,532	10,651,783		1.088
2104008220 2104008230 2104008320 2104008330	Wood Stoves: inserts & freestanding EPA certified, non and catalytic	2,977,877	**1,375,813**	4,353,690		1.462
2104008210 2104008310	Conventional non-certified woodstoves and inserts	5,221,191	0	5,221,191	4,975,892	0.953
2104008400	Pellet Stoves	846,931	**1,077,182**	1,924,113		2.272
2104008510	Furnace: indoor, cordwood	197,362	338,734	536,096	338,734	1.716
2104008610	Outdoor Hydronic Heating Systems (including 10% that may be indoors)	176,673	110,584	287,257	276,199	1.563
New certified woodstoves and pellet stoves in 2020			**2,452,995**			

The ratios in Table 4-24 are used as projection factors for RWC for all states except New York. Recall in Section 2.2.3, that we used MARAMA (RPO) RWC emissions for New York rather than 2008 NEI emissions. New York was unique in that their RPO RWC emissions were reported in only three SCCs: fireplaces (2104008100), "woodstoves" (2104008320), and outdoor wood burning devices (2104008700). However, there are two problems with these SCC assignments for New York RWC:

1. The outdoor wood burning devices actually represent outdoor hydronic heaters (OHH). Therefore, projections of SCC=2104008700 are assigned the projection factor for OHH (2104008610) in New York.
2. New York did not have enough information to split out "wood stoves" into separate categories for inserts versus freestanding units, catalytic versus non-catalytic, indoor furnaces, and also to delineate non-EPA certified from EPA-certified units. Therefore, we used the distribution of 2008 NEI $PM_{2.5}$ emissions for New York wood stoves to create a composite "wood stove" (2104008320) projection factor. The equations and worksheet for this composite NY woodstove projection factor are provided in Table 4-25. The resulting projection factor for NY woodstoves is 1.153, the sum of NEI-based 2020 projected emissions for all woodstove SCCs, divided by those for 2008 (12,373/10,734).

Table 4-25. Worksheet for creating NY "woodstove" projection factor from

SCC	Description	NEI $PM_{2.5}$	non-NY Projection Factor	NEI-based Projected Emissions	NY composite Projection Factor
2104008210	Woodstove: fireplace inserts; non-EPA certified	2,148	0.950	2,041	n/a
2104008220	Woodstove: fireplace inserts; EPA certified; non-catalytic	442	1.462	645	
2104008230	Woodstove: fireplace inserts; EPA certified; catalytic	153	1.462	223	
2104008310	Woodstove: freestanding, non-EPA certified	5,211	0.950	4,950	
2104008320	Woodstove: freestanding, EPA certified, non-catalytic	1,071	1.462	1,564	
2104008330	Woodstove: freestanding, EPA certified, catalytic	372	1.462	543	
2104008400	Woodstove: pellet-fired, general (freestanding or FP insert)	193	2.272	438	
2104008510	IF: Indoor Furnaces: cordwood-fired, non-EPA certified	1,144	1.716	1,968	
2104008230	**Total Wood stoves in New York**	**10,734**		**12,373**	**1.153**

California also did not report detailed SCCs in the 2008 NEI, reporting simply 15,373 tons of $PM_{2.5}$ as general fireplaces (SCC=2104008100) and 22,456 tons of $PM_{2.5}$ as general woodstoves (SCC=2104008300). Without appliance counts at specific appliance types (e.g., certified versus non-certified), and a lack of data for incorporating significant local RWC control programs in California, we decided to leave the general woodstoves emissions unchanged in the future and grow the general fireplaces consistent with all other states. Table 4-26 therefore presents the projection factors used to project all U.S. states in the 2007 base case for residential wood combustion.

Table 4-26. Residential Wood Combustion projection factors to year 2020

State(s)	SCC	Description	Projection Factor
New York	2104008320	New York only: all woodstoves including indoor furnaces, composite Projection Factor based on 2008 NEI emissions at all wood stove SCCs	1.153
New York	2104008700	New York only: incorrect SCC assignment, really Outdoor Hydronic Heaters, so Projection Factor is from OHH	1.563
all other	2104008100	Fireplace: general	1.088
all other	2104008210	Woodstove: fireplace inserts; non-EPA certified	0.950
all other	2104008220	Woodstove: fireplace inserts; EPA certified; non-catalytic	1.462
all other	2104008230	Woodstove: fireplace inserts; EPA certified; catalytic	1.462
all other	2104008310	Woodstove: freestanding, non-EPA certified	0.953
all other	2104008320	Woodstove: freestanding, EPA certified, non-catalytic	1.462
all other	2104008330	Woodstove: freestanding, EPA certified, catalytic	1.462
all other	2104008400	Woodstove: pellet-fired, general (freestanding or FP insert)	2.272
all other	2104008510	IF: Indoor Furnaces: cordwood-fired, non-EPA certified	1.716
all other	2104008610	OHH: Outdoor Hydronic heaters	1.563

4.2.8 CSAPR and NODA Controls, Closures and consent decrees (nonpt, ptnonipm)

We 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. We received several control programs and other responses that we 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 2020 base case projection. But for those controls, closures and consent decree information that are implemented after 2008, we used these controls/data after we mapped 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. We 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 we would assume that the 2008 NEI emissions did not reflect this control and we would need to reflect this control in our 2020 base case. 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 we received usable feedback from the CSAPR comments and related 2005 platform NODA.

<u>Nonpoint controls:</u> packet “CONTROL_CSAPR_nonpoint_2020_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.

<u>Ptnonipm controls:</u> packet “CONTROL_CSAPR_ptnonipm_2020_2007v5”
We 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.

<u>Ptnonipm closures:</u> 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. We found a couple of units in our 2008 NEI-based inventory that were reported as closed in year 2007; therefore, the compliance dates in this packet range from 2007 to 2012. We 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. We 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.

<u>Ptnonipm projection:</u> 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. We included the shutdown of the coal boiler 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.

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 we removed all consent decrees with compliance dates prior to late-2008, we 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, we recomputed the percent reductions such that the future year emissions would match those for facilities originally projected from the 2005 platform. We 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. We were left with consent decree controls in sixteen states (AL, CA, IN, KS, KY, LA, MI, MS, MO, OH, OK, TN, TX, UT, WI, WY) that accounted approximately 4,100 tons of NO_X and 37,000 tons of SO_2 cumulative reductions, respectively.

4.2.9 Remaining non-EGU plant closures (ptnonipm)

We have already discussed facility and unit closures at cement facilities and those received from the CSAPR comments. There are three additional packets that we developed for projecting the 2007 base case to 2020. For each of these three packets, we relied heavily on the Emissions Inventory System (EIS) to validate facility and unit IDs, and in the case of the "EIS" packet, the facility status code.

1) Packet: "CLOSURES_2012ck_2008NEIv2"

This packet was developed for the NEI2005-based emissions modeling platform from EPA staff for projecting emissions through year 2010. This is the first closures packet developed by EPA staff in 2008; additional closures information was gathered between 2008 and 2010 and that is discussed in the subsequent packet. For this packet, we translated the original NEI2005-based dataset to the NEI2008 facility identifiers using the "FACILITY_ID" and "UNIT_ID" fields in the NEI2005 and the "AGY_FACILITY_ID" and AGY_POINT_ID" in the NEI2008. We also checked the closure status using the EIS. Most of the facilities in this original dataset were assumed to close during 2007; however, several of these facilities were still found after our matching procedure. We also retained closures that were from 2007 even if there was not a match in the NEI2008 data because we want this packet to be useful if users want to project a year-2007 inventory. Therefore, as expected, very few facilities are closed by this packet, with cumulative reductions of only 117 tons of NO_X and less for other pollutants.

2) Packet: "CLOSURES_OAQPS_emv4.2_2008NEIv2"

This packet was also developed for the NEI2005-based emissions modeling platform from EPA staff, but was created after scouring the web for new closures information in between 2008 and 2010. This packet includes closures information for facilities and units that were not reflected in the "2012ck" packet just described. We applied the same matching criteria as the aforementioned "2012ck" packet. This closures packet impacts much larger facilities in 17 states and is therefore far more detailed, with specific websites and contact information for each unit and facility. With the exception of a small plant in Georgia that was closed by 2007, the closures are all implemented in year 2008 through late 2010. The cumulative reductions in emissions from this packet are fairly significant and are shown in Table 4-27.

Table 4-27. Cumulative reductions from facility and unit closures obtained between 2008 and 2010

Pollutant	Reductions
CO	20,517
NH_3	297
NO_X	5,029
PM_{10}	3,598
$PM_{2.5}$	2,724
SO_2	20,364
VOC	3,104

3) Packet: "CLOSURES_EIS_2008NEIv2"

This packet was developed specifically for the 2007 platform and is based on a query against the EIS facility status. The EIS provided information on facilities that closed prior to January 2012. Permanent shutdowns have a facility status "PS" and temporary shutdowns have a facility status of "TS". Some states provided additional information to independently confirm closure status and metadata on what happened to the unit or facility. The cumulative reductions in emissions from this packet are fairly significant and are shown in Table 4-28.

Table 4-28. Cumulative reductions from facility and unit closures obtained from the EIS

Pollutant	Reductions
CO	6,532
NH_3	91
NO_X	5,782
PM_{10}	3,399
$PM_{2.5}$	2,521
SO_2	4,821
VOC	10,397

4.2.10 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. The impacts of all packets on the future year emissions are provided in Appendix F.

4.2.10.1 Aircraft growth (ptnonipm)

Packet: "PROJECTION_2008_2020_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. We 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. We computed growth factors for each operation type by dividing future-year 2020 ITN by 2008-year ITN. We 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 4-29 provides the national growth factors for aircraft; all factors are applied to year 2008 emissions. For example, year 2020 commercial aircraft emissions are 11.6% higher than year 2008 emissions.

Table 4-29. Factors used to project 2008 base-case aircraft emissions to 2020

SCC	Description	Projection Factor
2270008005	Commercial Aircraft: Diesel Airport Ground Support Equipment, Air Ground Support Equipment	1.116
2275000000	All Aircraft Types and Operations	1.116
2275001000	Military Aircraft, Total	1.062
2275020000	Commercial Aviation, Total	1.116
2275050000	General Aviation, Total	0.928
2275050011	General Aviation, Piston	0.928
2275050012	General Aviation, Turbine	0.928
2275060000	Air Taxi, Total	0.962
2275060011	Air Taxi, Total: Air Taxi, Piston	0.962
2275060012	Air Taxi, Total: Air Taxi, Turbine	0.962
2275070000	Commercial Aircraft: Aircraft Auxiliary Power Units, Total	1.116
27501014	Military aircraft: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Military; Jet Engine: JP-4	1.062
27501015	Military aircraft, This SCC is in 2005v2: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Military; Jet Engine: JP-5	1.062
27502001	Commercial Aircraft, Total, This SCC is in 2005v2 NEI: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Commercial; Piston Engine: Aviation Gas	1.116
27502011	Commercial Aircraft, Total, This SCC is in 2005v2 NEI: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Commercial; Jet Engine: Jet A	1.116
27505001	General Aviation Total. This SCC is in 2005v2 NEI: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Civil; Piston Engine: Aviation Gas	0.928
27505011	General Aviation Total. This SCC is in 2002 NEI: Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Civil; Jet Engine: Jet A	0.928
27601014	Military aircraft: Internal Combustion Engines; Rotary Wing Aircraft L & TO Exhaust; Military; Jet Engine: JP-4	1.062
27601015	Military aircraft: Internal Combustion Engines; Rotary Wing Aircraft L & TO Exhaust; Military; Jet Engine: JP-5	1.062
27602011	Commercial aircraft: Internal Combustion Engines; Rotary Wing Aircraft L & TO Exhaust; Commercial; Jet Engine: Jet A	1.116

None of our aircraft emission projections account for any control programs. We 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.

4.2.10.2 Boiler reductions not associated with the MACT rule (ptnonipm)

Packet: CONTROL_IndBoilers_nonMACT_by2008_2007v5

The Boiler MACT ICR collected data on existing controls. We used an early version of a data base developed for that rulemaking entitled "survey_database_2008_results2.mdb" (EPA-HQ-OAR-2002-0058-0788) which is posted under the Technical Information for the Boiler MACT major source rule (http://www.epa.gov/ttn/atw/boiler/boilerpg.html). This dataset of controls was originally developed in support of the 2005 NEI-based CSAPR emissions modeling platform. When using the 2008 NEI, we found only one unit in King William county Virginia that had a control that was installed during or after 2008. We determined a percent reduction, and verified with the source owner that the wet scrubber control was actively in use. SO_2 emissions at this unit were reduced by 1,484 tons.

4.2.10.3 NY Ozone SIP controls (nonpt, ptnonipm)

Packet: CONTROLS_NYSIP_VOC_2007v5

As part of the CSAPR response to comments, New York state provided 8-hour ozone SIP controls for select nonpoint and point sources. These sources and reductions are fully implemented by year 2012 and are described in Appendix J of the NY attainment demonstration document http://www.dec.ny.gov/docs/air_pdf/NYMASIP7final.pdf. We mapped the source categories in this document with SCCs in the 2008 NEI and created the control factor percent reductions based on the product of the control factor (CF), rule effectiveness (RE) and rule penetration (RP). These controls impacted VOC and NO_X emissions at the sources listed in Table 4-30. We applied the same VOC reductions to the BAFM VOC HAPs in order to maintain the consistency of our speciation approach. Additional background on this 2008 NY ozone SIP is found in Section 9 on the NY Department of Environmental Conservation Ozone Attainment Demonstration website: http://www.dec.ny.gov/chemical/37012.html.

Table 4-30. New York Ozone SIP controls reflected in the 2020 base case

Pollutant	Source Category	Sector	Percent Reduction
NO_X	Glass Manufacturing	ptnonipm	70%
VOC	Architectural and Industrial Maintenance (AIM) Coatings	nonpt	31%
VOC	Mobile Equipment Repair	nonpt	38%
VOC	Solvent Metal Cleaning	nonpt	66%
VOC	Adhesives and Sealants	nonpt	64.4%
VOC	Consumer Products: Solvent Utilization	nonpt	15.92%

4.2.10.4 Boat Manufacturing MACT (ptnonipm)

Packet: CONTROL_MACT_BoatManuf_2007v5

We include MACT rules where compliance dates were 2008 or later. The EPA OAQPS Sector Policies and Programs Division (SPPD) provided all controls information related to the MACT rules, and this information is as consistent as possible with the preamble emissions reduction percentages for these rules.

A 32% reduction to VOC and VOC BAFM HAPs was applied to the Boat Manufacturing SCCs in the ptnonipm inventory. Compliance with the MACT reduction is expected to occur by use of low HAP resins and gel coats and use of non-atomized resin spray application systems. Documentation on this control is provided in the Guidance for Estimating VOC and NOX Emission Changes from MACT Rules document (EPA, 2007b).

4.2.10.5 Lafarge and St. Gobain settlements (ptnonipm)

Packet: CONTROL_LaFarge_StGobain_2007v5

This control packet impacts the ptnonipm sector and includes settlements for all 15 U.S. plants owned by Saint-Gobain Containers, Inc., the nation's second largest container glass manufacturer, and all 13 U.S. plants owned by the Lafarge Company and two subsidiaries, the nation's second largest manufacturer of Portland cement. These settlements are the first system-wide settlements for these sectors under the Clean Air Act and require pollution control upgrades, acceptance of enforceable emission limits, and payment of civil penalties. The settlements require various NO_X and SO_2 controls, some of which (SO_2 scrubbers) also reduce PM emissions. A couple of Lafarge kilns were also scheduled to be shut down. One of these units was shutdown prior to 2008 and as expected, is not in the 2007 base case. However, a Lafarge kiln in Joppa Illinois was unexpectedly found in the 2008 NEI and communication with the Illinois DEP indicated that this unit was not closed as of the summer of 2012. More information on the Lafarge settlement can be found here: http://www.epa.gov/compliance/resources/cases/civil/caa/lafarge.html. More information on the Saint-Gobain settlement is available here: http://www.epa.gov/compliance/resources/cases/civil/caa/saintgobain0110.html. Many of the controls for the units at these facilities were implemented prior to 2008; however, cumulatively, there is still significant reductions post-2008: approximately 6,300 tons of NO_X, 300 tons of $PM_{2.5}$ and 2,100 tons of SO_2.

4.2.10.6 OECA consent decrees (ptnonipm)

Packet: CONTROLS_OECA_2008NEIv2

The Office of Enforcement and Compliance Assurance (OECA) provided emission reduction information for several consent decrees while we were preparing emissions for the NEI2005-based modeling platform (http://www.epa.gov/ttn/chief/emch/toxics/proposed_toxics_rule_main.pdf). The press releases for these consent decrees are available on the EPA's enforcement website (http://www.epa.gov/enforcement/) and some were available with quantitative emission reductions that we were able to convert into a control packet. The consent decrees discussed in this section were released in the 2003-2010 time period and include information for a few corporations but with aggregate reductions over numerous facilities under these companies and subsidiaries. Therefore, we developed an initial table of NEI2005 emissions summed over all affected facilities for each company. Then we merged the multi-facility expected reductions from each of these consent decrees to develop an overall future year (post-compliance date) emissions estimate for each company after all controls/reductions are implemented. Using this methodology, the emissions reductions were apportioned to each plant owned/operated by each company using the same percent reduction from the 2005 NEI emissions.

Now that we are using an NEI2008-based inventory, we expected that some of these consent decree controls/reductions would have already been applied by 2008. We did not want to over-control any particular plant. Therefore, we computed facility-specific reductions based on the controlled emissions from the 2005 NEI. For example, as seen in Table 4-31, NO_X emissions at all Bunge facilities were reduced about 29.5% in the 2005 NEI: from 914 tons to 644 tons. This roughly matches the 278 tons of reductions in the consent decree. In the 2008 NEI, NO_X emissions at these same Bunge facilities totaled 852 tons, so only 208 tons were needed to achieve the 644 consent decree target. Rather than reducing all Bunge facilities 24.4%, we applied controls to each individual facility such that the controlled emissions from the 2008 NEI matched the controlled emissions from the 2005 NEI. If the 2008 NEI emissions for any facility were less than the controlled emissions based on the 2005 NEI, then we did not apply any further reductions. Actual achieved reductions in our 2007v5 platform are close, but usually slightly less than the target 2020 reductions because of other controls or closures already applied at these facilities. We also do not list in Table 4-31 every company subject to the OECA consent decree controls because the emissions and expected reductions were very small.

Table 4-31. Target company-wide reductions from OECA consent decree information

Corporation	Pollutant	2005 NEI Emissions	Controlled Emissions, via 2005 NEI	Reductions from 2005	2008 NEI Emissions	Target 2020 Reductions	Actual 2020 (Total only) Reductions
Bunge	NO_X	914	644	270	852	208	
	$PM_{2.5}$	416	189	227	265	76	
	SO_2	2,918	2,346	572	3,758	1,412	
	VOC	2,627	1,559	1,068	2,539	980	
Cargill	CO	10,968	262	10,706	10,889	10,627	
	NO_X	4,173	2,907	1,266	3,466	559	
	SO_2	9,639	7,579	2,060	8,790	1,211	
Conoco Phillips	NO_X	17,409	7,409	10,000	14,394	6,985	
Sunoco	NO_X	6,475	1,975	4,500	4,506	2,531	
	$PM_{2.5}$	885	585	300	1,030	445	
Valero	NO_X	13,742	9,742	4,000	10,800	1,058	
	$PM_{2.5}$	2,569	2,043	526	2,635	592	
	SO_2	19,608	3,608	16,000	11,603	7,995	
Total	CO	10,968	262	10,706	10,889	10,627	9,987
	NO_X	42,712	22,677	20,035	34,017	11,340	12,519
	$PM_{2.5}$	3,870	2,816	1,053	3,929	1,113	1,066
	SO_2	32,166	13,533	18,633	24,151	10,617	9,422
	VOC	2,627	1,559	1,068	2,539	980	1,149

4.2.10.7 Refinery consent decrees (ptnonipm)

Packet: CONTROLS_Refineries_additional_consent_2008NEIv2

Two additional refinery consent decrees were obtained from the EPA's Sector Policies and Programs Division (SPPD). The BP Whiting Settlement consent decree impacts several NO_X and SO_2 units in Lake County Indiana: http://www.epa.gov/compliance/resources/cases/civil/caa/bp-whiting.html. The Marathon Petroleum Detroit consent decree only impacts NO_X at its' Wayne County Michigan facility: http://www.epa.gov/compliance/resources/cases/civil/caa/marathonrefining.html. Cumulatively, these consent decrees reduce NO_X by 900 tons and SO_2 by about 160 tons. It is worth noting that several other facilities are subject to refinery consent decrees but we did not have the resources to extract and convert these into usable control packets for our projections effort.

4.2.10.8 CISWI/HWI controls (ptnonipm)

Packet: CONTROL_CISWI_2007v5

On March 21, 2011, the EPA promulgated the revised NSPS and emission guidelines for Commercial and Industrial Solid Waste Incineration (CISWI) units. This was a response to the voluntary remand that was granted in 2001 and the vacatur and remand of the CISWI definition rule in 2007. In addition, the standards re-development included the 5-year technology review of the new source performance standards and emission guidelines required under Section 129 of the Clean Air Act (CAA). The history of the CISWI implementation is documented here: http://www.epa.gov/ttn/atw/129/ciwi/ciwipg.html. Baseline and CISWI rule impacts associated with the CISWI rule are documented here:

http://www.epa.gov/ttn/atw/129/ciwi/baseline_emission_reductions_memo.pdf. We mapped the units from the CISWI baseline and controlled dataset to the NEI2008 inventory and because the baseline CISWI emissions and the NEI2008 emissions were not the same, we computed percent reductions such that our future year emissions matched the CISWI controlled dataset values. Cumulatively, CISWI reductions are applied in five states - Arkansas, Louisiana, Massachusetts, Oklahoma and Tennessee- and reduce $PM_{2.5}$ and SO_2 by approximately 140 and 3,500 tons, respectively.

Packet: CONTROL_HWI_2007v5

EPA issued the NESHAP for Hazardous Waste Combustors (HWCs) on October 12, 2005. The HWC category includes combustion units that burn hazardous waste as it is defined under the Resource Conservation and Recovery Act (RCRA). HWCs burn hazardous waste for various purposes, such as burning for energy recovery or destruction (treatment) of the hazardous waste. This NESHAP covers the following categories of combustion units that burn hazardous waste: incinerators, cement kilns, lightweight aggregate kilns, industrial boilers, and hydrochloric acid production furnaces. In 2005, EPA estimated that there were 267 hazardous waste combustors operating in the U.S. Of this total, there were 116 industrial boilers, 107 incinerators, 25 cement kilns, 10 hydrochloric acid production furnaces, and nine lightweight aggregate kilns. Additional information on the HWC NESHAP can be found at http://www.epa.gov/osw/hazard/tsd/td/combust/index.htm.

A control packet developed for the NEI2005 was mapped to the 2008 NEI using EIS facility and unit code matching. Cumulatively, this packet reduces $PM_{2.5}$ emissions by about 4,100 tons across 25 states.

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

We used year 2006 WRAP Phase III oil and gas emissions for both the 2007 and 2020 base cases. These point and nonpoint inventories are discussed in the 2007 base case Sections 2.1.2 and 2.2.3, respectively. Only year 2006 baseline inventories were available while we were constructing the 2020 base case during the summer of 2012. Since then, mid-term projections for years 2010 and 2012 inventories for some basins have been made available. Summaries of these mid-term projections are posted on the WRAP Phase III oil and gas project website: http://www.wrapair2.org/PhaseIII.aspx.

We intended to project Texas oil and gas drilling rig emissions to year 2020 based on estimates from the Texas Commission of Environmental Quality (TCEQ): http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/5820783985FY0901-20090715-ergi-Drilling_Rig_EI.pdf. However, we accidentally applied the national RICE NESHAP Reconsideration Amendments in precedence over the TCEQ projection target factors. As illustrated in Table 4-32 the RICE NESHAP reductions result in lower reductions/higher emissions in 2020 than TCEQ projections. Future year base cases in subsequent versions of the 2007 platform will include the correct TCEQ-based emissions as well as more local, detailed, and accurate estimates for Permian Basin emissions that were received after we completed this 2020 base case.

Table 4-32. Texas oil and gas missed reductions by EPA

Pollutant	2008 Emissions	2020 TCEQ Emissions	2020 EPA Emissions	Missed 2020 Reductions
CO	16,721	6,035	15,738	9,703
NO_X	55,238	30,771	54,470	23,699
PM_{10}	2,543	800	2,543	1,743
$PM_{2.5}$	2,467	776	2,467	1,691
SO_2	956	35	480	445
VOC	4,326	2,205	4,326	2,121

4.3 Mobile source projections

Mobile source monthly inventories of onroad and nonroad mobile emissions were created for 2020 using a combination of the NMIM and the SMOKE-MOVES models. The 2020 onroad emissions account for changes in activity data and the impact of on-the-books rules including: the Light-Duty Vehicle Tier 2 Rule (EPA, 2000), the 2007 Heavy Duty Diesel Rule (http://www.epa.gov/otaq/highway-diesel/), the Mobile Source Air Toxics (MSAT2) Rule (EPA, 2007a), the Renewable Fuel Standard (RFS2) (EPA, 2010a), the LD GHG/CAFE standards for 2012-2016 (EPA, 2010c), and the Heavy-Duty Vehicle Greenhouse Gas Rule (EPA, 2011a). The emissions do not account for the 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule (LD GHG), published October 15, 2012. The 2017 LD GHG rule (EPA, 2012b) was not included in this analysis because the rule was not signed at the time the modeling was performed, and it is expected to have little impact on particulate matter emissions. Local inspection and maintenance (I/M) and other onroad mobile programs such as the National Low Emissions Vehicle (LEV) and Ozone Transport Commission (OTC) LEV regulations are also included: http://www.epa.gov/otaq/lev-nlev.htm.

Nonroad mobile emissions reductions for these years include reductions to locomotives, various nonroad engines including diesel engines and various marine engine types, fuel sulfur content, and evaporative emissions standards.

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.

4.3.1 Onroad mobile (onroad and onroad_rfl)

The onroad emissions for 2020 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

Our estimate of total national Vehicle Miles Travelled (VMT) in 2020 came from DOE's Annual Energy Outlook (AEO) 2012 (http://www.eia.gov/forecasts/aeo/). We allocated this VMT between vehicle types using a version of MOVES2010b that had been modified with VMT growth factors from the AEO 2012 early release (http://www.eia.gov/forecasts/aeo/er/) and with historical data from FHWA (http://www.fhwa.dot.gov/policyinformation/statistics.cfm). The growth was allocated to county and month using information in the NMIM County Database (NCD20101201), which reflects regional differences in growth based on economic modeling. Details may be found in “Appendix G: Description of VMT growth approach," EPA Document ID EPA-HQ-OAR-2009-0491-4198 in Docket ID EPA-HQ-OAR-2009-0491 (Clean Air Transport Rule)Vehicle Vehicle populations by county, month and vehicle type were estimated by dividing annual VMT by 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). 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.

4.3.1.2 Fuels

In order for EPA to generate the 2020 fuel supplies used in MOVES modeling, the regional fuel supplies generated for the 2007 county fuel properties were first updated to refinery certification data produced in 2009. Steps 2 through 5 from the 2007 fuels process outlined in Section 2.5.1.3 above proceeded as normal. In order to account for additional ethanol required by the RFS2 regulations, all counties are assumed to have a market share of 100% E10. Diesel fuel is assumed to be at 15 ppm sulfur nationally, with a biodiesel volume of 3.4% nationally and at 5% in areas with local regulatory constraints encouraging the use of biodiesel. All counties also contain significant volumes of E85, as shown by vehicle in-use fractions outlined in Table 4-33 below. Usage fractions are zero for years prior to 1998. Vehicle type 21 represents passenger cars, 31 represents passenger trucks and 32 represents light commercial trucks (Table 3.3 in http://www.epa.gov/otaq/models/moves/420b10023.pdf). The speciation of the VOC emissions reflected these changes in fuel composition (see Section 3.2.1.4 for details).

Table 4-33. E85 Usage Fraction by Model Year for 2020

	VEHICLE TYPE	21	31/32
Model Year	1998	0.003451	0.0077
	1999	0.006378	0.013743
	2000	0.008829	0.018626
	2001	0.008979	0.017386
	2002	0.013396	0.024916
	2003	0.014679	0.024995
	2004	0.011625	0.018739
	2005	0.012389	0.020728
	2006	0.013782	0.016652
	2007	0.015127	0.043189
	2008	0.021302	0.043784
	2009	0.017812	0.047721
	2010	0.037429	0.077135
	2011	0.040462	0.12271
	2012	0.046882	0.163283
	2013	0.04512	0.17408
	2014	0.044443	0.178874
	2015	0.043993	0.182297
	2016	0.043378	0.187309
	2017	0.042857	0.191911
	2018	0.042338	0.196838
	2019	0.041817	0.202174
	2020	0.041214	0.208914

4.3.1.3 Run MOVES to create EF

Emission factor tables were created by running SMOKE-MOVES using the same procedures and models as described above for 2007 (see Section 2.5.1.7). The same meteorology and the same representative counties were used. Changes between 2007 and 2020 are VMT and fuels (described above) 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.

4.3.1.4 California emissions

The adjustment of California onroad emissions for 2020 uses the same approach as 2007 to match the emissions totals for 2020 to those provided by CARB (see Section 2.5.1.9). The only differences between the 2007 approach and 2020 is the latter uses the 2020 emissions from CARB and the 2020 SMOKE-MOVES output. The 2020 CARB emissions were produced from working draft versions of EMFAC2011-LD and EMFAC2011-HD and include the following heavy duty regulations: chip reflash, extended idling, public fleet, trash trucks, drayage trucks, and trucks and buses. It does not include the GHG/smartway regulations for trucks, or the low carbon fuel standard.

4.3.2 Nonroad mobile (nonroad)

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. Like the onroad emissions, NMIM provides nonroad emissions for VOC by three emission modes: exhaust, evaporative and refueling.

With the exception of California, U.S. emissions for the nonroad sector (defined as the equipment types covered by the NONROAD model) were created using a consistent NMIM-based approach as was used for 2007. Fuels for 2020 were assumed to be E10 everywhere for nonroad equipment. The fuels were developed from MOVES fuels, and were supplied in the database "RegionalE10_2020_05172012_NMIM." The only difference between the 2007 and 2020 procedures was that counties were grouped to conserve computer resources for the 2007 run, but were run individually for 2020. The 2020 emissions account for increases in activity (based on NONROAD model default growth estimates of future-year equipment population), changes in fuels and engines that reflect implementation of national regulations and local control programs that impact each year differently due to engine turnover.

The version of NONROAD used was the current public release, NR08a, which models all in-force nonroad controls. Recent rules include:

- "Clean Air Nonroad Diesel Final Rule - Tier 4", published June, 2004: http://www.epa.gov/otaq/nonroad-diesel.htm
- Control of Emissions from Nonroad Large Spark-Ignition Engines, and Recreational Engines (Marine and Land-Based), November 8, 2002 ("Pentathalon Rule").
- OTAQ's Small Engine Spark Ignition ("Bond") Rule, October, 2008: http://www.epa.gov/otaq/smallsi.htm

Not included are voluntary local programs such as encouraging either no refueling or evening refueling on Ozone Action Days.

<u>California nonroad emissions</u>

Similar to the 2007 base nonroad mobile, NMIM was not used to generate future-year nonroad emissions for California, other than for NH_3. We 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, we converted the CARB-supplied 2020 nonroad annual inventory to monthly emissions values by using the 2020 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. 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 2020 inventories from the 2007 base case. The first component to the 2020 c1c2rail inventory is the non-California data projected from the 2007 base case. The second component is the CARB-supplied year 2020 data for California. The third component is a new year-2020 inventory from OTAQ that contains c1c2 CMV and locomotive emissions above and beyond the CARB and non-CARB projections that represent additional emissions from the EISA (RFS2) mandate. We discuss each of these three components below.

Non-California projections from the 2007 base case, Packet: "PROJECTION_2008_2020_c1c2rail"

For all states except California, year 2020 locomotive and Class 1 and Class 2 commercial marine vessel (CMV) emissions were calculated using projection factors that were computed based on national, annual summaries in 2008 and 2020. These national summaries were used to create national by-pollutant, by-SCC projection factors. The national summaries 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/marinesi-equipld/420r08014.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 and 2020, we are potentially being careful not to overly-reduce emissions by year 2020. 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 2020. 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, we simply apply the ratio of the RIA 2020 to 2008 emissions to project the 2007 platform emissions. These projection ratios are provided in Table 4-34.

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.

We applied HAP factors for VOC HAPs by using the VOC projection factors to obtain 1,3-butadiene, acetaldehyde, acrolein, benzene, and formaldehyde. C1/C2 diesel emissions (SCC = 2280002100 and 2280002200) were projected based on the Final Locomotive Marine rule national-level factors provided in Table 4-34. Similar to locomotives, VOC HAPs were projected based on the VOC factor.

Table 4-34. Non-California year 2020 Projection Factors for locomotives and Class 1 and Class 2 Commercial Marine Vessel Emissions

SCC	Description	Pollutant	Projection Factor
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	CO	0.924
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	NO_X	0.637
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	PM_{10}	0.583
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	$PM_{2.5}$	0.583
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	SO_2	0.064
2280002X00	Marine Vessels, Commercial;Diesel;Underway & port emissions	VOC	0.675
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	CO	1.210
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	NO_X	0.706
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	PM_{10}	0.556
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	$PM_{2.5}$	0.556
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	SO_2	0.035
2285002006	Railroad Equipment;Diesel;Line Haul Locomotives: Class I Operations	VOC	0.488
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	CO	1.210
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	NO_X	1.112
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	PM_{10}	1.069
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	$PM_{2.5}$	1.072
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	SO_2	0.035
2285002007	Railroad Equipment;Diesel;Line Haul Locomotives: Class II / III Operations	VOC	1.211
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	CO	1.100
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	NO_X	0.476
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	PM_{10}	0.457
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	$PM_{2.5}$	0.457
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	SO_2	0.031
2285002008	Railroad Equipment;Diesel;Line Haul Locomotives: Passenger Trains (Amtrak)	VOC	0.371
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	CO	1.100
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	NO_X	0.476
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	PM_{10}	0.456
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	$PM_{2.5}$	0.457
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	SO_2	0.031
2285002009	Railroad Equipment;Diesel;Line Haul Locomotives: Commuter Lines	VOC	0.371
2285002010	Railroad Equipment;Diesel;Yard Locomotives	CO	1.210
2285002010	Railroad Equipment;Diesel;Yard Locomotives	NO_X	0.958
2285002010	Railroad Equipment;Diesel;Yard Locomotives	PM_{10}	0.923
2285002010	Railroad Equipment;Diesel;Yard Locomotives	$PM_{2.5}$	0.923
2285002010	Railroad Equipment;Diesel;Yard Locomotives	SO_2	0.035
2285002010	Railroad Equipment;Diesel;Yard Locomotives	VOC	0.906

California projections, New inventory: "2020re_california_c1c2rail_annual_ff10"

The locomotive, and class 1 and 2 commercial marine year 2020 emissions used for California were obtained from CARB, 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 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. We converted the CARB inventory TOG to VOC by dividing the inventory TOG by the available VOC-to-TOG speciation factor.

Additional c1c2rail emissions from the EISA mandate, New inventory: "C1C2_CMV_RAIL_2020_RFS2_additions_NONPOINT_ff10"

Rail is used to transport ethanol from production facilities to bulk terminals. To account for emissions associated with this transport, 2022 RFS2 rule rail impacts were adjusted to account for differences in ethanol volumes and locomotive emission rates between 2022 and 2020. Emission factors used to make adjustments were obtained from an EPA locomotive emission factor fact sheet (EPA, 2009e). The adjusted national inventory impacts were allocated to individual counties using factors developed from an Oak Ridge National Laboratory analysis of ethanol transport (Oak Ridge National Laboratory, 2009). These impacts were then applied to the model platform inventory.

Class 1 and 2 commercial marine vessels are also used to transport ethanol. In EPA's RFS2 final rule, impacts of water transport of ethanol on combustion emissions from the C1 and C2 commercial marine inventory were estimated for 2022, based on the difference between ethanol volumes mandated by EISA versus RFS1 rule volumes (EPA, 2010a). These impacts were based on the Oak Ridge National Laboratory analysis cited above. For this inventory, RFS2 rule impacts were adjusted to account for (a) differences in commercial marine vessel emission rates in 2020 versus 2022, and (b) the difference in ethanol volume impacts for 2020 under EISA versus the 8.7 billion gallons assumed for the unadjusted 2020 inventory. Emission factors used to make these adjustments were obtained from analyses done to support the 2010 Category 3 Marine Diesel Rule (EPA, 2009f). The adjusted national inventory impacts were allocated to individual counties using factors developed from the Oak Ridge analysis. These impacts were then applied to the unadjusted inventory.

These emissions from updated ethanol volumes are not included in the previously-discussed loco-marine rule-based projections and CARB inventory. These additional emissions are quite small and are shown in Table 4-35.

Table 4-35. Additional c1c2rail emissions in 2020 from the EISA mandate

Pollutant	C1/C2 CMV	Locomotives
CO	148	977
NH_3	0	2
NO_X	582	3,928
PM_{10}	19	109
$PM_{2.5}$	18	107
SO_2	3	2
VOC	14	162

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 year 2020 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 2020 c3marine inventory from the 2007 base case are provided in Table 4-36. 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 4-36. Growth factors to project the 2007 ECA-IMO inventory to 2020

		2020 Adjustments Relative to 2007					
Region	**EEZ FIPS**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**VOC (HC)**	**CO**	**SO_2**
East Coast (EC)	85004	1.108	0.240	0.240	1.772	1.772	0.063
Gulf Coast (GC)	85003	0.909	0.198	0.199	1.449	1.450	0.052
North Pacific (NP)	85001	0.988	0.211	0.214	1.534	1.532	0.059
South Pacific (SP)	85002	1.183	0.263	0.264	1.921	1.903	0.074
Great Lakes (GL)	n/a	1.016	0.160	0.160	1.234	1.241	0.044
Outside ECA	98001	1.399	0.386	0.382	1.754	1.754	0.318

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 year 2018. A background on the development of year-2018 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 emissions differences between the 2007 evaluation case, the 2007 base case and the 2020 base case. These summaries are provided at the national-level by sector 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, we call this sector "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, and the onroad portion include CARB emissions for California. The "c3marine-US" sector represents c3marine sector emissions with U.S. FIPS only; these extend to roughly 3-5 miles offshore and all U.S. waters in the Great Lakes and also include all U.S. ports. The "c3marine, EEZ component" represents all non-U.S. c3marine emissions that are within the (up to) 200 nautical mile Exclusive Economic Zone (EEZ) boundary but outside of U.S. state waters. Finally, the "c3marine, non-US non-EEZ component" represents all non-U.S. emissions outside of the (up to) 200nm offshore boundary, including all Canadian and Mexican c3marine emissions. The c3marine sector is discussed in Section 2.5.5. The "Off-shore othpt" sector is the non-Canada, no-Mexico component of the othpt sector –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 sectors in the 2007 base case are listed as "Con U.S. Total w/ avefire" and includes emissions from the avefire sector. Next, we provide the 2007 point fire (ptfire) emissions, used instead of the avefire emissions for the 2007 evaluation case. Then, the total of all sectors in the 2007 evaluation case are listed as "Con U.S. Total w/ ptfire". Table 5-2 provides national emissions totals by sector for all CAPs in the 2020 base case.

Table 5-3 provides national-by sector emission summaries for CO for all three cases: 2007 evaluation, 2007 base case and 2020 base case. Table 5-4, Table 5-5, Table 5-6, Table 5-7, Table 5-8 and Table 5-9 provide the same summaries for NH_3, NO_X, $PM_{2.5}$, PM_{10}, SO_2 and VOC, respectively. These national tables also include differences and percent differences for each modeling sector between the 2007 base case and 2020 base case. Note that ptfire emissions, unique to the 2007 evaluation case, are listed after these comparisons in each table.

Table 5-1. National by-sector CAP emissions summaries for 2007 base and evaluation cases

Sector	**CO**	**NH_3**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**VOC**
afdust-adj				5,853,639	825,331		
ag		3,595,429					
c1c2rail	218,854	557	1,338,370	43,835	41,019	48,814	61,558
c3marine-US	12,724		138,033	12,476	11,452	104,822	4,902
nonpt	4,336,565	155,317	1,230,624	767,225	676,243	402,633	6,456,455
nonroad	17,794,112	1,920	1,894,569	188,504	179,165	101,735	2,480,715
onroad	36,764,690	145,285	7,562,752	363,551	277,350	40,406	3,222,877
onroad_rfl							224,681
ptipm	703,771	25,428	3,357,384	437,096	329,584	9,136,151	38,071
ptnonipm	2,938,024	68,020	2,079,637	586,910	411,085	1,590,091	1,059,429
avefire	15,984,435	262,375	219,611	1,627,425	1,379,174	120,584	3,771,643
Con U.S. Total w/ avefire	**78,753,176**	**4,254,330**	**17,820,981**	**9,880,662**	**4,130,403**	**11,545,235**	**17,320,331**
ptfire	33,600,784	550,283	397,094	3,363,355	2,850,301	233,739	7,910,324
Con U.S. Total w/ ptfire	**96,369,525**	**4,542,238**	**17,998,463**	**11,616,591**	**5,601,530**	**11,658,391**	**21,459,013**
c3marine, non-US EEZ component	41,125		498,850	41,363	38,015	309,370	17,477
c3marine-non-US, non-EEZ component	17,125		208,040	17,166	15,770	127,334	7,272
Canada othar	2,833,571	386,690	466,717	812,493	250,089	61,435	938,655
Canada othon	3,304,429	17,579	392,505	11,083	7,718	4,049	200,007
Canada othpt	571,566	15,536	338,722	65,369	39,734	831,520	155,998
Mexico othar	407,882	109,398	170,948	70,853	46,961	53,105	447,730
Mexico othon	579,968	2,629	83,353	7,019	6,500	5,038	85,462
Mexico othpt	100,076		343,485	120,755	89,359	731,692	77,255
Off-shore othpt	82,146		74,285	780	769	1,021	60,823
Non-US Total	**7,937,888**	**531,832**	**2,576,904**	**1,146,880**	**494,914**	**2,124,563**	**1,990,679**

Table 5-2. National by-sector CAP emissions summaries for 2020 base case

Sector	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
afdust-adj				5,896,649	833,802		
ag		3,764,319					
c1c2rail	242,208	567	949,823	26,024	24,355	6,972	36,329
c3marine-US	20,405		143,351	2,708	2,491	6,160	7,848
nonpt	4,672,881	157,793	1,355,270	822,545	724,136	323,646	6,402,307
nonroad	12,769,579	2,355	961,175	95,043	89,422	2,719	1,294,962
onroad	17,302,817	84,304	2,234,887	188,936	102,314	28,284	1,183,159
onroad_rfl							65,183
ptipm	862,058	40,416	1,878,795	295,816	233,331	2,098,072	45,885
ptnonipm	2,648,200	68,073	2,043,239	545,193	373,563	996,320	1,042,514
avefire	15,984,435	262,375	219,611	1,627,425	1,379,174	120,584	3,771,643
Con U.S. Total	**54,502,582**	**4,380,203**	**9,786,151**	**9,500,338**	**3,762,588**	**3,582,757**	**13,849,831**
c3marine, non-US EEZ component	69,610		528,220	9,564	8,799	19,135	29,656
c3marine-non-US, non-EEZ component	29,488		278,988	6,159	5,618	35,400	12,521
Canada othar	2,833,571	386,690	466,717	812,493	250,089	61,435	938,655
Canada othon	3,304,429	17,579	392,505	11,083	7,718	4,049	200,007
Canada othpt	571,566	15,536	338,722	65,369	39,734	831,520	155,998
Mexico othar	524,259	109,378	225,512	70,707	47,045	19,178	573,020
Mexico othon	390,851	4,404	46,128	9,281	8,465	649	62,025
Mexico othpt	148,761		544,720	170,845	127,737	1,066,541	94,352
Off-shore othpt	82,146		74,285	780	769	1,021	60,823
Non-US Total	**7,954,682**	**533,588**	**2,895,795**	**1,156,280**	**495,973**	**2,038,927**	**2,127,057**

Table 5-3. National by-sector CO emissions (tons/yr) summaries with differences

Sector	2007	2020 Base	2020 minus 2007 Base	
ptipm	703,771	862,058	158,287	22%
ptnonipm	2,938,024	2,648,200	-289,825	-10%
afdust-adj				
ag				
nonpt	4,336,565	4,672,881	336,316	8%
onroad	36,764,690	17,302,817	-19,461,873	-53%
onroad_rfl			0	
nonroad	17,794,112	12,769,579	-5,024,533	-28%
c1c2rail	218,854	242,208	23,354	11%
c3marine, US	12,724	20,405	7,680	60%
avefire	15,984,435	15,984,435	0	0%
Total CO, All Sources Base Case	**78,753,176**	**54,502,582**	**-24,250,594**	**-31%**
ptfire	33,600,784	n/a	n/a	n/a
Total CO: 2007 Evaluation Case	**96,369,525**	**n/a**	**n/a**	**n/a**
c3marine non-US, EEZ	41,125	69,610	28,485	69%
c3marine non-US, non-EEZ	17,125	29,488	12,363	72%
Canada othar	2,833,571	2,833,571	0	0%
Canada othon	3,304,429	3,304,429	0	0%
Canada othpt	571,566	571,566	0	0%
Mexico othar	407,882	524,259	116,378	29%
Mexico othon	579,968	390,851	-189,117	-33%
Mexico othpt	100,076	148,761	48,686	49%
Off-shore othpt	82,146	82,146	0	0%
Total CO: 2007 Non-US	**7,937,888**	**7,954,682**	**16,794**	**0%**

Table 5-4. National by-sector NH_3 emissions (tons/yr) summaries with differences

Sector	**2007**	**2020 Base**	**2020 minus 2007 Base**	
ptipm	25,428	40,416	14,988	59%
ptnonipm	68,020	68,073	54	0%
afdust-adj				
ag	3,595,429	3,764,319	168,891	5%
nonpt	155,317	157,793	2,476	2%
onroad	145,285	84,304	-60,981	-42%
onroad_rfl				
nonroad	1,920	2,355	435	23%
c1c2rail	557	567	11	2%
c3marine, US				
avefire	262,375	262,375	0	0%
Total NH_3, All Sources Base Case	**4,254,330**	**4,380,203**	**125,873**	**3%**
ptfire	550,283	n/a	n/a	n/a
Total NH_3: 2007 Evaluation Case	**4,542,239**	**n/a**	**n/a**	**n/a**
c3marine non-US, EEZ				
c3marine non-US, non-EEZ				
Canada othar	386,690	386,690	0	0%
Canada othon	17,579	17,579	0	0%
Canada othpt	15,536	15,536	0	0%
Mexico othar	109,398	109,378	-20	0%
Mexico othon	2,629	4,404	1,776	68%
Mexico othpt				
Off-shore othpt				
Total NH_3: 2007 Non-US	**531,832**	**533,588**	**1,756**	**0%**

Table 5-5. National by-sector NO_X emissions (tons/yr) summaries with differences

Sector	2007	2020 Base	2020 minus 2007 Base	
ptipm	3,357,384	1,878,795	-1,478,590	-44%
ptnonipm	2,079,637	2,043,239	-36,398	-2%
afdust-adj				
ag				
nonpt	1,230,624	1,355,270	124,646	10%
onroad	7,562,752	2,234,887	-5,327,866	-70%
onroad_rfl				
nonroad	1,894,569	961,175	-933,394	-49%
c1c2rail	1,338,370	949,823	-388,546	-29%
c3marine, US	138,033	143,351	5,317	4%
avefire	219,611	219,611	0	0%
Total NO_X, All Sources Base Case	**17,820,981**	**9,786,151**	**-8,034,830**	**-45%**
ptfire	397,094	n/a	n/a	n/a
Total NO_X: 2007 Evaluation Case	**17,998,715**	**n/a**	**n/a**	**n/a**
c3marine non-US, EEZ	498,850	528,220	29,370	6%
c3marine non-US, non-EEZ	208,040	278,988	70,948	34%
Canada othar	466,717	466,717	0	0%
Canada othon	392,505	392,505	0	0%
Canada othpt	338,722	338,722	0	0%
Mexico othar	170,948	225,512	54,564	32%
Mexico othon	83,353	46,128	-37,226	-45%
Mexico othpt	343,485	544,720	201,235	59%
Off-shore othpt	74,285	74,285	0	0%
Total NO_X: 2007 Non-US	**2,576,904**	**2,895,795**	**318,891**	**12%**

Table 5-6. National by-sector $PM_{2.5}$ emissions (tons/yr) summaries with differences

Sector	2007	2020 Base	2020 minus 2007 Base	
ptipm	329,584	233,331	-96,253	-29%
ptnonipm	411,085	373,563	-37,522	-9%
afdust-adj	825,331	833,802	8,471	1%
ag				
nonpt	676,243	724,136	47,893	7%
onroad	277,350	102,314	-175,036	-63%
onroad_rfl				
nonroad	179,165	89,422	-89,743	-50%
c1c2rail	41,019	24,355	-16,664	-41%
c3marine, US	11,452	2,491	-8,961	-78%
avefire	1,379,174	1,379,174	0	0%
Total $PM_{2.5}$, All Sources Base Case	**4,130,403**	**3,762,588**	**-367,815**	**-9%**
ptfire	2,850,301	n/a	n/a	n/a
Total $PM_{2.5}$: 2007 Evaluation Case	**5,601,530**	**n/a**	**n/a**	**n/a**
c3marine non-US, EEZ	38,015	8,799	-29,216	-77%
c3marine non-US, non-EEZ	15,770	5,618	-10,152	-64%
Canada othar	250,089	250,089	0	0%
Canada othon	7,718	7,718	0	0%
Canada othpt	39,734	39,734	0	0%
Mexico othar	46,961	47,045	84	0%
Mexico othon	6,500	8,465	1,965	30%
Mexico othpt	89,359	127,737	38,378	43%
Off-shore othpt	769	769	0	0%
Total $PM_{2.5}$: 2007 Non-US	**494,914**	**495,973**	**1,059**	**0%**

Table 5-7. National by-sector PM_{10} emissions (tons/yr) summaries with differences

Sector	2007	2020 Base	2020 minus 2007 Base	
ptipm	437,096	295,816	-141,281	-32%
ptnonipm	586,910	545,193	-41,717	-7%
afdust-adj	5,853,639	5,896,649	43,010	1%
ag				
nonpt	767,225	822,545	55,320	7%
onroad	363,551	188,936	-174,616	-48%
onroad_rfl				
nonroad	188,504	95,043	-93,461	-50%
c1c2rail	43,835	26,024	-17,811	-41%
c3marine, US	12,476	2,708	-9,768	-78%
avefire	1,627,425	1,627,425	0	0%
Total PM_{10}, All Sources Base Case	**9,880,662**	**9,500,338**	**-380,324**	**-4%**
ptfire	3,363,355	n/a	n/a	n/a
Total PM_{10}: 2007 Evaluation Case	**11,616,592**	**n/a**	**n/a**	**n/a**
c3marine non-US, EEZ	41,363	9,564	-31,799	-77%
c3marine non-US, non-EEZ	17,166	6,159	-11,007	-64%
Canada othar	812,493	812,493	0	0%
Canada othon	11,083	11,083	0	0%
Canada othpt	65,369	65,369	0	0%
Mexico othar	70,853	70,707	-146	0%
Mexico othon	7,019	9,281	2,262	32%
Mexico othpt	120,755	170,845	50,090	41%
Off-shore othpt	780	780	0	0%
Total PM_{10}: 2007 Non-US	**1,146,880**	**1,156,280**	**9,399**	**1%**

Table 5-8. National by-sector SO_2 emissions (tons/yr) summaries with differences

Sector	2007	2020 Base	2020 minus 2007 Base	
ptipm	9,136,151	2,098,072	-7,038,079	-77%
ptnonipm	1,590,091	996,320	-593,770	-37%
afdust-adj				
ag				
nonpt	402,633	323,646	-78,987	-20%
onroad	40,406	28,284	-12,122	-30%
onroad_rfl				
nonroad	101,735	2,719	-99,016	-97%
c1c2rail	48,814	6,972	-41,842	-86%
c3marine, US	104,822	6,160	-98,662	-94%
avefire	120,584	120,584	0	0%
Total SO_2, All Sources Base Case	**11,545,235**	**3,582,757**	**-7,962,478**	**-69%**
ptfire	233,739	n/a	n/a	n/a
Total SO_2: 2007 Evaluation Case	**11,658,391**	**n/a**	**n/a**	**n/a**
c3marine non-US, EEZ	309,370	19,135	-290,235	-94%
c3marine non-US, non-EEZ	127,334	35,400	-91,934	-72%
Canada othar	61,435	61,435	0	0%
Canada othon	4,049	4,049	0	0%
Canada othpt	831,520	831,520	0	0%
Mexico othar	53,105	19,178	-33,927	-64%
Mexico othon	5,038	649	-4,389	-87%
Mexico othpt	731,692	1,066,541	334,849	46%
Off-shore othpt	1,021	1,021	0	0%
Total SO_2: 2007 Non-US	**2,124,563**	**2,038,927**	**-85,636**	**-4%**

Table 5-9. National by-sector VOC emissions (tons/yr) summaries with differences

Sector	2007	2020 Base	2020 minus 2007 Base	
ptipm	38,071	45,885	7,814	21%
ptnonipm	1,059,429	1,042,514	-16,916	-2%
afdust-adj				
ag				
nonpt	6,456,455	6,402,307	-54,148	-1%
onroad	3,222,877	1,183,159	-2,039,718	-63%
onroad_rfl	224,681	65,183	-159,498	-71%
nonroad	2,480,715	1,294,962	-1,185,753	-48%
c1c2rail	61,558	36,329	-25,228	-41%
c3marine, US	4,902	7,848	2,946	60%
avefire	3,771,643	3,771,643	0	0%
Total VOC, All Sources Base Case	**17,320,331**	**13,849,831**	**-3,470,500**	**-20%**
ptfire	7,910,324	n/a	n/a	n/a
Total VOC: 2007 Evaluation Case	**21,459,013**	**n/a**	**n/a**	**n/a**
c3marine non-US, EEZ	17,477	29,656	12,179	70%
c3marine non-US, non-EEZ	7,272	12,521	5,249	72%
Canada othar	938,655	938,655	0	0%
Canada othon	200,007	200,007	0	0%
Canada othpt	155,998	155,998	0	0%
Mexico othar	447,730	573,020	125,290	28%
Mexico othon	85,462	62,025	-23,436	-27%
Mexico othpt	77,255	94,352	17,096	22%
Off-shore othpt	60,823	60,823	0	0%
Total VOC: 2007 Non-US	**1,990,679**	**2,127,057**	**136,378**	**7%**

6 References

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