2008 National Emissions Inventory: Review, Analysis and Highlights

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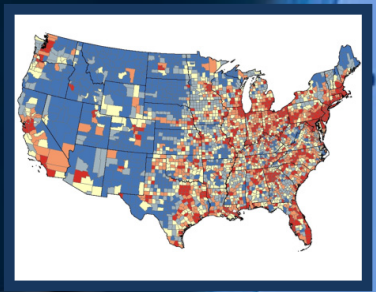

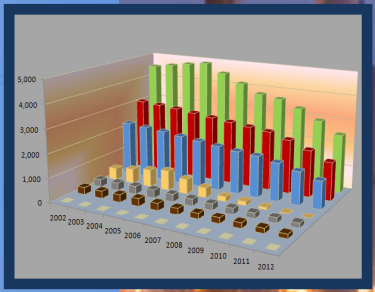

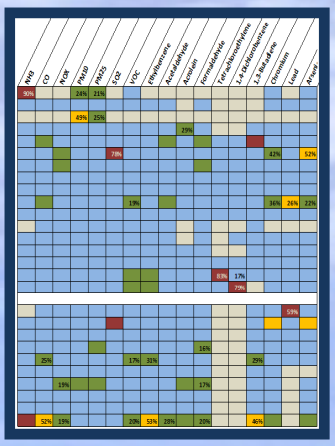

United States Environmental Protection Agency

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1. Highlights

- Within the last 5 years, 2008-2012, emissions of nitrogen oxides (NO_x) and sulfur dioxide (SO_2) have decreased the most, while particulate matter (PM) and ammonia (NH_3) show the least change.
- The large criteria air pollutant (CAP) emissions decreases between the 2005 and 2008 inventories occurred in: fuel combustion sources [NO_x, SO_2 and PM]; nonroad mobile commercial marine vessels, railroad and nonroad diesel equipment [NO_x, SO_2, carbon monoxide (CO)]; and highway vehicle emissions [volatile organic compounds (VOC), CO]. Changes in emissions are based on both real reductions and changes to methods for estimating emissions from commercial marine vessels, nonroad diesel equipment, and highway vehicles.
- The largest hazardous air pollutant (HAP) emissions decreases between the 2005 and 2008 inventories are seen in: industrial processes (ethylbenzene, tetrachloroethylene, 1,4-dichlorobenzene, chromium); and highway vehicles (formaldehyde, 1,3-butadiene). Some of these changes are attributable to methods changes in estimating emissions.
- The Eastern U.S. has the highest CAP emissions density (tons/square mile). Some parts of California and some Western mountain states also show high emissions density for many CAPs. Ammonia emission densities are highest in the Central U.S. (Iowa, Minnesota and Kansas areas).
- National trends by major sectors show that much of the VOC and nearly all of the CO emission reductions are coming from mobile sources. Many of the SO_2 reductions are coming from fuel combustion sources, particularly from EGUs. NOx reductions are evenly distributed between the fuel combustion and mobile source categories. For PM, there are increases in the highway vehicle category associated with data improvements included in the emissions estimation model.
- There is a downward trend in HAP emissions between 2005 and 2008, with the noted exceptions being acetaldehyde and acrolein. The increase in acetaldehyde and acrolein emissions can be attributed to emissions from stationary fuel combustion processes, highway vehicles and prescribed fires. Increased use of ethanol in fuels in 2008 likely contributed to the noted increases in acetaldehyde, an ethanol combustion product. National emissions of mercury in 2008 are 42 percent less than in 2005. Electricity generating units (EGUs-coal boilers) comprise the majority of mercury emissions in 2005 and 2008 and also the majority of mercury reductions seen between 2005 and 2008.
- In 2008, the largest portions of multiple CAPs and HAPs are emitted by coal and biomass combustion, residential wood combustion, light duty gasoline vehicles, and industrial processes such as chemical manufacturing, metal products, mineral products, pulp and paper production, petroleum refineries, and solvent use.
- Regionally in 2008, the highest amounts of ozone and PM-forming emissions occur in the Central, South and Southeast regions, with key contributing sectors of multiple CAPs and HAPs similar to the national patterns noted in the report. The West region has relatively low amounts of ozone and PM-forming emissions, which can be partly attributed to much of the West region's emissions coming from a handful of high population centers. These emissions are no less significant for addressing air quality management in some areas of the West.
- As part of this report, EPA used 2008 ozone and PM air quality data along with the 2005 National Air Toxics Assessment (NATA) modeled HAP risks to illustrate which areas of the U.S. face multiple air quality/risk issues. Emissions from two local areas that show a "nexus" of air quality issues are further examined for how they compare to the regional emissions profiles.

HIGHLIGHTS

- Improvements sought in future NEI development cycles include: more reliable control information; more complete emissions from oil and gas operations; more complete HAP emissions, especially from some nonpoint sectors; and reviewing and prioritizing reporting of emissions from previously identified high-emitting facilities.

2. Introduction

The United States Environmental Protection Agency (EPA) has completed the National Emissions Inventory (NEI) for 2008. EPA compiles the NEI every three years and the 2008 NEI is the most recent in that series. Unless otherwise noted, most of the summaries and discussion in this report focus on the 2008 NEI version 2 General Public Release inventory (2008v2GPR, released on February 16, 2012). This version, referred to in this report as the "2008 NEI," is a national compilation of emissions sources collected from state, local and tribal air agencies (SLTs) and uses data from EPA emissions programs including the Toxics Release Inventory (TRI), emissions trading programs such as the Acid Rain Program, and data gathered for EPA regulatory development for reducing air toxic emissions. Using quality assurance procedures, the data from multiple sources are blended together to complete the NEI.

The Clean Air Act requires EPA to set air quality standards to protect public health and the environment. EPA established National Ambient Air Quality Standards (NAAQS) for six common air pollutants: ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, nitrogen dioxide and lead. Because human health and environmental criteria (science-based guidelines) are used to set standards for these pollutants, they are called the "criteria" pollutants. Some of the criteria pollutants are emitted directly from sources, while others are secondarily formed when their precursors react in the atmosphere. For example, ozone is formed when its precursors - volatile organic compounds (VOCs) and nitrogen oxides (NO_x) - react in the presence of sunlight. In this report, emission profiles are presented for the criteria air pollutants and precursors (CAPs), and for specific hazardous air pollutants (HAPs) contained in the NEI. This includes: carbon monoxide (CO), lead (Pb), nitrogen oxides (NO_x), volatile organic compounds (VOCs), sulfur dioxide (SO_2), ammonia (NH_3) and particulate matter (PM_{10} and $PM_{2.5}$) and specific HAPs from the list of 187 HAPs established by the Clean Air Act.

The NEI is a readily-available U.S. inventory with extensive spatial, pollutant and sector coverage - representing detailed processes within industrial facilities, county totals for non-industrial stationary sources, on-road vehicles and nonroad mobile sources, and emissions from large fires based on day-specific events. One of the primary goals of the NEI is to provide the best assessment of current emission levels using the data, tools and methods available. Uses of the NEI include regulatory analyses; large-scale air quality, emissions and climate change assessments; emissions trends; and international reporting. The NEI undergoes continuous improvement by EPA and SLT partners.

2.1 Purpose and Contents of this Report

The overarching purpose of this report is to present analysis of the 2008 NEI and comparison to previous years of inventory data, with a primary focus on the last full NEI - the 2005 NEI. We describe the national and regional patterns of CAP/HAP emission distributions in the 2008 NEI and which sources contribute to these releases. We do not assess nor predict the absolute risks to human health and ecosystems that may be associated with the presence of any of these specific air pollutants, but rather focus on the intensity of emission releases that may pose elevated risks.

Pollutants of greatest interest include not only those that contribute to ozone and particle pollution, but also HAPs that are predicted by the 2005 NATA to be the most harmful to human health. To facilitate a more concise document, we have included just 27 pollutants in the report, which are listed in Table 1. Eight of these 27 pollutants are either CAPs or precursors to CAPs, and the remaining 19 are HAPs that were selected based on criteria that will be discussed later in this report.

About this Report:

- All of the analyses presented here are based on the publically released version 2 of the NEI (denoted as "2008 NEI" throughout) from February, 2012, except where otherwise noted. Subsequent versions of the NEI may be released at later dates, and that the data in those releases may differ from what is shown in this report.
- In those graphics and analyses that show emission changes over time, some of the changes are caused by changes to the way emissions are estimated for a given pollutant/sector, also called "methods changes." In this report, we attempt to identify where these methods changes contribute to the changes seen in emissions over time. In addition, we hold constant emissions between NEI years in some cases, and this could lead to some uncertainty in the time series shown for the pollutant/sector in question. We also note this uncertainty in relevant sections of the report.
- We report particulate matter (PM) as $PM_{2.5}$ (2.5 microns or smaller) or PM_{10} (10 microns or smaller). In both cases, the estimates of PM include both condensable and filterable emissions.
- Throughout the report, some charts have 2 vertical axes. Care should be taken to ensure that the appropriate axis is considered when viewing these graphics. These types of charts occur most often in the "regional" section.

Table 1: Complete List of CAPs and HAPs Evaluated in this Report

Pollutant	CAP or HAP?
NO_x	CAP
VOC	CAP
CO	CAP
SO_2	CAP
NH_3	CAP
$PM_{2.5}$	CAP
PM_{10}	CAP
Lead	CAP/HAP
1,3-Butadiene	HAP
1,4-Dichlorobenzene	HAP
Acetaldehyde	HAP
Acrolein	HAP
Arsenic	HAP
Benzene	HAP
Chlorine	HAP
Chromium compounds	HAP
Cyanide compounds	HAP
Ethylbenzene	HAP
Formaldehyde	HAP
Hydrochloric Acid	HAP
Manganese	HAP
Mercury	HAP
Methyl Chloride	HAP
Naphthalene	HAP
Polycyclic Organic Matter	HAP
Tetrachloroethylene	HAP
Xylenes	HAP

In the remainder of section 2, we provide additional background on the NEI. We then provide summaries to characterize the spatial patterns (national and regional) of the emissions contained in the 2008 NEI and show how CAP emissions have changed since 2002. We follow that with a CAP/HAP comparison to the last full NEI developed for 2005. The latter part of this report addresses multi-pollutant air quality issues in two local areas and their emission profiles. Lastly, we discuss improvements necessary to the NEI as EPA looks ahead to the 2011 inventory cycle and beyond.

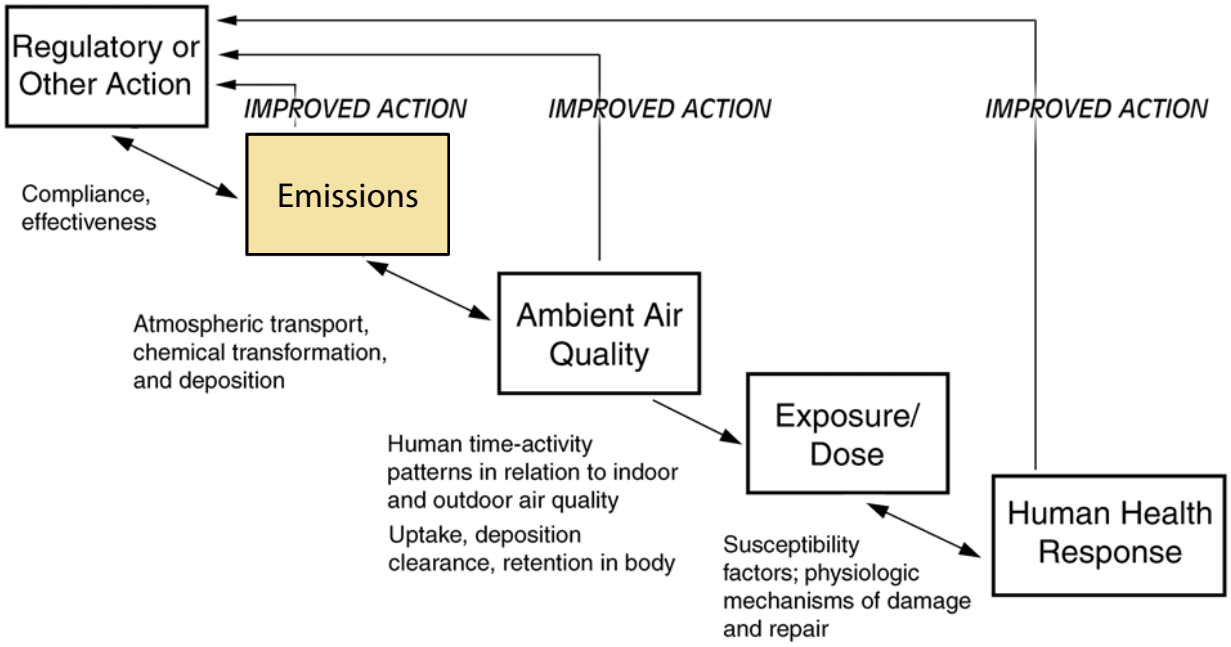


Figure 1: Role of Emissions in the Air Quality to Health Effects Paradigm

2.2 Background

2.2.1 Role of NEI in Air Quality Management

Emissions are not the only factor in determining air quality status and potential health risks from air pollution, but they can have a significant influence on exposure factors that are harmful to humans and ecosystems. Various policy and technical elements, which include emission releases, account for air quality status as illustrated in Figure 1 [ref 1].

For many purposes, the NEI is the main source of information for the box labeled "Emissions" in Figure 1. While emission information is only one component of the information required to assess health outcomes, it plays an important role in that process as it feeds air quality and exposure models. The NEI is created by EPA to provide federal and state decision makers, the public and other countries, the best and most complete estimates of CAP and HAP emissions in the U.S. While EPA is not directly obligated to create the NEI under the Clean Air Act, the Act authorizes the EPA Administrator to implement data collection efforts needed to properly administer the NAAQS program. Therefore, EPA's Office of Air Quality Planning and Standards (OAQPS) maintains the NEI program in support of the NAAQS.

Because the NAAQS are the basis on which EPA collects CAP emissions from state, local and tribal air agencies, EPA does not require collection of HAP emissions. The HAP reporting requirements are voluntary; nevertheless, HAP emissions are an essential part of the NEI program. These emissions estimates allow EPA to assess progress in meeting HAP reduction goals described in the Clean Air Act Amendments of 1990. These goals include reducing the negative impacts of HAP emissions on people and the environment and assessing emission reductions since 1990. The 2008v2GPR Technical Support Document [ref 2] shows that 44 states volutarily reported point source HAPs and 41 states reported nonpoint source HAPs to the 2008 NEI.

In addition to point, mobile and nonpoint source emissions, the NEI also contains detailed CAP and HAP emissions estimates from large fires (prescribed and wild) as well as CAPs from smaller agricultural fires. Emissions from natural sources are also included in the NEI but are limited to the biogenic land-based plant and soil emissions and not ocean, geogenic or lightning emissions.

For many readers, the 2008 NEI webpage (http://www.epa.gov/ttn/chief/net/2008inventory.html) provides a convenient way to access NEI data summaries. Data for

both CAP and HAP emissions are provided in various levels of aggregation. The 2008 NEI webpage gives users the option of creating custom summaries for any county, state or national total. This approach makes the data more accessible to a large variety of data users, from the general public to researchers.

2.2.2 Choice of Pollutants for this Report

As described above, while all CAPs and their precursors (hereafter, "CAPs" means both directly emitted pollutants and their precursors) will be covered in this report, we chose a limited number of the 187 HAPs for analysis and presentation. We gave the highest priority to CAPs and HAPs that:

- Contribute directly to, or are involved in, the formation of air pollution for which there are national ambient air quality standards, and
- Are toxic pollutants identified by the national air toxics assessment (NATA 2005) [ref 3] as potential high inhalation risk for cancer and/or non-cancer hazard. NATA 2005 identifies both "national" risk drivers and "regional" risk drivers; both of these classifications schemes were used here.

Further details on the 2005 NATA are provided below but, in general, the purpose of NATA is to provide answers to questions about emissions, ambient air concentrations, exposures and risks across broad geographic areas (such as counties, states and the nation) at a moment in time. These assessments are based on assumptions and methods that limit the range of questions that can be answered reliably. The results cannot be used to identify exposures and risks for specific individuals, or even to identify exposures and risks in small geographic regions such as a specific census block, i.e., hotspots. These estimates reflect chronic exposures resulting from the inhalation of the air toxics emitted and do not consider exposures which may occur indoors or as a result of exposures other than inhalation (i.e., dermal or ingestion). These limitations, or caveats, must always be kept in mind when interpreting NATA results. For a complete listing of NATA limitations, the reader is referred to the NATA website at www.epa.gov/nata. Specifically, for the 2005 emissions year, the assessment includes four steps:

- Compiling a national emissions inventory of air toxics emissions from outdoor sources
- Estimating ambient and exposure concentrations of air toxics across the U. S.
- Estimating population exposures across the U.S.
- Characterizing potential public health risk due to inhalation of air toxics including both cancer and non-cancer effects

There are six national ambient air quality standards (NAAQS) for carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter (PM_{10} and $PM_{2.5}$), and sulfur dioxide [ref 4]. Ozone is generally not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. Particulate matter may be *primary particles* that are emitted directly from a source, or *secondary particles* that are a result of chemical interactions in the atmosphere. The majority of fine particle pollution in the U.S. consists of *secondary* particles [ref 5].

Directly emitted pollutants related to the formation of these 6 CAPs include:

- Nitrogen oxides (NO_x)
- Volatile organic compounds (VOCs)
- Sulfur dioxide (SO_2)
- Particulate matter ($PM_{2.5}$, PM_{10})
- Ammonia (NH_3)
- Carbon monoxide (CO)
- Lead (Pb)

These CAPs are included in this review of the 2008 NEI.

Since it is not possible to cover all of the 187 HAPs that are in the NEI, we let the NATA 2005 [ref 3] help identify key HAP pollutants that contribute to cancer and non-cancer risk—at both the national and regional levels. The non-cancer hazards include respiratory and neurological effects. NATA considers the cancer and non-cancer toxicity of a pollutant to estimate its

potential risk. Note that a higher toxicity can indicate that a pollutant, even if emitted in a small amount, can pose a potential high risk.

Figures 2 through 4 below show the pollutant percent contribution, based on the 2005 NATA, to the total predicted national risk for cancer, neurological and respiratory risk, respectively. In each of these graphics the incremental contribution to risk by pollutant is greatest up through 95 percent. As shown in Figure 2, benzene and formaldehyde contribute up to 60 percent of the total national cancer risk; ten more HAPs contribute approximately 35 percent to the cancer risk. Beyond that, other pollutants do not contribute any significant risk.

Figures 3 and 4 show similar results for non-cancer (neurological) and respiratory risk from the 2005 NATA. Five pollutants capture 95 percent of the non-cancer risk, and four pollutants capture 95 percent of the respiratory risk.

In this report, the 17 HAPs that contribute up to 95 percent of total national cumulative risk are labeled as "key contributors" and are further analyzed. In addition, the HAPs chlorine and hydrochloric acid are included as key contributors due to high potential for

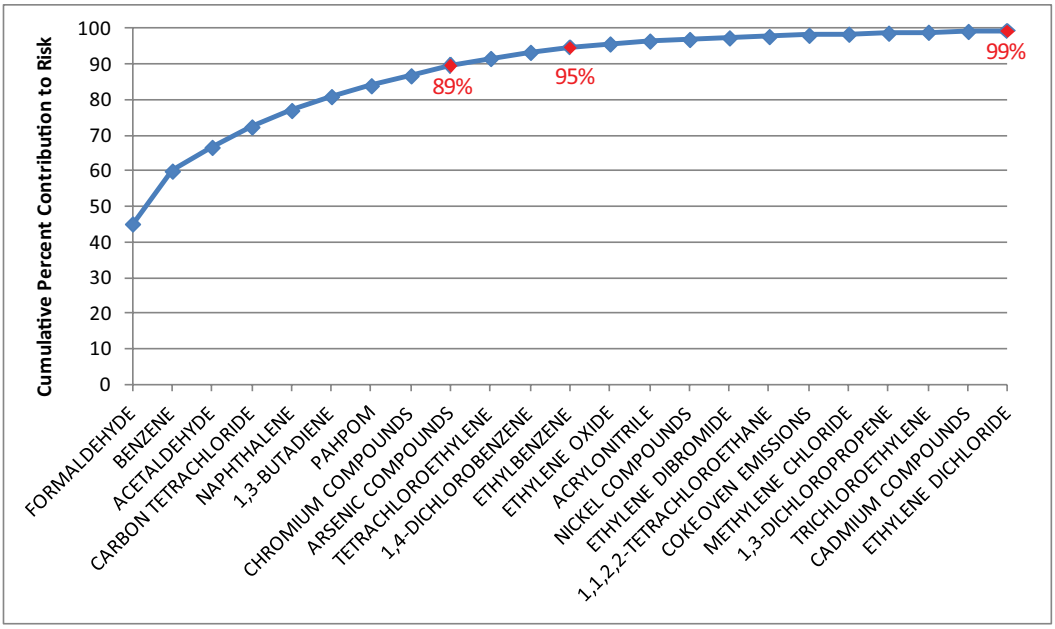


Figure 2: Pollutant Percent Contribution to Total National Cancer Risk

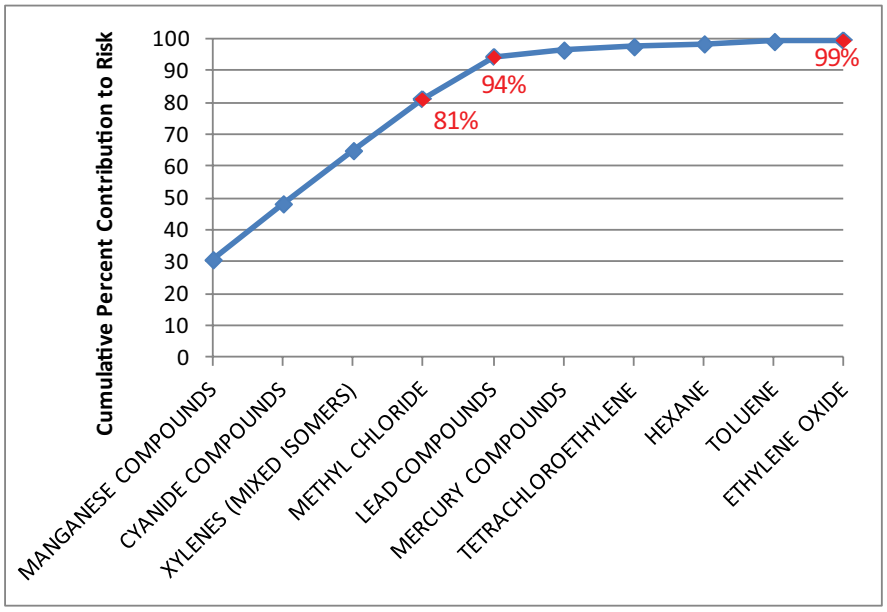


Figure 3: Pollutant Percent Contribution to Total National Neurological Risk

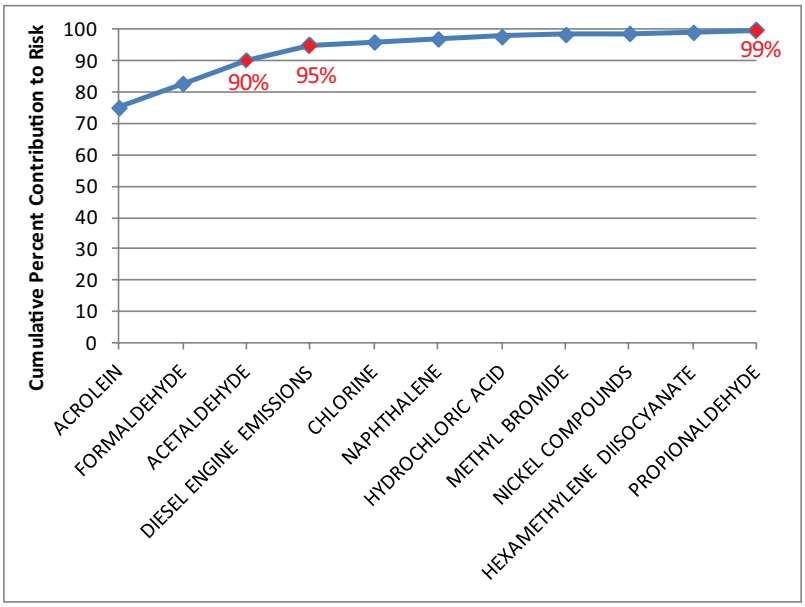


Figure 4: Pollutant Percent Contribution to Total National Respiratory Risk

respiratory risk, resulting in 19 HAPs analyzed in this report. The HAPs included in this review, plus lead, comprise 65 percent of the total HAP emissions (in tons) in the 2008 NEI.

NATA may identify other HAPs of concern for specific local areas and these results can be consulted to understand, in more detail, potential exposure risks for a specific local area, e.g., county or census tract. For instance, coke oven pollutant emissions and nickel do not fall into the pool of pollutants that contribute up to 95 percent of total national cancer risk but would be a potentially important source of risk to consider in a local area where such emission releases occur.

In addition, the 2005 NATA results indicate the following for specific pollutants considered here:

- Carbon tetrachloride - While the risks are high, they are mainly driven by background levels associated with persistent transport of past emissions, and therefore we do not include carbon tetrachloride in this review.
- PM from diesel engines - When inhaled, can contribute to chronic respiratory risks and have been linked to increased cancer risk in epidemiological studies. PM from diesel engines is quantified as the $PM_{2.5}$ portion of the emissions. This review includes $PM_{2.5}$ diesel emissions from mobile sources.
- Mercury - Other HAPs, such as mercury, pose multi-pathway risks through exposure routes such as ingestion. Mercury exhibits a non-cancer neurological risk via the ingestion pathway and is addressed in this review.
- Lead - A key contributor to the total national neurological risk and is also a CAP for purposes of the NAAQS. While "lead and lead compounds" is the HAP, the emission from only lead is included.

Table 2 summarizes the above discussion and lists the CAPs and HAPs included in this report and some of the associated air quality and risk attributes. Attributes identified include: 1) ozone precursors that can facilitate the formation of ozone in the atmosphere, 2) ozone forming potential relative to VOC reactivity, 3) PM precursors that are constituents of particulate matter or which can facilitate the formation of $PM_{2.5}$, 4) secondary organic aerosols (SOA) which can facilitate the formation of $PM_{2.5}$, and 5) key contributors to total national cancer/neurological/respiratory risks. The mixture of CAP and HAP emission releases and the local and regional climate and weather patterns help determine how the chemicals will interact to form ozone and fine particles ($PM_{2.5}$) and/or transform to other toxic species. The footnotes for the table provide additional details on these attributes as well as appropriate references. The species noted as influential for secondary organic

Table 2: Pollutants Included in this Report at National and Regional Scales

	Emissions included in 2008 NEI report					NATA 2005 Estimate of Inhalation Risk Key contributor to the national risk for category			Geo-level profiles	
Pollutant	CAP or HAP	Ozone Precursor[1]	PM Precursor[2]	Ozone forming potential[3]	SOA Potential[4]	Cancer risk	"Non-cancer respiratory"	"Non-cancer neurological"	National	Re-gional
NO_x	CAP	Y	Y	High					Y	Y
VOC	CAP	Y	Y		Medium-High				Y	Y
CO	CAP	Y							Y	Y
SO_2	CAP		Y						Y	Y
NH_3	CAP		Y						Y	Y
$PM_{2.5}$	CAP		Y						Y	Y
PM_{10}	CAP		Y						Y	Y
Lead[5]	CAP & HAP							Y	Y	Y
1,3-Butadiene	HAP	Y		H		Y			Y	Y
1,4-Dichlorobenzene	HAP			Low		Y			Y	Y
Acetaldehyde	HAP	Y		H		Y	Y		Y	Y
Acrolein[6]	HAP	Y		H			Y		Y	Y
Arsenic	HAP		Y			Y			Y	Y
Benzene	HAP	Y	Y	L	H	Y			N	Y
Chlorine	HAP	Y		H			Y		N	Y
Chromium compounds[7]	HAP					Y			Y	Y
Cyanide compounds[8]	HAP							Y	N	Y
Ethylbenzene	HAP	Y	Y	M	H	Y			Y	Y
Formaldehyde	HAP	Y		H		Y	Y		Y	Y

Table 2: Pollutants Included in this Report at National and Regional Scales (continued)

	Emissions included in 2008 NEI report					NATA 2005 Estimate of Inhalation Risk Key contributor to the national risk for category			Geo-level profiles	
Pollutant	CAP or HAP	Ozone Precursor[1]	PM Precursor[2]	Ozone forming potential[3]	SOA Potential[4]	Cancer risk	"Non-cancer respiratory"	"Non-cancer neurological"	National	Re-gional
Hydrochloric Acid	HAP	Y	Y				Y		N	Y
Manganese	HAP		Y					Y	N	Y
Mercury[9]	HAP		Y						N	Y
Methyl Chloride	HAP			L				Y	N	Y
Naphthalene	HAP	Y	Y	M	H	Y			N	Y
Polycyclic Organic Matter[10]	HAP					Y			N	Y
Tetrachloroethylene	HAP			L		Y			Y	Y
Xylenes[11]	HAP	Y	Y	H	H			Y	N	Y

aerosol are only those specifically indicated in the reference consulted (see footnote 4 of Table 2).

1. Ozone precursors can facilitate the formation of ozone in the atmosphere.
2. PM precursors are constituents of particulate matter or can facilitate the formation of $PM_{2.5}$.
3. Ozone forming potential refers specifically to VOC reactivity: High, Medium, Low. Incremental reactivity for VOC (ozone formation) maximum incremental reactivity (MIR), larger number higher reactivity [ref 6].
4. Secondary organic aerosol (SOA) can facilitate the formation of $PM_{2.5}$. SOA potential (SOAP) is expressed as High or Medium. SOAP index is expressed relative to toluene = 100 [ref 7]
5. Lead is a criteria pollutant for purposes of NAAQS and is also included in NATA due to toxic attributes.
6. The respiratory hazard indicated by NATA for acrolein is based on emission sources other than wildfires. Over seventy percent of national acrolein emissions are from wildfires. As wildfires are an uncontrollable intermittent source, NATA 2005 did not include risks associated with wildfire emissions.
7. Chromium compounds include chromium (Cr) III and VI and small amounts of reported chromium trioxide and chromic acid. NATA cancer risk is based on Cr VI.
8. Cyanide compounds include cyanide and hydrogen cyanide.
9. Mercury has a potentially high non-cancer neurological risk based on multi-pathway exposure including ingestion.
10. POM includes many reported species. See [ref 8] for detailed list.
11. Xylenes include -m, -o, -p, and mixed isomers.

There is also the question of scale (regional versus national) of the pollutants chosen for study in this report, since we present some pollutants as national summaries and some as regional summaries. CAPs are generally considered to be important at both national and regional scales. Of the key contributor HAPs selected and included in this report, the 2005 NATA designates some as national drivers (contributors) to risk, and others as regional drivers of risk according to the populations exposed. The national emission summaries in this report include only the HAPs with a national scope of influence and the regional/local emission summaries include all the HAPs listed (both a regional and national scope). In the context of NATA, the national versus regional pollutant drivers of risk are simply classified as follows:

- National Drivers: More people exposed to elevated risks
  - For example, formaldehyde is a national driver for cancer risk, emissions are from various point and nonpoint sources, and formaldehyde is also secondarily formed in the atmosphere making exposure more likely in more areas.
- Regional Drivers: Fewer people exposed to elevated risks
  - The 2005 NATA example is benzene as a driver for cancer risk, emissions are mostly from on-road vehicles, and exposures are highest in local areas of high vehicular traffic.

2.2.3 Summary of Emission Sectors used in this Report

In addition to the choice of pollutants, an equally important consideration is how we summarize emissions by sectors (or sources). Emissions from different source types may be aggregated in numerous ways to derive sector summaries. Figure 5 illustrates the major emissions data categories and depicts numerous sources within each category. In building an emissions inventory, each of these "sub-sectors" needs to be characterized properly to arrive at the correct aggregated total.

In Figure 5, "nonpoint" refers to stationary sources such as field burning and residential wood combustion and emissions that are estimated across a county area. "Mobile" category emissions are also typically estimated across county areas - "on-road" refers to cars and trucks, while "nonroad" refers to sources such as aircraft and agricultural field equipment. "Point" refers to large stationary sources like electric utilities, heavy industry and emissions that are estimated for a distinct location. These major emission data categories contain numerous source types. The NEI Technical Support Document provides additional details about the source types within these major data categories. [ref 2].

For the purposes of this report, the most detailed sector characterization we review are the 60 sectors from EPA's Emissions Inventory System (EIS), which is used to build the NEI. These sectors are listed in the left-most column of Table 3. The other

Figure 5: Simplified Diagram of Major Emissions Data Categories

three columns in Table 3 show the related sector aggregations that are used for different analyses shown in this report. In practice, these different sector aggregations are often requested by NEI data users as ways to summarize and display emissions information. Table 3 shows the "mapping" that is used in this report to aggregate the 60 EIS sectors all the way up to just seven sectors. In this report, summaries use different levels of aggregation (as shown in the individual columns in Table 3) depending on the national, regional or local profile being depicted. Local patterns are generally shown with more detailed sectors.

One exception to our use of the sectors in Table 3 is that prescribed fires and wildfires (in sum, known as "wild land" fires) are not included in most of the analyses presented in this report. Emissions from these type of fires are dealt with separately in this report. This approach is partly due to the fact that fires are so variable from year to year (especially wildfires), that including them in the 2008 summaries may cause the other sectors' contributions to be minimized as a result of a "high fire year" in 2008. In addition to the 2008 summaries, wild fires have also been removed from the trends analysis (section 3.2) to allow for a more accurate curve of anthropogenic sources. Agricultural burning (also referred to as crop residue burning), which is also a sector listed in the left-most column of Table 3, has much smaller emissions and has more consistent emissions from year to year; accordingly this sector is included in all of the analyses in this report.

Table 3: Listing of the 60 EIS Sectors and Crosswalks to Other Sector Groupings Used in this Report

SECTORS 60 EMISSION INVENTORY SYSTEM (EIS)	SECTORS 29	SECTORS 17	SECTORS 10	SECTORS 7
Agriculture-Crops & Livestock Dust	Agriculture	Agriculture	Agriculture	Misc
Agriculture-Fertilizer Application	Agriculture	Agriculture	Agriculture	Misc
Agriculture-Livestock Waste	Agriculture	Agriculture	Agriculture	Misc
Bulk Gasoline Terminals	MiscBulkGas	Misc	Misc	Misc
Commercial Cooking	MiscCommCook	Misc	Misc	Misc
Gas Stations	MiscGasStations	Misc	Misc	Misc
Miscellaneous Non-Industrial NEC	MiscNon-IndustNEC	Misc	Misc	Misc
Waste Disposal	MiscWasteDisp	Misc	Misc	Misc
Dust-Construction Dust	DustConstrc	Dust-RoadsConstrc	Dust-RoadsConstrc	Misc
Dust-Paved Road Dust	DustPavedUnPaved	Dust-RoadsConstrc	Dust-RoadsConstrc	Misc
Dust-Unpaved Road Dust	DustPavedUnPaved	Dust-RoadsConstrc	Dust-RoadsConstrc	Misc
Fires-Agricultural Field Burning	Fires-Agricultural Field Burning	Fires-Agricultural Field Burning	Fires-Agricultural Field Burning	Misc
Fires-Prescribed Fires	Fires-Prescribed Fires	Fires-Prescribed Fires	Fires-Prescribed Fires	Misc
Fires-Wildfires	Fires-Wildfires	Fires-Wildfires	Fires-Wildfires	Fires-Wildfires
Fuel Comb-Comm/Institutional-Biomass	FuelComb-Biomass	FuelComb-Comm/Instit	Fuel Comb	Fuel Combustion
Fuel Comb-Comm/Institutional-Coal	FuelComb-Coal	FuelComb-Comm/Instit	Fuel Comb	Fuel Combustion
Fuel Comb-Comm/Institutional-Natural Gas	FuelComb-Ngas	FuelComb-Comm/Instit	Fuel Comb	Fuel Combustion
Fuel Comb-Comm/Institutional-Oil	FuelComb-Oil	FuelComb-Comm/Instit	Fuel Comb	Fuel Combustion
Fuel Comb-Comm/Institutional-Other	FuelComb-Other	FuelComb-Comm/Instit	Fuel Comb	Fuel Combustion
Fuel Comb-Electric Generation-Biomass	FuelComb-Biomass	FuelComb-ElecGen	Fuel Comb	Fuel Combustion
Fuel Comb-Electric Generation-Coal	FuelComb-Coal	FuelComb-ElecGen	Fuel Comb	Fuel Combustion
Fuel Comb-Electric Generation-Natural Gas	FuelComb-Ngas	FuelComb-ElecGen	Fuel Comb	Fuel Combustion
Fuel Comb-Electric Generation-Oil	FuelComb-Oil	FuelComb-ElecGen	Fuel Comb	Fuel Combustion

Table 3: Listing of the 60 EIS Sectors and Crosswalks to Other Sector Groupings Used in this Report (continued)

SECTORS 60 EMISSION INVENTORY SYSTEM (EIS)	SECTORS 29	SECTORS 17	SECTORS 10	SECTORS 7
Fuel Comb-Electric Generation-Other	FuelComb-Other	FuelComb-ElecGen	Fuel Comb	Fuel Combustion
Fuel Comb-Industrial Boilers, ICEs-Biomass	FuelComb-Biomass	FuelComb-IndusBoilers	Fuel Comb	Fuel Combustion
Fuel Comb-Industrial Boilers, ICEs-Coal	FuelComb-Coal	FuelComb-IndusBoilers	Fuel Comb	Fuel Combustion
Fuel Comb-Industrial Boilers, ICEs-Natural Gas	FuelComb-Ngas	FuelComb-IndusBoilers	Fuel Comb	Fuel Combustion
Fuel Comb-Industrial Boilers, ICEs-Oil	FuelComb-Oil	FuelComb-IndusBoilers	Fuel Comb	Fuel Combustion
Fuel Comb-Industrial Boilers, ICEs-Other	FuelComb-Other	FuelComb-IndusBoilers	Fuel Comb	Fuel Combustion
Fuel Comb-Residential-Natural Gas	FuelComb-Ngas	FuelComb-Residential	Fuel Comb	Fuel Combustion
Fuel Comb-Residential-Oil	FuelComb-Oil	FuelComb-Residential	Fuel Comb	Fuel Combustion
Fuel Comb-Residential-Other	FuelComb-Other	FuelComb-Residential	Fuel Comb	Fuel Combustion
Fuel Comb-Residential-Wood	FuelComb-Biomass	FuelComb-Residential	Fuel Comb	Fuel Combustion
Industrial Processes-Cement Manuf	Industrial Proc	Industrial Proc	Industrial Proc	Industrial Processes
Industrial Processes-Chemical Manuf	Industrial Proc	Industrial Proc	Industrial Proc	Industrial Processes
Industrial Processes-Ferrous Metals	Industrial Proc	Industrial Proc	Industrial Proc	Industrial Processes
Industrial Processes-Mining	Industrial Proc	Industrial Proc	Industrial Proc	Industrial Processes
Industrial Processes-NEC	Industrial Proc	Industrial Proc	Industrial Proc	Industrial Processes
Industrial Processes-Non-ferrous Metals	Industrial Proc	Industrial Proc	Industrial Proc	Industrial Processes
Industrial Processes-Oil & Gas Production	Industrial Proc	Industrial Proc	Industrial Proc	Industrial Processes
Industrial Processes-Petroleum Refineries	Industrial Proc	Industrial Proc	Industrial Proc	Industrial Processes
Industrial Processes-Pulp & Paper	Industrial Proc	Industrial Proc	Industrial Proc	Industrial Processes
Industrial Processes-Storage and Transfer	Industrial Proc	Industrial Proc	Industrial Proc	Industrial Processes
Solvent-Consumer & Commercial Solvent Use	SolvConsumerComm	Solvent	Solvent	Industrial Processes
Solvent-Degreasing	SolvCommIndust	Solvent	Solvent	Industrial Processes
Solvent-Dry Cleaning	SolvCommIndust	Solvent	Solvent	Industrial Processes
Solvent-Graphic Arts	SolvCommIndust	Solvent	Solvent	Industrial Processes
Solvent-Indust Surface Coating & Solvent Use	SolvCommIndust	Solvent	Solvent	Industrial Processes
Solvent-Non-Industrial Surface Coating	SolvCommIndust	Solvent	Solvent	Industrial Processes
Mobile-Aircraft	Aircraft	Aircraft	Mobile	Mobile Nonroad
Mobile-Commercial Marine Vessels	CMV	CMV	Mobile	Mobile Nonroad
Mobile-Locomotives	Railroad	Railroad	Mobile	Mobile Nonroad
Mobile-Non-Road Equipment - Diesel	MobNR-Diesel	NonroadEquip	Mobile	Mobile Nonroad
Mobile-Non-Road Equipment - Gasoline	MobNR-Gas	NonroadEquip	Mobile	Mobile Nonroad
Mobile-Non-Road Equipment - Other	MobNR-Other	NonroadEquip	Mobile	Mobile Nonroad
Mobile-On-Road Diesel Heavy Duty Vehicles	MobOR-DieselHD	OnroadVehicles	Mobile	Mobile Onroad
Mobile-On-Road Diesel Light Duty Vehicles	MobOR-DieselLD	OnroadVehicles	Mobile	Mobile Onroad
Mobile-On-Road Gasoline Heavy Duty Vehicles	MobOR-GasHD	OnroadVehicles	Mobile	Mobile Onroad
Mobile-On-Road Gasoline Light Duty Vehicles	MobOR-GasLD	OnroadVehicles	Mobile	Mobile Onroad
Biogenics-Vegetation & Soil	Biogenics	Biogenics	Biogenics	Biogenics

3. National Emissions Information

In this section we present national CAP/HAP emissions in a number of ways to show their spatial distribution and their changes over time. We also separately characterize the fire and biogenic sectors.

3.1 Total National Emissions and Emission Density Maps

Table 4 shows the total national CAP and HAP emissions in the 2008 NEI (including fire and biogenic emissions). The total sum for all HAPs is shown. Later in the report, results for specific HAPs and grouping of HAPs are also available. The following general comments apply to the data shown in Table 4:

- For convenience of display, the units are shown as "x1000" short tons. This means, for example, that the first entry is 82,696,000 short tons of CO, and so on.
- Among CAPs, CO is the largest emissions in total. Lead is the smallest.
- CO, VOCs, HAPs and NO_x emissions all have anthropogenic (man-made) and biogenic (natural source) contributions, VOC is the only CAP that has more emissions from biogenic sources than from anthropogenic sources.
- Only three HAPs contribute to the biogenic emissions listed in Table 4: formaldehyde, acetaldehyde and methanol. Formaldehyde and acetaldehyde have the dominant amounts of biogenic emissions in the NEI.
- In general, more CAP emissions are found in urban areas than rural ones, with the notable exception being NH_3 emissions, which are mostly emitted from fertilizer and livestock sources. The urban/rural assignment for counties in the U.S. used in this report is the same as the assignment used for the 2005 NATA [ref 3].

Figures 6 through 16 show the national emission totals from Table 4 using the NEI's county emission totals divided by the county area. This new variable is referred to as "emissions density" and is expressed as tons/square mile. Because county sizes vary considerably, the emissions density is more comparable from one county to the next than total emissions. One important difference in the maps from the emissions in Table 4 is that all of the maps (Figures 6 through 16) exclude emissions from wildfires, prescribed fires and biogenic sources.

Numerous observations about the spatial distribution of pollutants are made from the information in Table 4 and the maps in Figures 6 through 16:

- CO emission densities (Figure 9) are generally higher in the Eastern U.S. than the West. Three-fourths of total CO emissions occur in urban counties. This is an expected result since the vast majority of CO comes from mobile sources.
- NH_3 emission densities (Figure 10) are high in several areas of the country but highest in the North-Midwest part of the U.S., and in parts of North Carolina, California and Pennsylvania. Unlike most other pollutants, the emissions density is highest in more rural areas: 57 percent of total emissions are estimated to occur in rural areas. This is an expected result since most NH_3 emissions come from agricultural sources, including fertilizer application and livestock.
- While total NO_x emissions are significantly lower than CO, they follow a similar spatial pattern. NO_x emission densities (Figure 11) are higher in the Eastern U.S. and some parts of California. The urban/rural split for NO_x is tilted towards urbanized counties (69 percent), but is lower than the estimated urban percentage for CO. This may be due to NO_x emissions coming from both mobile sources and power plants, since many power plants are situated in rural areas [ref 9].
- The SO_2 emissions density map (Figure 12) shows high densities in the East, where most power plants are located. Emissions occur more in urbanized counties (58 percent), but there are significant emissions in rural areas as well, since many power plants are situated away from urban centers. Because SO_2 is mostly emitted by stationary sources (for example, power plants), it is also interesting to

Table 4: National Totals of CAPs and HAPs in the 2008 NEI (includes wild and prescribed fires, and biogenics)

Pollutant	Anthropogenic Contribution (x1000 Short Tons)	Biogenic Contribution (x1000 Short Tons)	Total (x1000 Short Tons)	Percentage of Total occurring in urban counties	Percentage of Total occurring in rural counties
CO	82,696	6,474	89,170	74	26
VOC	17,871	31,744	49,615	70	30
NO_x	18,168	1,078	19,246	69	31
SO_2	10,827	-	10,827	58	42
$PM_{2.5}$	6,123	-	6,123	58	42
PM_{10}	21,693	-	21,693	55	45
NH_3	4,367	-	4,367	43	57
Pb	1	-	1	80	20
Total HAPs	3,649	4,332	7,981	53	47

review the emissions using an alternate "bubble map," depicted in Figures 6 and 7. Each circle (or "bubble") represents emissions density centered on the county centroid. Larger circles indicate more and/or larger emissions that emit SO_2 in that county. Figure 6 shows a high prevalence of larger emissions in the East. Figure 7 shows the Eastern U.S. in more detail and further illustrates that emissions density is highest in and around the Tennessee Valley, due primarily to large power plants in this region.

- VOC emission densities (Figure 13) are higher in the Eastern U.S., with some pockets of high emissions in the Western mountain states and California. The main source of anthropogenic VOCs in the U.S. are mobile sources and solvent operations, both of which tend to occur more in urbanized areas. Table 4 shows that more than two-thirds of VOC emissions occur in urban counties.
- The emission density map for $PM_{2.5}$ (Figure 14) shows a larger fingerprint in the Eastern U.S. Direct $PM_{2.5}$ emissions occur more in urban counties (58 percent), but there are sources of pollutants in rural areas that play a role as well. It should be noted that $PM_{2.5}$ measured at ambient monitors captures both primary and secondary contributions (see "choice of pollutants" section above for more details), with secondary contributions being very significant for $PM_{2.5}$. Emission inventories only deal with the primary portion of the pollutant's contribution to the total. While this is true for all pollutants, it is most important for $PM_{2.5}$ where secondary contributions are significant across the U.S. [ref 10].
- The PM_{10} emissions density map (Figure 15) shows a pattern that is very similar to $PM_{2.5}$ in the Eastern U.S., as similar sources emit both these pollutants in the Eastern U.S. In the West, there is a different spatial pattern for PM_{10} compared to $PM_{2.5}$, with more emissions from sources like dust from agricultural activities and unpaved roads. There are also more PM_{10} emissions estimated to occur in rural areas (45 percent) than $PM_{2.5}$ due to the differences in source types that contribute to these pollutants.
- The last map (Figure 16) in this series depicts lead emission densities. Lead, which is both a CAP as well as a HAP, is primarily a local pollutant and is emitted from point sources and aircraft. The states in and adjacent to the Upper Midwest have the highest lead emission densities from these sources. Most lead emissions are found in urban counties (80 percent).

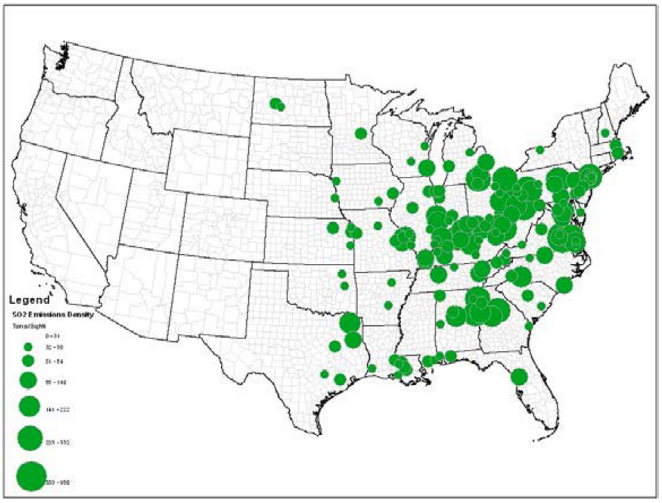


Figure 6: SO_2 Emissions Density, Entire U.S.

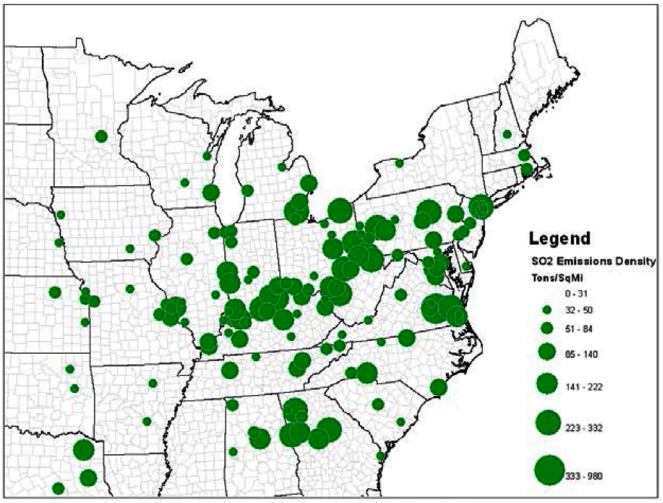


Figure 7: SO_2 Emissions Density, Eastern U.S.

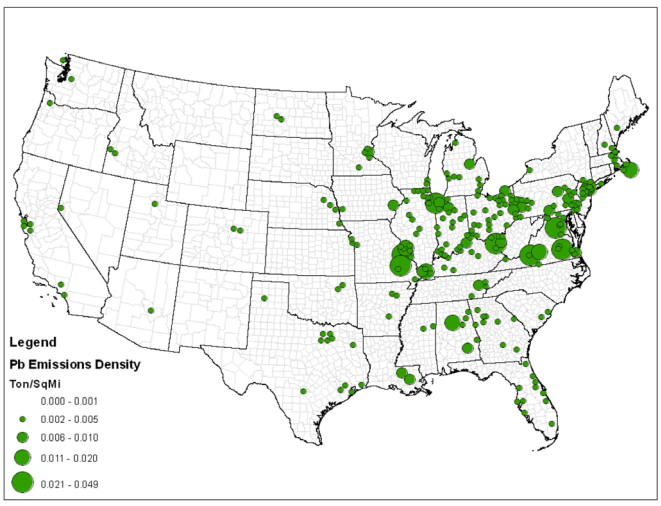


Figure 8: Lead Emissions Density

3.2 Current Year Emissions and National Emission Trends by Sector

While most of this report focuses on the 2008 NEI, this section deals with the common question of current year emissions (2012 and recent historical trends). EPA uses the triennial inventories, such as the 2008 NEI, to understand emissions changes over time. The resultant inventory years, e.g., 2002, 2005, 2008, etc., establish the basis of the emission trends time series. EPA also estimates the interim year emissions, such as for 2003-2004, 2006-2007, 2009-2010, etc. using:

- Available year-specific emissions data, e.g., continuous emissions monitoring (CEM) data reported to the EPA by large electric generating utilities, and mobile source modeled emissions for a specific year;
- Projected future-year emissions for mobile sources to use as an end point for interpolating from the latest past year of data available;
- Constant emissions from previous year(s) for sectors where year-specific or future-year emissions are not available and emissions are highly uncertain or do not vary much with time. In other words, emissions from an interim year are assumed to be equal to emissions from a collected year.

The EPA updates the national emission trends for CAPs as new data become available. The most recent information is posted on EPA's Emissions Trends webpage [ref 11] and is summarized here to describe the national trend during the last ten years, including 2002 to 2012. The trend in the national total CAP emissions and emissions for each major sector group is shown in Figures 17 through 23. The trend series does not include HAP emissions due to the voluntary nature of reporting.

Figure 17 summarizes the change in total CAP emissions over this 11-year time frame. Most of the pollutant levels have decreased over this decade. Some of the national CAP totals are decreasing faster than others, while pollutants like $PM_{2.5}$, PM_{10} and NH_3 show little change. Within the last five years, 2008-2012, the rate of decrease is highest for NO_x and SO_2. In

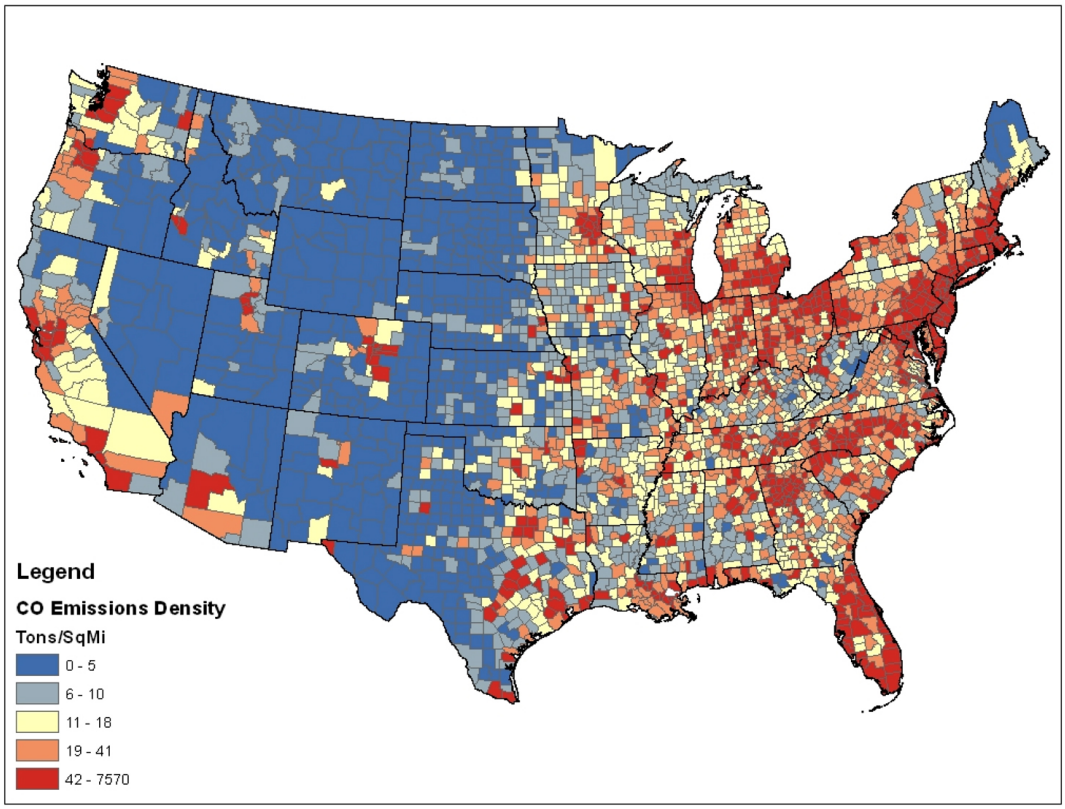


Figure 9: CO Emissions Density

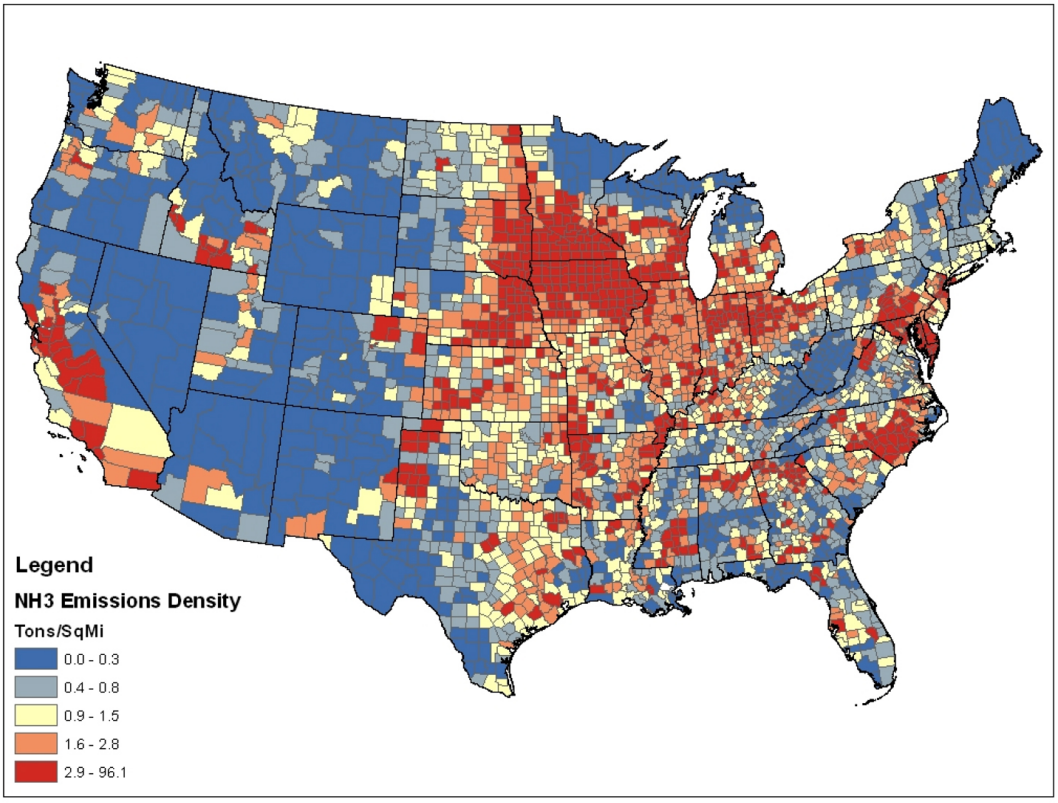


Figure 10: NH_3 Emissions Density

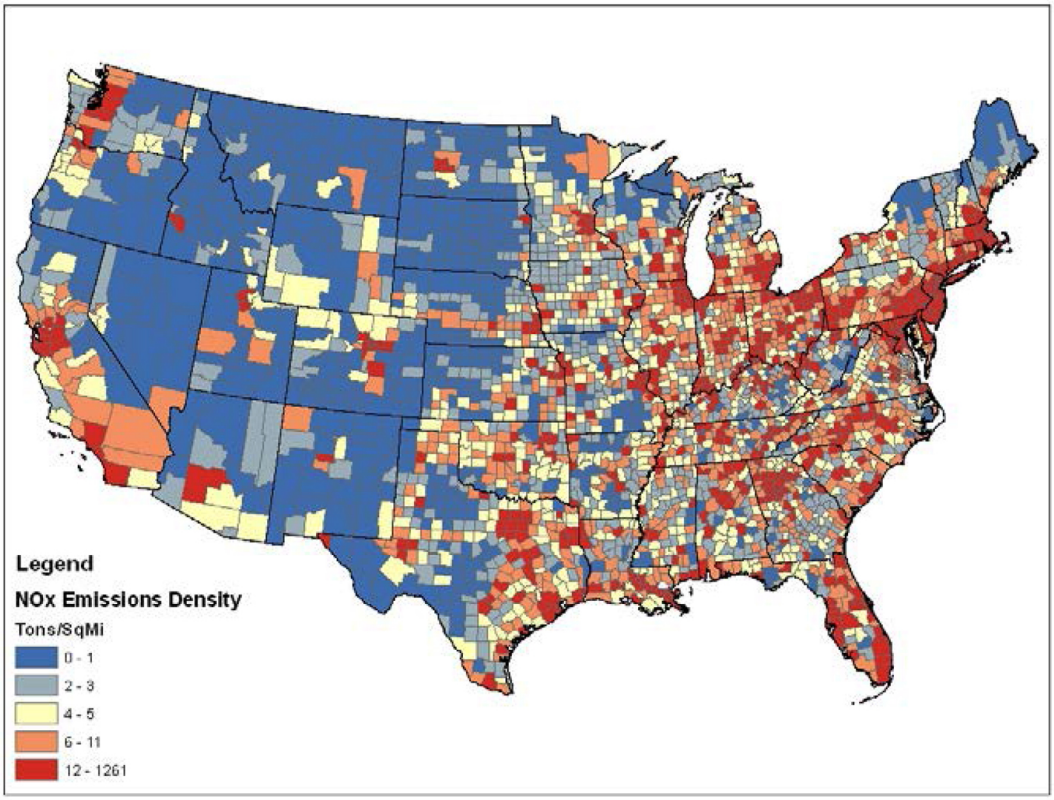


Figure 11: NO_x Emissions Density

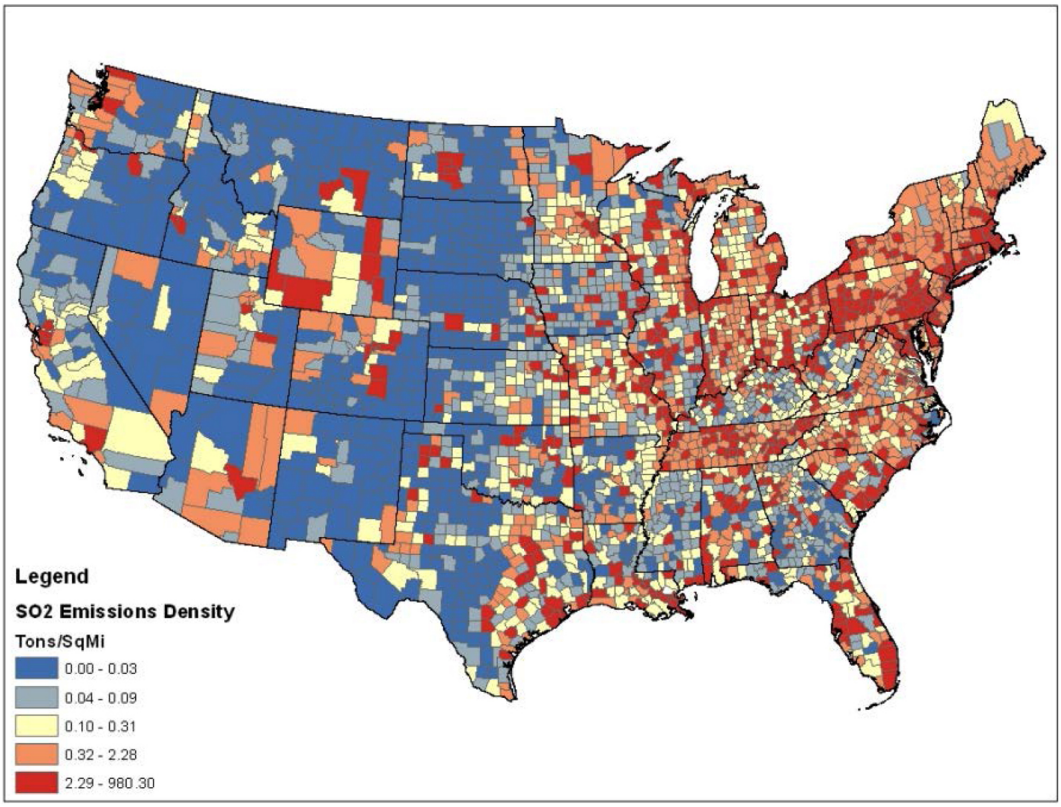


Figure 12: SO_2 Emissions Density

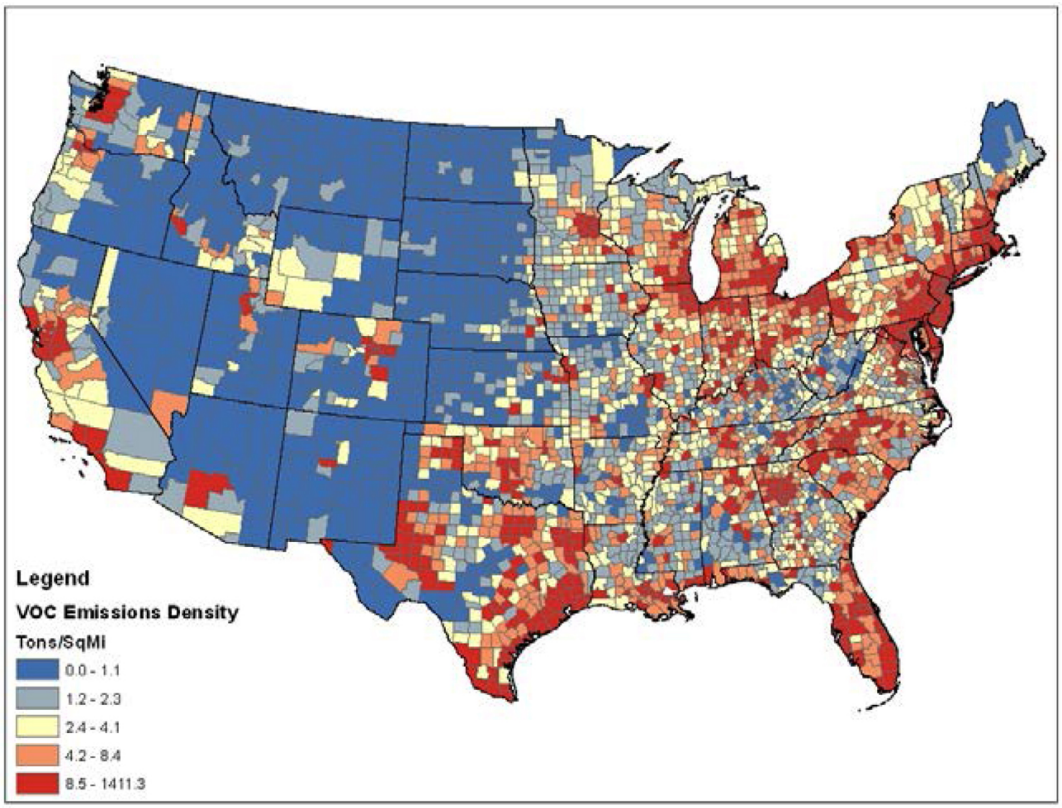


Figure 13: VOC Emissions Density

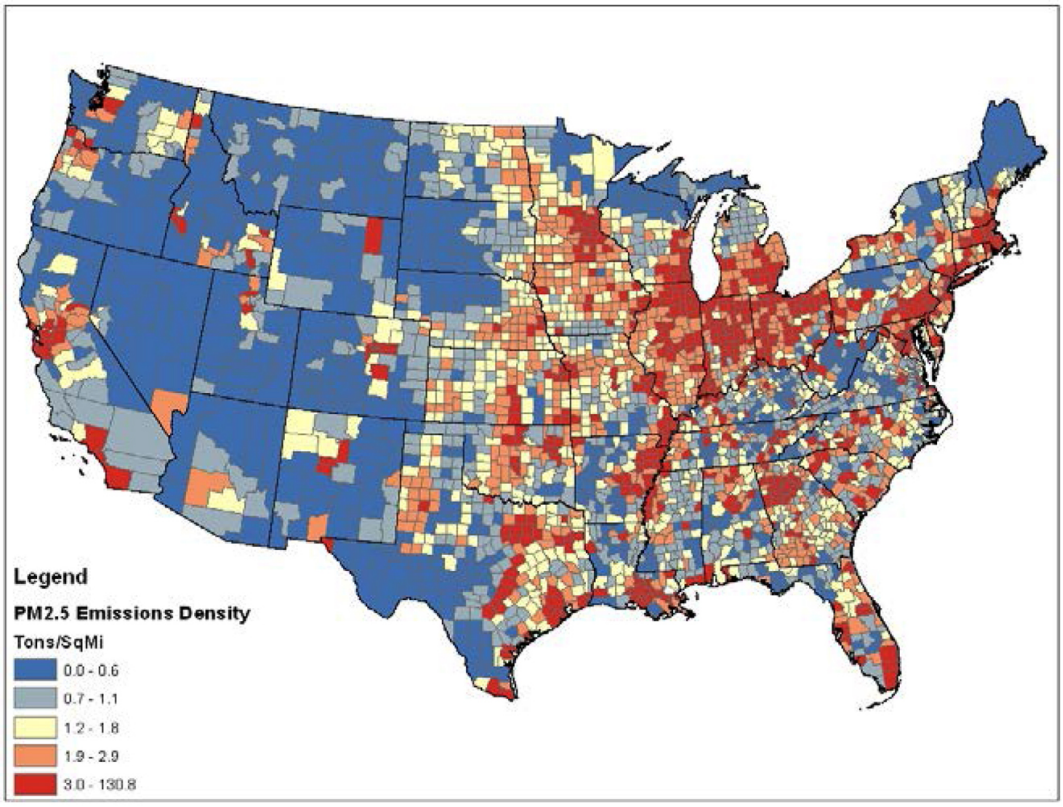


Figure 14: $PM_{2.5}$ Emissions Density

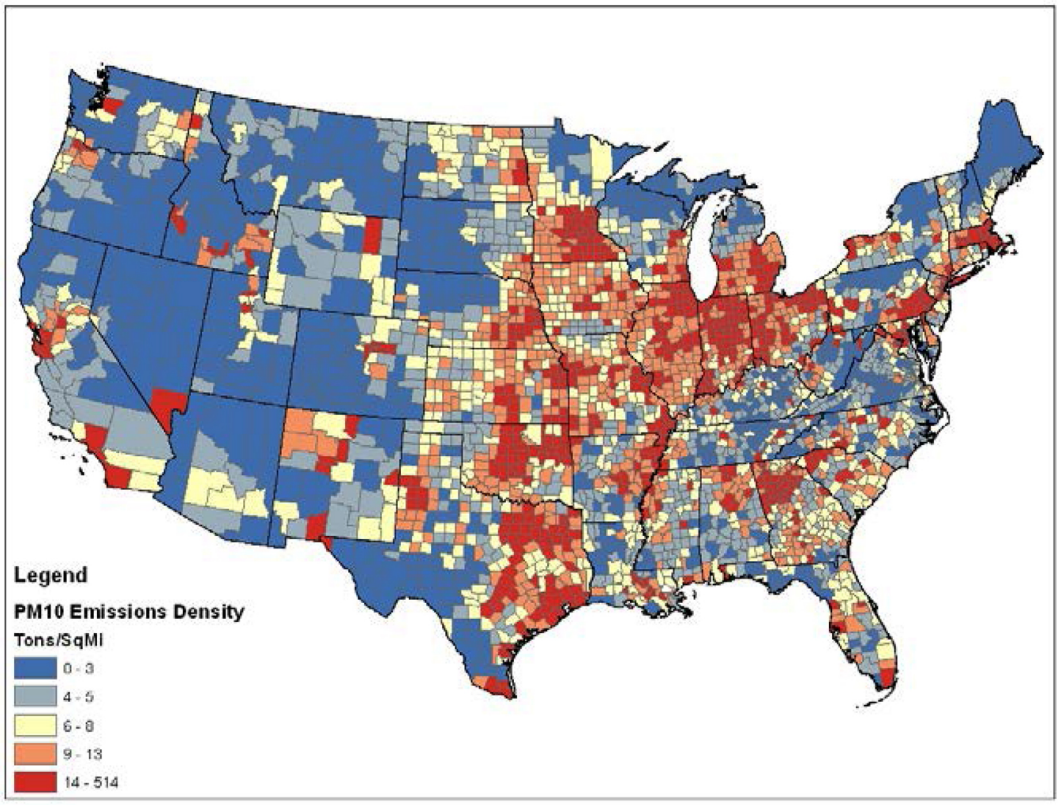


Figure 15: PM_{10} Emissions Density

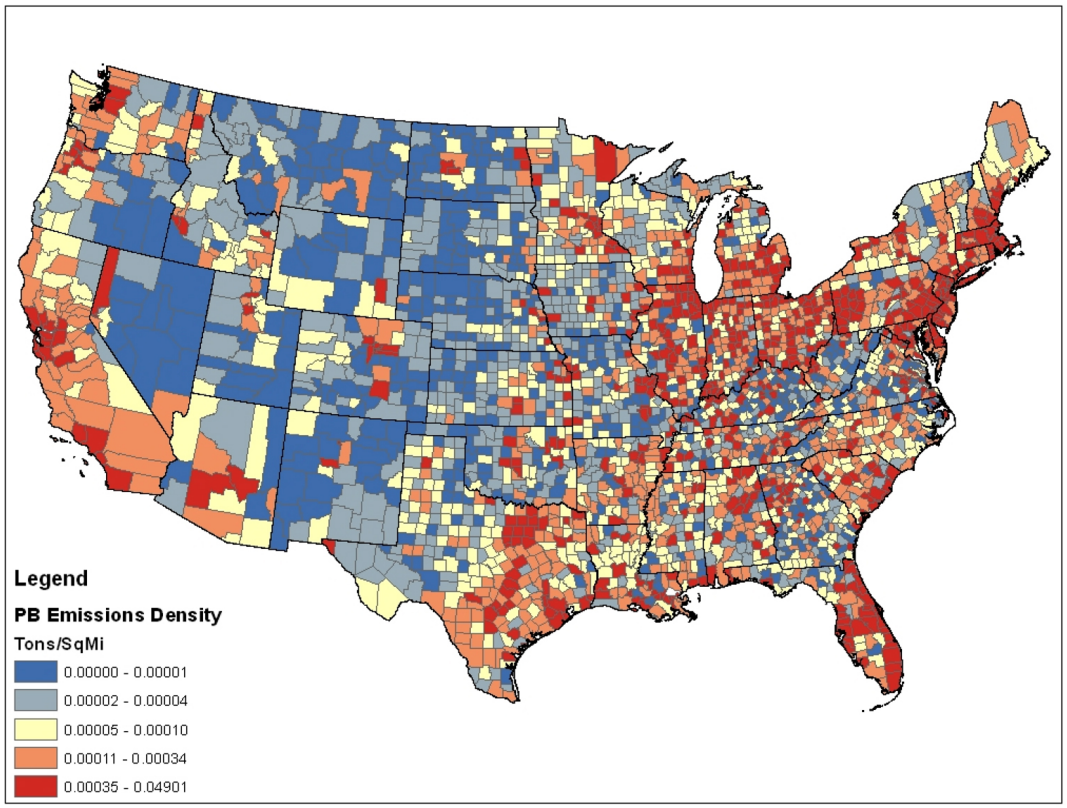


Figure 16: Pb Emissions Density

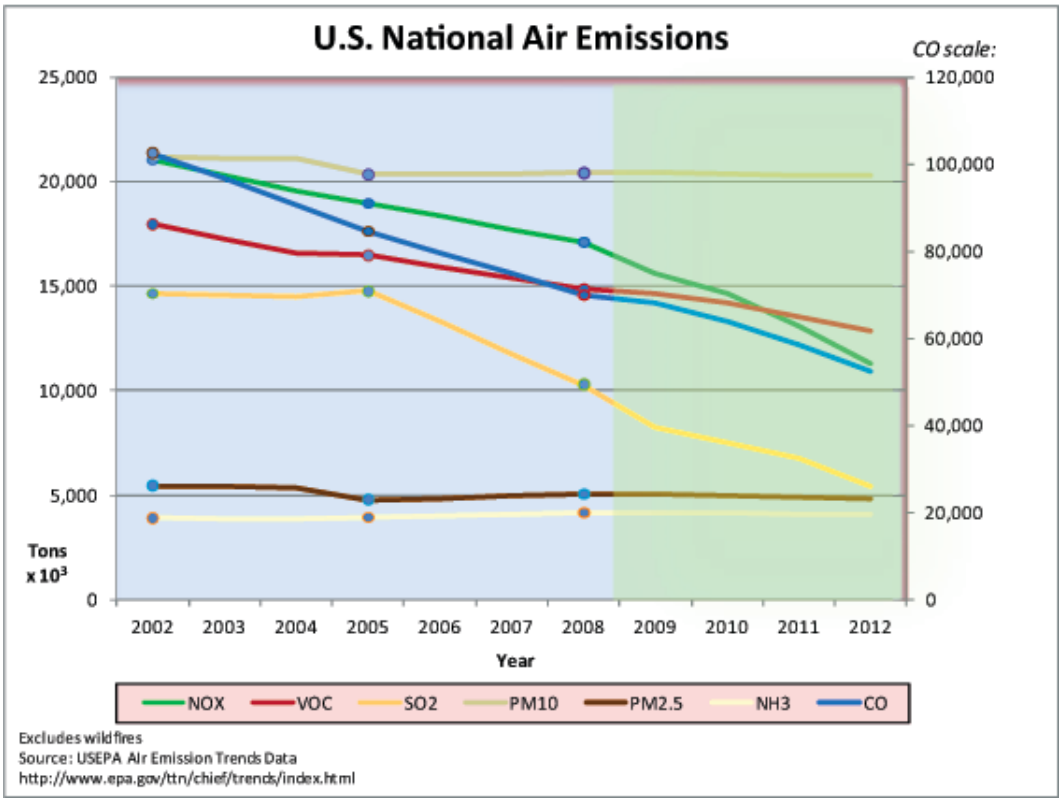


Figure 17: National Air Emissions, 2002-2012

addition, SO_2 experienced the sharpest decline between the years 2005-2009. Table 5 summarizes the overall trends seen in Figure 17 for different time periods.

From Table 5 and Figure 17, it is evident that EPA's inventories indicate that emissions of CO, NO_x, SO_2 and VOC decreased by significant amounts from 2002 to 2012, with at least half of these reductions occurring within the last five years. EPA emission control programs that are helping areas meet national ambient air quality standards (NAAQS) and that influence such pollutant reductions include the:

- NO_x Budget Program and the Clean Air Interstate Rule (CAIR);
- New Source Performance Standards (NSPS);
- Maximum Achievable Control Technology standards (MACT), which though intended to reduce HAP emissions, have co-benefits for VOC and PM emission reductions;
- Motor vehicle programs for cleaner fuels and engines;
- Nonroad engine control and clean fuels program for small engines, commercial marine vessels, and locomotives.

The current understanding of national trends is based on the triennial NEI for 2002, 2005 and 2008, projected 2012 inventory data for the mobile source sectors and reported available data through 2012 for power plants. Otherwise, these data use 2008 emissions in subsequent years. In Figure 17, the data points from the 2002, 2005 and 2008 NEI are indicated with circles. The shaded area after 2008 indicates that specific NEI data are not available for 2009-2012, though power plant data are included on data available through the third quarter of 2012 and adjusted for the entire year of 2012 based on available data. $PM_{2.5}$ and PM_{10} emissions have decreased by a lesser amount, and

Table 5: Percent Differences for Data Shown in Figure 17

Time Period	NO_X	VOC	SO_2	PM_{10}	$PM_{2.5}$	NH_3	CO
2002-2012	-46	-29	-63	-4	-11	5	-49
2002-2008	-19	-17	-30	-4	-8	7	-32
2008-2012	-34	-14	-47	-1	-4	-1	-25

NH_3 emissions are fairly constant. A sector's emissions that are held constant between 2008 and 2012 create uncertainties for both higher and lower emissions. These uncertanties affect NH_3 and PM emissions more than other pollutants, because the trends for NO_x, VOC, SO_2 and CO are based on more year-specific data or available projected data. National trends updates over time using new data can cause the 2008-2012 percent differences to change.

While Figure 17 shows the total national emission trends, Figures 18 to 23 show these trends stratified by five broad sectors over the same time period. The five sectors are similar to the "Tier" aggregations commonly used to summarize national trends and follow the "Sectors 7" column Table 3, excluding wildfires and biogenic emissions. Some observations based on the sector-segregated trends include:

- Sector-based trends correspond to the overall trends shown in Figure 17. Much of the VOC reductions and nearly all of the CO reductions are coming from mobile sources. Much of the SO_2 reductions are coming from fuel combustion sources, primarily from power plants. NO_x reductions are evenly distributed between the fuel combustion and mobile source categories. The NO_x and SO_2 reductions in fuel combustion include the power plant reductions reported to EPA through the third quarter of 2012.
- For highway vehicles, the emissions model used to estimate on-road mobile source emissions was different for the NEI 2002, 2005 and 2008. A version of the MOVES model [ref 12] was used during the development of 2008 NEI, and the previously available MOBILE6 model [ref 13] was used to develop NEI 2005 and 2002. The effect of this method change and use of the different models is shown in Figure 20 for NO_x emissions, which appear to increase between 2005 and 2008 and then decrease after 2008. Figure 21 is provided to indicate the effect on emissions for this sector when applying the same model; in this case, the EPA's most recent available MOVES2010b model. NO_x emissions, which are sensitive to the temperature impacts applied in the MOVES2010b, are higher in 2002, with steady reductions through 2008. CO and VOC emissions are generally lower overall using the MOVES2010b. PM emissions are somewhat higher with MOVES, which includes temperature impacts on $PM_{2.5}$ and NO_x emissions based on new emissions testing, with higher emissions at colder temperatures. For more discussions of the reasons for the differences between the two models, see http://moves.supportportal.com/link/portal/23002/23024/ArticleFolder/1466/Mobile-6-2-Transition.
- Trends seen in nonroad mobile emissions between 2005 and 2008 are influenced by methods changes in the emissions models ("NONROAD2005" model vs. "NONROAD2008" model) between 2005 and 2008.
- The increase in NH_3 emissions for the miscellaneous category comes from prescribed fires and waste disposal sources. The former is due to methods changes and the latter is due to the addition of municipal/commercial composting emissions in more recent NEIs.
- The increases in the miscellaneous category (Figure 23) emissions are related to increases in dust from agricultural tilling and livestock, especially for PM_{10}. The apparent increase in $PM_{2.5}$ from 2005 to 2008 is also related to a change in methods for computing $PM_{2.5}$ emissions from paved roads. Specifically, a new method for 2008 paved road emissions was based on truck vehicle miles tracking and road particulate testing in collaboration with industry groups, resulting in new emission factors that give higher $PM_{2.5}$ and lower PM_{10} emissions. The $PM_{2.5}$ increases offset $PM_{2.5}$ decreases from other sectors.

Some sectors (as shown in the totals in Figure 17 and Table 5) show emissions decreases or little change after 2008. This may be due to our approach to hold emissions contant from several categories in absence of a projection year emissions inventory. For instance, the NH_3 trend for agriculture has been upward. The flat-line of the agriculture emissions in the miscellaneous category from 2008, along with increases in the other sectors, allows for an apparent increase of 5 percent from 2002 to 2012.

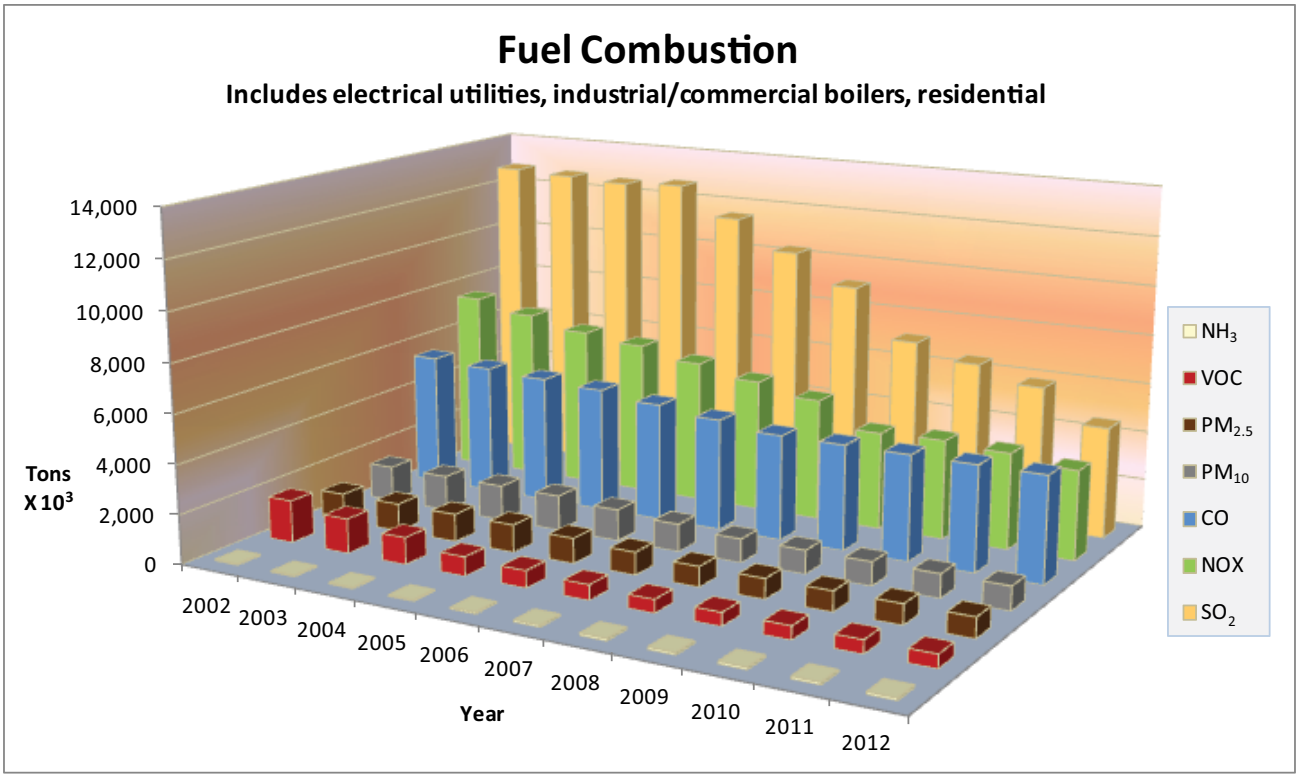


Figure 18: National Air Emissions, Fuel Combustion Sector, 2002-2012

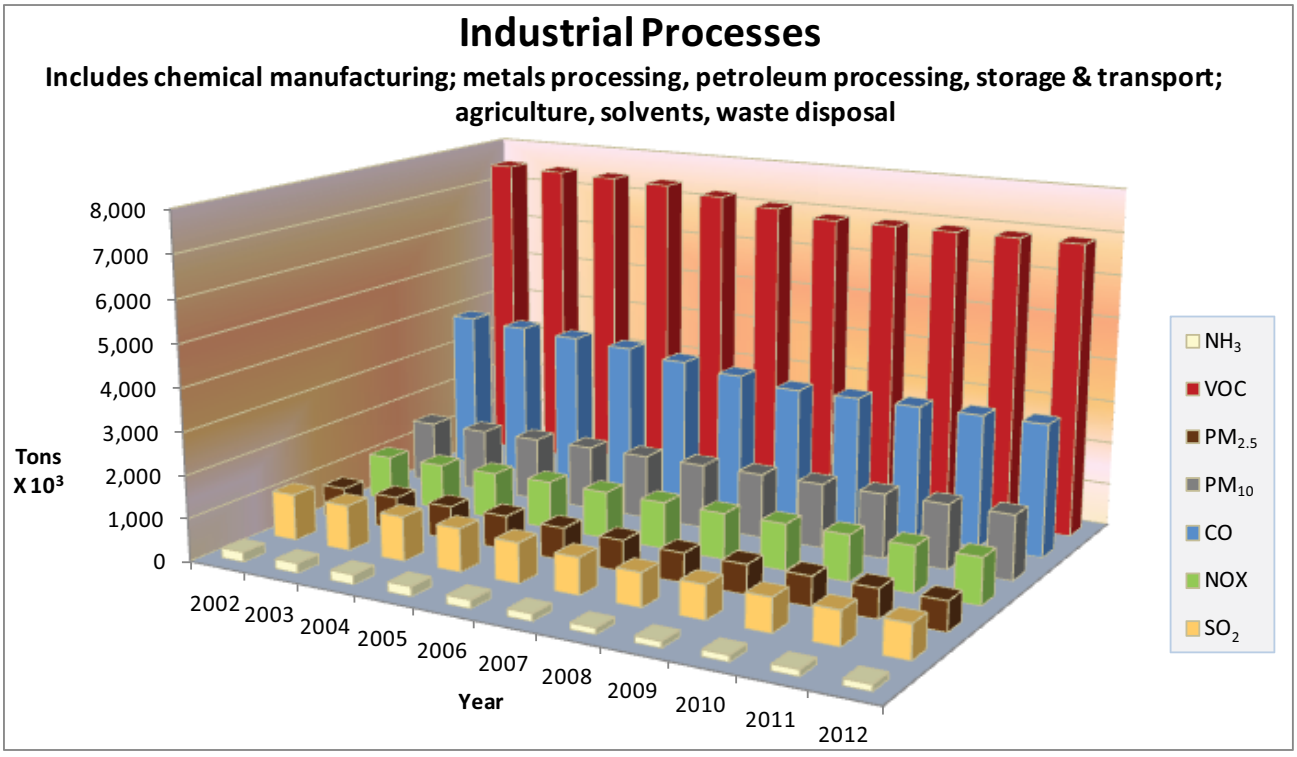


Figure 19: National Air Emissions, Industrial Processes Sector, 2002-2012

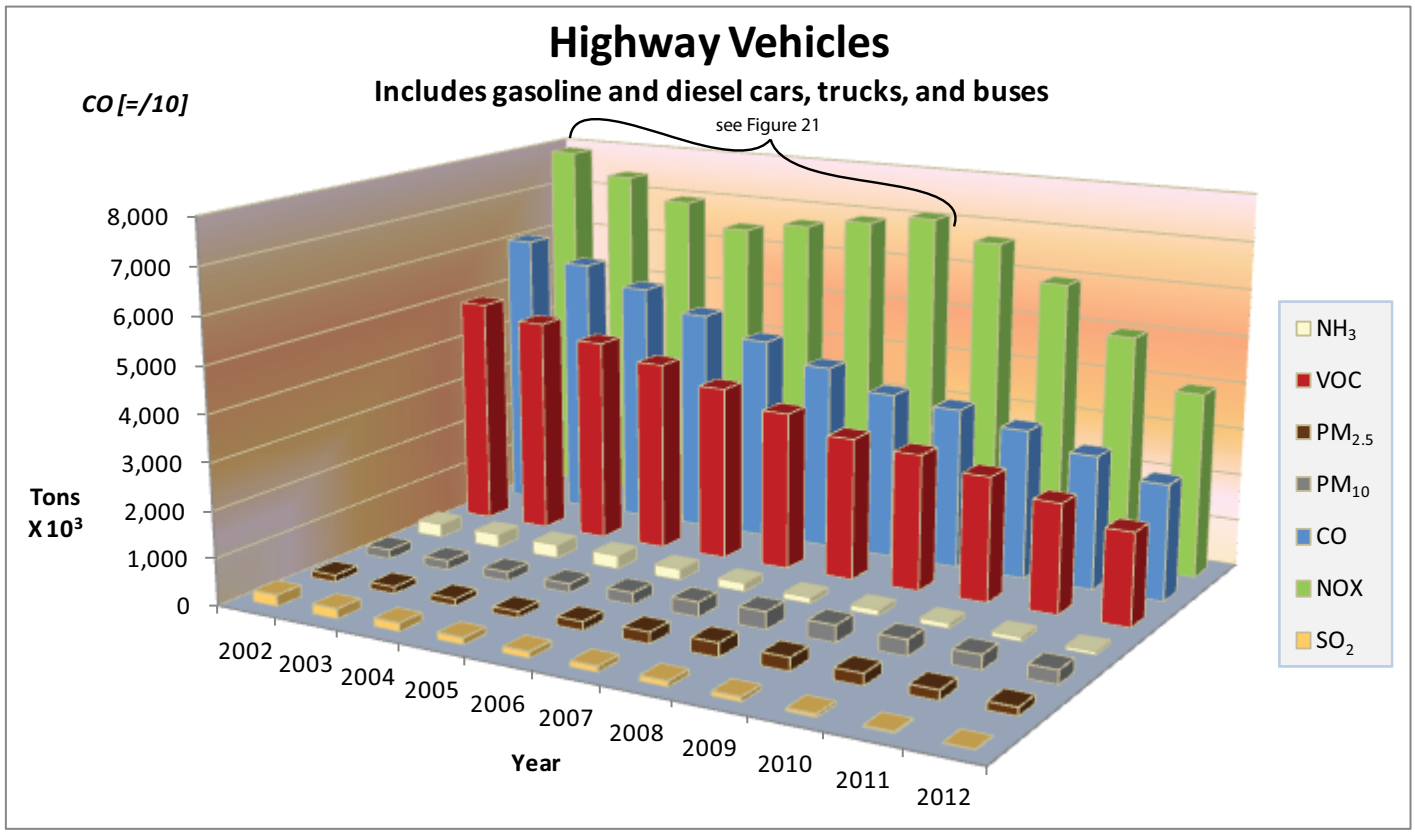


Figure 20: National Air Emissions, On-road Mobile Highway Vehicles Sector, 2002-2012

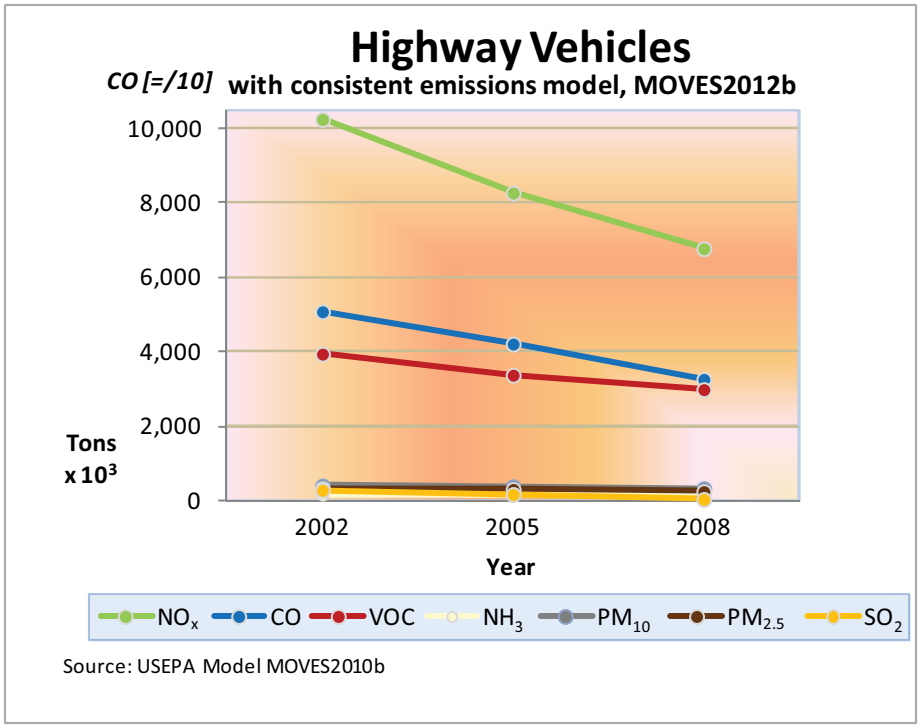


Figure 21: National Air Emissions, On-road Mobile Highway Vehicles Sector, 2002-2008, Using Consistent MOVES 2010b

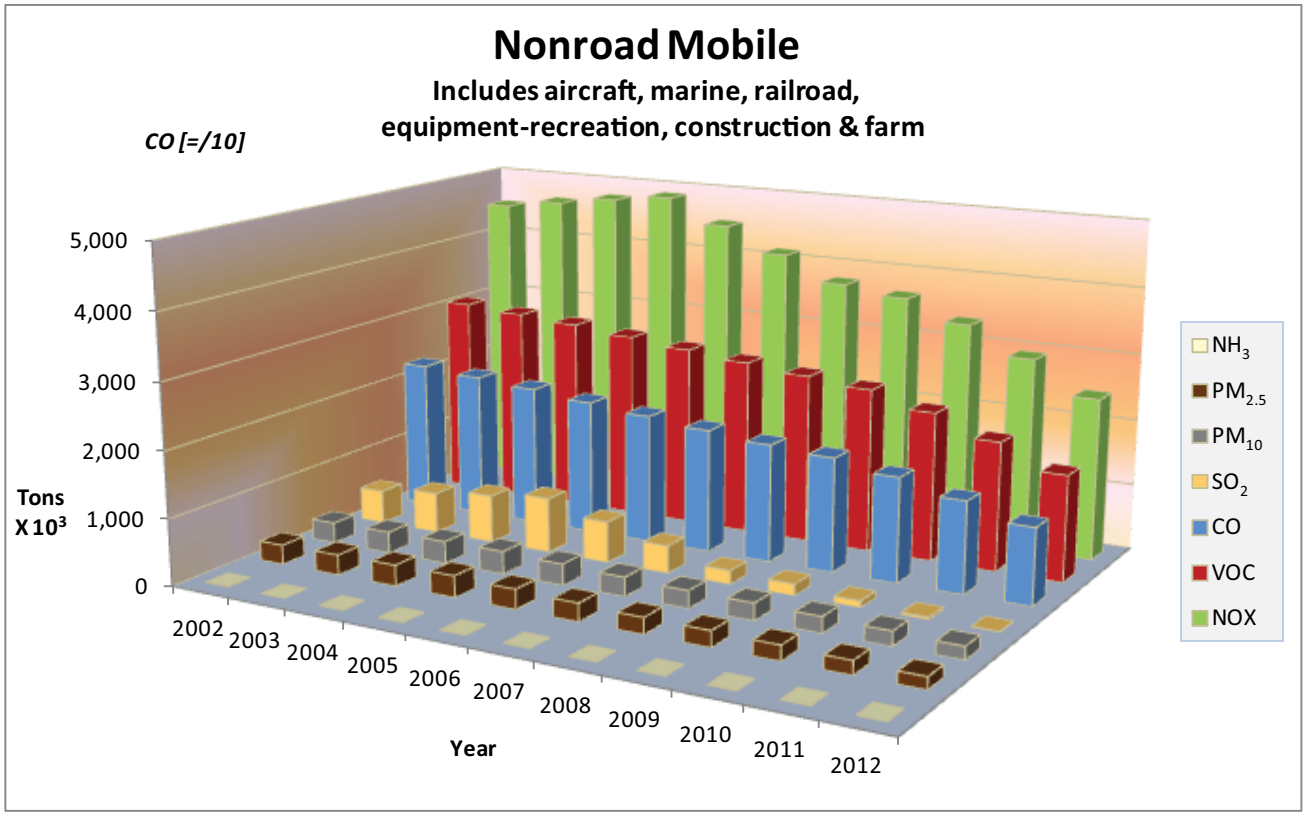


Figure 22: National Air Emissions, Nonroad Mobile Sector, 2002-2012

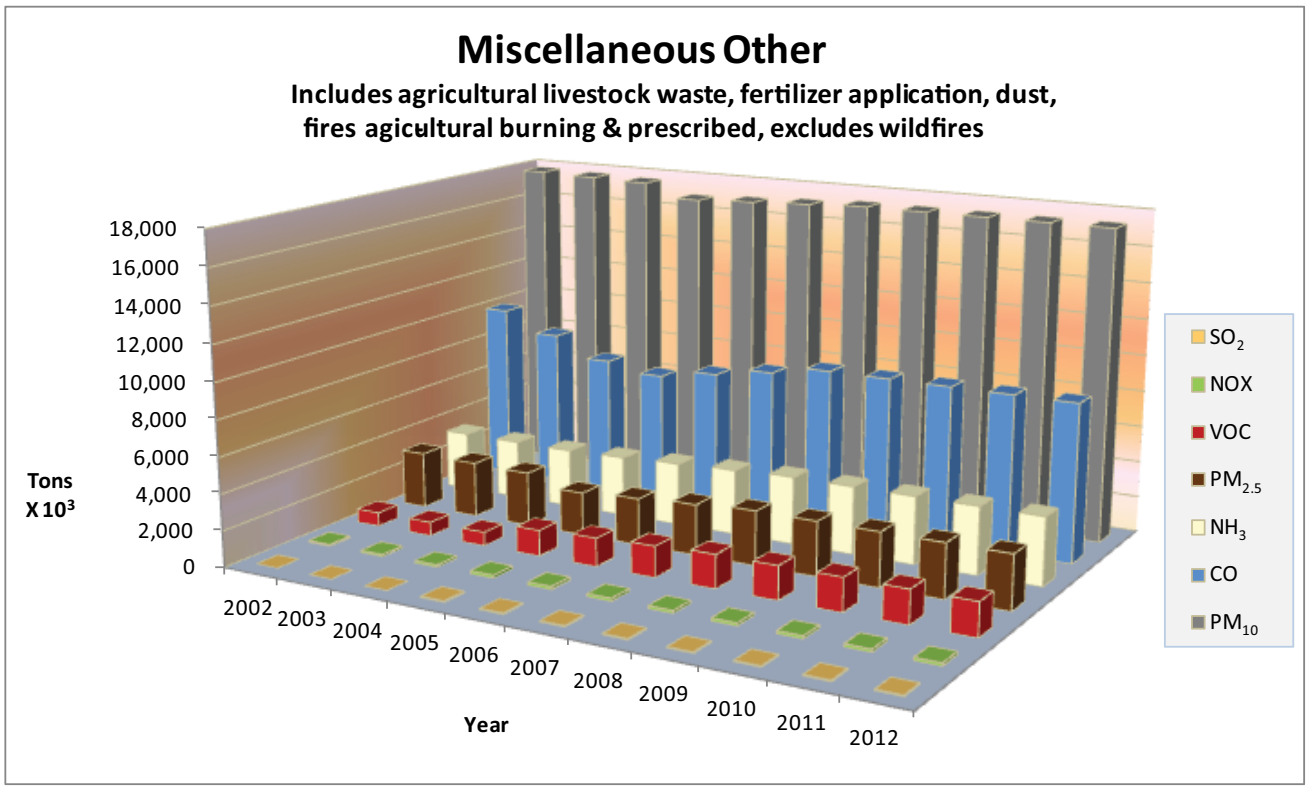
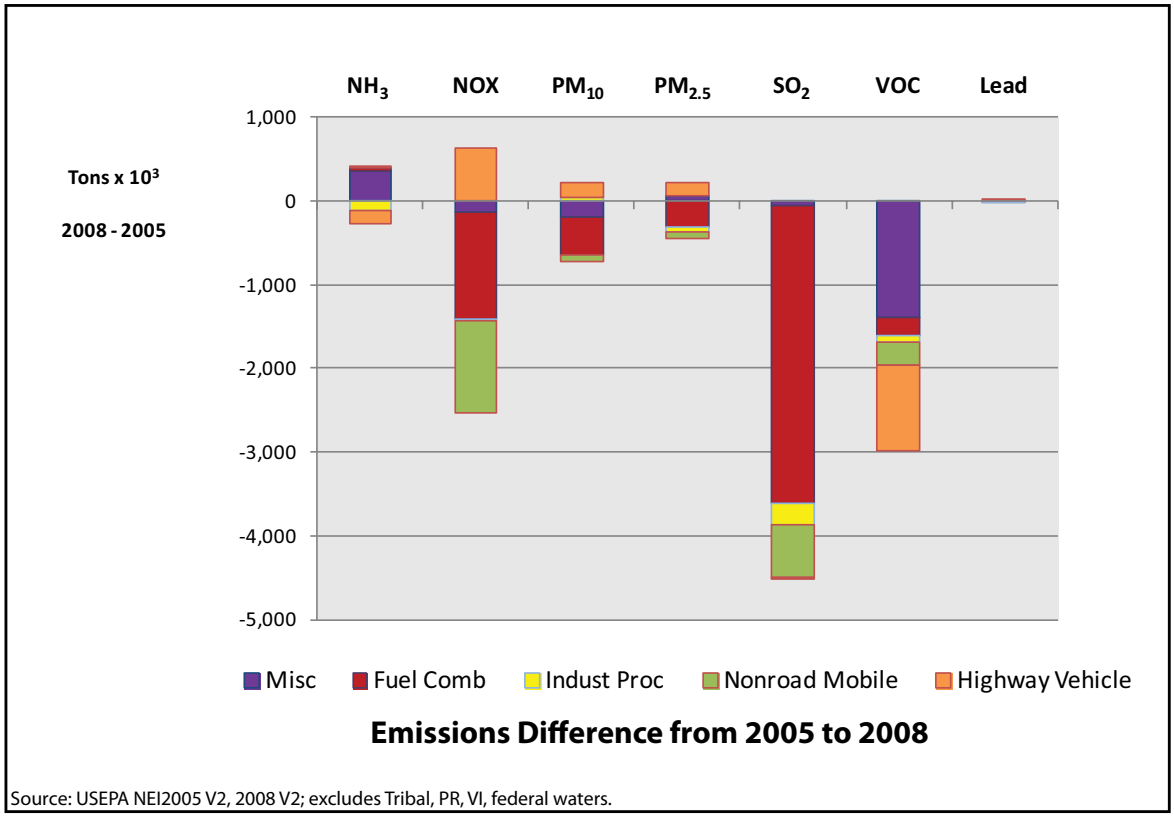


Figure 23: National Air Emissions, Miscellaneous/Other Sector, 2002-2012



Source: USEPA NEI2005 V2, 2008 V2; excludes Tribal, PR, VI, federal waters.

Figure 24: Comparison of CAP Emissions from 2005 to 2008, Excluding Wildfires and Biogenics

3.3 Emissions by Sector Comparisons for 2005 and 2008

3.3.1 CAP Comparisons

In the previous section we discussed the general CAP emission trends over time at a national level, both in total sum and by broad sector aggregation. In this section we review and compare, in more detail, the most recent comprehensive inventories completed by the EPA – the NEI for years 2005 and 2008 – to see where emission reductions have occurred and to explain how much of the differences result from real changes rather than methods differences. Figures 24 and 25 compare the latest CAP inventories for 2005 and 2008. The y-axis shows the emissions difference as estimated by subtracting the 2005 emissions from the 2008 emissions. Values greater than zero indicate that 2008 emissions are larger than 2005 values. Figure 24 compares CAP emissions for five of the seven broad sectors as described in Table 3 (excluding wildfires and biogenic emissions), while Figure 25 compares the wildfire emissions. Table 6 describes the emission changes for each pollutant/sector combination and Table 7 identifies the source within the sector that drives the decrease or increase observed by pollutant / sector combination and notes where some differences are also due to method changes.

Explanations for these differences are shown by pollutant/sector in Table 7. Figure 24-25, together with Table 6, illustrate that:

- For most sectors and most of the CAPs, emissions are lower in 2008 than in 2005; the exceptions are some small increases in NO_x, $PM_{2.5}$ and PM_{10} for the highway vehicle sector, PM_{10} from fuel combustion and NH_3 from the miscellaneous sector, nonroad mobile and fuel combustion. Table 7 identifies the source within the sector that drives the observed increase. Wildfire CAP emissions are significantly higher in 2008 than in 2005.
- For highway vehicles, the emissions model available and used to estimate source emissions was different for the NEI 2005 (MOBILE6) and 2008 (MOVES). The effect of this method change and use of the different models is an apparent increase for NO_x and PM emissions between 2005 and 2008. As

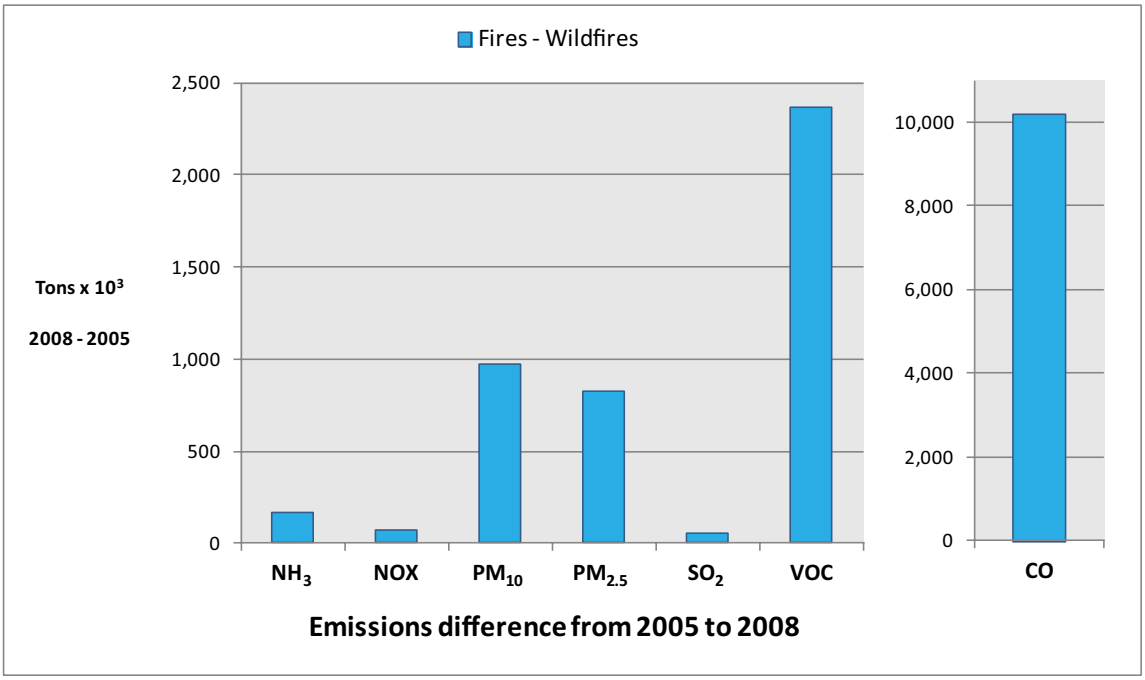


Figure 25: Comparison of CAP Emissions from 2005 to 2008, Wildfires

Table 6: Emission Sum Differences for CAP Emissions Shown in Figures 24 and 25

EMISSIONS SUM DIFFERENCE								
TOTAL SUM DIFFERENCE EXCLUDES WILDFIRE	**116,791**	**-20,500,373**	**-1,914,466**	**-515,461**	**-221,214**	**-4,527,812**	**-2,996,339**	**-227**
Sector	NH_3	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb
Miscellaneous	351,833	-4,466,303	-124,828	-183,959	68,657	-45,950	-1,387,799	-54
Fuel Combustion	40,065	-758,726	-1,280,291	-469,882	-311,270	-3,581,292	-223,469	0
Industrial Processes	-117,038	-324,165	-31,943	37,250	-57,140	-247,786	-71,762	-255
Nonroad Mobile	970	-2,610,750	-1,110,248	-79,987	-79,609	-624,566	-273,620	81
Highway Vehicle	-159,039	-12,340,429	632,843	181,117	158,146	-28,218	-1,039,690	0
Fires - Wildfires	164,606	10,161,767	65,901	968,203	820,866	53,863	2,364,983	
POLLUTANT PERCENT DIFFERENCE 2005 TO 2008								
Total percent Difference excludes wildfire	3	-23	-10	-2	-4	-31	-17	-19

Table 7: Explanations of the Differences Seen in CAP Emissions Between 2005 and 2008

	Miscellaneous	Fuel Combustion	Industrial Processes	Nonroad Mobile	Highway Vehicle
NH_3	Increases: Prescribed fires; Waste disposal - addition of municipal/ commercial composting results in increase for NH_3. This sector drives the overall small increase in NH_3.	Slight increase is in residential wood combustion.	Decreases:Industrial Processes Not Elsewhere Classified, which includes mostly point processes - food & agriculture and food & kindred products.		Decreases: gasoline vehicles.
CO	Increases: Prescribed fires; Agricultural field burning. Decreases: Misc Non-Industrial NEC processes which includes other combustion structure fires. Magnitude drives overall decrease for sector.	Slight decrease, most of which is in industrial boilers.	Slight decrease, mostly in petroleum refineries, pulp & paper, and storage and transfer.	Decrease for commercial marine and largest decrease in gas equipment.	Increases: diesel vehicles 17 percent Decreases: gasoline vehicles 56 percent. Drives overall decrease.
NO_x	Decreases: Waste Disposal, which includes open burning; Misc Non-Industrial NEC, includes nonpoint processes for petroleum product storage, other combustion structure fires, and cremation.	General decreases in commercial/ institutional boilers and heating, electric utilities, and industrial boilers.	General decreases in all processes, somewhat larger decrease in mineral products and storage & transfer.	Decreases: railroad 24 percent; commercial marine 70 percent; gas equipment 45 percent; nonroad diesel equipment 7 percent	Increases: diesel vehicles 47 percent Decreases: gasoline vehicles 21 percent Overall increase due to change in mobile model.
$PM_{2.5}$	Increases: Prescribed fire 76 percent; Agricultural crop tilling & livestock dust 67 percent; Dust from paved road 128 percent - due to method change.	General decrease in all combustion processes. Magnitude drives overall decrease for $PM_{2.5}$.	General decrease in all processes.	Decrease: aircraft 56 percent; commercial marine 79 percent	Increases: gasoline vehicles 43 percent; diesel vehicles 155 percent. Due to change in mobile model. Not a nationally significant source of PM.
SO_2	Increase: Prescribed fires Decreases: Misc Non-industrial NEC, which includes nonpoint processes for petroleum product storage, other combustion structure fires, and cremation. Magnitude drives overall decrease for sector.	Large decreases in commercial/institution, electric utilities, and industrial boilers.	General decreases in most processes, somewhat larger decrease in petroleum refineries and pulp & paper.	Decreases: railroad 86 percent; commercial marine 88 percent; nonroad diesel equip 84 percent; gas equipment 33 percent.	Decreases: gasoline vehicles. Drives the overall small decrease for sector.
VOC	Decreases: Bulk gas terminals; Fires - agriculture field burning; Misc Non-industrial NEC, which includes nonpoint petroleum product storage.	General decreases in all combustion processes.	General increase for some processes, most notably for oil and gas. General decreases across many other processes with substantial decrease in solvent surface coating – both industrial and non-industrial.	General decreases across all processes.	Decreases: gasoline vehicles 96 percent. Drives overall decrease for sector.
Lead	Large decrease in waste disposal.		Decreases most notably in industrial processes-NEC and storage & transfer.	Small increase, mostly aircraft.	

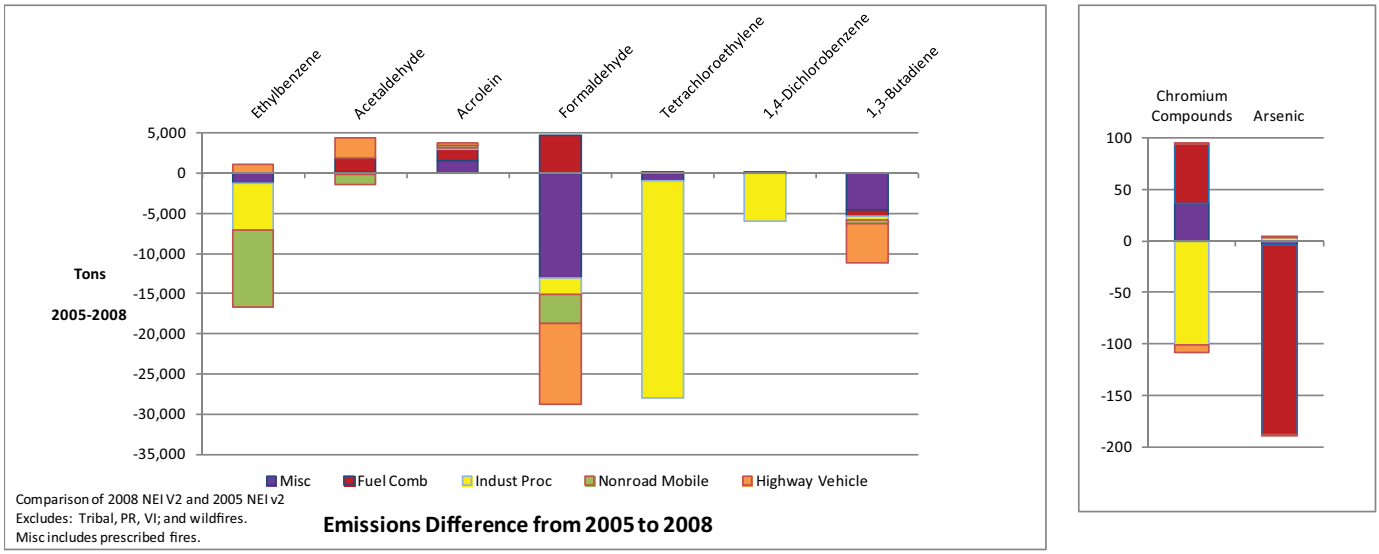


Figure 26: Comparison of HAP Emissions from 2005 to 2008, Excluding Wildfires and Biogenics

indicated in Figure 21, when applying the same and most recent available EPA model to both 2005 and 2008 – all CAP emissions decline through 2008.

3.3.2 HAP Comparisons

For the national HAPs of relevance shown in Table 2, Figure 26 compares 2005 to 2008 emissions for the same sectors depicted in Figure 24 (fires are not shown for HAPs), using the NATA 2005 inventory for the 2005 emission values. Some observations from this figure and from the associated emission totals in Table 8 include:

- There are greater than 5,000 tons of emission reductions of ethylbenzene, tetracholoroethylene, and 1,4-dichlorobenzene from industrial processes.
- Highway vehicle emissions decreased in 2008 for 1,3-butadiene and formaldehyde compared to 2005 levels.
- In combination with the emissions changes shown in Table 8, most of the HAPs show reductions from 2005 to 2008, with the reductions ranging from 84 percent for dicholorobenzene to 2 percent for chromium compounds. Note that percent differences can be high even when corresponding amounts of emissions are low. The reader should use both Figure 26 and Table 8 as a guide for which pollutants have decreased by the most significant amounts, both on a percentage basis and on a mass basis.
- Acetaldehyde and acrolein both show increases in total emissions from 2005 to 2008. Acetaldehyde increases are from increased industrial natural gas combustion and increases in on-road mobile estimates that have occurred by changing to the MOVES model. In addition, ethanol in the fuel supply increased between 2005 and 2008, contributing to increased acetaldehyde. Increases in acrolein are from higher prescribed burning emissions (because of new estimation methods) and higher industrial combustion of fossil fuels and biomass. Table 9 provides further descriptions for each HAP/sector's change from 2005 to 2008.
- The emissions changes for specific sources described in Table 9 are caused by a combination of actual emission changes and method changes. For example, emission estimation models for on-road mobile sources and fire emissions changed and cause some of the emission differences noted in this section. Table 9 also shows that much of the change for the industrial process sector is caused by solvent use emissions changes. This resulted from procedural changes in the portion of specific solvent emissions estimated by the EPA and the portion estimated by the states/ local agencies. Many of the changes to methods are described more fully in the 2008 NEI Technical Support Document [ref 2].

Table 8: Emission Sum Differences for HAP Emissions Shown in Figure 26

EMISSION SUM DIFFERENCES									
TOTAL SUM DIFFERENCE EXCLUDES WILDFIRE	-15,468	2,987	3,739	-24,188	-27,911	-6,041	-11,094	-13	-184
Sector	Ethylbenzene	Acetaldehyde	Acrolein	Formaldehyde	Tetra chloroethylene	1,4 - Dichlorobenzene	1,3 - Butadiene	Chromium Compounds	Arsenic
Miscellaneous	-1,187	137	1,572	-13,026	-912	-45	-4,521	36	-4
Fuel Combustion	-117	1,729	1,467	4,665	17	0	-805	58	-184
Industrial Processes	-5,753	-128	50	-2,097	-27,015	-5,997	-524	-100	3
Nonroad Mobile	-9,530	-1,338	299	-3,660	0	0	-381	2	1
Highway Vehicle	1,120	2,588	352	-10,070	0	0	-4,863	-8	0
POLLUTANT PERCENT DIFFERENCE 2005 TO 2008									
Total percent Difference excludes wildfires	-14	3	13	-9	-83	-84	-22	-2	-57

Table 9: Explanations of the Differences Seen in HAP Emissions Between 2005 and 2008

Sector	Miscellaneous	Fuel Combustion	Industrial Processes	Nonroad Mobile	Highway Vehicle
Ethylbenzene	Decreases: waste disposal; gas stations		Decreases: Industrial processes-NEC; Solvents - consumer & commercial, and industrial surface coating	Large decrease in nonroad gasoline equipment	Slight increase, both onroad gasoline and diesel vehicles
Acetaldehyde		Increases: Industrial boilers natural gas		Decreases: commercial marine vessels and nonroad diesel equipment	General increases in on-road gasoline and diesel vehicles
Acrolein	Large increase - Prescribed fires	Increases: Mostly in Industrial boilers natural gas, and some biomass; smaller increases in electric utility biomass and coal			
Formaldehyde	Decreases: Misc Non-Industrial NEC; Waste Disposal		Decreases: Industrial processes-NEC; Oil & Gas Production		

Table 9: Explanations of the Differences seen in HAP Emissions Between 2005 and 2008 in Table 8 (continued)

Sector	Miscellaneous	Fuel Combustion	Industrial Processes	Nonroad Mobile	Highway Vehicle
Tetrachloroethylene			Decreases: Solvents - consumer & commercial, degreasing, and dry cleaning		
1,4-Dichlorobenzene			Large decrease in Solvents - consumer & commercial		
1,3-Butadiene	Decreases: Misc Non-Industrial NEC				Large decrease in onroad gasoline vehicles
Chromium Compounds	Small increase, in agriculture crops and livestock dust; construction dust	Small increase in electric utility coal	Small decrease is mostly due to Industrial Processes-NEC and Solvent Industrial Surface Coating	Slight increase, commercial marine and nonroad gasoline equipment	Slight increase in heavy duty diesel and heavy duty gasoline vehicles
Arsenic Compounds		Decreases: electric utility coal; industrial boilers coal			

3.4 Biogenic Emissions and Wild Land Fire Emissions

3.4.1 Biogenic Emissions in the 2008 NEI

Table 4 shows that several pollutants in the NEI have a biogenic contribution: the most notable of these are the VOCs, of which there are about twice as much biogenic VOC emissions as anthropogenic emissions. For the spatial distribution of non-biogenic sources illustrated by the VOC emission density map (Figure 13), we pointed out that most of the anthropogenic VOC emissions come from mobile sources and solvent operations. On the other hand, biogenic VOC emissions come mostly from vegetation. This section reviews the spatial and chemical nature of biogenic emissions in the 2008 NEI. It should be noted that biogenic emissions are the largest source of HAP emissions for the sectors analyzed in this report.

Figure 27 shows total VOC biogenic emissions (including terpenes) [ref 14] using emissions density. As stated previously, emissions in a county are divided by area to arrive at the density values shown on the map. Sesquiterpene emissions are shown in total in Table 10 but omitted from Figure 27. Figure 27 shows that the greatest density of total VOC biogenic emissions is in the Southeast and the West Coast, areas where vegetation is abundant and average ambient temperatures are high. Table 10 shows that biogenic VOCs contribute, on average, 97 percent of the total mass of biogenic organics. The key pollutants include isoprene, formaldehyde, methanol, acetaldehyde and terpenes. Sesquiterpene emissions constitute the remaining 3 percent.

Table 10: Biogenic VOCs in the 2008 NEI

	Total Emissions 2008 (Tons)	Average Fraction of Total Biogenic Emissions 2008
Total Biogenic	39,755,361	
VOC	38,909,251	0.974
Sesquiterpenes	846,110	0.026

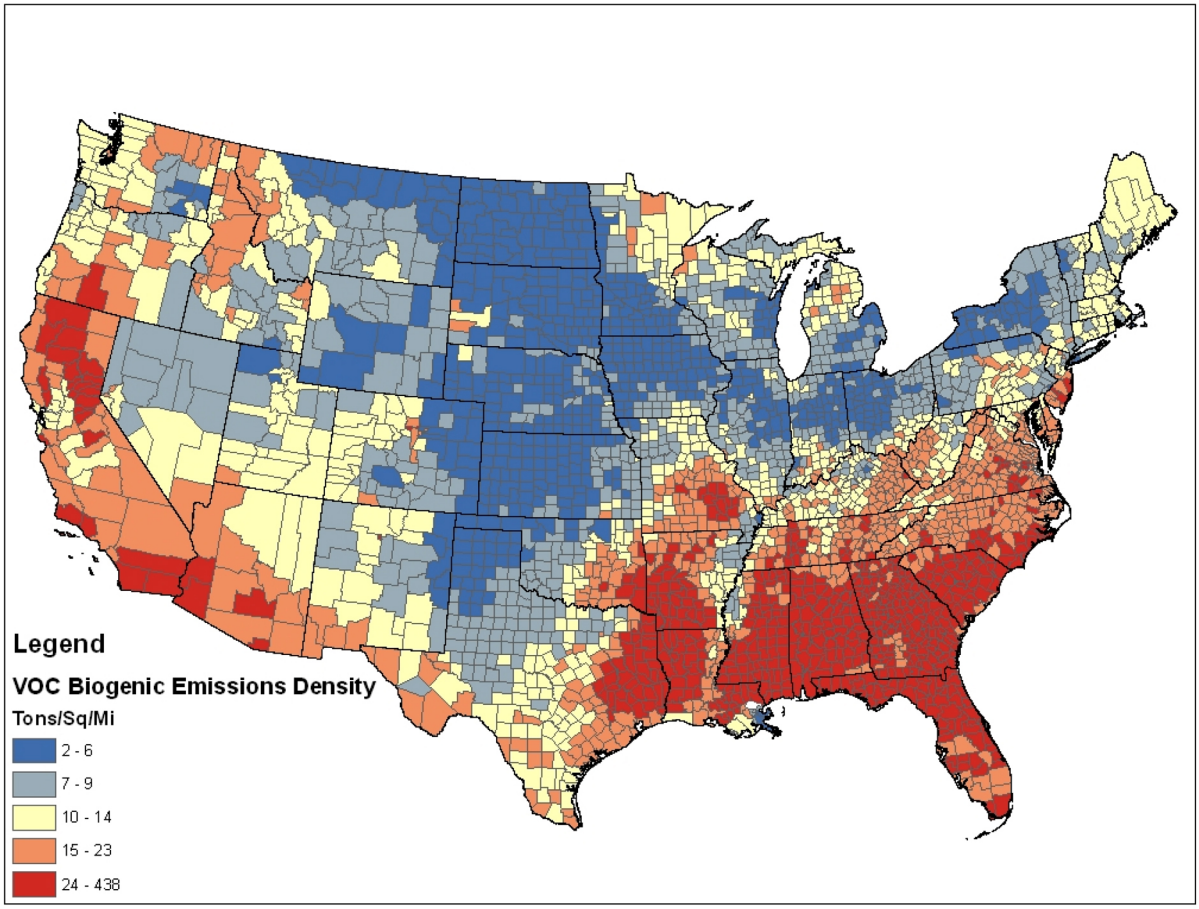


Figure 27: Total VOC Biogenic Emissions Density, 2008 NEI

3.4.2 Wild Land Fires in the 2008 NEI

In most of the emission summaries shown in this report, we have excluded wild land fires (large wildfires and prescribed fires) because the emissions are highly variable from year to year, so changes can skew the conclusions of relative importance of emissions from other sectors. Also wildfires occur naturally and are not an anthropogenic source of emissions that can be readily controlled.

In contast, agricultural fires (also a sector in Table 3) are included in all of the analyses and graphics presented in this report. These fires are generally much smaller (and emit much less) than wildfires or prescribed fires, do not vary as much year to year and their occurrences and timing can be planned.

As described previously, the emission estimates in the 2008 NEI are a combination of SLT-submitted and EPA-generated estimates. In the case of these large fires, very few states submitted emission estimates and, as such, EPA estimates were used in most cases. EPA estimates are based on a modeling framework that combines results from BlueSky and SMARTFIRE2 (SF2) modules [ref 15]. The BlueSky framework was developed to compute smoke emissions (and impacts) given known fire information. The SF2 system was later developed to help reconcile disparate sources of fire information for use in BlueSky. Additional information and references on these methods are included in the 2008 NEI Technical Support Document [ref 2]. Together these modules estimate daily, location-specific fire emissions. The improved algorithms in SF2 allow for every fire to be assigned to a fire type (either prescribed or wildfire). Table 11 shows annual CAP emission totals from these types of fires with the following highlights:

- Wild land fires are a major contributor to national $PM_{2.5}$ emissions in 2008 (they contribute 28 percent of the total emissions). They produced an estimated total of nearly 1.8 million tons of $PM_{2.5}$ in 2008.

Table 11: CAP Emissions from Wild Land Fires in the 2008 NEI

Pollutant	Prescribed Fires, Emissions in Tons	Wildfires, Emissions in Tons	Total 2008 NEI Emissions, Tons	Percent Contribution from Prescribed Fires	Percent Contribution from Wildfires	Total Contribution from Wild Land Fires, percent
CO	815,760	12,200,112	89,170,000	1	14	15
NH_3	118,766	198,112	4,367,000	3	5	7
NO_x	138,584	96,370	19,246,000	1	1	1
$PM_{2.5}$	699,907	998,605	6,123,000	11	16	28
PM_{10}	824,000	1,178,000	21,693,000	4	5	9
SO_2	65,327	69,993	10,287,000	1	1	1
VOC	1,696,194	2,846,633	49,615,000	3	6	9

- Wild land fires also contribute over 9 percent to total CO, PM_{10} and VOC emissions in the 2008 NEI.
- Wild land fires are a very minor contributor to NO_x and SO_2 emissions.
- Due to the nature of the burns, wildfires contribute more to emissions for all CAPs except NO_x than do prescribed burns. This is despite there being about an equal amount of acres burned nationally with prescribed burns in 2008.

Wild land fires are also a dominant contributor to acrolein emissions and a significant contributor to 1,3-butadiene, acetaldehyde, formaldehyde and benzene emissions.

The 2008 NEI data on fires allow us to look at wildfires and prescribed fires in more detail. Figure 28 shows the spatial distribution of acres burned, and Figure 29 shows $PM_{2.5}$ emissions by the fire type (either prescribed or wild fires). These maps also identify a third fire type: wild land fire use. These fires are started as wildfires but then brought under control and used as a prescribed burn. These types of fires make up a very small part of the total fires (usually in the Western U.S.) and are part of the wildfire emission estimates shown in Table 11.

Some interesting highlights from Figures 29 and 30 include:

- States that have larger amounts of area burned associated with prescribed fires (GA, KS and most Eastern states) tend to have lower $PM_{2.5}$ emissions than states with higher amounts of activity associated with wildfires (CA, TX), which have higher $PM_{2.5}$ emissions. This is due to the fact that wildfires emit more pollutants than prescribed fires due to nature and conditions of burning, which is captured by the models used to estimate the emissions.
- Both acres burned and $PM_{2.5}$ emissions are low in the Northeastern and Midwestern states, with the exception of Minnesota, where deep organic fires in 2008 caused higher activity and emissions from fires [ref 16]
- The Eastern U.S. is dominated by prescribed fires, with Southeastern states showing much higher activity (acres burned) associated with prescribed burns than elsewhere in the country.
- North Carolina has a low amount of acres burned by wildfires, yet the corresponding $PM_{2.5}$ emissions are very high. This was primarily caused by the Evans Road fire [ref 17], which burned in Eastern NC for over a month in summer 2008, resulting in significant amounts of smoldering emissions.
- As discussed earlier, in the 2008 NEI EPA used SF2 to estimate wild land fire emissions. Most of these emissions are shown in Figures 28 to 29. To examine how these emissions have changed over the past few NEI cycles, EPA has relied on older versions of SMARTFIRE to develop these wild land fire emission estimates, and while the methods within SMARTFIRE (SF) have changed over time, the overall approach used in the NEI is the same since

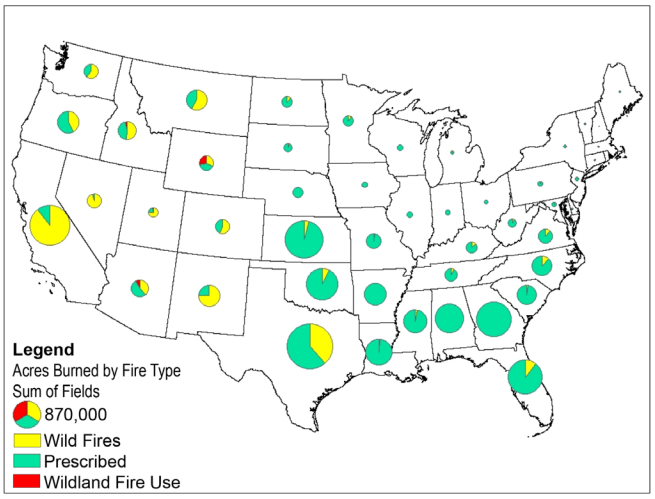


Figure 28: Spatial Distribution of Acres Burned by "Fire Type" in the 2008 NEI

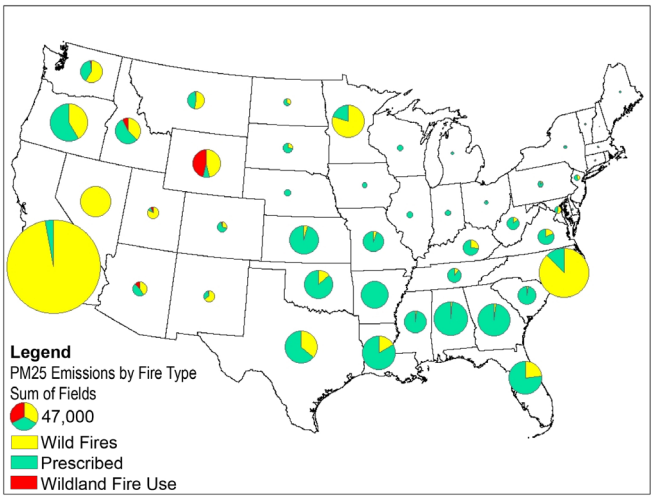


Figure 29: Spatial Distribution of $PM_{2.5}$ Emissions by "Fire Type" in the 2008 NEI

about 2003. Figure 30 provides the trends in U.S. $PM_{2.5}$ emissions from wild land fires from 2003 to 2009 for the lower 48 states. The bar graph shows trends in $PM_{2.5}$ emissions for prescribed and wildfires separately. In sum, no consistent trend is seen in $PM_{2.5}$ emissions from 2003 to 2011, though 2006, 2007 and draft 2011 are seen to be "high fire" years, and have been identified as such by other sources [ref 18]. Total emissions not having a consistent pattern is due to the year-to-year variation seen in wildfires (green). Prescribed fires (red) are seen to be very similar in emission levels from 2003-2011. Figure 30 also reveals that in total (for the lower 48 states) $PM_{2.5}$ emissions vary from an estimated low of about 900,000 tons in 2004 to about 2.3 million tons in 2007. Regardless of the year in question, the contribution of $PM_{2.5}$ emissions from these fires to the overall total $PM_{2.5}$ emissions in the NEI is significant.

3.5 Focus on the 2008 NEI: Summary of CAPs and Select HAPs

3.5.1 Emissions Percent Distributions and Emissions from Stationary and Mobile Sources

In this section we take a more detailed look at the 2008 NEI and the national profile of CAPs and the select HAPs to better understand the multiple pollutant nature of emissions from different sectors. Figures 31 and 32 depict national-level CAP emissions for the stationary and mobile emissions categories, respectively. Along the x-axes of both these figures are the 15 sectors that make up the total for each of these two broad categories—these are the sectors from the "sector17" column in Table 3 without wild and prescribed fires. The y-axes in these figures show the percent contribution by pollutant in each of the sectors displayed on the x-axes. These figures only describe the relative proportion of pollutant emissions within each sector and do not confirm the amount of emissions contributed by each sector. The emission magnitudes are provided in subsequent tables. For example, the first bar in Figure 31 shows that within the agriculture sector, about 40 percent of the total CAP emissions are from NH_3; about 50 percent from PM_{10}; and the remaining 10 percent comes from $PM_{2.5}$ and VOCs. Figures 31 and 32 together show that at the national level for CAPs:

- The solvent sector emits exclusively VOC emissions.
- SO_2 is the primary pollutant emitted from fuel combustion for electricity generation, and emit twice as much SO_2 as NO_X. In contrast, industrial, commercial and institutional fuel combustion emit multiple pollutants (NO_x, CO and SO_2) in near-similar proportions.
- The dust sector emits mostly PM, while agricultural burning emits mostly CO emissions. The dust sector includes road and construction dust.
- The industrial processes and miscellaneous categories emit multiple CAPs in significant proportions.

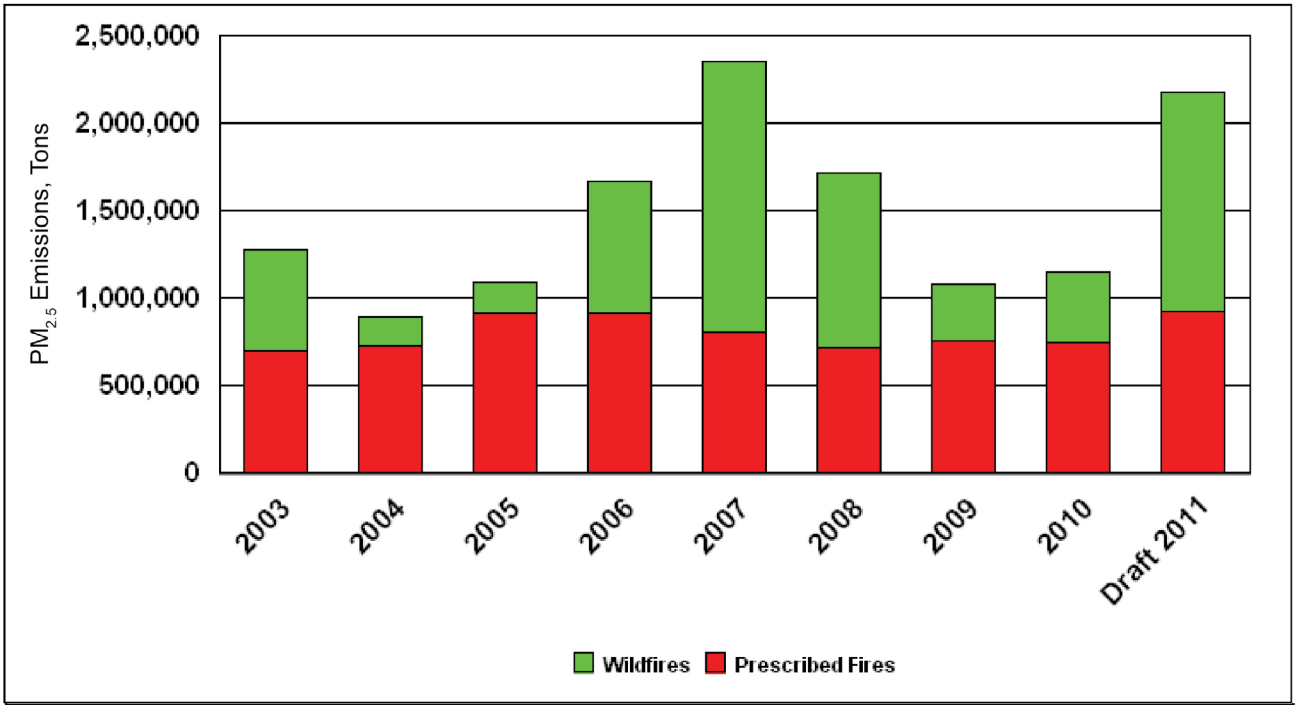


Figure 30: $PM_{2.5}$ Emission Trends in Wild Land Fires, 2003-2009

Further details on some of these emission sources are provided in the following sections.

- CO emissions represent a significant proportion of total mass of CAPs emitted by on-road, nonroad equipment and aircraft.
- Commercial Marine Vessels (CMV) and rail contain high proportions of NO_x emissions and CMV also has a high proportion of SO_2 emissions, due to high sulfur fuel being used in the larger CMV engines.
- The proportions of CO emissions from several mobile source categories tend to mask the contribution by other CAPs to these categories ($PM_{2.5}$, VOC and NO_x). In the sections to follow we will address these multi-pollutant releases in more detail.

Next, Figures 33 and 34 show the same details as Figure 31 and 32, except that select HAPs are shown in these graphics. Only the HAPs of relevance at the national level (as discussed earlier) are displayed in Figures 33 and 34 below. Lead emissions are shown separately in Figure 35.

Figures 33 to 35 show that at the national level, for these select HAPs:

- The agriculture and dust sectors are comprised mainly of chromium emissions. While the percent contribution is high for these sectors, Table 12 indicates that the amount of chromium compound emissions is 15 and 35 tons respectively. For the agriculture sector, chromium emissions were reported by California for crops and livestock dust. For dust, California data also account for the majority of chromium emissions reported for construction dust. California is currently looking further into the accuracy of these estimates.
- Acrolein accounts for a high proportion of HAP emissions from agricultural burning.
- The fuel combustion categories have high proportions of total HAP emissions from formaldehyde and acetaldehyde.
- The miscellaneous and solvent categories have equal proportions of multiple HAP emissions. The predominate portions of the solvent category are VOC HAPs such as ethylbenzene and tetrachloroethylene.
- Industrial processes have numerous HAPs emitted in significant proportions, including chromium (about 5-6 percent of total).

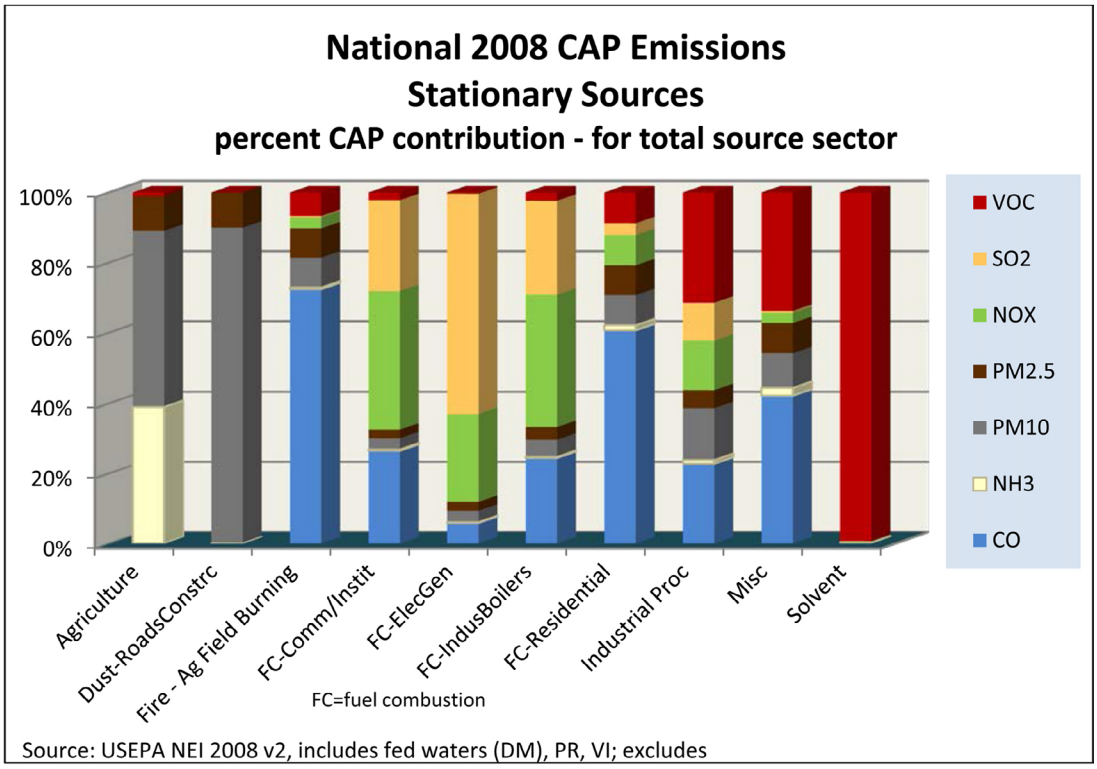


Figure 31: National CAP Emissions for Stationary Sources, 2008 NEI

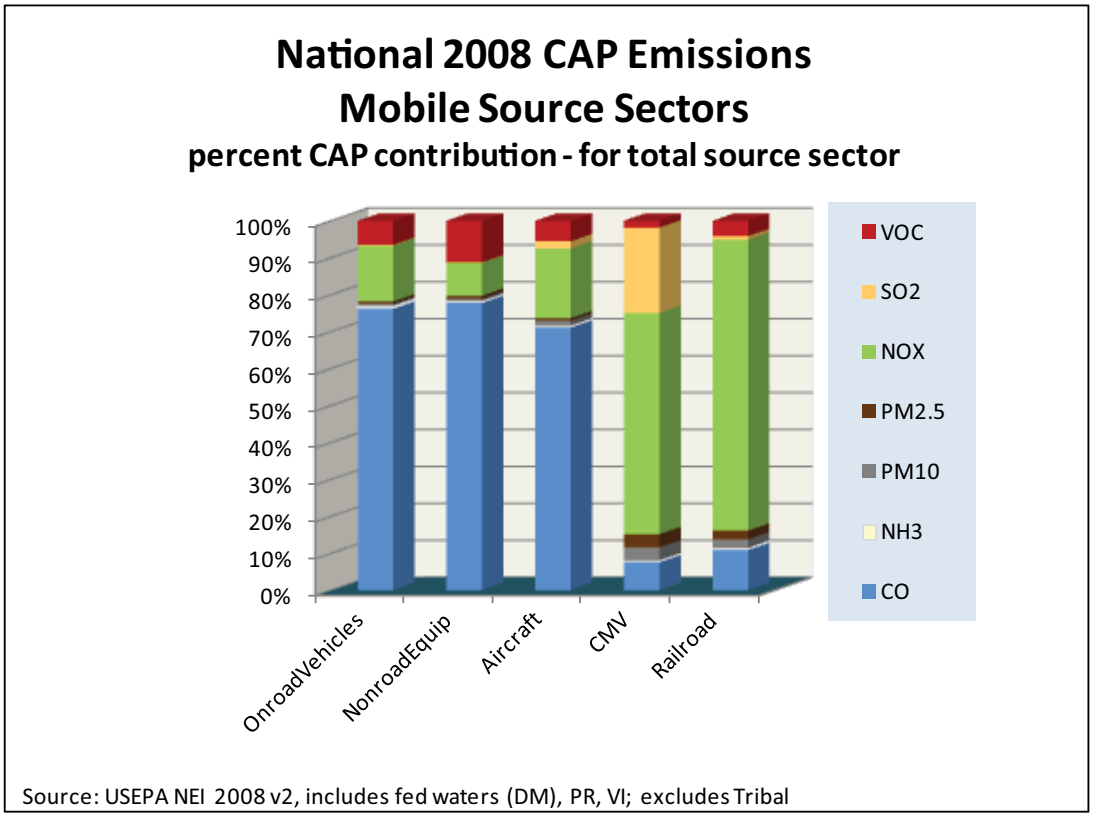


Figure 32: National CAP Emissions for Mobile Sources, 2008 NEI

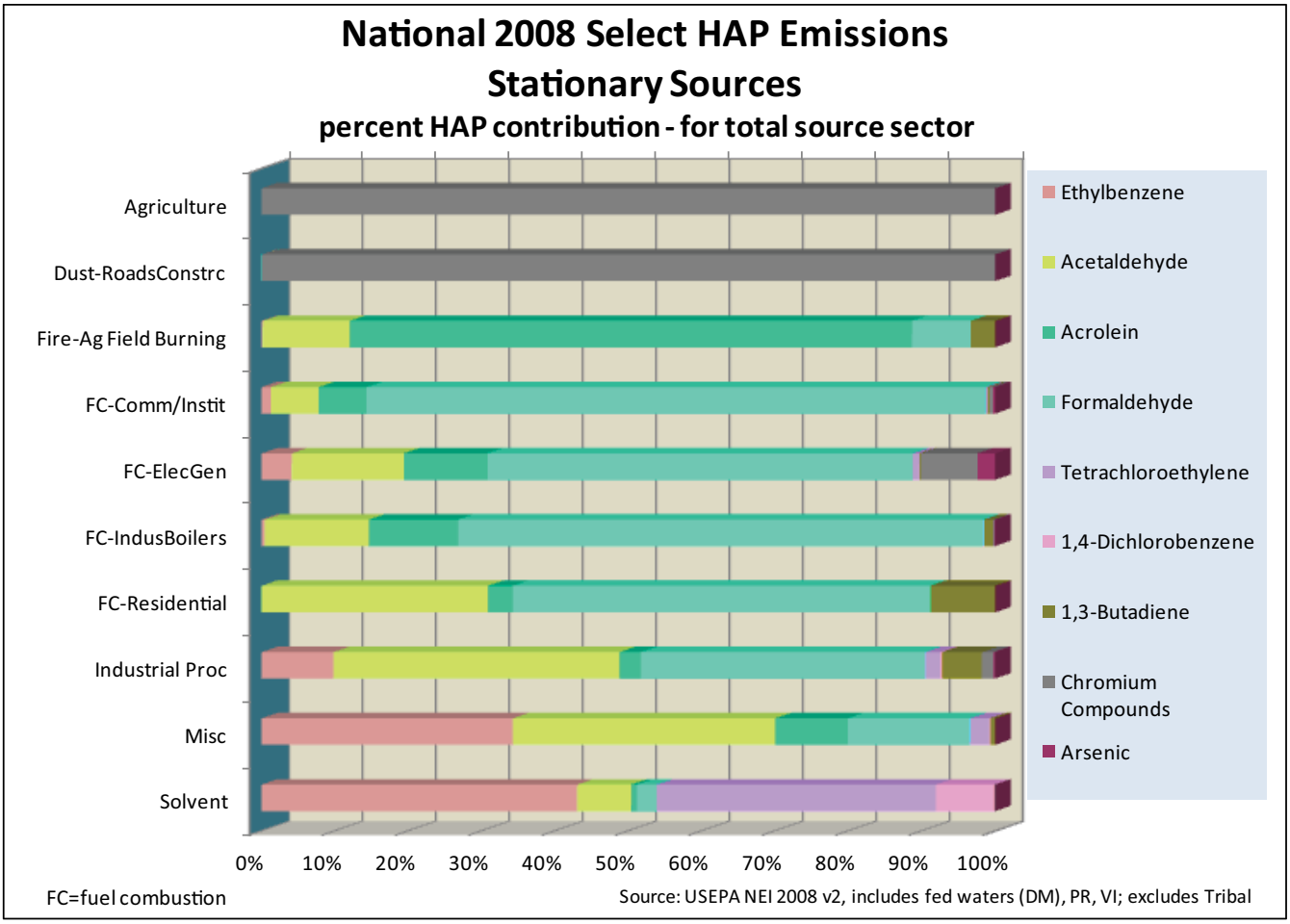


Figure 33: National HAP Emissions for Stationary Sources, 2008 NEI

- On-road vehicles and nonroad equipment have near equal proportions of ethylbenzene and formaldehyde emissions. Acetaldehyde is also emitted in significant proportions.
- Aircraft, CMV and rail categories all have a high proportion of formaldehyde emissions and a significant proportion of acetaldehyde emissions.
- In the Table 12 summary of CAP and HAP emission totals, lead is indicated as a relatively small amount nationally, with most of the contributions coming from aircraft (piston engines). Figure 35 shows that the largest portion of the national lead contribution is from aircraft, industrial processes and fuel combustion from EGU and industrial boilers. All of the aircraft-based lead emissions occur from piston engine aircraft.

Figures 31 to 34 show the fraction of the multiple pollutant emission contributions within a given sector but does not describe the amount of emissions contributed by each sector. To better understand the magnitude of emissions at the national level for these sectors, Table 12 summarizes the actual tons of emissions for these pollutant/sector groupings for stationary and mobile sources. Some interesting observations for these national-level emissions include:

- About 90 percent of CO emissions come from mobile sources.
- Both mobile sources and stationary sources are important contributors to NO_x and VOC emissions.
- A majority of PM emissions come from stationary sources.
- Among the HAPs, formaldehyde is emitted in the highest quantity with a majority of the emissions coming from mobile sources. Ethylbenzene and acetaldehyde emissions are also emitted at significant levels nationally. As indicated in Section 3.4, biogenic sources are the largest source of these HAP emissions.

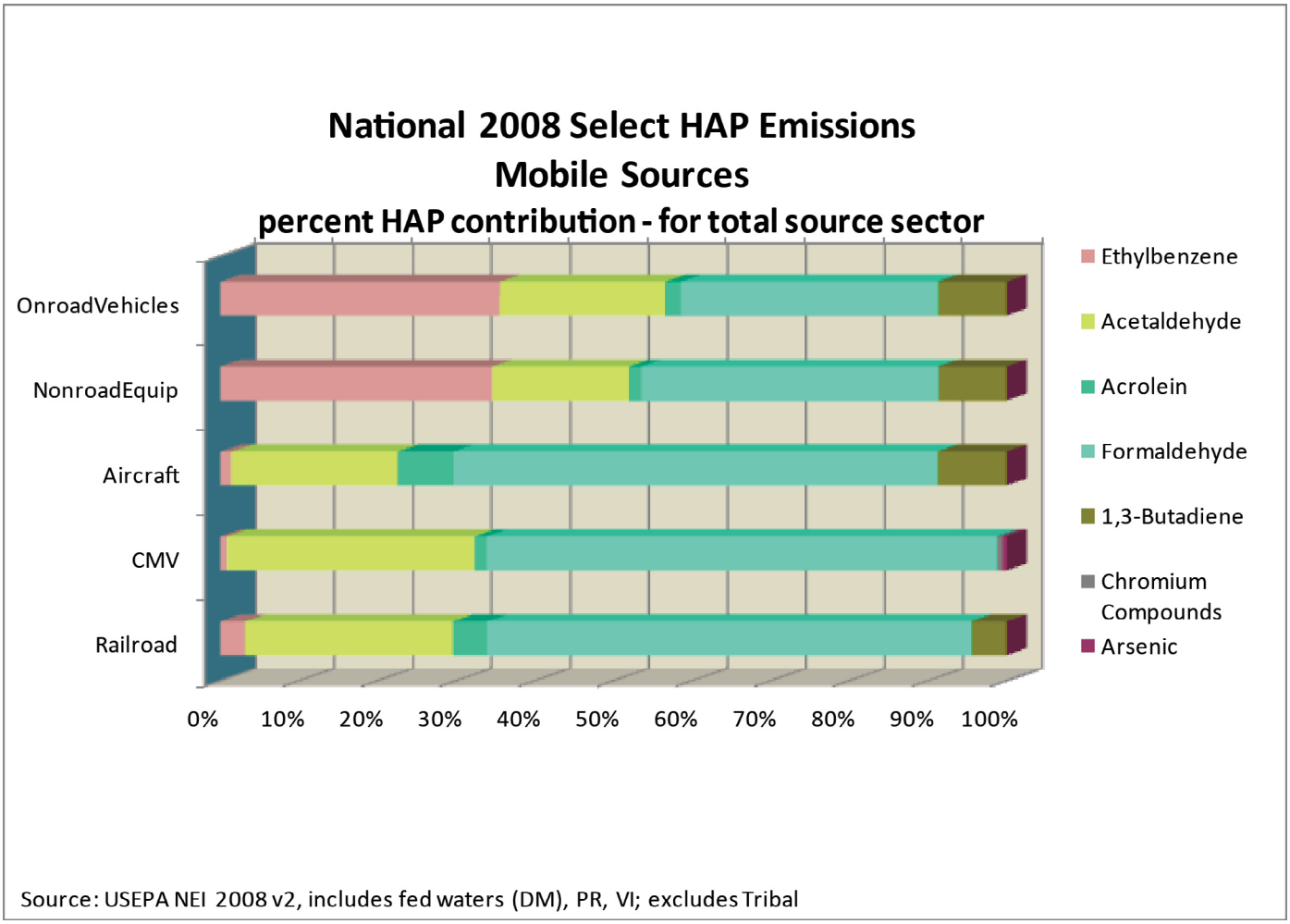


Figure 34: National HAP Emissions for Mobile Sources, 2008 NEI

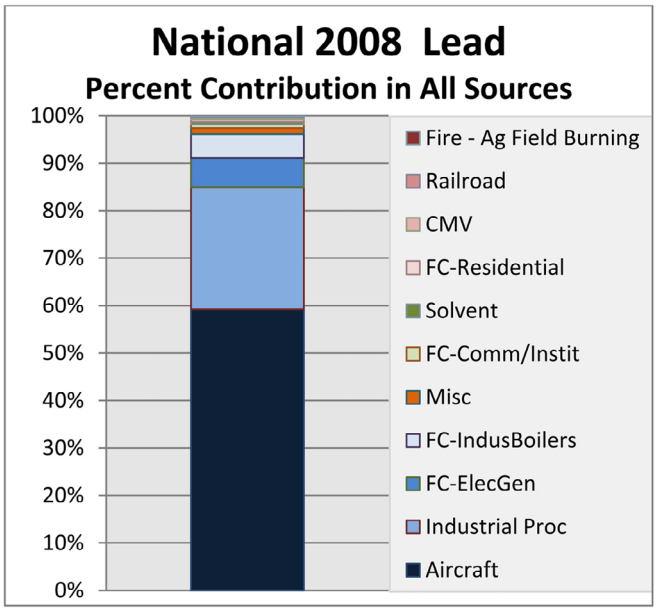


Figure 35: National Lead Emissions From All Sources, 2008 NEI

- Nearly all 1,3-butadiene emissions come from mobile sources. For the aldehydes and metal HAPs (chromium, lead, arsenic), there are contributions from both mobile and stationary sources.
- By looking at the individual columns in Table 12, sectors that have significant multi-pollutant emissions include on-road vehicles, fuel combustion sources and industrial processes.

In the next section multiple pollutant emission contributions by sector will be reviewed in more detail.

3.5.2 Top Pollutant/Sector Emission Contributions in the 2008 NEI

In this section we review the national profile of multiple emissions contributions at a more detailed sector level to show which pollutant/sectors stand out

Table 12: HAP/CAP Emission Totals (in Tons) for Stationary and Mobile Sources

2008 CAP and Select HAP Emissions (tons) for Stationary Sources, excluding wildfire and prescribed fires

Pollutant	Agriculture	Dust Roads Constrc	Fire Ag Field Burning	FC Comm/Instit	FC ElecGen	FC IndusBoilers	FC Residential	Industrial Proc	Misc	Solvent	Total Stationary
NH_3	3,636,596	1	3,882	2,263	26,835	10,356	61,278	86,681	77,059	417	3,905,367
CO		168	569,531	160,940	721,973	841,517	2,534,832	1,839,586	1,443,933	6,745	8,119,227
NO_X		73	24,743	239,972	3,030,541	1,294,501	360,485	1,125,603	99,272	6,959	6,182,149
PM_{10}	4,671,081	11,745,767	67,814	19,302	398,239	168,377	358,914	1,194,717	332,886	4,308	18,961,404
$PM_{2.5}$	930,446	1,311,903	66,219	15,063	303,080	125,630	355,488	412,030	294,611	3,796	3,818,266
SO_2		1	3,416	157,937	7,761,470	928,850	141,556	879,069	20,918	695	9,893,911
VOC	91,888	17	52,584	13,452	42,642	81,598	366,785	2,543,344	1,155,935	3,298,637	7,646,882
Ethylbenzene		0	10	9	112	81	0	1,228	3,195	6,016	10,650
Acetaldehyde		0	612	46	412	2,472	9,744	4,890	3,336	1,025	22,537
Acrolein			3,957	47	308	2,114	1,065	361	920	110	8,881
Formaldehyde		0	414	600	1,565	12,471	17,987	4,856	1,550	374	39,818
Tetrachloroethylene				2	24	18	0	255	246	5,317	5,861
1,4-Dichlorobenzene				0	1	1	0	37	17	1,115	1,170
1,3-Butadiene			170	2	4	198	2,778	673	58	1	3,883
Chromium Compounds	15	35	0	4	209	39	3	201	1	12	520
Lead		0	1	7	59	48	5	248	12	5	386
Arsenic	0	0	0	2	65	18	2	32	0	1	121

Footnote:
Selected HAPs are those indicated by NATA 2005 as nationally significant risk drivers
FC = Fuel combustion
Zero values = values that round to zero
Data source = NEI 2008 v2, includes federal waters, PR, and VI; excludes Tribal

2008 CAP and HAP Emissions (tons) for Mobile Sources

Pollutant	Onroad Vehicles	Nonroad Equip	Aircraft	CMV	Railroad	Total Mobile
NH_3	138,684	2,988		690	362	142,724
CO	36,049,690	17,343,721	457,600	204,107	119,936	54,175,053
NO_X	7,134,479	1,987,146	121,106	1,565,705	845,682	11,654,118
PM_{10}	375,527	190,169	10,138	98,557	27,567	701,958
$PM_{2.5}$	295,373	179,886	4,222	91,798	25,432	596,711
SO_2	117,639	34,718	12,638	606,629	10,786	782,411
VOC	3,055,362	2,491,936	35,441	46,554	44,188	5,673,481
Ethylbenzene	53,887.7	30,132.1	77.6	22.8	88.3	84,208
Acetaldehyde	31,817	15,158	1,140	839	743	49,697
Acrolein	3,107	1,347	382	39	122	4,998
Formaldehyde	49,509	32,902	3,320	1,729	1,731	89,191
1,3-Butadiene	13,184	7,549	475	0	125	21,333

Table 12: HAP/CAP Emission Totals (in Tons) for Stationary and Mobile Sources (continued)

2008 CAP and HAP Emissions (tons) for Mobile Sources						
Pollutant	Onroad Vehicles	Nonroad Equip	Aircraft	CMV	Railroad	Total Mobile
Chromium Compounds	15	1	0	17	0	33
Lead		0	571	5	2	578
Arsenic	7	7	0	15	0	28

Footnote:
Selected HAPs are those indicated by NATA 2005 as nationally significant risk drivers
Zero values = values that round to zero
Data source = NEI 2008 v2, includes federal waters, PR, and VI; excludes Tribal

from an emissions perspective. This is done using the tile chart in Figure 36 in which the rows list the sectors and the columns list the CAPs and select HAPs from the previous charts and tables. The top pollutant/sector combinations are indicated using emission thresholds as a color benchmark. Figure 36 presents a convenient way to quickly gauge the multi-pollutant significance of a given sector, with additional information to indicate the importance of a pollutant/sector to the national emissions total for a given pollutant.

There are two distinct pieces of information in Figure 36. First, the colors of the cells represent the percent contribution (based on emissions) within each of the stationary and mobile source groups, with red cells representing contributions greater than or equal to 70 percent; and second, the numbers shown in some of the cells indicate the pollutant/sector contribution that is also greater than or equal to 15 percent of the total 2008 NEI emissions for that pollutant. As an example, the first cell in Figure 36 for agriculture/NH_3 emissions: the red color indicates the contribution to total stationary source ammonia emissions is 70 percent or greater; in addition, the number "90 percent" in the cell indicates that agricultural NH_3 emissions constitute greater than 15 percent (in this case, 90 percent) of the total NH_3 emissions in the 2008 NEI. Grey cells indicate pollutants which are not emitted for the noted sector. For example, lead emissions are not present in any of the on-road mobile source categories.

Noteworthy observations from Figure 36 include the fact that:

- The dust sectors (from paved and upaved roads and construction) have only PM emissions and the amount of the total PM emissions contributed from this source type is significant.
- Agriculture is important for NH_3 and PM emissions.
- The fuel combustion categories generally contribute large amounts of HAPs and CAPs, with biomass and coal combustion standing out for 1,3-butadiene and SO_2 emissions, respectively, within the stationary source categories.
- Industrial processes also emit large amounts of many of the HAPs and CAPs listed; they also make major contributions to the national total for some of the metal HAPs and for VOC.
- The solvent sector has major emissions for several HAPs, including tetrachloroethylene and 1,4-dichlorobenzene, as well as for total VOCs.
- On-road gasoline vehicles are major emitters of several CAPs and HAPs. NH_3 emissions from on-road gasoline sources are significant within the mobile source sector.
- Piston-engine aircraft is the only significant source of lead among all mobile sources. CMV has a significant amount of SO_2 emissions.

3.5.3 Example Sectors that emit multiple HAPs/CAPs: Industrial Processes and Fuel Combustion—Biomass

Figure 36 provides a convenient way to understand the multi-pollutant significance of a given sector, and what pollutants/sectorsare significant relative to the national emissions total for all sources.

Four sectors are chosen from Figure 36 to illustrate how "digging deeper" into the sector and source classifications can lead to more information about

which individual sources cause a sector to stand out in terms of its multipollutant characteristics.

The industrial processes sector under stationary sources shows all pollutants listed in Figure 36 with emission contributions and also indicates that some of the metal HAP emissions are important at a national level. For this reason, we took a closer look at the contributing sources to this sector. The results are shown in Table 13. In this table the industrial processes sector is further revealed by its more detailed sectors (the columns in Table 13) and the emission contributions from each to the sector total. Pollutant emissions for the individual source types are reported as a percentage of the total emissions for the industrial processes sector as a whole.

Six sectors stand out for contributing more than 25 percent of the total industrial processes emissions (highlighted in gold in Table 13) for four or more pollutants: storage and transfer; pulp and paper; non-ferrous metals; industrial NEC (not elsewhere classified); ferrous metals; and chemical manufacturing. Pulp and paper (top 25 percent for five HAPs) and industrial NEC (top 25 percent for several HAPs and $PM_{2.5}$ and NH_3) have greater than 25 percent contribution for five or more pollutants. The industrial NEC is an important source type within industrial processes at the national level for multiple pollutant emission releases and includes various manufacturing processes related to food and agriculture, food and kindred products and mineral products.

Fuel combustion-biomass is the next aggregated sector reviewed in more detail from Figure 36. Figure 36 indicates emission contributions for all criteria pollutants and national risk-driver HAPs, and many with large contributions to the stationary source national pollutant totals. For example, 1,3-butadiene, has greater than a 70 percent contribution to that pollutant total for all stationary sources. Table 14 expands the list of the related sources for this biomass sector that lead to the overall characterization shown in Figure 36. Table 14 indicates that within this sector, at the national level, residential wood combustion is the dominant contributor of CAP and HAP emissions.

Industrial boilers that combust biomass as fuel are also important contributors nationally, especially for many of the metal HAPs as well as for hydrochloric acid, NO_x and SO_2.

Fuel combustion-coal is also seen to be an important sector nationally (Figure 36). Table 15 further breaks out coal-based fuel combustion by the sub-categories that make up the sector. Electric generation is the dominant contributor to this sector for nearly all CAPs and HAPs examined.

In Figure 36, the agriculture sector stands out for PM and NH_3 emissions. In looking further at the contributions to the agriculture sector in Table 16, crop and livestock dust stand out for PM_{10} and $PM_{2.5}$ emissions, while fertilizer application and livestock waste contribute significantly to NH_3 emissions. Livestock waste also contributes all of the VOC emissions in the agriculture sector. The chromium emissions were reported by California for crops and livestock dust.

3.6 Mercury Emissions in the 2008 NEI

Mercury (Hg) has not been included in any of the previous review and analysis. The primary reason is that the sectors used to categorize mercury are different than the sectors presented for the other pollutants. Primary focus for the mercury sectors is on regulatory categories and categories of interest to the international community. The following charts summarize the Hg emissions using these sectors which keeps the traditional categorization used in past mercury summaries. Emission differences between 2005 and 2008 are shown by sector and grouped by degree of emission magnitude: high (red Figure 37); medium (blue Figure 38); and low (green Figure 39). Note the difference in scales in each of the charts presented. Table 17 summarizes all of the emission amounts from the charts and leaves the color coding to emphasize the high, medium and low emission magnitudes. Some of the highlights from this information include:

- National emissions for 2008 are 42 percent less than in 2005.
- For 2008, the sum total of 61 tons is comprised of 59 tons from stationary sources and 2 tons from

2008 CAP and Select HAP Emission Tons Distribution Within Stationary and Mobile Sources

Percent Contributions ≥ to 15% of the National Pollutant Sum Total (stationary + mobile) Are Also Indicated

Stationary Sources	NH3	CO	NOX	PM10	PM25	SO2	VOC	Ethylbenzene	Acetaldehyde	Acrolein	Formaldehyde	Tetrachloroethylene	1,4-Dichlorobenzene	1,3-Butadiene	Chromium	Lead	Arsenic
Agriculture	90%			24%	21%												
DustConstrc																	
DustPavedUnPaved				49%	25%												
Fire-Ag Field Burning										29%							
FC-Biomass																	
FC-Coal						78%								42%		52%	
FC-Ngas																	
FC-Oil			Stationary														
FC-Other																	
Industrial Proc							19%							36%	26%	22%	
MiscBulkGas																	
MiscCommCook																	
MiscGasStations																	
MiscNon-IndustNEC																	
MiscWasteDisp																	
SolvCommIndust												83%	17%				
SolvConsumerComm													79%				
Mobile Sources																	
Aircraft																59%	
CMV																	
Railroad																	
MobNR-Diesel											16%						
MobNR-Gas		25%					17%	31%						29%			
MobNR-Other																	
MobOR-DieselHD			19%								17%						
MobOR-DieselLD																	
MobOR-GasHD																	
MobOR-GasLD		52%	19%				20%	53%	28%		20%			46%			

Footnote:

Selected HAPs are those indicated by NATA 2005 as nationally significant risk drivers.

Sector percent emission contribution is calculated as portion of the pollutant total for each sector group - Stationary and Mobile.

Emission thresholds = ≥ 70% | 50%-69% | 21- 49% | 0-20% | no emiss

Percent contribution greater than or equal ≥ 15% the national pollutant sum is based on the sum of stationary and mobile.

FC = fuel combustion; CMV = commerical marine vessel

Data source = NEI 2008 v2, includes federal waters, PR, and VI; excludes Tribal; excludes sectors - wilfires and biogenics.

Figure 36: Percent Emission Contribution by Source for CAPs and Select HAPs in 2008 NEI

mobile sources. In 2005 the sum total of 105 tons is comprised of 1.2 tons from mobile sources and the remaining 103.8 tons from stationary sources.

- Stationary source emissions for 2008 consist of 29.5 tons from coal-fired EGUs with units larger than 25 megawatts (MW).

Table 13: A Detailed Look at the Industrial Processes Source Category: CAPs and HAPs

Industrial Processes - Distribution of Source Type Emissions Emissions Contributions ≥ to 25 percent of Industrial Processes Total are Highlighted											
Industrial Process Sources											
Pollutant	**Cement Manuf**	**Chemical Manuf**	**Ferrous Metals**	**Mining**	**Industrial NEC**	**Non-ferrous Metals**	**Oil & Gas Production**	**Petroleum Refineries**	**Pulp & Paper**	**Storage & Transfer**	**% Total Sum**
NH_3	1.0 %	22.2 %	0.7 %	0.0 %	58.8 %	1.1 %	0.0 %	3.5 %	6.9 %	5.7 %	100 %
CO	5.5 %	11.1 %	25.4 %	1.6 %	14.1 %	17.9 %	11.8 %	4.6 %	7.2 %	0.9 %	100 %
NOX	16.6 %	6.8 %	5.6 %	0.5 %	17.6 %	1.5 %	35.9 %	8.2 %	6.6 %	0.6 %	100 %
PM10	2.0 %	2.5 %	3.7 %	62.5 %	15.6 %	2.1 %	0.9 %	2.2 %	4.1 %	4.4 %	100 %
$PM_{2.5}$	3.2 %	5.6 %	8.6 %	25.7 %	29.1 %	4.9 %	1.7 %	5.7 %	9.8 %	5.6 %	100 %
SO_2	12.1 %	22.3 %	3.7 %	0.4 %	18.0 %	15.0 %	7.0 %	16.3 %	4.5 %	0.6 %	100 %
VOC	0.4 %	4.0 %	0.8 %	0.1 %	8.7 %	0.7 %	67.9 %	2.7 %	5.2 %	9.6 %	100 %
Hydrochloric Acid	18.7 %	5.7 %	4.4 %	4.5 %	18.3 %	30.2 %	0.0 %	3.1 %	14.0 %	1.0 %	100 %
Chlorine	2.1 %	47.1 %	7.3 %	0.0 %	13.2 %	11.7 %	0.0 %	7.1 %	4.3 %	7.2 %	100 %
Benzene	7.4 %	10.0 %	5.3 %	0.0 %	11.1 %	0.7 %	22.9 %	12.1 %	2.0 %	28.4 %	100 %
Ethylbenzene	0.9 %	16.2 %	0.4 %	0.0 %	22.8 %	1.0 %	8.1 %	15.7 %	2.3 %	32.5 %	100 %
Naphthalene	9.2 %	6.1 %	10.5 %	0.0 %	18.6 %	1.2 %	0.3 %	26.0 %	13.2 %	14.9 %	100 %
Xylenes	0.9 %	16.1 %	0.7 %	0.0 %	26.4 %	0.6 %	11.3 %	13.0 %	3.8 %	27.3 %	100 %
Acetaldehyde	0.3 %	12.6 %	0.1 %	0.0 %	24.2 %	0.1 %	0.2 %	0.2 %	60.8 %	1.5 %	100 %
Acrolein	0.1 %	3.8 %	0.7 %	0.0 %	15.7 %	0.3 %	1.3 %	0.6 %	76.7 %	0.9 %	100 %
Formaldehyde	2.5 %	4.5 %	0.8 %	0.0 %	25.9 %	0.3 %	12.2 %	6.0 %	45.6 %	2.2 %	100 %
Cyanide Compounds	0.3 %	47.2 %	1.1 %	2.2 %	28.3 %	9.2 %	0.0 %	8.7 %	0.1 %	2.9 %	100 %
Tetrachloroethylene	0.0 %	13.8 %	0.0 %	0.0 %	29.8 %	17.1 %	0.2 %	4.9 %	25.2 %	9.0 %	100 %
Methyl Chloride	0.4 %	55.1 %	0.0 %	0.0 %	8.4 %	0.8 %	0.0 %	0.3 %	34.6 %	0.3 %	100 %
1,4-Dichlorobenzene	1.1 %	20.7 %	0.0 %	0.0 %	4.1 %	0.0 %	9.4 %	0.2 %	0.2 %	64.3 %	100 %
1,3-Butadiene	4.6 %	73.8 %	0.0 %	0.0 %	6.2 %	1.8 %	1.0 %	4.4 %	0.0 %	8.2 %	100 %
Polycyclic Organic Matter	0.8 %	2.5 %	1.5 %	0.0 %	43.7 %	36.4 %	0.0 %	4.5 %	6.4 %	4.3 %	100 %
Manganese	1.9 %	1.2 %	51.0 %	2.1 %	30.2 %	6.2 %	0.0 %	0.4 %	2.9 %	4.2 %	100 %
Chromium Compounds	1.6 %	2.7 %	44.2 %	0.2 %	39.9 %	7.7 %	0.0 %	1.0 %	1.1 %	1.5 %	100 %
Lead	3.3 %	4.8 %	31.8 %	1.0 %	16.3 %	34.7 %	0.0 %	2.1 %	2.1 %	3.8 %	100 %
Arsenic	2.0 %	1.6 %	19.2 %	1.7 %	37.7 %	29.2 %	0.1 %	1.9 %	1.9 %	4.5 %	100 %

Footnote:
Select HAPs of both national and regional scope are shown.
NEC source category = Not Elsewhere Classified
NEC is attributed to Food & Agriculture, Kindred Products; Mineral Products, i.e., glass, lime; clay asphalt; and Industrial Products NEC.

Table 14: A Detailed Look at the Fuel Combustion--Biomass Source Category: CAPs and HAPs

Fuel Combustion Biomass - Distribution of Sector Emissions

Emissions Contributions ≥ to 25% of FC Biomass Total are Highlighted

Pollutant	Fuel Combustion Biomass Sources				% Total Sum
	Commercial / Institutional	Electric Generation	Industrial Boilers, ICEs *	Residential Wood	
NH_3	0.9%	6.3%	7.2%	85.5%	100%
CO	0.7%	0.8%	7.4%	91.2%	100%
NO_x	4.2%	8.0%	60.9%	26.9%	100%
PM_{10}	0.8%	0.5%	9.9%	88.8%	100%
$PM_{2.5}$	0.7%	0.4%	8.4%	90.5%	100%
SO_2	4.3%	7.0%	63.2%	25.6%	100%
VOC	0.2%	0.3%	2.3%	97.2%	100%
Hydrochloric Acid	3.6%	19.6%	76.8%	0.0%	100%
Chlorine	1.1%	7.3%	20.9%	70.7%	100%
Benzene	1.4%	0.9%	6.3%	91.5%	100%
Ethylbenzene	30.1%	14.8%	55.1%	0.0%	100%
Naphthalene	1.1%	0.3%	5.0%	93.5%	100%
Xylenes	3.0%	0.1%	9.4%	87.5%	100%
Acetaldehyde	0.1%	0.4%	2.1%	97.5%	100%
Acrolein	1.8%	8.2%	24.3%	65.7%	100%
Formaldehyde	0.2%	0.8%	3.2%	95.8%	100%
Cyanide Compounds	2.4%	2.2%	95.3%	0.0%	100%
Tetrachloroethylene	6.1%	14.5%	79.4%	0.0%	100%
Methyl Chloride	4.1%	12.0%	83.8%	0.0%	100%
1,4-Dichlorobenzene	0.0%	22.9%	77.1%	0.0%	100%
1,3-Butadiene	0.0%	0.0%	0.0%	100.0%	100%
Polycyclic Organic Matter	1.6%	0.5%	7.9%	90.0%	100%
Manganese	7.2%	17.8%	74.1%	0.9%	100%
Chromium Compounds	3.3%	8.6%	88.1%	0.0%	100%
Lead	3.3%	10.7%	83.4%	2.6%	100%
Arsenic	6.7%	21.9%	66.6%	4.8%	100%

Footnote:
Select HAPs of both national and regional scope are shown.
* ICEs = internal and external combustion

Table 15: A Detailed Look at the Fuel Combustion--Coal Source Category: CAPs and HAPs

Fuel Combustion Biomass - Distribution of Sector Emissions

Emissions Contributions ≥ to 25% of FC Biomass Total are Highlighted

Pollutant	Fuel Combustion Biomass Sources				% Total Sum
	Commercial / Institutional	Electric Generation	Industrial Boilers, ICEs *	Residential Wood	
NH_3	0.9%	6.3%	7.2%	85.5%	100%
CO	0.7%	0.8%	7.4%	91.2%	100%
NO_x	4.2%	8.0%	60.9%	26.9%	100%
PM_{10}	0.8%	0.5%	9.9%	88.8%	100%
$PM_{2.5}$	0.7%	0.4%	8.4%	90.5%	100%
SO_2	4.3%	7.0%	63.2%	25.6%	100%
VOC	0.2%	0.3%	2.3%	97.2%	100%
Hydrochloric Acid	3.6%	19.6%	76.8%	0.0%	100%
Chlorine	1.1%	7.3%	20.9%	70.7%	100%
Benzene	1.4%	0.9%	6.3%	91.5%	100%
Ethylbenzene	30.1%	14.8%	55.1%	0.0%	100%
Naphthalene	1.1%	0.3%	5.0%	93.5%	100%
Xylenes	3.0%	0.1%	9.4%	87.5%	100%
Acetaldehyde	0.1%	0.4%	2.1%	97.5%	100%
Acrolein	1.8%	8.2%	24.3%	65.7%	100%
Formaldehyde	0.2%	0.8%	3.2%	95.8%	100%
Cyanide Compounds	2.4%	2.2%	95.3%	0.0%	100%
Tetrachloroethylene	6.1%	14.5%	79.4%	0.0%	100%
Methyl Chloride	4.1%	12.0%	83.8%	0.0%	100%
1,4-Dichlorobenzene	0.0%	22.9%	77.1%	0.0%	100%
1,3-Butadiene	0.0%	0.0%	0.0%	100.0%	100%
Polycyclic Organic Matter	1.6%	0.5%	7.9%	90.0%	100%
Manganese	7.2%	17.8%	74.1%	0.9%	100%
Chromium Compounds	3.3%	8.6%	88.1%	0.0%	100%
Lead	3.3%	10.7%	83.4%	2.6%	100%
Arsenic	6.7%	21.9%	66.6%	4.8%	100%

Footnote:
Select HAPs of both national and regional scope are shown.
* ICEs = internal and external combustion

Table 16: A Detailed Look at the Agriculture Source Category: CAPs and HAPs

Agriculture - Distribution of Source Type Emissions Emissions Contributions ≥ to 25% of Agriculture Total are Highlighted				
	Agriculture Sources			
Pollutant	Crops & Livestock Dust	Fertilizer Application	Livestock Waste	% Total Sum
NH_3	0.0%	32.7%	67.3%	100%
PM_{10}	99.5%	0.0%	0.5%	100%
$PM_{2.5}$	99.2%	0.0%	0.8%	100%
VOC	0.0%	0.0%	100%	100%
Chromium Compounds	100%	0.0%	0.0%	100%
Footnote Select HAPs of both national and regional scope are shown. Chromium emissions for Crops & Livestock Dust is approx 15 tons.				

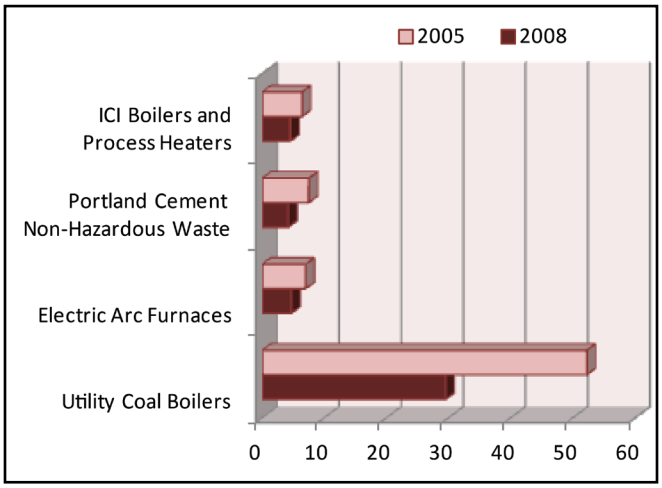


Figure 37: High Emitting Hg Sectors

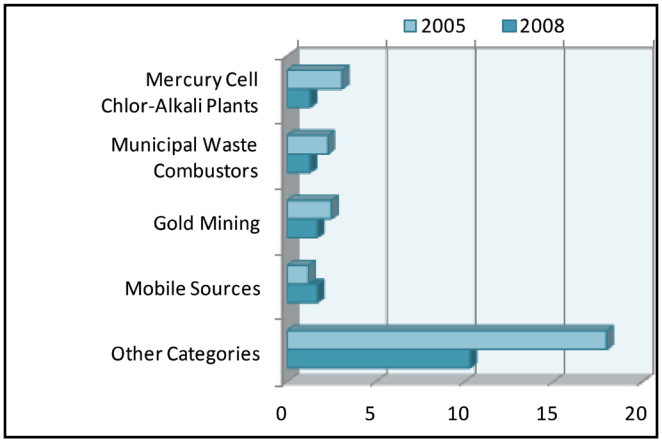


Figure 38: Medium-High Emitting Hg Sectors

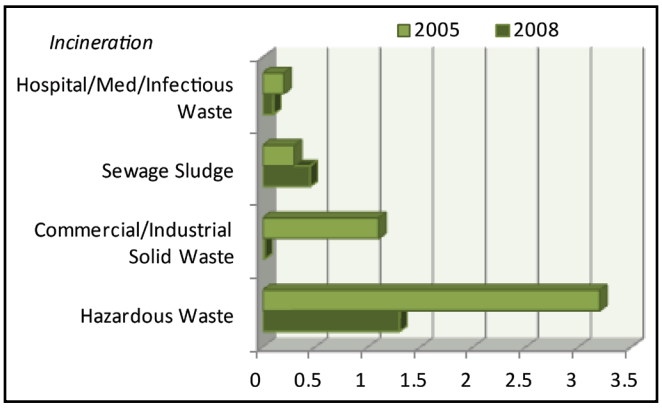


Figure 39: Low Emitting Hg Sectors

Table 17: Summary of 2005 and 2008 Hg Emissions in the NEI

	Year	
Sector	**2005**	**2008**
Utility Coal Boilers	52.2	29.5
Electric Arc Furnaces	7	4.7
"Portland Cement Non-Hazardous Waste"	7.5	4.2
Industrial Commercial Insitutional Boilers and Process Heaters	6.4	4.5
Chlor-Alkali Plants	3.1	1.3
Municipal Waste Combustors	2.3	1.3
Gold Mining	2.5	1.7
Mobile Sources	1.2	1.7
Other Categories	18	10.3
Hazardous Waste	3.2	1.3
Commercial/Industrial Solid Waste	1.1	0.02
Sewage Sludge	0.3	0.45
Hospital/Med/Infectious Waste	0.2	0.1
Total (all categories)	**105**	**61**

Source: 2008 NEI v2 Technical Support Document [ref 2]

4. Regional Emissions Information

All of the previous review and analyses have characterized emissions at the national level. In this section, we provide a regional emissions profile of NEI CAPs and select HAPs. The HAPs included here are those important at both the national and regional level as indicated in Table 2. We start by providing an overview of the choice of regions, and then analyze emissions based on these regions and present summary results. As before, all these analyses do not contain emissions from wildland fires and biogenic sources.

4.1 National Climatic Data Center (NCDC) Regions

The regions used for this review are shown in Figure 40 below and are based on the climatological map developed and maintained by NOAA (National Oceanic and Atmospheric Administration). This map splits the U.S. into 9 regions based on homogeneity in meteorological conditions as determined by data analysis conducted by NOAA [ref 19]. These are the national climatic data center regions and are regularly used in climate-based analyses and summaries. These NCDC regions will be used in this report to aggregate and display regional emission patterns.

Readers may also be interested in how these NCDC regions relate to the more traditional EPA regions that are often used. Figure 41 shows this relationship by including a white border to identify these EPA regions. Since there are nine NCDC regions and ten EPA regions, some of the NCDC regions overlap multiple EPA regions.

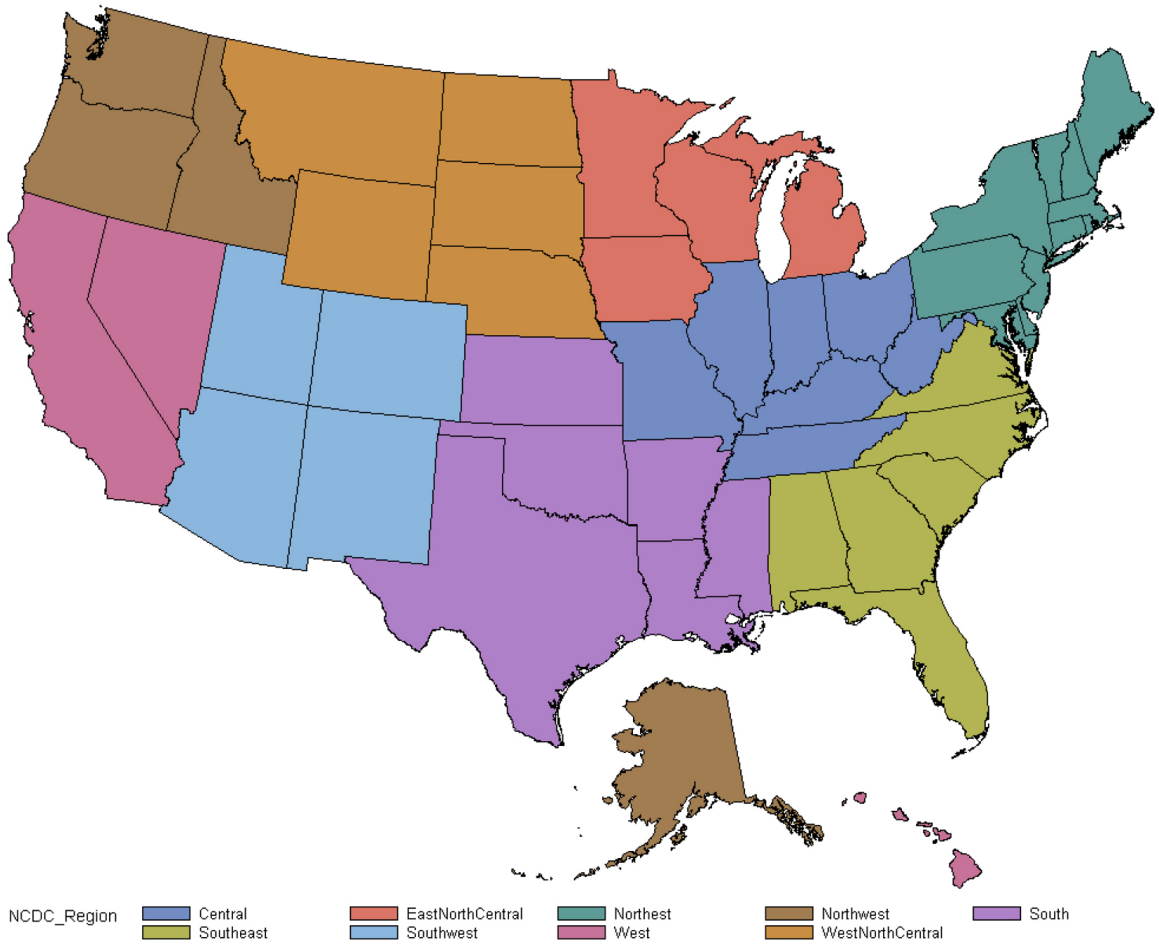


Figure 40: NCDC Regions in the U.S.

4.2 Regional CAP and HAP Emissions Characterization

Figure 42 shows total CAP emissions as a stacked bar for each NCDC region. The select HAPs are grouped, and group totals are shown in Figure 43 for each NCDC region. The HAPs are grouped based on the attributes noted in Table 2 for ozone and PM-forming potential, as well as chemical similarities (metals, aromatics, carbonyls, etc.) The following observations are based on the regional patterns of CAP emissions shown in Figure 42:

- The Central, South and Southeast regions have the highest total CAP emissions. These regions also contain some of the most populated areas in the U.S. In the Central region, SO_2 emissions are the second highest contributor (after CO) to total CAP emissions; in the South region, PM_{10} is the second highest contributor; while in the Southeast region, NO_x, VOC, SO_2 and PM_{10} are emitted in about equal amounts after CO.
- The Northwest, West North Central, West and Southwest regions have the smallest amounts of total CAP emissions. While the West has a smaller amount of total CAP emissions, there are areas of high emissions within the region (such as the large cities in California).
- Except in the West North Central region, where PM_{10} (from paved/unpaved roads and construction dust) is the major contributor to total CAP emissions, CO emissions are the dominant contributor to total CAP emissions.
- Proportionally, the South region has more PM_{10} than all the other regions. Most of the PM_{10} comes from dust sources.

For the HAPs, Figures 43 to 45 present emission summaries by NCDC region for various HAP groups. The horizontal axis identifies each region similar to Figure 42 above. Each of the Figures 43 to 45 has two different vertical axes that reflect different scales for emission strength that correspond to the two different pollutant groups. Figure 43 shows emission sums for two groups of HAPs: Group 1 contains the pollutants xylenes, napthalenes, ethylbenzene and benzene;

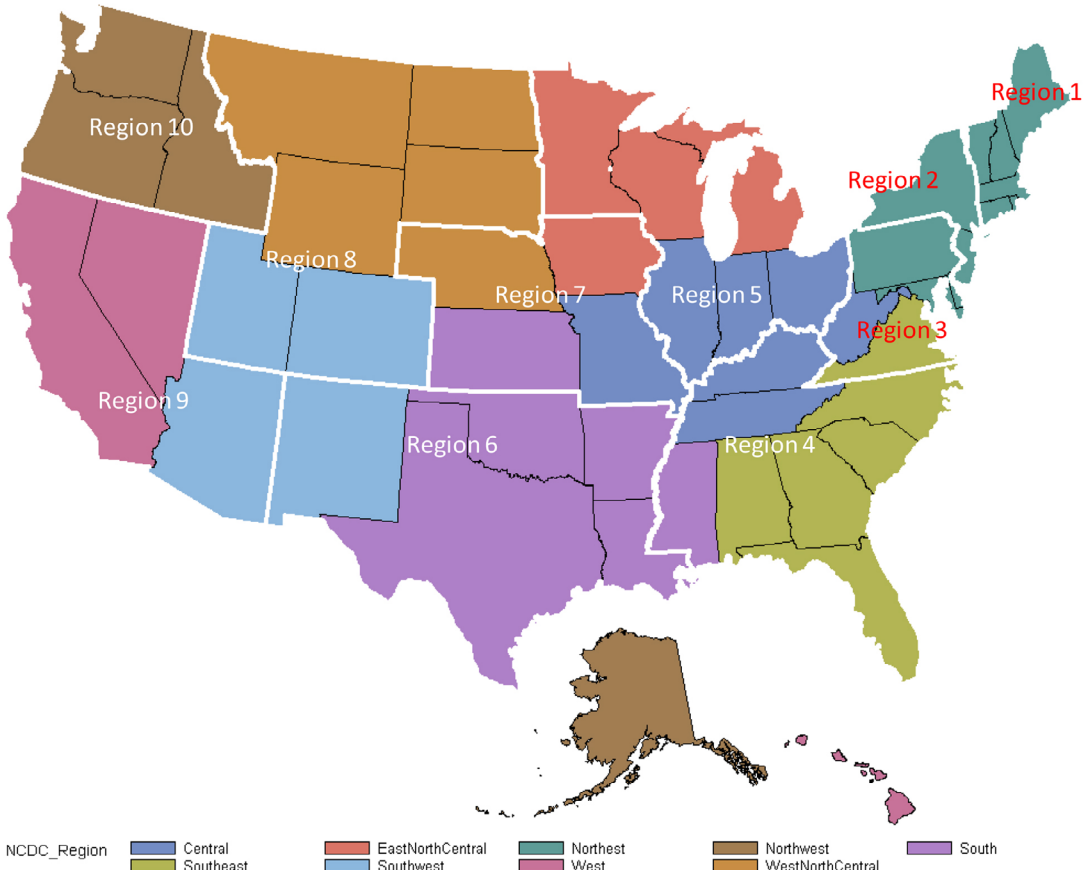


Figure 41: NCDC Regions and Their Relationship to EPA Regions

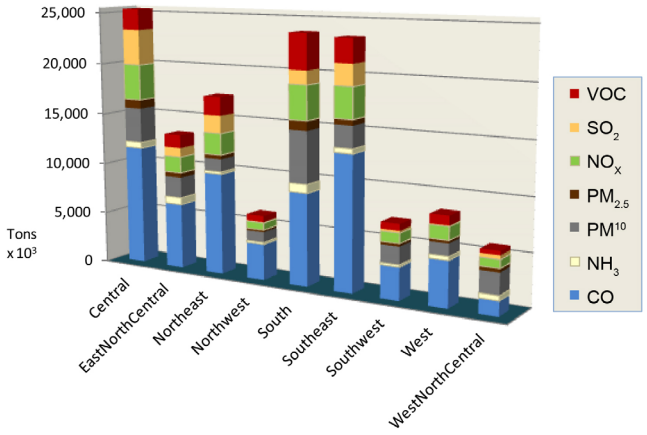


Figure 42: CAP Emissions by NCDC Regions, 2008 NEI

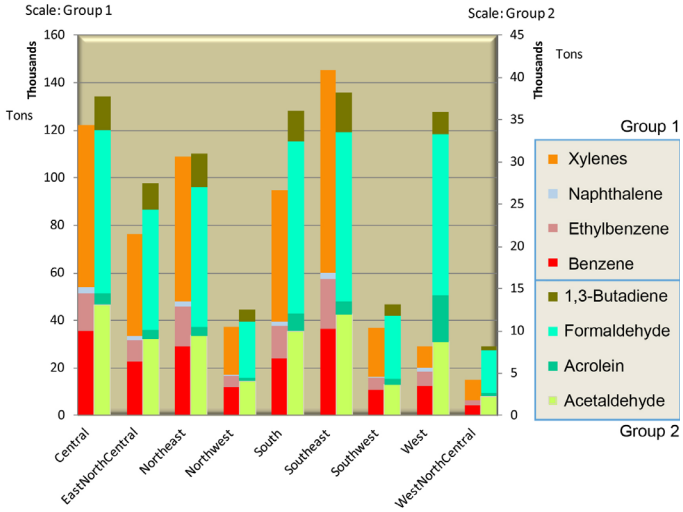


Figure 43: HAP Emissions by NCDC Regions, 2008 NEI

Group 2 is displayed on the right vertical axis and contains 1,3-butadiene, formaldehyde, acrolein and acetaldehyde. These HAPs are grouped due to their similar ozone and PM forming potential as well as a similarity in the chemical class they represent. Some interesting observations from Figure 43 include:

- Group 1 HAP emissions are highest in the Southeast region and lowest in the West North Central region. Several regions have high emissions of group 1 HAPs (South, Central, East North Central) and xylenes are emitted in the highest proportion.
- The Group 2 HAPs are highest in the Southeast and lowest in the West North Central region. Several regions (East North Central, Northeast, and South) are high emitters of group 2 HAPs. Formaldehyde and acetaldehyde are emitted in the highest proportion in all regions.
- The relative proportions of HAPs within Group 1 and Group 2 are relatively consistent amongst all regions.

Figure 44 also contains two HAP groups summed by NCDC region. Group 1 is chlorine and hydrochloric acid (HCl), and Group 2 consists of POM (polycyclic organic matter) compounds, methyl chloride, tetrachloroethylene, and 1,4-dichlorobenzene. Group 2 emission sums are indicated on the right vertical axis and by a different scale. Some highlights from Figure 44 include:

- Emissions from Group 1 compounds are highest in the Central and Southeast regions. In all regions except the West, the majority of emissions are from HCl. In the West region, there are about equal amounts of HCl and chlorine.

Emissions of the Group 2 HAPs vary widely amongst the regions, both in sum and relative proportions for individual HAPs. The highest emissions are in the West, and the least emissions are in the West North Central region. Tetrachloroethylene and POM are significant Group 2 HAPs emitted in nearly all regions. The amount of methyl chloride is also significant in the South.

Finally, Figure 45 shows regional emissions of HAP metals and cyanide compounds. Group 1 contains lead, arsenic, chromium and manganese compounds, while Group 2 contains cyanide compounds. Items worth noting from Figure 45 include:

- The splits among the Group 1 metals are fairly consistent region to region. The Group 1 metals sum is highest in the Central region. Six of nine regions show manganese to be the predominant HAP in Group 1.
- Cyanide is emitted in much higher amounts than any single Group 1 metal HAP and is highest in the Central, South and Southeast regions.
- The Northwest region has very low levels of both Group 1 HAPs and cyanide compounds.

4.3 Regional Intensity for Ozone and PM Formation, HAPs and CAPs

In the previous section, the relative distribution of

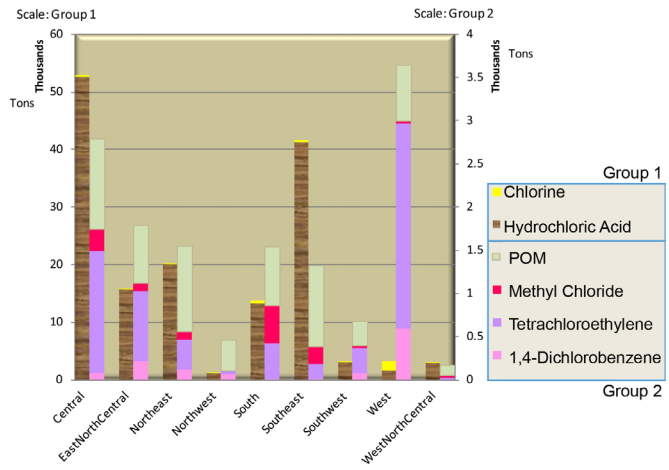


Figure 44: HAP Emissions by NCDC Regions, 2008 NEI

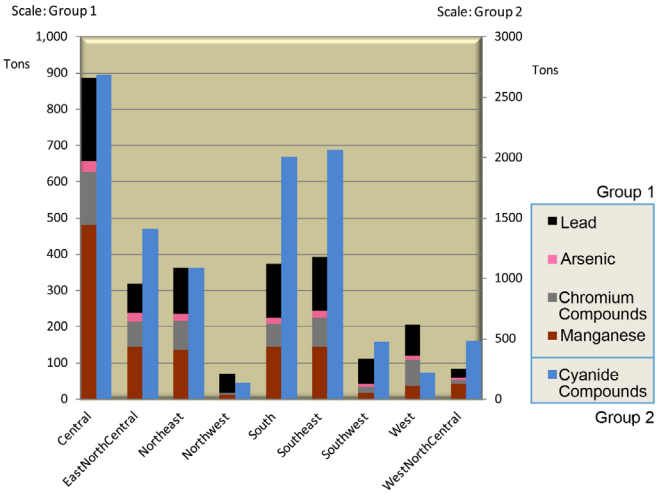


Figure 45: HAP Emissions by NCDC Regions, 2008 NEI

CAPs and HAPs are shown by NCDC region. Another way to view emissions by NCDC region is based on the intensity of the multiple pollutants that form both ozone and PM. This is done in Figure 46. Each climate region has similar meteorological patterns that help determine how the chemicals will interact to form ozone and fine particles ($PM_{2.5}$) and/or transform to other toxic species. For each region, there are two bars, or "sparc" lines: the top one shows the sum total of CAP emissions (excluding CO and PM_{10}) and the lower one shows the sum of the select HAP emissions. The HAPs selected are those in Table 2 indicated to have a high potential to end up as secondarily formed aerosol (SOA) which can facilitate formation of $PM_{2.5}$, and those also with limited or high ozone forming potential based on high VOC reactivity.

The scales are the same for CAPs and HAPs across the regions: 10 million tons for CAPs and 200,000 tons for HAPs. The legend describes the specific CAPs and HAPs that are summed in the color bars. For the top CAP bar, the two different colors separate those CAPs that contribute to ozone and PM formation versus just PM formation. Similarly, for the bottom HAP bar, the two colors describe the sum of the select HAPs by their propensity to form either ozone and PM or just ozone. Figure 46, therefore, presents a convenient way to compare region-by-region emissions loading that influences ozone and PM formation. Some interesting highlights from Figure 46 include:

- CAP emissions that form ozone and PM are highest in the Central, South and Southeast parts of the country. CAP emissions that contribute solely to PM are most prevalent in the Central region.
- HAP emissions that contribute to PM and ozone are high in many Eastern regions, and HAP emissions that contribute solely to ozone formation are highest in the Central and Southeast regions.
- Most of the Western regions have comparatively lower amounts of emissions (HAP and CAP) that participate in ozone and PM formation. The number of populated centers in the West are fewer than in the East and emissions densities are accordingly lower there for most pollutants (see Figure 9-16). This does not mean, however, that specific local areas do not experience ozone or PM problems in the West. This is discussed further in the "local profiles" section.
- The regional patterns shown in Figure 46 correspond directly to some of the patterns of regional emissions shown in the previous section. In translating from areas of high emissions to air quality, other factors such as those reviewed in the earlier background discussion (climate, topography, etc.) also play a role in determining air quality and need to be considered along with emissions when describing the entire air quality picture for a region/locale.

4.4 Regional CAP/HAP Emissions, Top Sector Contributions

This section reviews the top sector contributions of HAP/CAP emissions, region by region. The regional tile chart in Figure 47 has a similar format as the

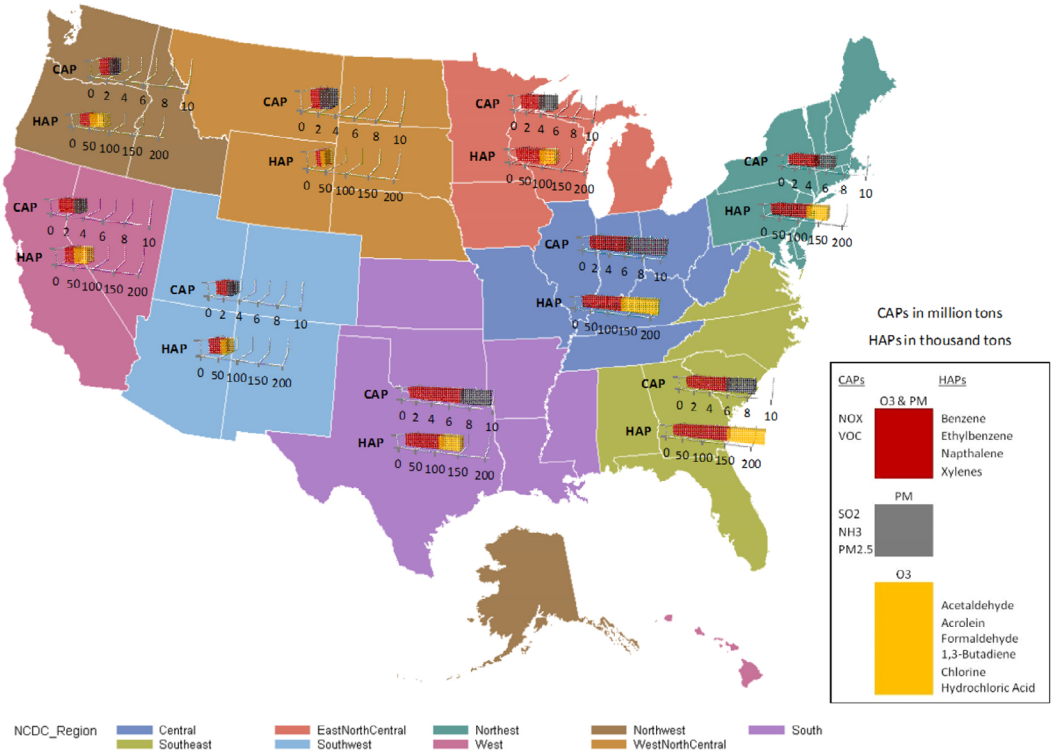


Figure 46: Regional CAP/HAP Intensities to Form Ozone and PM

national tile chart shown in Figure 36, with one key difference. Here, the investigation of emissions by region is based on the sectors that rank in the top 25 percent of pollutant emissions (rather than based on specific emission thresholds). This reveals the top emitters for individual pollutants and multiple pollutants even if the emissions contribution for a pollutant varies widely among the top emitters. Figure 47 shows the higher emitting sectors that the majority of regions have in common, identified by the red color. For instance, for stationary source NH_3, the agriculture sector ranks in the top 25 percent of NH_3 emissions for all nine regions – and is therefore identified in red. While agriculture contributes most of the NH_3 emissions for all regions, NH_3 from industrial processes is also in the top ranked 25 percent of stationary source NH_3 emissions for many regions. Sources of NH_3 within industrial processes include manufacturing of food, agriculture and kindred products, and mineral products such as glass, lime, clay and asphalt. Looking at the top ranked emitting sectors reveals the top emitters for individual pollutants even if the emissions contribution for a pollutant varies widely among the top emitters. The range of emissions among the top emitters may be small for some pollutants and sectors. For example, mobile on-road light duty gas vehicles highlight manganese, chromium and arsenic - for which the ranges of emissions for an individual region are between 3 and less than 0.5 tons. So even though these pollutant emissions are low in magnitude relative to stationary sources, they are a significant contribution when considered among only the mobile source sectors. The mobile source inventory for these metals is also based on very limited data and is highly uncertain. Some other interesting observations based on Figure 47 include:

- The majority of regions, i.e., equal to or greater than six, as shown by dark and light red colors, have the same pollutants that rank in the top 25 percent for stationary sources and for mobile sources as follows:

Stationary sources -

- NH_3 - agricultural; industrial processes
- CO - fuel combustion biomass; industrial processes; waste disposal
- NO_x - fuel combustion coal and natural gas
- PM_{10}, $PM_{2.5}$ - agriculture; road and construction dust

- SO_2 - fuel combustion coal; industrial processes
- VOC - solvent uses
- Lead - fuel combustion coal; industrial processes
- HAPs - fuel combustion biomass, coal, and natural gas; industrial processes; gas stations; waste disposal; solvent uses

Mobile sources -

- NH_3 - on-road light duty gasoline vehicles
- CO and VOC - nonroad gasoline equipment; on-road vehicle light duty gas
- NO_x - on-road heavy duty diesel and light duty gasoline vehicles
- PM_{10}, $PM_{2.5}$ - on-road heavy duty diesel and light duty gasoline vehicles; nonroad diesel equipment
- SO_2 - commercial marine vessels; on-road heavy duty diesel vehicles
- Lead - piston-engine aircraft
- HAPs - nonroad gasoline equipment; on-road heavy duty diesel and light duty gasoline vehicles

In general, the sectors that show low contributions across all regions (bulk gas, commercial cooking, etc.) may be important for some pollutants at a local level. Tables 18 and 19 describe the proportion of pollutant emissions contributed by each region to the national pollutant total for all stationary sources and for all mobile sources. The higher percent (10 percent or more) contributions for each pollutant and sector are highlighted within the stationary and mobile source tables. The regional observations from the data shown in Tables 18 and 19 include:

For stationary sources, Table 18 indicates that:

- The Central region has large percent contributions for the most pollutants-sector combinations.
- The larger portions of NH_3 are in the South, East North Central, and Central regions and come from the agriculture sectors.
- Road dust PM_{10} is predominant in the South.
- The Central, East North Central, and Northeast regions have large contributions from fuel combustion biomass for several HAPs, and the West has a large proportion of 1,3-butadiene, and POM. This is attributed to more residential wood burning in those areas.
- The Central, Northeast and Southeast regions contribute large portions of NO_x, SO_2 and several HAPs coming from stationary coal combustion; the South has a large portion of cyanide, also from coal combustion.
- In the South, a large proportion of several HAPs comes from natural gas fuel combustion and industrial processes. VOC from industrial processes in the South is also a predominant contributor (24 percent), though this sector is not a large emitter in other regions.
- The Central, East North Central, Northeast and West regions have large portions of several HAPs emitted from solvent use. 1,4-dichlorobenzene from commercial/industrial solvent uses is also predominant (17 percent) in the West, though not a high emitter shared by a majority of the regions.

For Mobile Sources, Table 19 indicates that:

- The largest contributions of lead are in the South and Southeast regions from piston-engine aircraft.
- The Southeast has a large portion of xylenes from nonroad gasoline equipment and of POM from on-road heavy duty diesel vehicles.
- The Central and Southeast regions have some of the largest portions of NH_3, CO, VOC and HAPs, all from on-road light duty gasoline vehicles; and the West also has large portions of NH_3 and manganese from this sector.

Tables 18 and 19 show for each region the relative percent emission contribution to national pollutant totals by sector within stationary sources and mobile sources. Table 20 shows the regional contribution of the noted pollutant and sector to the national total emissions, i.e., stationary plus mobile, for that pollutant.

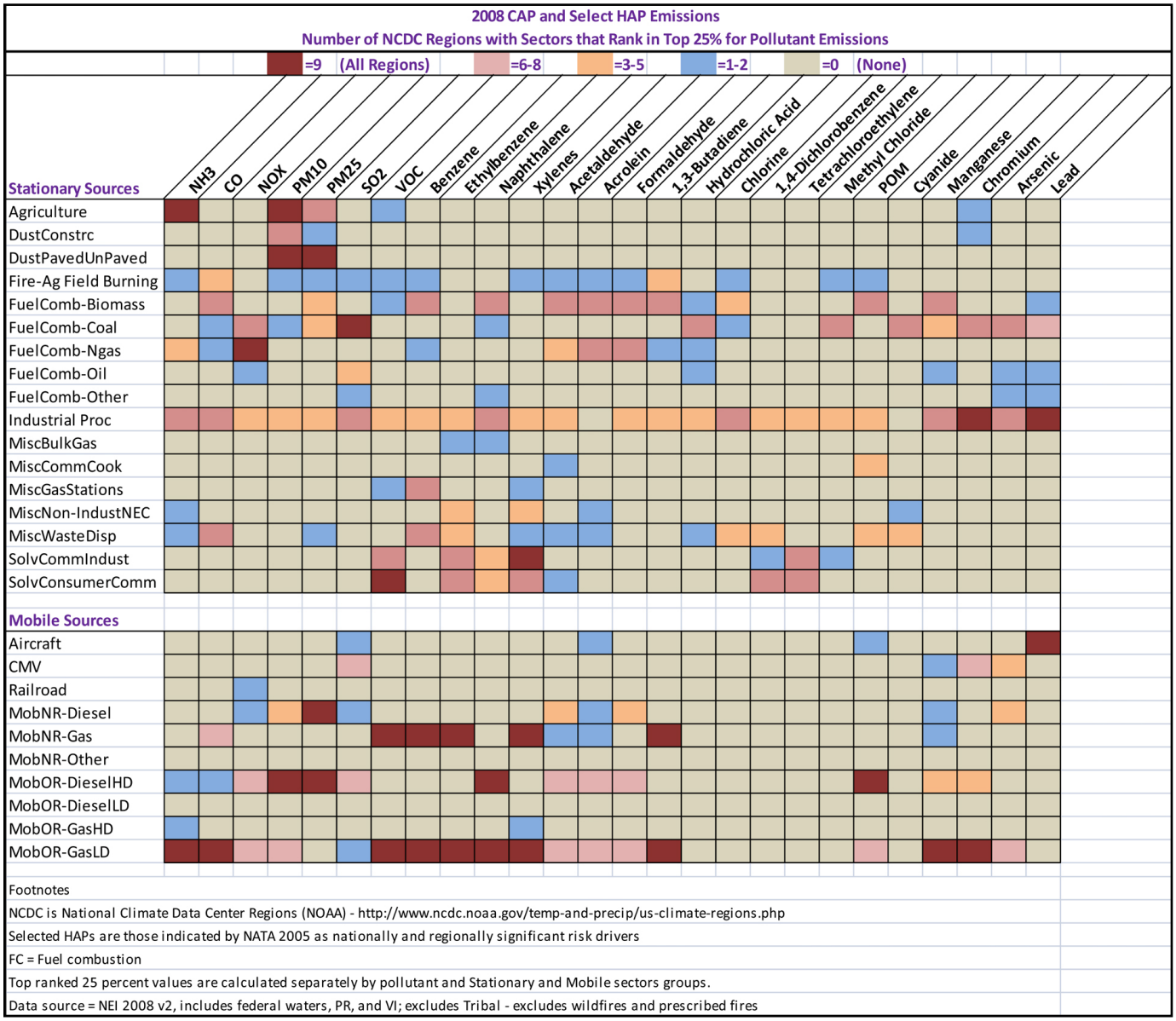


Figure 47: Number of NCDC Regions With Sectors that Rank in Top 25 Percent of Emissions

The observations from comparing the regional contributions within source categories (Tables 18 and 19) to Table 20, which shows the relative regional contributions for all sources (stationary + mobile), are noted:

- Some of the same regions that contributed large portions of pollutant emissions within the stationary sources or within the mobile sources also contribute the largest percentage of the pollutant total for all sources. Examples include fuel combustion - coal has the highest SO_2 in the Central region for both stationary and all sources. Commercial/industrial solvent sources has the highest contribution in the Western region both in stationary and all sources. For piston-engine aircraft, lead is highest within mobile sources and all sources in the Southern region. Ethylbenzene is highest in the Southeastern region for both mobile and all sources. While the Central region has large percent contributions for the most pollutants/sector combinations within stationary sources, it also contributes the largest percentages to the national pollutant totals, and these come from the same stationary sectors, as were shown in Table 18.
- Many of the large regional contributions within stationary sources are also predominant contributions to national emissions totals for all

Table 18: Percent Region Contribution to National Pollutant Total for Stationary Sources

Stationary Sources	**Pollutant**	**NCDC Regions**								
		Central	**ENC**	**NE**	**NW**	**S**	**SE**	**SW**	**W**	**WNC**
Agriculture	NH3	13.4%	16.8%	4.7%	4.8%	19.3%	10.8%	4.7%	6.9%	11.8%
	PM10	5.5%	4.4%	0.6%	0.8%	6.8%	1.2%	0.8%	0.2%	4.3%
	PM2.5	5.5%	4.4%	0.0%	0.7%	6.8%	0.0%	0.8%	0.0%	4.4%
DustConstrc	PM10	2.1%	0.7%	1.0%	0.5%	2.2%	1.1%	0.9%	2.4%	0.0%
DustPavedUnPaved	PM10	7.0%	3.9%	2.7%	3.4%	15.0%	6.2%	5.9%	2.0%	4.9%
	PM2.5	3.8%	2.3%	1.7%	2.2%	8.1%	3.7%	3.3%	1.2%	2.6%
FuelComb-Biomass	CO	5.8%	6.5%	6.8%	2.8%	0.0%	2.7%	1.7%	3.8%	0.5%
	Benzene	13.6%	12.7%	10.2%	4.0%	0.0%	3.1%	2.5%	0.0%	0.8%
	Naphthalene	10.6%	10.3%	10.6%	4.8%	2.6%	3.2%	3.0%	0.0%	0.9%
	Acetaldehyde	7.6%	9.3%	7.9%	3.9%	0.0%	3.0%	2.4%	7.5%	0.7%
	Acrolein	2.1%	3.6%	2.5%	1.6%	0.0%	3.4%	0.7%	2.7%	0.4%
	Formaldehyde	7.3%	9.3%	9.4%	5.0%	2.5%	3.7%	3.1%	4.8%	0.0%
	1,3-Butadiene	9.8%	12.3%	15.5%	7.9%	0.0%	5.0%	5.0%	11.2%	1.4%
	POM	10.6%	9.6%	11.1%	5.7%	0.0%	5.0%	3.5%	15.8%	1.0%
	Manganese	0.0%	3.7%	2.3%	0.7%	4.2%	6.1%	0.0%	0.6%	0.0%
FuelComb-Coal	NOX	19.8%	5.7%	5.4%	0.5%	6.2%	9.7%	3.6%	0.0%	4.0%
	SO2	32.5%	8.3%	14.6%	0.2%	9.7%	18.0%	1.5%	0.1%	3.4%
	Hydrochloric Acid	29.0%	6.3%	11.1%	0.0%	6.6%	23.1%	1.3%	0.5%	1.7%
	Methyl Chloride	6.8%	0.0%	2.0%	0.2%	0.0%	3.1%	1.3%	0.0%	1.7%
	Cyanide Compounds	17.1%	9.3%	5.0%	0.0%	13.0%	10.7%	2.8%	0.6%	3.6%
	Cr Compounds	13.4%	7.0%	3.6%	0.1%	5.7%	10.6%	2.6%	0.0%	2.0%
	Arsenic	22.1%	14.2%	10.4%	0.4%	8.0%	10.5%	0.0%	0.0%	2.6%
	Lead	9.1%	3.3%	1.7%	0.0%	1.5%	2.0%	0.5%	0.0%	0.6%
FuelComb-Ngas	NOX	4.0%	2.0%	2.9%	1.3%	8.5%	1.9%	1.7%	1.2%	1.1%
	Acrolein	1.4%	1.0%	0.0%	0.1%	9.7%	1.7%	3.4%	0.0%	1.8%
	Formaldehyde	3.1%	2.0%	2.0%	0.6%	14.0%	3.4%	4.7%	2.2%	2.2%
Industrial Proc	NH3	0.1%	0.0%	0.0%	0.1%	1.0%	0.3%	0.1%	0.0%	0.2%
	CO	9.3%	0.0%	2.2%	1.0%	4.8%	3.4%	0.0%	0.0%	0.7%
	SO2	2.6%	0.6%	0.5%	0.2%	3.0%	1.4%	0.5%	0.3%	0.3%
	Naphthalene	5.0%	0.9%	1.7%	0.0%	4.7%	1.9%	0.0%	3.6%	0.1%
	Chlorine	7.9%	0.0%	2.2%	1.9%	8.3%	5.1%	0.0%	0.0%	1.4%
	Methyl Chloride	14.1%	2.7%	5.6%	0.0%	33.3%	9.7%	0.0%	0.0%	0.0%
	Manganese	34.8%	6.6%	6.6%	0.4%	6.0%	3.4%	0.0%	1.5%	0.6%
	Cr Compounds	13.8%	5.2%	10.4%	0.1%	3.9%	2.6%	0.3%	2.9%	0.1%
	Arsenic	3.0%	6.0%	0.0%	0.4%	3.2%	1.6%	4.5%	8.0%	1.3%
	Lead	29.4%	5.1%	8.6%	0.3%	7.1%	5.9%	5.0%	2.1%	1.0%
MiscWasteDisp	CO	3.0%	1.2%	2.7%	0.0%	0.0%	5.3%	0.7%	0.6%	0.0%
	Benzene	7.7%	2.1%	2.5%	1.0%	2.5%	3.2%	0.0%	0.5%	0.4%
SolvCommIndust	VOC	4.9%	2.3%	4.2%	0.5%	3.7%	3.9%	0.9%	1.6%	0.0%
	Ethylbenzene	5.2%	3.0%	0.0%	0.6%	3.9%	4.0%	1.4%	2.4%	0.3%
	Xylenes	12.9%	7.2%	5.0%	1.9%	6.4%	7.8%	1.8%	5.7%	0.6%
	Tetrachloroethylene	22.3%	11.6%	2.0%	0.2%	5.0%	1.0%	4.2%	36.6%	0.0%
SolvConsumerComm	VOC	3.8%	2.4%	3.3%	1.3%	0.0%	4.5%	1.3%	0.8%	0.9%
	Ethylbenzene	1.7%	1.3%	23.5%	0.5%	0.0%	0.0%	0.0%	2.2%	1.7%
	Xylenes	2.1%	2.5%	2.0%	0.9%	0.0%	0.0%	0.7%	2.7%	1.9%
	1,4-Dichlorobenzene	4.8%	18.8%	9.5%	5.3%	0.0%	0.0%	6.9%	33.5%	0.0%
	Tetrachloroethylene	0.8%	1.2%	2.2%	0.4%	0.0%	0.0%	0.5%	2.8%	0.0%

Footnote:

Pollutant/ sector selections are based on Figure 47 - the higher emitting sectors that the majority of regions have in common.

Emissions ≥ 10% of pollutant total in all stationary sources are highlighted.

Emissions in federal waters are excluded.

Table 19: Percent Region Contribution to National Pollutant Total for Mobile Sources

Mobile Sources	**Pollutant**	**NCDC Regions**								
		Central	**ENC**	**NE**	**NW**	**S**	**SE**	**SW**	**W**	**WNC**
Aircraft	Lead	11.6%	7.4%	12.7%	8.1%	18.5%	17.3%	8.1%	12.1%	2.9%
CMV	SO2	1.0%	1.3%	3.6%	2.6%	5.2%	3.7%	0.0%	1.7%	0.0%
MobNR-Diesel	PM2.5	3.6%	2.4%	2.4%	0.8%	3.6%	3.2%	1.0%	1.9%	1.6%
MobNR-Gas	CO	4.5%	2.9%	6.2%	1.4%	3.4%	6.5%	1.3%	1.9%	0.5%
	VOC	5.8%	5.9%	8.2%	2.1%	5.1%	8.0%	1.7%	2.6%	0.8%
	Benzene	5.1%	3.6%	6.1%	1.7%	4.7%	8.1%	1.7%	2.6%	0.6%
	Ethylbenzene	5.4%	3.3%	5.9%	1.9%	5.2%	8.9%	1.8%	2.0%	0.7%
	Xylenes	6.9%	5.3%	8.2%	2.4%	6.1%	10.5%	2.1%	0.5%	0.9%
	1,3-Butadiene	4.7%	6.0%	6.1%	1.6%	3.2%	6.2%	1.5%	3.7%	0.7%
MobOR-DieselHD	NH3	0.8%	0.4%	0.6%	0.2%	0.8%	1.0%	0.3%	0.0%	0.1%
	NOX	5.3%	2.5%	3.4%	1.1%	4.9%	5.8%	1.8%	3.3%	0.0%
	PM10	6.1%	2.9%	3.8%	1.3%	5.7%	7.2%	2.0%	2.2%	0.8%
	PM2.5	6.5%	3.1%	4.1%	1.4%	6.1%	7.7%	2.1%	2.3%	0.8%
	SO2	2.2%	1.0%	1.4%	0.4%	2.0%	2.8%	0.7%	0.0%	0.3%
	Naphthalene	4.9%	2.3%	3.1%	1.0%	4.3%	5.7%	1.5%	2.4%	0.7%
	Acetaldehyde	3.3%	0.0%	2.1%	0.0%	2.9%	3.8%	1.0%	4.0%	0.0%
	Acrolein	6.0%	2.8%	3.8%	1.2%	5.3%	7.0%	1.8%	0.0%	0.8%
	Formaldehyde	4.1%	0.0%	2.6%	0.8%	3.7%	4.8%	1.3%	4.4%	0.0%
	POM	10.7%	5.1%	6.8%	2.2%	0.0%	12.6%	3.3%	0.3%	1.4%
	Manganese	1.6%	0.8%	1.1%	0.0%	2.2%	1.9%	0.0%	0.0%	0.2%
MobOR-GasLD	NH3	14.2%	6.9%	14.2%	3.3%	12.4%	17.9%	4.5%	14.6%	1.6%
	CO	11.6%	6.1%	8.4%	3.6%	8.5%	13.1%	3.3%	4.1%	1.3%
	NOX	5.5%	2.8%	4.2%	1.5%	4.4%	7.1%	1.8%	1.9%	0.0%
	PM10	3.6%	2.1%	3.3%	1.0%	0.0%	3.7%	1.0%	2.0%	0.0%
	VOC	8.4%	4.6%	6.5%	2.4%	6.7%	10.2%	2.7%	4.1%	0.9%
	Benzene	10.6%	6.1%	7.9%	4.1%	7.8%	12.6%	3.6%	3.5%	1.3%
	Ethylbenzene	11.0%	6.0%	8.3%	3.2%	8.7%	13.5%	3.5%	4.0%	1.2%
	Naphthalene	10.3%	6.0%	7.9%	2.9%	7.8%	11.9%	3.0%	5.2%	1.2%
	Xylenes	10.4%	5.7%	7.9%	3.0%	8.3%	12.8%	3.3%	0.7%	1.2%
	Acetaldehyde	8.3%	5.4%	6.7%	1.9%	5.6%	7.9%	2.2%	0.0%	1.1%
	Acrolein	4.7%	2.8%	3.7%	1.3%	0.0%	5.3%	1.4%	3.6%	0.0%
	Formaldehyde	5.1%	3.0%	4.1%	1.3%	4.0%	5.9%	1.5%	0.0%	0.6%
	1,3-Butadiene	9.8%	5.5%	8.1%	2.7%	8.0%	12.3%	2.9%	4.4%	1.2%
	POM	5.6%	3.5%	4.6%	1.7%	3.8%	5.8%	1.6%	0.0%	0.7%
	Manganese	4.3%	2.2%	4.7%	1.0%	4.0%	5.5%	1.4%	17.5%	0.5%
	Cr Compounds	7.1%	3.5%	7.7%	1.6%	6.6%	9.1%	2.4%	0.5%	0.8%
	Arsenic	3.8%	1.9%	4.2%	0.9%	3.6%	4.9%	1.3%	0.0%	0.4%

Footnote
Pollutant/ sector selections are based on Figure 47 - the higher emitting sectors that the majority of regions have in common.
Emissions ≥ 10% of pollutant total in all mobile sources are highlighted.
Emissions in federal waters are excluded.

Table 20: Percent Region Contribution to National Pollutant Total for All Sources

Stationary Sources	**Pollutant**	**NCDC Regions**								
		Central	**ENC**	**NE**	**NW**	**S**	**SE**	**SW**	**W**	**WNC**
Agriculture	NH3	12.9%	16.2%	4.5%	4.6%	18.6%	10.4%	4.5%	6.7%	11.4%
	PM10	5.3%	4.2%	0.6%	0.7%	6.6%	1.2%	0.8%	0.2%	4.2%
	PM2.5	4.8%	3.8%	0.0%	0.6%	5.8%	0.0%	0.7%	0.0%	3.8%
DustConstrc	PM10	2.0%	0.6%	1.0%	0.4%	2.2%	1.1%	0.9%	2.3%	0.0%
DustPavedUnPaved	PM10	6.7%	3.8%	2.6%	3.2%	14.5%	6.0%	5.7%	1.9%	4.7%
	PM2.5	3.3%	2.0%	1.4%	1.9%	7.0%	3.2%	2.8%	1.0%	2.3%
FuelComb-Biomass	CO	0.7%	0.8%	0.9%	0.4%	0.0%	0.3%	0.2%	0.5%	0.1%
	Benzene	3.2%	3.0%	2.4%	1.0%	0.0%	0.7%	0.6%	0.0%	0.2%
	Naphthalene	3.9%	3.8%	3.9%	1.8%	1.0%	1.2%	1.1%	0.0%	0.3%
	Acetaldehyde	2.4%	2.9%	2.5%	1.2%	0.0%	0.9%	0.8%	2.3%	0.2%
	Acrolein	1.3%	2.3%	1.6%	1.0%	0.0%	2.2%	0.5%	1.8%	0.3%
	Formaldehyde	2.2%	2.9%	2.9%	1.5%	0.8%	1.1%	1.0%	1.5%	0.0%
	1,3-Butadiene	1.5%	1.9%	2.4%	1.2%	0.0%	0.8%	0.8%	1.7%	0.2%
	POM	6.2%	5.7%	6.5%	3.3%	0.0%	3.0%	2.0%	9.3%	0.6%
	Manganese	0.0%	3.6%	2.3%	0.6%	4.1%	6.0%	0.0%	0.6%	0.0%
FuelComb-Coal	NOX	6.2%	1.8%	1.7%	0.2%	2.0%	3.1%	1.1%	0.0%	1.3%
	SO2	30.0%	7.6%	13.4%	0.2%	9.0%	16.6%	1.4%	0.1%	3.1%
	Hydrochloric Acid	29.0%	6.3%	11.1%	0.0%	6.6%	23.1%	1.3%	0.5%	1.7%
	Methyl Chloride	6.8%	0.0%	2.0%	0.2%	0.0%	3.1%	1.3%	0.0%	1.7%
	Cyanide Compounds	17.1%	9.3%	5.0%	0.0%	13.0%	10.7%	2.8%	0.6%	3.6%
	Cr Compounds	12.5%	6.5%	3.4%	0.1%	5.3%	10.0%	2.4%	0.0%	1.9%
	Arsenic	17.6%	11.3%	8.3%	0.3%	6.4%	8.4%	0.0%	0.0%	2.0%
	Lead	3.6%	1.3%	0.7%	0.0%	0.6%	0.8%	0.2%	0.0%	0.3%
FuelComb-Ngas	NOX	1.2%	0.6%	0.9%	0.4%	2.7%	0.6%	0.5%	0.4%	0.3%
	Acrolein	0.9%	0.6%	0.0%	0.1%	6.2%	1.1%	2.2%	0.0%	1.1%
	Formaldehyde	1.0%	0.6%	0.6%	0.2%	4.3%	1.0%	1.5%	0.7%	0.7%
Industrial Proc	NH3	0.1%	0.0%	0.0%	0.1%	0.9%	0.3%	0.1%	0.0%	0.2%
	CO	1.2%	0.0%	0.3%	0.1%	0.6%	0.4%	0.0%	0.0%	0.1%
	SO2	2.4%	0.6%	0.5%	0.2%	2.7%	1.3%	0.5%	0.3%	0.2%
	Naphthalene	1.9%	0.3%	0.6%	0.0%	1.7%	0.7%	0.0%	1.3%	0.1%
	Chlorine	7.9%	0.0%	2.2%	1.9%	8.3%	5.1%	0.0%	0.0%	1.4%
	Methyl Chloride	14.1%	2.7%	5.6%	0.0%	33.3%	9.7%	0.0%	0.0%	0.0%
	Manganese	34.3%	6.5%	6.5%	0.4%	5.9%	3.4%	0.0%	1.5%	0.6%
	Cr Compounds	13.0%	4.9%	9.8%	0.1%	3.7%	2.4%	0.3%	2.8%	0.1%
	Arsenic	2.4%	4.8%	0.0%	0.3%	2.5%	1.2%	3.6%	6.3%	1.0%
	Lead	11.8%	2.1%	3.4%	0.1%	2.8%	2.3%	2.0%	0.9%	0.4%
MiscWasteDisp	CO	0.4%	0.2%	0.4%	0.0%	0.0%	0.7%	0.1%	0.1%	0.0%
	Benzene	1.8%	0.5%	0.6%	0.2%	0.6%	0.8%	0.0%	0.1%	0.1%
SolvCommIndust	VOC	2.8%	1.3%	2.4%	0.3%	2.1%	2.2%	0.5%	0.9%	0.0%
	Ethylbenzene	0.6%	0.3%	0.0%	0.1%	0.4%	0.4%	0.2%	0.3%	0.0%
	Xylenes	1.7%	1.0%	0.7%	0.3%	0.9%	1.0%	0.2%	0.8%	0.1%
	Tetrachloroethylene	22.3%	11.6%	2.0%	0.2%	5.0%	1.0%	4.2%	36.6%	0.0%
SolvConsumerComm	VOC	2.2%	1.4%	1.9%	0.8%	0.0%	2.6%	0.8%	0.5%	0.5%
	Ethylbenzene	0.2%	0.1%	2.6%	0.1%	0.0%	0.0%	0.0%	0.3%	0.2%
	Xylenes	0.3%	0.3%	0.3%	0.1%	0.0%	0.0%	0.1%	0.4%	0.3%
	1,4-Dichlorobenzene	4.8%	18.8%	9.5%	5.3%	0.0%	0.0%	6.9%	33.5%	0.0%
	Tetrachloroethylene	0.8%	1.2%	2.2%	0.4%	0.0%	0.0%	0.5%	2.8%	0.0%

Footnote
Pollutant/ sector selections are based on Figure 47 - the higher emitting sectors that the majority of regions have in common.
Emissions ≥ 10% of pollutant total in all sources (stationary + mobile) are highlighted.
Emissions in federal waters are excluded.

Table 20: Percent Region Contribution to National Pollutant Total for all Sources (continued)

Mobile Sources	**Pollutant**	**NCDC Regions**								
		Central	**ENC**	**NE**	**NW**	**S**	**SE**	**SW**	**W**	**WNC**
Aircraft	Lead	6.9%	4.5%	7.6%	4.9%	11.1%	10.4%	4.9%	7.3%	1.8%
CMV	SO2	0.1%	0.1%	0.3%	0.2%	0.4%	0.3%	0.0%	0.1%	0.0%
MobNR-Diesel	PM2.5	0.5%	0.3%	0.3%	0.1%	0.5%	0.4%	0.1%	0.3%	0.2%
MobNR-Gas	CO	3.9%	2.5%	5.4%	1.2%	3.0%	5.6%	1.2%	1.6%	0.5%
	VOC	2.5%	2.5%	3.5%	0.9%	2.2%	3.4%	0.7%	1.1%	0.4%
	Benzene	3.9%	2.7%	4.7%	1.3%	3.6%	6.2%	1.3%	2.0%	0.5%
	Ethylbenzene	4.8%	2.9%	5.3%	1.7%	4.6%	7.9%	1.6%	1.8%	0.6%
	Xylenes	6.0%	4.6%	7.1%	2.1%	5.3%	9.1%	1.8%	0.4%	0.8%
	1,3-Butadiene	4.0%	5.0%	5.2%	1.4%	2.7%	5.2%	1.3%	3.1%	0.6%
MobOR-DieselHD	NH3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	NOX	3.5%	1.7%	2.2%	0.7%	3.2%	3.8%	1.2%	2.1%	0.0%
	PM10	0.2%	0.1%	0.1%	0.0%	0.2%	0.3%	0.1%	0.1%	0.0%
	PM2.5	0.9%	0.4%	0.6%	0.2%	0.8%	1.0%	0.3%	0.3%	0.1%
	SO2	0.2%	0.1%	0.1%	0.0%	0.1%	0.2%	0.1%	0.0%	0.0%
	Naphthalene	3.1%	1.5%	1.9%	0.6%	2.7%	3.6%	1.0%	1.5%	0.4%
	Acetaldehyde	2.3%	0.0%	1.4%	0.0%	2.0%	2.6%	0.7%	2.7%	0.0%
	Acrolein	2.1%	1.0%	1.4%	0.4%	1.9%	2.5%	0.7%	0.0%	0.3%
	Formaldehyde	2.9%	0.0%	1.8%	0.6%	2.6%	3.3%	0.9%	3.1%	0.0%
	POM	4.4%	2.1%	2.8%	0.9%	0.0%	5.2%	1.3%	0.1%	0.6%
	Manganese	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MobOR-GasLD	NH3	0.6%	0.3%	0.6%	0.1%	0.5%	0.8%	0.2%	0.6%	0.1%
	CO	10.1%	5.3%	7.3%	3.1%	7.4%	11.4%	2.8%	3.6%	1.2%
	NOX	3.6%	1.8%	2.7%	1.0%	2.9%	4.6%	1.2%	1.2%	0.0%
	PM10	0.1%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%	0.1%	0.0%
	VOC	3.6%	2.0%	2.8%	1.0%	2.9%	4.4%	1.1%	1.7%	0.4%
	Benzene	8.1%	4.7%	6.1%	3.2%	6.0%	9.6%	2.7%	2.7%	1.0%
	Ethylbenzene	9.8%	5.3%	7.4%	2.9%	7.8%	12.0%	3.1%	3.6%	1.1%
	Naphthalene	6.5%	3.8%	5.0%	1.9%	4.9%	7.5%	1.9%	3.3%	0.8%
	Xylenes	9.0%	4.9%	6.9%	2.6%	7.2%	11.1%	2.8%	0.6%	1.0%
	Acetaldehyde	5.7%	3.7%	4.6%	1.3%	3.9%	5.5%	1.5%	0.0%	0.8%
	Acrolein	1.7%	1.0%	1.3%	0.5%	0.0%	1.9%	0.5%	1.3%	0.0%
	Formaldehyde	3.5%	2.1%	2.8%	0.9%	2.7%	4.1%	1.0%	0.0%	0.4%
	1,3-Butadiene	8.3%	4.7%	6.8%	2.3%	6.8%	10.4%	2.4%	3.7%	1.0%
	POM	2.3%	1.5%	1.9%	0.7%	1.6%	2.4%	0.6%	0.0%	0.3%
	Manganese	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%	0.0%	0.3%	0.0%
	Cr Compounds	0.4%	0.2%	0.5%	0.1%	0.4%	0.5%	0.1%	0.0%	0.0%
	Arsenic	0.7%	0.4%	0.8%	0.2%	0.7%	0.9%	0.2%	0.0%	0.1%

Footnote
Pollutant/ sector selections are based on Figure 47 - the higher emitting sectors that the majority of regions have in common.
Emissions ≥ 10% of pollutant total in all sources (stationary + mobile) are highlighted.
Emissions in federal waters are excluded.

sources, i.e., stationary and mobile sources. These regional contributions are seen in agriculture, road dust, and fuel combustion coal for NH_3, PM_{10}, and NO_x /SO_2 respectively. Similarly, large regional contributions to national emissions totals are indicated for numerous HAPs - in fuel combustion coal, industrial processes and solvent uses. By contrast, and within stationary sources, specific regions make significant HAP contributions to fuel combustion-biomass, but they are not predominant contributions to those national HAP emissions totals for all sources.

- For mobile sources, the South and Southeast also contribute the largest portions of lead to the national total, from aircraft. The Southeast is also a major contributor of the pollutants listed for on-road vehicles light duty gas, based on those pollutant totals for all sources. Emissions from these sectors in these regions are the largest contributor to the National Inventory across all sectors.

5. Local Emissions Information

As discussed previously, the mixture of CAP and HAP emission releases, and the local and regional climate and weather patterns, help determine how the chemicals will interact to form ozone and fine particles ($PM_{2.5}$) and transform to other toxic compounds. Areas that are experiencing multiple air quality issues, such as exceeding one or more NAAQS and having elevated risks from HAP emissions, may benefit from addressing such problems and possible solutions in an integrated fashion. Such solutions may include emission control programs that simultaneously provide desired air quality improvements, reduced overall costs and greater health benefits from targeting multiple pollutants together. Local control strategies are reliant on air quality modeling, which benefits from more detailed and localized information on emissions. Local emission inventories may also show important sector-pollutant patterns that are different from what the regional patterns for those areas show.

So far, we have discussed national and regional emission patterns. This section investigates local emission profiles for two areas that are experiencing multiple air quality issues. While other factors such as meteorology, topography, distance between source and monitor and transport likely contribute to the air quality problems, only the emissions part of that contribution is considered here. In looking at the local emissions profiles, patterns of sources will be identified and contrasted with the regional patterns discussed earlier.

5.1 Nexus of Air Quality Issues for Local Areas

The term "nexus" is used here to describe the confluence of ozone, PM and HAP air quality/risk issues. These nexus areas are revealed by examining 2008 ambient monitoring data and cancer risk data from the 2005 NATA (subject to caveats in the 2005 NATA as previously detailed in the report). Figure 48 shows the areas that exceed the level of the ambient NAAQS for annual $PM_{2.5}$ and ozone and which also have potential cancer risks that are in the top 10 percent for the country. The ambient annual air quality standard is 15 micrograms/cubic meter ($\mu g/m^3$) for $PM_{2.5}$ and 75 parts per billion (ppb) for ozone. The top 10 percent of potential cancer risk areas are also referred to as the 90th percentile. The nexus based on Core Based Statistical Area (CBSA) that satisfy these criteria are indicated in black color. A CBSA is a U.S. geographic area defined by the Office of Management and Budget (OMB) based around an urban center

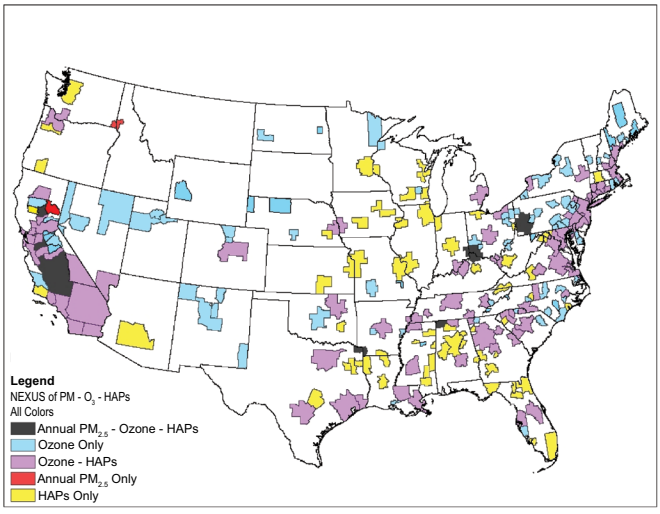


Figure 48: NEXUS Areas Defined by 2008 Air Quality Data and NATA 2005 Cancer Risk Values

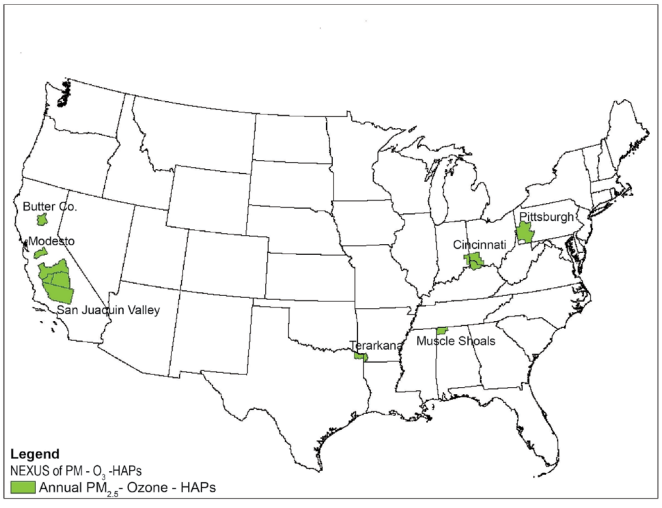


Figure 49: Areas that Experienced Multiple Air Quality Problems in 2008 Based on Figure 48

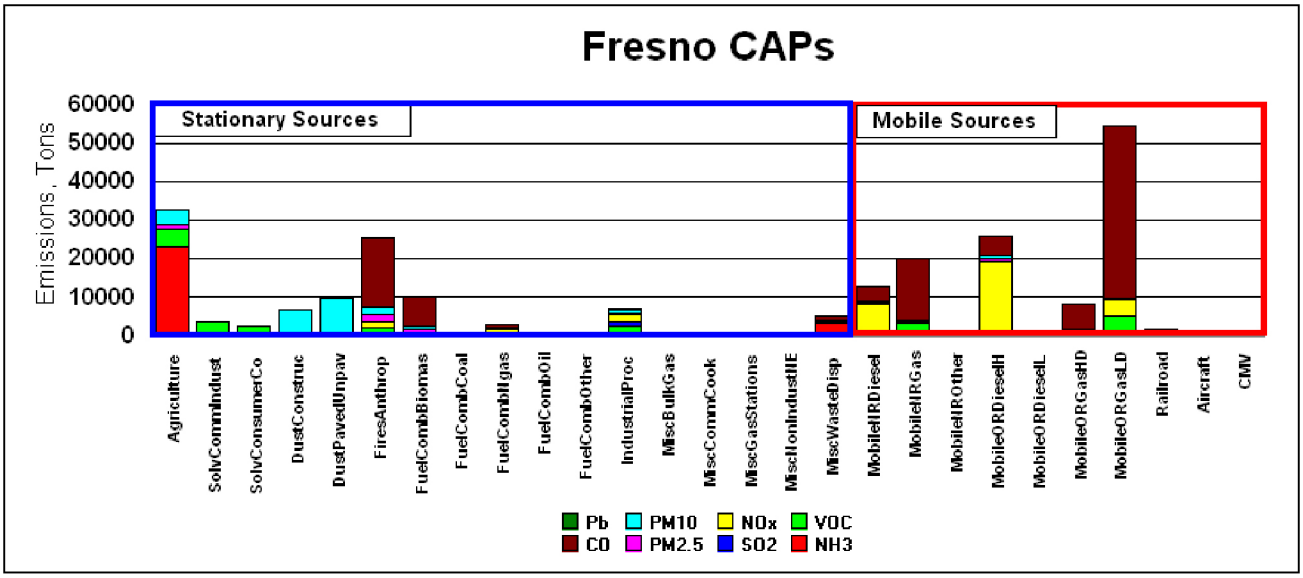
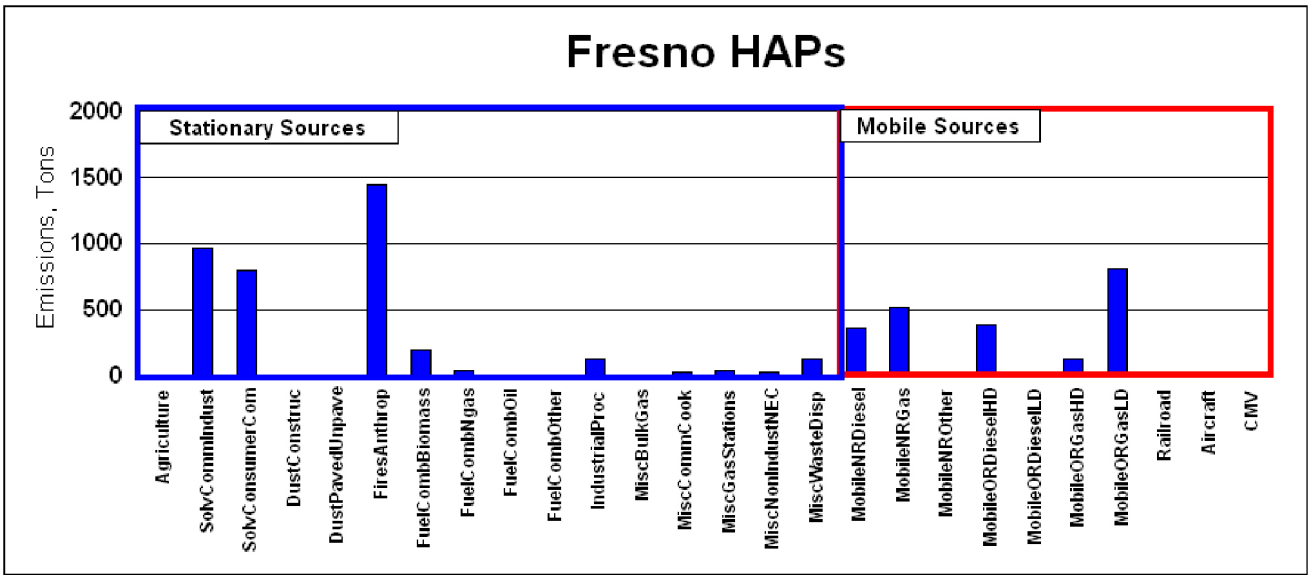


Figure 50: Total CAPs in Fresno, CA by Sector, 2008 NEI



F igure 51: Total HAPs in Fresno, CA by Sector, 2008 NEI

of at least 10,000 people and adjacent areas that are socioeconomically tied to the urban center by commuting. The term "CBSA" refers collectively to both metropolitan statistical areas and micropolitan areas[ref 20]. For convenience, these counties shown in black are displayed separately in Figure 49 in green. From Figure 49, it can be noted that there are several nexus areas in California and some areas in the East and South.

5.2 Local Profiles for Two Nexus Areas

Two of the nexus areas from Figure 49 are Fresno, CA and Pittsburgh, PA. To further investigate emissions in these two areas, we review the profile of sources that contribute to the $PM_{2.5}$, ozone and cancer risk issues to identify sectors with the largest contribution of emissions of multiple pollutants. The counties in the two metropolitan areas are included in their entirety, which also cover the ozone and $PM_{2.5}$ non-attainment areas shown in the previous maps.

The following counties are included in the emissions profile for the Fresno and Pittsburgh areas:

Fresno, CA - Fresno County; Pittsburgh, PA - Allegheny, Armstrong, Beaver, Butler, Fayette, Washington and Westmoreland Counties.

Using the "Sector29" emissions groups from Table 3, Figures 50 to 51 and 53 to 54 summarize emissions in each area and exclude emissions from wild land fires and biogenic sources. Figures 50 and 51 show the CAP and HAP sector emission totals for Fresno, CA. The CAP bars in each figure represent the sum of CAPs in the 2008 NEI: CO, NH_3, VOC, SO_2, NO_x, $PM_{2.5}$ and PM_{10}. The HAP bars represent the sum of all the HAPs in the 2008 NEI, not just the specific list of HAPs analyzed in other parts of this report. A similar set of charts is shown in Figures 53 and 54 for Pittsburgh, PA.

Based on Figures 50 and 51, Fresno shows the following characteristics:

- The ratio of total CAP to HAP is 35. The sum of CAP emissions is 208,382 tons and the sum of HAP emissions is 6,026 tons.
- Mobile sources emit the highest amounts of both HAP and CAP emissions.

CAP Highlights:

- Largest CAP source - on-road mobile sources. Other significant contributors include agriculture and dust. Most of the emissions from agriculture are NH_3 and all of the emissions in the dust categories are PM.
- Within on-road mobile sources, light duty gasoline vehicles contribute a much higher fraction of emissions than do the heavy duty diesel vehicles. All of the CAPs except for SO_2 are emitted in significant amounts from mobile sources.
- The stationary fuel combustion categories have only a small portion of the total CAP emissions.

HAP Highlights:

- Largest HAP sources – mobile sources, solvents, and anthropogenic fires (agricultural/crop residue burning).
- Within the anthropogenic fires category, the HAP acrolein is significant and accounts for over 90 percent of the HAP emissions; chlorine (4 percent) and 1,3-butadiene (2 percent) make smaller contributions from fires.
- Within mobile sources, nonroad and on-road sources contribute equal fractions of total HAPs. A significant amount (>70 percent) of the HAP emissions are from BTEX – benzene, toluene, ethylbenzene and xylenes; and 1,3-butadiene.
- For the solvent sectors, the HAPs emitted in significant amounts include ethylene glycol, methyl chloride, hexane and xylene.
- The fact that fires and solvents are key sectors for HAP emissions in Fresno is supported by the 2005 NATA results, which indicate that Fresno county is among the highest 61 counties in terms of total cancer risk, and that the biggest contributor to that total risk comes from the nonpoint sector.

Priority Facilities:

- As part of the 2011 NEI planning cycle, EPA has developed a list of 2008 NEI point sources that contribute to the top 80 percent of the national point source total for any of the CAPs and key HAPs [ref 21]. Of the 8,784 facilities identified on the list, Fresno county has only 11 of those facilities (two are airports and three are breweries/distilleries/wineries), as shown in Figure 52, and most of them are significant only for VOC emissions.
- Based on Figures 53 and 54, the Pittsburgh, PA area shows these characteristics:
- The total CAP to HAP ratio is about 75. The estimated amount of CAPs emitted is 1.1 million tons while the total amount of HAPs emitted is 14,300 tons. The magnitude of CAP and HAP emissions is much higher than in Fresno county, in part because the metropolitan (and PM non-attainment) area here is much larger and encompasses seven counties.
- Emissions in the Pittsburgh area are dominated by CAPs compared to the Fresno area. The total emission mix in the Pittsburgh area is dominated by large stationary sources and sources such as fuel combustion and industrial processes.

CAP Highlights:

- Nearly 40 percent of the CAP emissions in Pittsburgh come from coal-based fuel combustion. Other significant contributors to total CAPs in Pittsburgh include nonroad gasoline equipment (11 percent) and on-road gasoline vehicles (25 percent). Most of

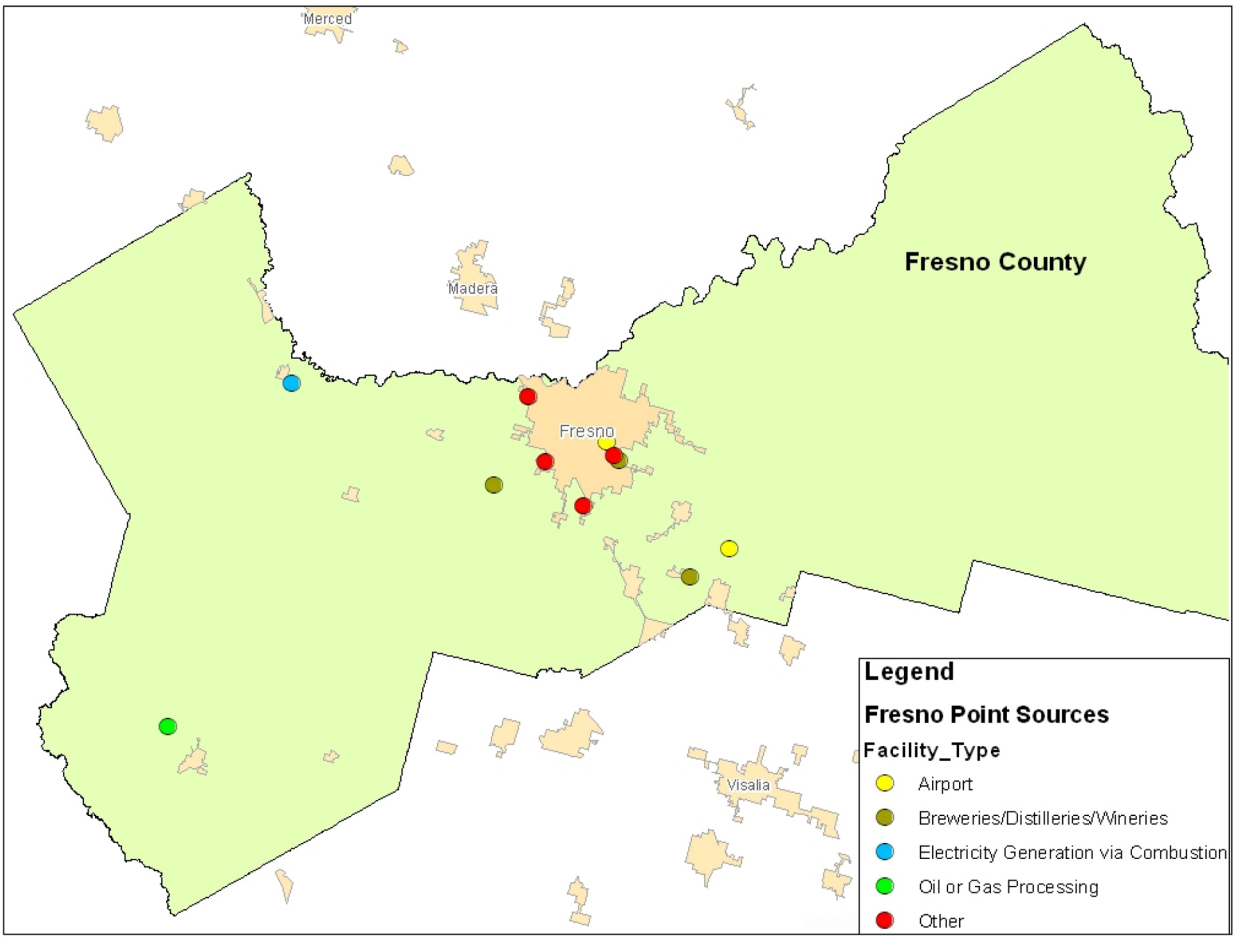


Figure 52: Key Point Sources in the Fresno, CA Area, 2008 NEI

the CAP emissions from coal-based fuel combustion are SO_2 and NO_x. Nearly all CAPs are emitted in significant amounts from the mobile source categories with the exception of SO_2 emissions.

- Biomass-based fuel combustion and industrial processes are also large contributors for CAP emissions as well, but to a lesser extent than the sources mentioned previously. CO, VOCs and PM are emitted at high levels in the biomass-based fuel combustion categories, while the industrial sources are dominated by direct PM, NO_x and VOC emissions.

HAP Highlights:

- The HAPs are emitted mainly by mobile source categories, fuel combustion categories and solvent utilization. The specific HAPs for the mobile sources and solvent categories are the same as noted for the Fresno area. For coal-based fuel combustion, the highest emitting HAPs are hydrochloric acid, hydrogen sulfide and hydrogen cyanide. For biomass-based fuel combustion, benzene, formaldehyde, acetaldehyde, toluene and 1,3-butadiene are the most-abundant HAPs emitted.
- 2005 NATA results support the fact that fuel combustion and industrial sources are key sectors for HAP emissions in the Pittsburgh vicinity, which indicate that Allegheny county is among the highest counties in terms of total cancer risk, and that the biggest contributor to the total cancer risk comes from the point sector. Point sources are also the most important contributing sources for cancer risk in all of the other counties.

Priority Facilities

- Of the 8,784 facilities identified on the list, the counties that comprise the Pittsburgh metropolitan area have 61 of those facilities (many EGUS, steel mills, iron and steel foundries, smelters and airports) and 11 of them are significant for more than six pollutants. These sources are shown in the map in Figure 55.

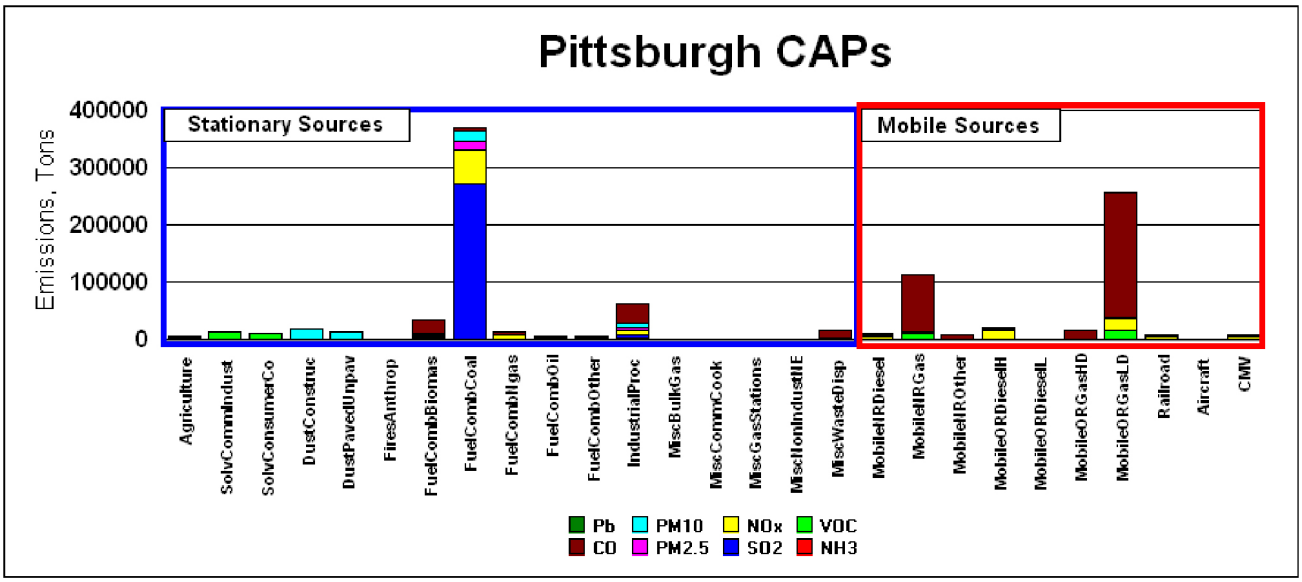


Figure 53: Total CAPs in Pittsburgh, PA by Sector, 2008 NEI

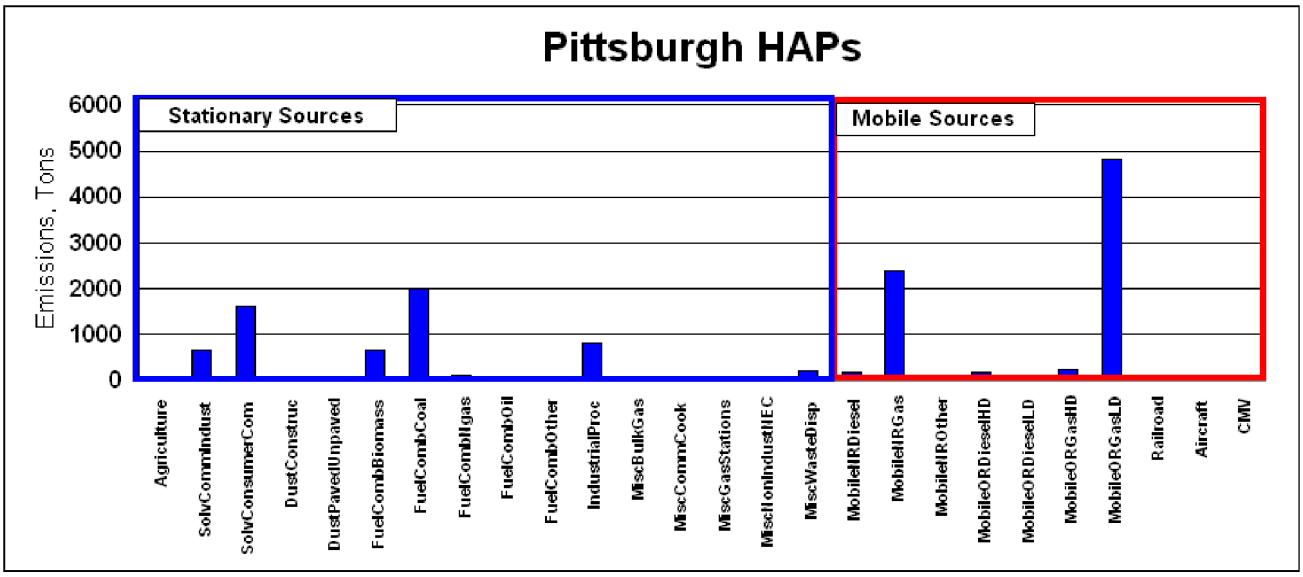


Figure 54: Total HAPs in Pittsburgh, PA by Sector, 2008 NEI

5.3 Examples and Recommendations for Developing Local Scale Inventories

To understand the source mix in a local area of interest, this review suggests that a more detailed analysis is warranted to support local-scale modeling for multiple air quality issues. Many areas are engaged in developing local-scale emissions inventories. An EPA study provides examples for inventory approaches that investigate possible contributions to multiple air quality issues (http://www.epa.gov/ttn/chief/local_scale/sti_epa_local_scale_ei_final_report.pdf). The study results [ref 22] provide details on these approaches, and some of the high-level recommendations include:

- Start with what you know—begin by identifying emissions sources in your area of interest, using existing inventories, permit data and other sources of information.
- Use simple approaches, such as emissions-to-distance (Q/D) analysis, to prioritize sources in terms of potential impact on monitoring sites. Emissions-to-distance ratios provide a quick way of comparing local sources.

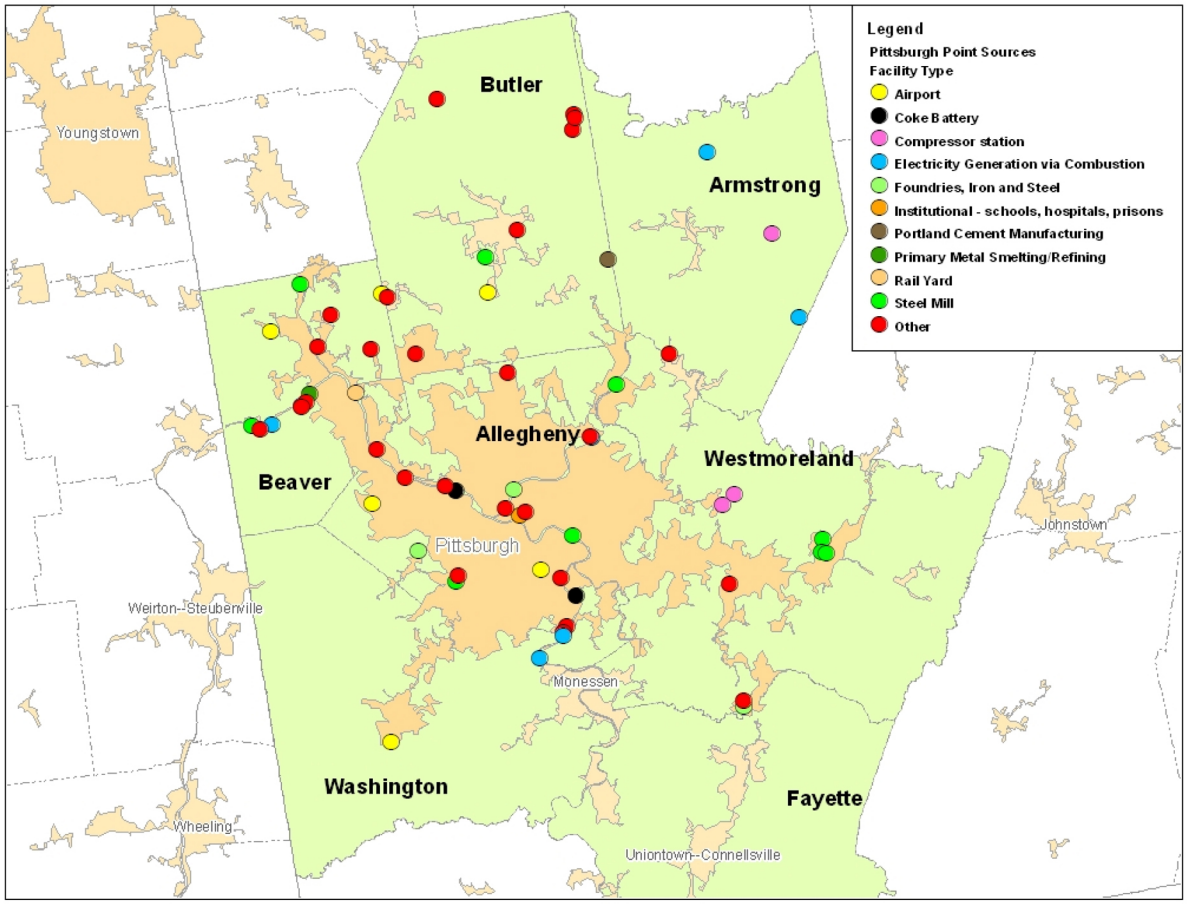


Figure 55: Key Point Sources in the Pittsburgh, PA Area, 2008 NEI

- When conducting analyses on local source contributions, use a weight-of-evidence approach, combining the results of receptor modeling, wind analyses and inter-monitor comparisons to identify sources with significant impacts on monitored concentrations.
- Compare state and local agencies' local-scale emissions data and the NEI to evaluate differences in key elements such as control information.

6. Improvements for 2008 and Future NEIs

The NEI represents a readily-available comprehensive inventory in terms of spatial, pollutant and sector coverage. It undergoes continuous improvement by EPA and with the assistance of state, local and tribal agencies by their reporting emissions information for facilities, other stationary sources and mobile sources. Each cycle of NEI development incorporates improvements based on lessons learned from the previous cycles. Estimation procedures for significant emissions sectors of key pollutants (the available data, tools and methods) typically evolve over time in response to identified deficiencies as the data are used. Some of the uses of the NEI include regulatory analysis using air quality modeling, general emission assessments, national and county-level trends and international reporting. Although the accuracy of individual emission estimates will vary from facility-to-facility or county-to-county, the NEI largely meets the needs of these uses.

The supporting documentation for the 2008 NEI describes some of the improvements for this inventory and data issues that are being resolved. Improvements include:

- More automated QA checks for reported data
- More complete point source augmentation procedures for HAP emissions expected but not reported
- Verification of location coordinates for priority facilities with significant emissions and/or high risk
- Collaboration with state, local and tribal agencies to devise a more consistent method for estimating some important stationary source emissions
- Use of updated estimation models for mobile sources – on-road and nonroad; and wild and prescribed fires
- The development cycle for the 2011 NEI is already underway. Some specific improvements anticipated for the 2011 NEI include:
  - Additional and more stringent QC procedures for reported data
  - More consistent approaches to filling in expected HAP nonpoint emissions that are not reported
  - Ensure emissions information is reported for priority facilities

There will always be aspects of the NEI that may warrant a more thorough review of the data to ensure its reliability. This typically results from questions or new information about potentially significant sources of emissions, or from a use that needs more complete information. Examples of some desired improvements for future NEIs include:

Control Information –

Processing emissions for air quality modeling and pollution control and cost scenarios is one of the significant uses of control information in the NEI. Inaccurate control information can be an important factor in over- or under-estimating the potential emission reductions and associated costs of proposed control programs. If controls are in place, but that information is not part of the NEI, then the EPA may assume that no controls exist and suggest adding controls on processes that are already controlled. A lack of information on existing controls also makes it hard to determine the benefit of additional controls. EPA is trying to better organize such information in more efficient tools for application in regulatory analysis. At this time the NEI is generally not a reliable source of control information, despite existing requirements for this information to be provided by SLTs. State/local or regional air quality modeling efforts typically seek control information outside of the NEI. Possible state and local resources include permits, compliance and emission inventory databases.

EPA also receives some control information as part of the data gathering and analysis for developing industry standards for specific sectors. It is expected that reliable control information in the NEI will benefit national, regional, and therefore local modeling for attainment of the air quality standards. Having more complete control information in the NEI in the future relies on improvements in electronic reporting between industry, states and the EPA.

Specific sector improvements, example: Oil and Gas sector –

High levels of growth in the oil and natural gas production sector, coupled with harmful pollutants emitted during oil and gas production, underscore the need for EPA to gain a better understanding of emissions and potential risks from the production of oil and gas. The 2008 NEI for oil and gas is incomplete. Current and anticipated efforts for improvement include: a focus on state/local/tribal involvement to enable their development and reporting of more complete information; the development of updated emission rates applicable to the various production processes of the oil and gas sector, and to leverage resources and results from on-going studies and other efforts that are addressing emissions from the oil and gas sector. Using these information sources, EPA is developing an oil and gas production estimation tool that will allow for augmentation of oil and gas emissions using nonpoint estimates. Much of this information is outlined in the recently completed Office of Inspector General (OIG) report on oil and gas. This report can be found at: http://www.epa.gov/oig/reports/2013/20130220-13-P-0161.pdf

HAP inventory -

While many states voluntarily submit some HAPs to the 2008 NEI, future improvements could center on making the HAP data more complete in terms of sector and pollutant coverage, as well as developing EPA-based fallback methods for more sectors to fill in data when states do not submit HAPs. Specifically, HAPs from nonpoint stationary sources need improvements for categories such as agricultural burning which currently do not have estimates for HAP emissions.

Improve reporting for key facilities identified in the 2008 NEI –

EPA identified facilities in the 2008 NEI with emissions that put them in the top 80 percent of the national point source category total for any of 18 key criteria and key hazardous air pollutants, i.e., those CAPs and HAPs reviewed in this report. The list is available at http://www.epa.gov/ttn/chief/net/2011inventory.html. With the help of state, local and tribal agencies, we will conduct a focused review of these facilities to result in more complete information for the 2011 NEI. EPA is also working to better use facility emissions estimates from its residual risk program.

7. Concluding Remarks

We would like to thank everyone who helped us complete this report, including all of the state, local and tribal agencies that report data to the NEI. Special thanks for the EPA Office of Research and Development's assistance to format and publish the report. All of the preceding analyses are based on Version 2 of the 2008 NEI that was released to the public in February 2012. Currently, version 3 of the 2008 NEI is available. While there are differences between versions 2 and 3 of the 2008 NEI, many of the major differences have been captured in this report. The reader is directed to http://www.epa.gov/ttn/chief/net/2008inventory.html for further details on version 3. The next full inventory will be completed for the year 2011 and is expected to be released in 2013.

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Reference 8 - List of POM species summarized in this Report:

Polycyclic organic matter (POM) Species with emissions in 2008 V2 NEI		
12-Methylbenz(a)Anthracene	Benzo(a)Fluoranthene	Dibenzo[a,h]Pyrene
1-Methylnaphthalene	Benzo(g,h,i)Fluoranthene	Dibenzo[a,i]Pyrene
1-Methylphenanthrene	Benzo[a]Pyrene	Dibenzo[a,j]Acridine
1-Nitropyrene	Benzo[b]Fluoranthene	Dibenzo[a,l]Pyrene
2-Chloronaphthalene	Benzo[e]Pyrene	Fluoranthene
2-Methylnaphthalene	Benzo[g,h,i,]Perylene	Fluorene
3-Methylcholanthrene	Benzo[j]fluoranthene	Indeno[1,2,3-c,d]Pyrene
5-Methylchrysene	Benzo[k]Fluoranthene	Methylanthracene
7,12-Dimethylbenz[a]Anthracene	Benzofluoranthenes	Methylchrysene
7H-Dibenzo[c,g]carbazole	Carbazole	PAH, total
Acenaphthene	Chrysene	PAH/POM - Unspecified
Acenaphthylene	Dibenz[a,h]acridine	Perylene
Anthracene	Dibenzo[a,e]Pyrene	Phenanthrene
Benz[a]Anthracene	Dibenzo[a,h]Anthracene	Pyrene

Acronym List

NEI	National Emissions Inventory
EPA	Environmental Protection Agency
AQAD	Air Quality Analysis Division
OAQPS	Office of Air Quality Planning and Standards
EIAG	Emissions Inventory Analysis Group
CHIEF	Clearinghouse for Inventories & Emissions Factors
CAP	Criteria Air Pollutant
HAP	Hazardous Air Pollutant
CO	Carbon Monoxide
NH_3	Ammonia
NO_x	Nitrogen Oxides
PM	Particulate Matter
PM_{10}	Particulate Matter 10 Microns or less
$PM_{2.5}$	Particulate Matter 2.5 Microns or less
SO_2	Sulfur Dioxide
VOC	Volatile Organic Compounds
Pb	Lead
Hg	Mercury
HCL	Hydrochloric Acid
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
POM	Polycyclic Organic Matter
SESQ	Sesquiterpenes
TERP	Terpenes
TSD	Technical Support Document
NAAQS	National Ambient Air Quality Standard
NATA	National-Scale Air Toxics Assessment ("2005" refers to NATA conducted for year 2005)
EGU	Electric Generating Unit
MOVES	Motor Vehicle Emission Simulator
GPR	General Public Release
TRI	Toxic Release Inventory
EIS	Emissions Inventory System
NCDC	National Climatic Data Center
NOAA	National Oceanic and Atmospheric Administration
SLT	State/Local/Tribe
SOAP	Secondary Organic Aerosol Production
MIR	Maximum Incremental Reactivity
SOA	Secondary Organic Aerosol
CEM	Continuous Emissions Monitoring
NEC	Not Elsewhere Classified
CMV	Commercial Marine Vehicle
FC	Fuel Combustion
MobNR	Mobile Nonroad
MobOR	Mobile Onroad
MobOR DieselHD	Mobile On-road Diesel Heavy Duty Vehicles
MobOR DieselLD	Mobile On-road Diesel Light Duty Vehicles
MobOR GasHD	Mobile Gasoline Heavy Duty Vehicles
MobOR GasLD	Mobile Gasoline Light Duty Vehicles
Solv-Commindust	Solvent Commercial Industry
Wild Land Fires	Includes both wildfires and prescribed fires
ICI	Industrial, Commerical and Institutional
Ngas	Natural Gas
FC	Fuel Combustion
SqMi	Square Mile
Ppm	Parts per million
MW	Megawatts
GTE	Greater than or equal (≥)
Mfg	Manufacturing
Agric	Agriculture
PR	Puerto Rico
VI	Virgin Islands
DM	Federal Waters (Domestic Waters)
BS	BlueSky
SF2	SMARTFIRE2
OMB	Office of Management & Budget
CBSA	Core Based Statistical Area

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Air Quality Assessment Division
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