Visualization and Comparison of recent versions of the National Emissions Inventory As a Prelude to MANE-VU Modeling Inventory

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ABSTRACT

To help prioritize 2002 emissions inventory needs for MANE-VU Regional Haze modeling efforts, MANE-VU previously summarized version 2 of the 1999 NEI for criteria pollutants and NH_3 for the Mid-Atlantic and Northeastern states, identifying the most important source categories in the region and gaps and abnormalities in the data. This paper builds on the previous work, summarizing and comparing recent inventories as a first step of preparing 2002 MANE-VU regional modeling inventory.

Specifically, this paper: (i) summarizes the 2002 preliminary NEI point, area, highway, and non-road PM10, PM2.5, SO2, NOx, VOC, and NH3 emissions for MANE-VU Region, (ii) compares the emission levels between the 1996, 1999 v2, 1999 v3, and preliminary 2002 NEI, (iii) includes county level emission density maps for those four major source groups and a number of source categories that are important for the region, and (iv) identifies source categories to which special attention should be given when preparing 2002 modeling inventory to eliminate gaps, abnormalities, and other potential problems.

INTRODUCTION

The 2002 preliminary National Emissions Inventory (NEI) has been used in this study. Also NEI 1996, 1999 v2 and 1999 v3 have been used for comparison purposes. States will be submitting their best data in June 2004 to EPA and a 2002 NEI inventory with state submitted data is expected to be released by EPA in 2005. Therefore, emissions presented in this study for 2002 do not necessarily reflect the most up to date NEI data that will become available.

The summary presented in this paper is the first step in preparing an improved regional modeling inventory for MANE-VU (Mid-Atlantic / North East Visibility Union). The purpose of this study is to help understand the most important source categories for the precursors of ozone, $PM_{2.5}$, and haze in the Mid-Atlantic and Northeast regions, and identify data gaps and abnormalities in the 2002 preliminary NEI. Lessons learned will be used to improve the 2002 base year modeling inventory and focus inventory work on those source categories where improvements are necessary. No inventory is ever complete or perfect. Usually very limited time is available between the release of a national inventory and required modeling studies for SIP or other demonstration purposes. A 2002 NEI with state submitted data will not be available until mid-2005. MANE-VU's goal is to prepare an improved regional inventory by the end of 2004.

Tables and plots presented in this paper give a brief overview of the preliminary 2002 inventory for the Mid-Atlantic and the Northeast Region. A much larger suite of summary tables and plots, and county based emissions density maps for those SCC categories comprising a large portion of the inventory for each pollutant of concern (CO, NH_3, NO_x, SO_2, $PM_{2.5}$, PM_{10}, and VOC) are available online at www.marama.org/visibility. Comments are invited.

The MANE-VU region covers Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

Mid-Atlantic Regional Air Management Association (MARAMA) states are Delaware, the District of Columbia, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, and West Virginia.

Northeast States for Coordinated Air Use Management (NESCAUM) states are Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.

SUMMARY OF EMISSIONS IN THE MID-ATLANTIC AND NORTHEAST REGION

Figure 1 shows the total annual emissions by state in the Mid-Atlantic and Northeast Region for NH_3, NO_x, SO_2, $PM_{2.5}$, PM_{10}, and VOC. The figure gives an overall comparison of emissions levels between the states for each pollutant.

Figure 2 shows the comparison of five source types (including biogenic emissions) by pollutant. Biogenic emissions only include NOx, VOC, and CO. Biogenics contributes 51% of total VOC in the MANE-VU region.

Figure 3 shows total annual emissions on a more specific level, by four major source types (point, area, onroad, and nonroad) in the MANE-VU region and compares 1996, 1999, and 2002 levels. Tables showing emissions for each pollutant by four major source types by state can be found online at www.marama.org/visibility.

Wildfires, Prescribed Fires and Agricultural Burning

Fires in the MANE-VU region are not a significant part of the inventory; however the emissions estimates are highly uncertain. Figures 4a and 4b show the fire emissions estimates from 2002 NEI for wildfires, and prescribed fires in MANE-VU.

IMPORTANT SOURCE CATEGORIES IN THE MANE-VU REGION

This discussion focuses on those source categories that represent the major contributions to primary fine particulate emissions and the gaseous precursors of secondary particulates in the MANE-VU region.

Emission summaries developed in this study will assist MANE-VU in deciding where to focus emissions inventory improvement activities. Emissions are presented for aggregate source categories summed for all states in the MANE-VU region for each pollutant for annual levels. Emissions totals for at least 90% of the emissions for each pollutant in the region can be found online at www.marama.org/visibility. In this paper, an example summary for NH_3 is presented in Table 1.

Carbon Monoxide

Gasoline Highway Vehicles (about 64%) and Gasoline Off Highway Vehicles (about 19%) comprise an overwhelming 83% of the CO emissions annually in the MANE-VU region. This is a slight (2%) increase in percentage of Gasoline Highway Vehicle contribution to CO emissions compared to the 1999 level. Total CO emissions in 2002 preliminary inventory are about 17.3 M t/y as compared to 19 M t/y in 1999 v3 NEI.

Ammonia

On an annual basis, Agricultural Production (Livestock) comprises over 56% of the regional NH_3 emissions (about a 6% increase with respect to 1999 numbers), followed by Highway Vehicles with 18% (a slight increase). Miscellaneous Area Sources and Wastewater Treatment activities each contribute about 11% (as opposed to 12.5% in 1999) to the total NH_3 emissions in the region (Table 1). An emissions density map for annual area source NH_3 emissions is presented in Figure 5.a. Total NH3 emissions in the 2002 preliminary inventory are about 0.273 M t/y as compared to 0.267 M t/y in 1999 v3 NEI.

Oxides of Nitrogen

Emissions from External Combustion Boilers (Electric Generation) make up about 16% of regional NO_x emissions. Highway Vehicle emissions (Gasoline: 26% and Diesel: 22%) comprise about 47% of the regional total. (Comparison with the 1999 numbers shows a 7% increase in the contribution of Highway Vehicle Emissions.) Residential Stationary Source Fuel Combustion, Diesel Nonroad Vehicles, and Industrial External Combustion Boilers are the other major NO_x contributors. An emissions density map for annual onroad NO_x emissions is shown in Figure 5.b. Total NOx emissions in 2002 preliminary inventory are about 2.7 M t/y as compared to 3.0 M t/y in 1999 v3 NEI.

Particulate Matter

Emissions from Roads (Paved: 21% and Unpaved: 23%) contribute about 44% (2% decrease compared to the 1999 numbers) of the PM_{10} emissions. Industrial Construction, Agricultural Crop Production, and Residential Wood Combustion are the following major contributors. Total PM emissions in 2002 preliminary inventory are about 1.7 M t/y as compared to 2.0 M t/y in 1999 v3 NEI.

Fine Particulate Matter

Similarly, Roads (Paved: 8% and Unpaved: 9.5%) contribute about 17.5% to the total $PM_{2.5}$ emissions. Open Burning comprises about 12%. All these categories show a decrease compared to their contribution levels of 1999. Industrial External Boilers and Industrial Construction are other major $PM_{2.5}$ sources in the region. An emissions density map for annual area source $PM_{2.5}$ emissions is shown in Figure 5.c. (Note that a paper by M. Schuster, S. Roe and M. Sullivan, et. al, on Residential Wood Combustion Activity and Emissions Inventory presented at this conference shows a need to revise the NEI for Residential Wood Combustion.) Total PM2.5 emissions in 2002 preliminary inventory are about 0.6 M t/y as compared to 0.75 M t/y in 1999 v3 NEI.

Sulfur Dioxide

External Combustion Boilers (Electric Generation) are responsible for about 70% of the regional SO_2 emissions. Industrial External Combustion Boilers, and Industrial Stationary Source Fuel Combustion are the following major source categories. An annual point source SO_2 emission level map is shown in Figure 5.d. Total SO2 emissions in 2002 preliminary inventory are about 2.5 M t/y as compared to 2.8 M t/y in 1999 v3 NEI.

VOC

Gasoline Highway Vehicles make up about 28% of the regional VOC emissions. Residential Stationary Source Fuel Combustion, Consumer Solvents, Industrial Surface Coating, and Pleasure Craft are other major contributors. Total VOC emissions in 2002 preliminary inventory are about 2.5 M t/y as compared to 3.0 M t/y in 1999 v3 NEI.

Emissions summaries for each pollutant (presented for NH_3 in Table 1) identify the source category groupings that may be the most significant contributors to pollution problems. A series of county based emissions density maps for the region for all source types (point, area, onroad, and nonroad) and for important source category grouping is available on-line at www.marama.org/visibility. These maps are being reviewed to judge data accuracy and, to identify possible emissions calculation inconsistencies between states. This effort will help establish transparency as well as help detect data abnormalities as a first step QA/QC while we put together our regional modeling inventory.

COMPARISON OF THE 1999 NEI WITH THE PREVIOUS INVENTORIES

Figures 6.a. through 6.d. display the comparisons between the 1996, 1999 v2 and v3, and preliminary 2002 NEI annual emissions for NH_3, NO_x, $PM_{2.5}$ (primary), and SO_2. NH3, NO_x, SO2 and $PM_{2.5}$ emissions show a slight decrease in 2002 compared to previous levels. It should be kept in mind that state submitted data and further improvements in the upcoming months may change the picture presented in these figures.

CURRENT EFFORTS TOWARD IMPROVED REGIONAL MODELING INVENTORY and NEXT STEPS

MANE-VU has completed several projects to improve the regional emissions inventory. The Open Burning report improved emission estimates from of residential burning of municipal solid waste, residential leaf and brush burning, and municipal yard waste burning. The Residential Wood Combustion project surveyed residences in the MANE-VU region and developed an improved emissions inventory for indoor and outdoor wood burning equipment. MANE-VU also completed a project on estimating ammonia emissions from cement plants, industrial refrigeration, composting and publicly owned treatment works. MARAMA is in the process of completing an in-house calculation sheets project. This project summarized emissions calculation methods for 17 area and nonroad source categories. The sheets describe in detail the preferred method of calculating emissions for the MANE-VU region. All emissions inventory improvement reports and data can be found on the MARAMA website at www.marama.org/visibility.

MANE-VU has several projects underway to develop a regional modeling emissions inventory. These include an Area and Point source modeling emissions inventory project and an onroad and nonroad emissions inventory project. The Area and Point source project will develop emission estimates for certain area source categories, such as fires and fugitive dust. These projects will result in a 2002 regional modeling inventory for Regional Haze, Ozone and PM base year modeling.

CONCLUSIONS

QA/QC of emissions inventories is a non-trivial and ambiguous task. Emissions modeling tools, such as SMOKE and EMS have visualization capabilities, however, only for the processed (spatially gridded, chemically speciated, temporally allocated) emissions. In most cases, visualization of raw data, i.e. NEI data, is beneficial to detect errors, data gaps, abnormalities, and inconsistencies between neighboring states or regions due to differences in emissions calculation methods. In an attempt to help detect those problems and to prevent them in the upcoming 2002 MANE-VU modeling inventory, MARAMA prepared a series of summary tables, comparison plots, and county-based emission density maps of preliminary 2002 NEI data and compared them with the previous inventories for the Mid-Atlantic and Northeastern states. An inter-RPO project will develop an emissions inventory database system that will allow visualization and QA/QC of the emissions inventory in this manner. That system will make it easier to develop similar summaries and reports.

ACKNOWLEDGEMENTS

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KEYWORDS

Emission Inventory
Regional Haze
Preliminary 2002 NEI
MANE-VU
MARAMA
NESCAUM
Point Source
Area Source
Onroad Sources
Nonroad Sources

TABLES

Table 1. 2002 NEI summary by source category for NH_3 in MANE-VU.

Source Category	Source Type	ANNUAL	
		Emissions (tons/year)	Percent of Total
Miscellaneous Area Sources-Agriculture Production - Livestock	Area	151,253	56
Highway Vehicles - Gasoline	Onroad	50,011	18
Miscellaneous Area Sources-Agriculture Production - Crops	Area	29,896	11
Waste Disposal, Treatment, and Recovery-Wastewater Treatment	Area	26,184	10
Miscellaneous Area Sources - Agriculture Production - Livestock - Horses and Ponies	Area	5,810	2
External Combustion Boilers-Electric Generation	Point	1,187	0
Highway Vehicles - Diesel	Onroad	1,096	0
Industrial Processes-Chemical Manufacturing	Point	1,040	0
Stationary Source Fuel Combustion-Industrial	Area	997	0
Stationary Source Fuel Combustion-Commercial/Institutional	Area	942	0
Top 10 Categories		268,416	98.5
Other Point Sources	Point	710	0.3
Other Nonroad Sources	Nonroad	512	0.2
Other Onroad Sources	Onroad	0	0.0
Other Area Sources	Area	2,873	1.1
Total NH3 Emissions		**272,510**	**100**

FIGURES

Figure 1. 2002 preliminary NEI total annual emissions by state (excludes Biogenics)

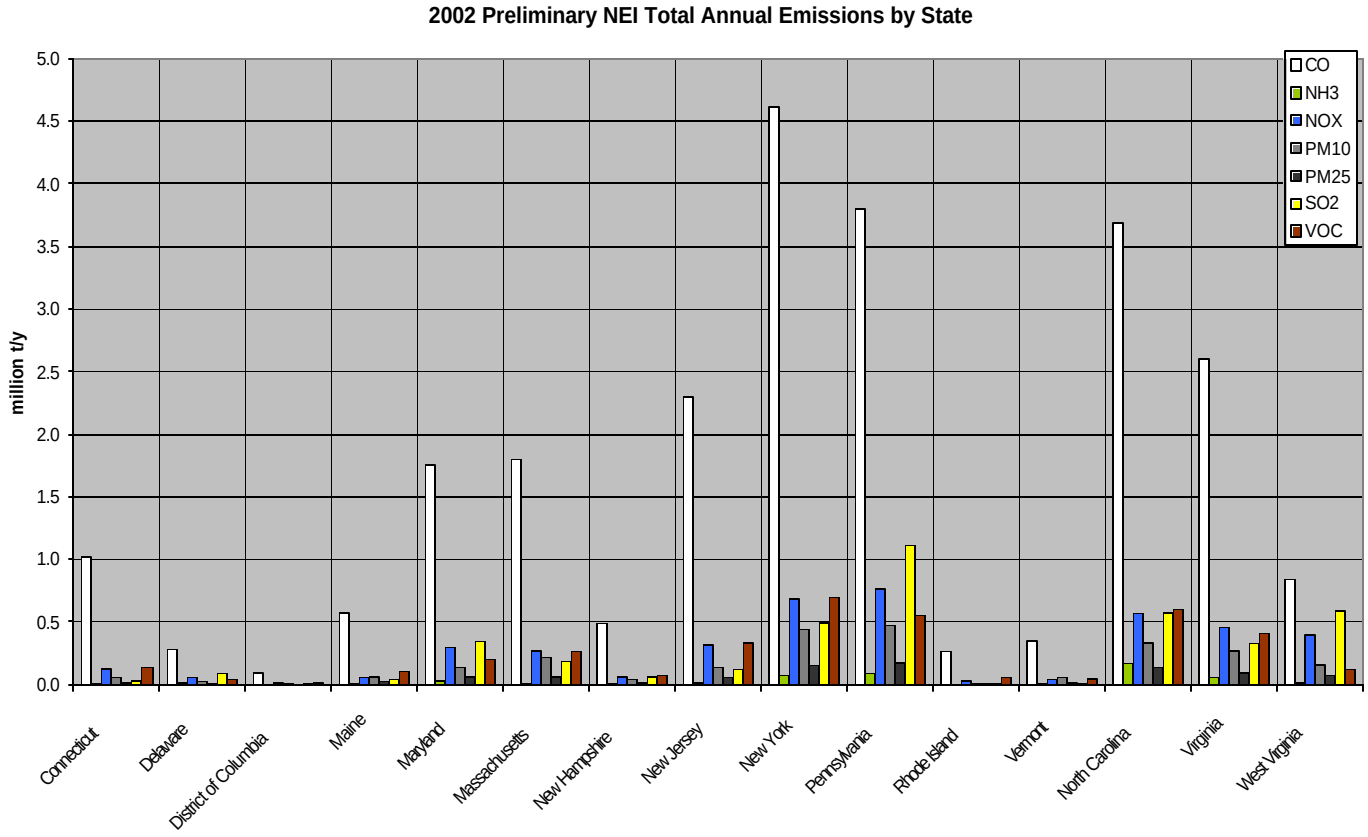
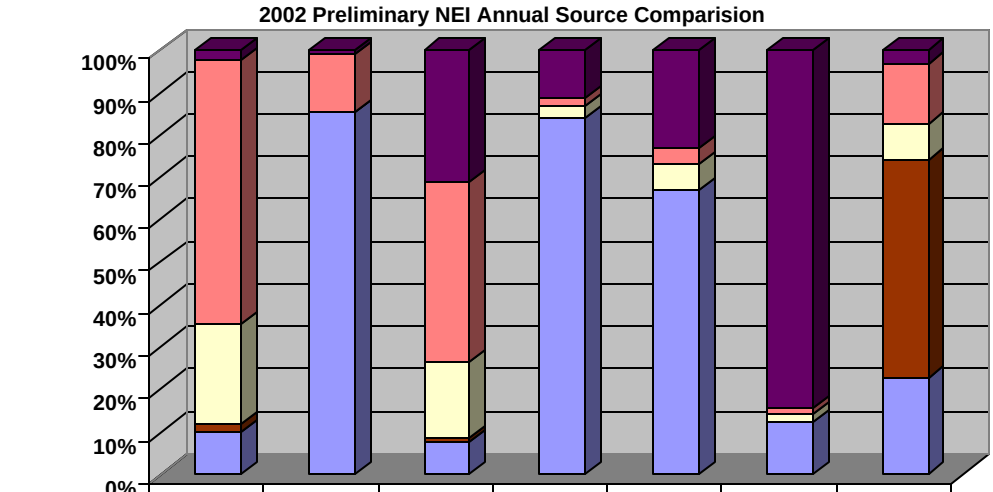


Figure 2. 2002 Preliminary NEI Annual Source Comparison including Biogenics



	CO	NH3	NOx	PM10	PM25	SO2	VOC
POINT	633,038	4,250	1,315,213	279,018	208,558	3,347,455	259,963
ONROAD	15,498,276	70,515	1,781,376	48,570	35,171	59,432	1,052,546
NONROAD	5,840,908	675	739,434	60,112	55,109	78,863	628,446
BIOGENIC	493,717		47,562				3,842,430
AREA	2,524,475	437,244	320,953	2,044,336	603,202	494,089	1,710,080

Figure 3. MANE-VU region annual point, area, mobile, non-road, and total emissions for 1999, and 2002.

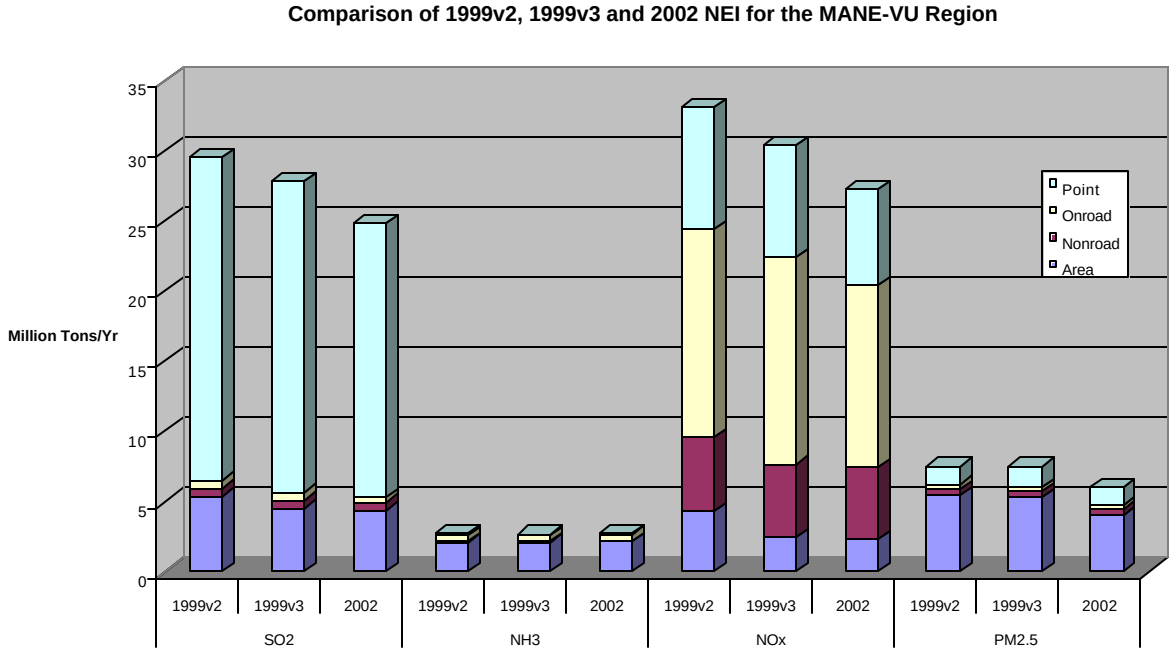


Figure 4.a. 2002 Preliminary NEI Wildfire emissions

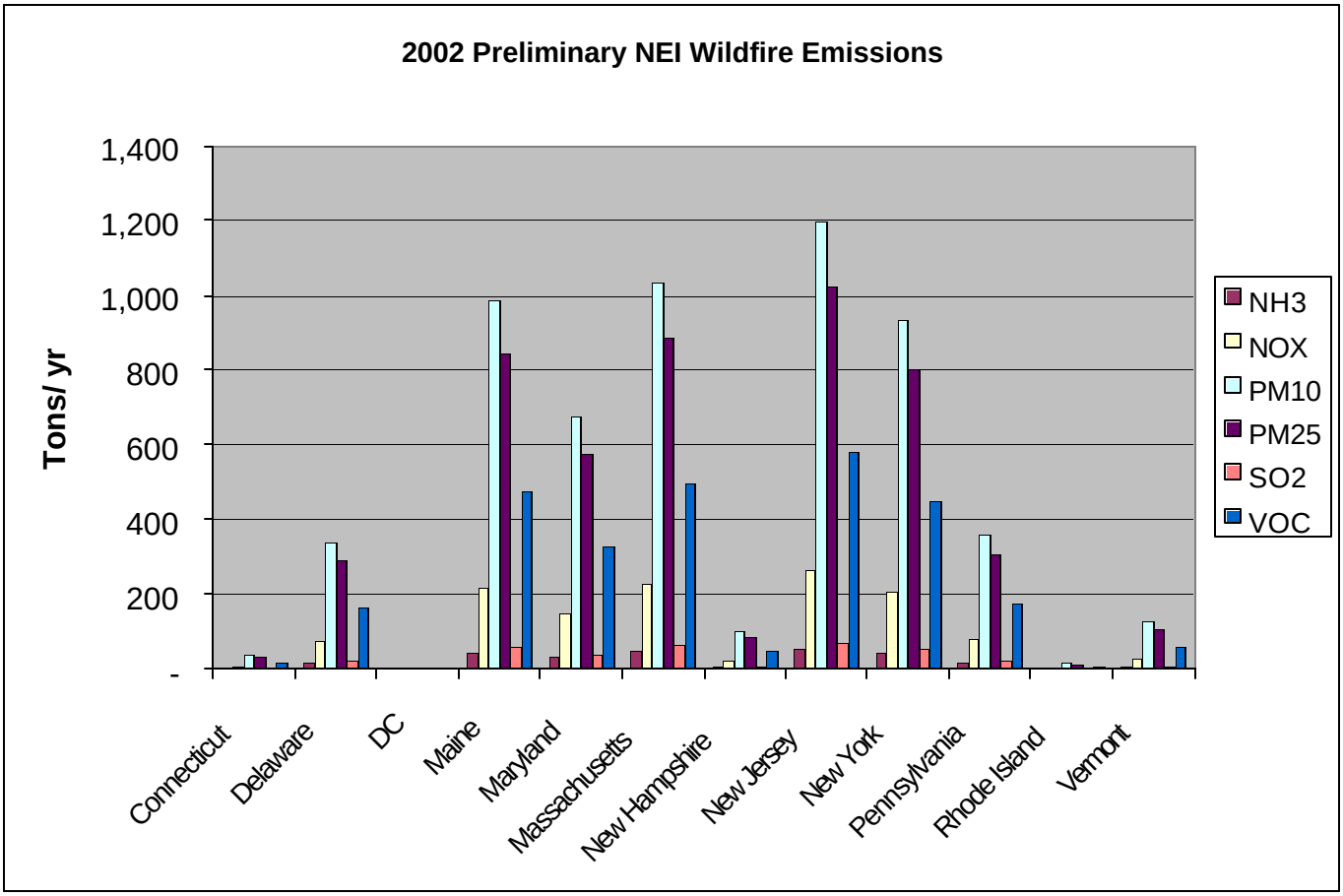


Figure 4.b. 2002 Preliminary NEI Prescribed Fire Emissions

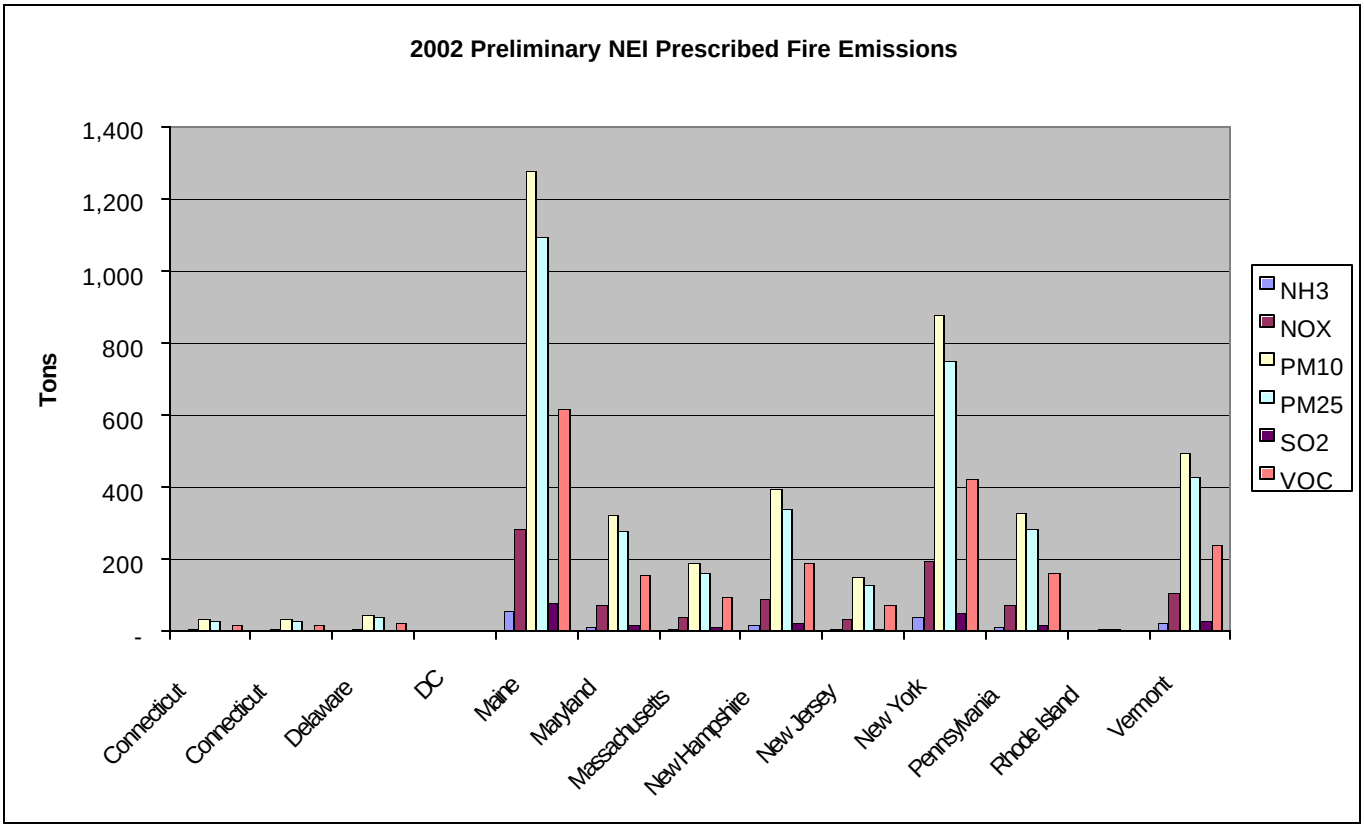


Figure 5.a. Emission Density Map for Annual Area Source NH3.

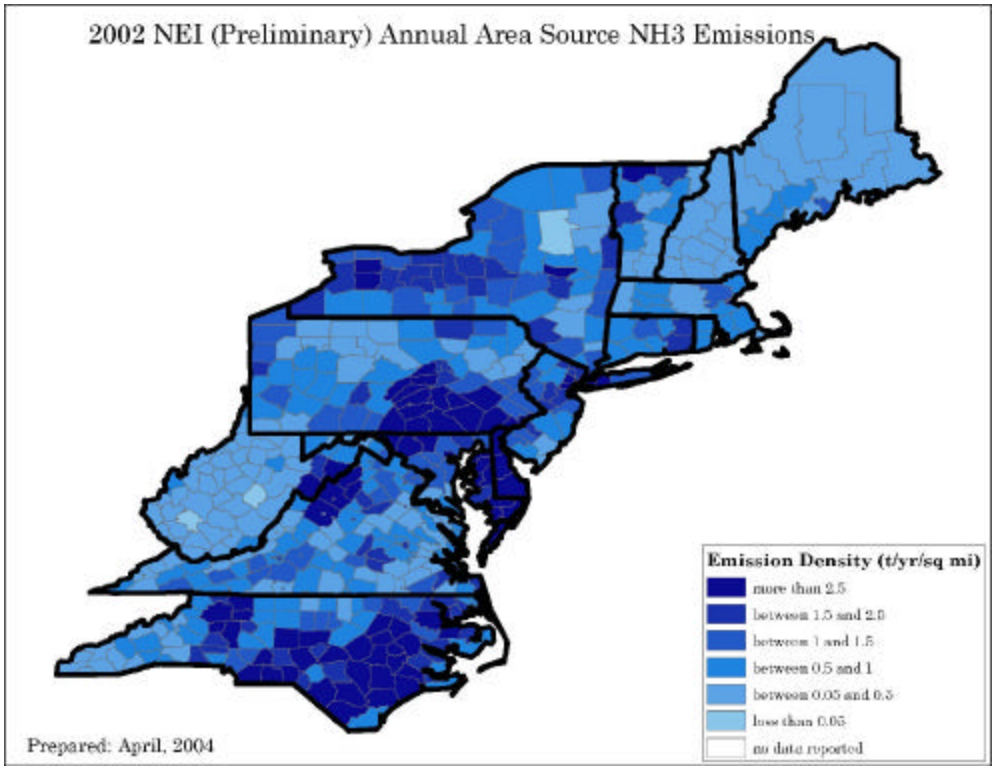


Figure 5.b. Emission Density Map for Annual Onroad Source NOx.

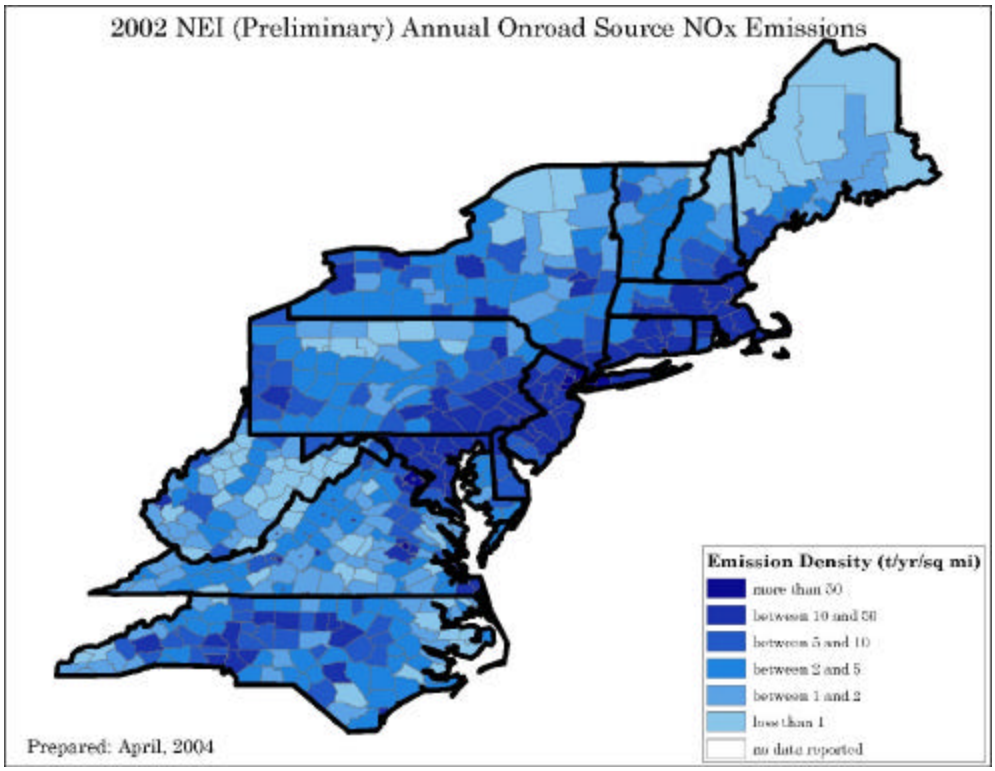


Figure 5.c. Emission Density Map for Annual Area Source PM2.5.

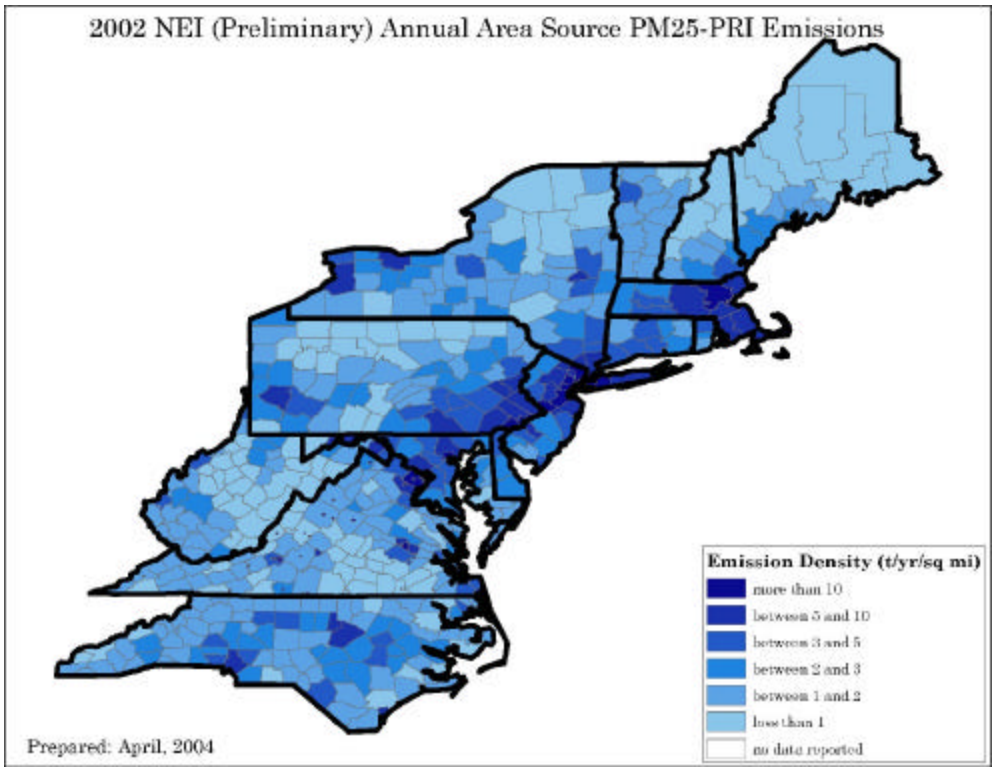


Figure 5.d. Emission Density Map for Annual Point Source SO2.

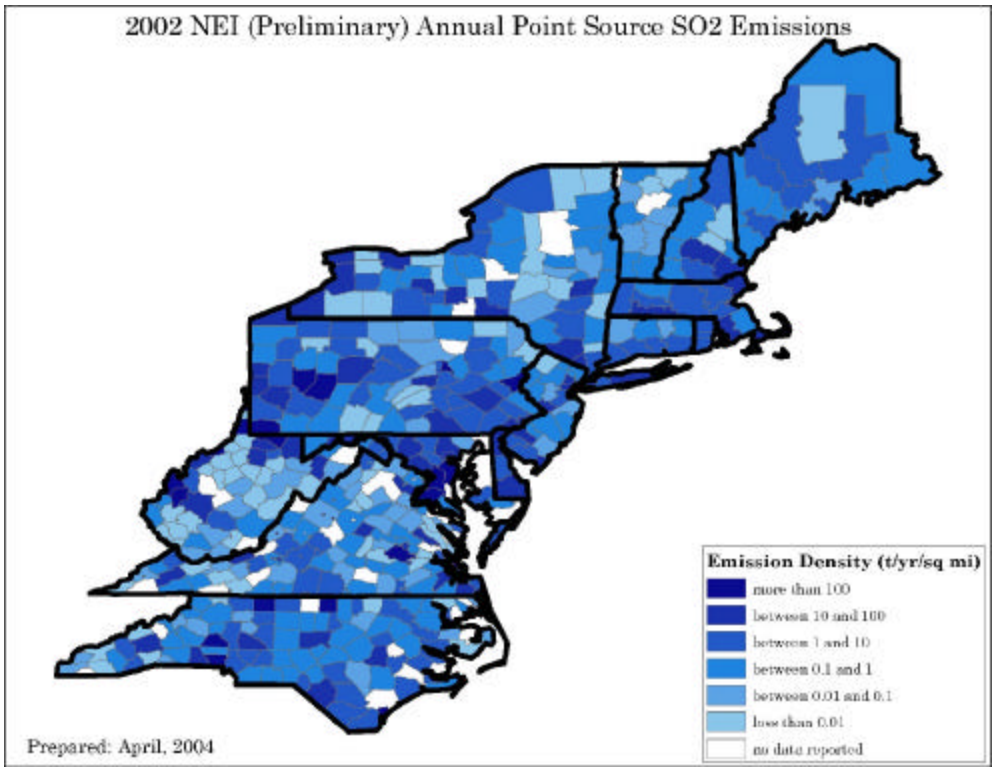


Figure 6.a. Comparison of Total Annual NH_3 emissions by state.

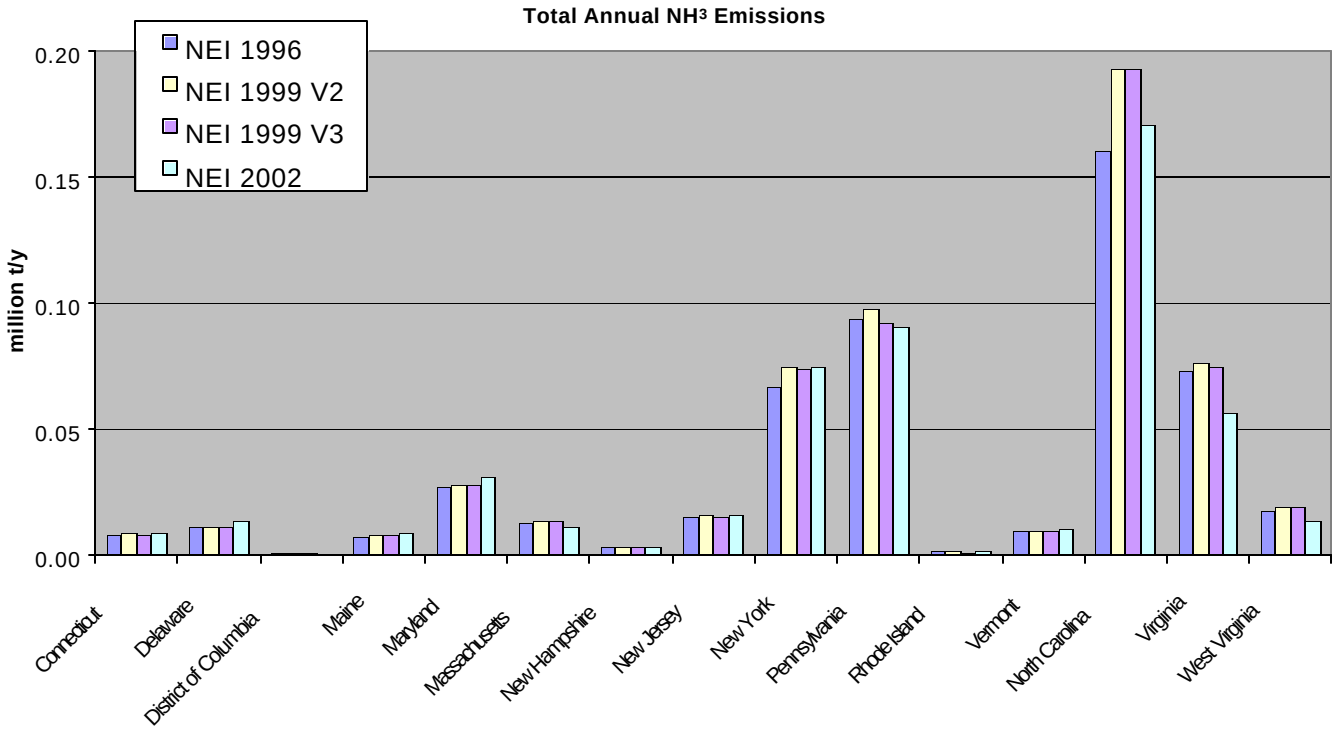


Figure 6.b. Comparison of Total Annual NOx emissions by state.

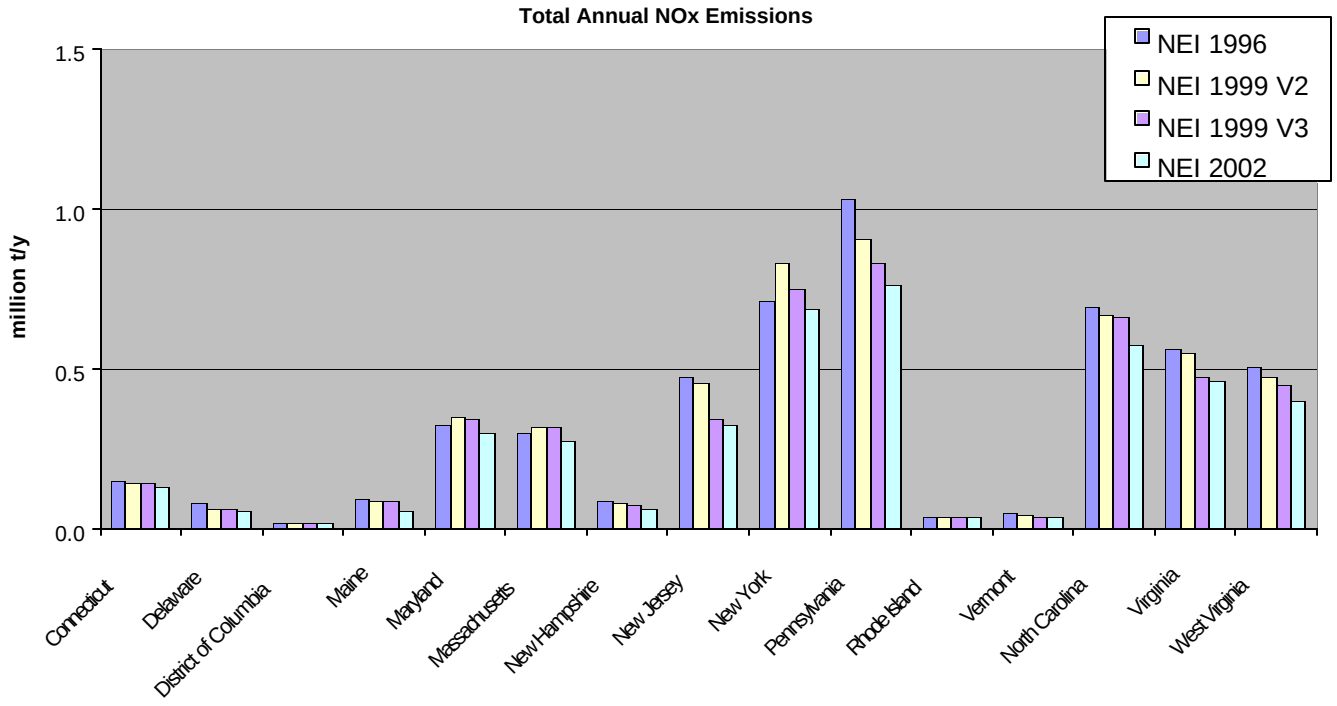


Figure 6.c. Comparison of Total Annual PM2.5 emissions by state.

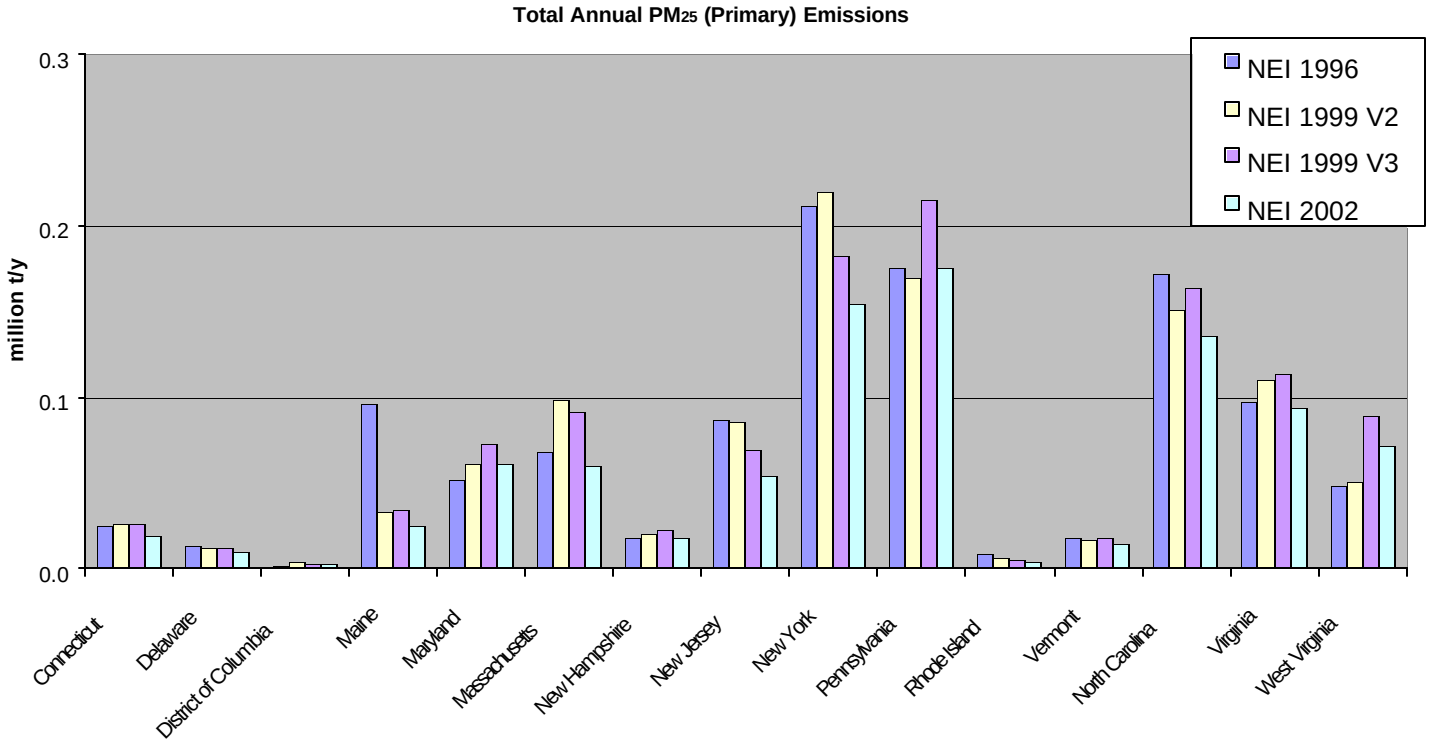


Figure 6.d. Comparison of Total Annual SO2 emissions by state.