Visualization of 1999 NEI as a Prelude to 2002 NEI Inventory for Mid-Atlantic and Northeastern States

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Purpose

- 2002 inventory is expected to be the basis for upcoming ozone, $PM_{2.5}$, and regional haze modeling
- Very limited time available between anticipated release of the inventory and the modeling work.
- It will be crucial to prepare a high quality 2002 modeling inventory that will require minimal revisions and iterations.

Purpose (cont'd)

- To help prioritize 2002 emissions inventory needs, identify:
  - most important source categories for precursors of haze in the MANE-VU region
  - gaps and abnormalities in the data
- 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.

Purpose (cont'd)

- Regional and state by state summary of total, point, area, highway, and non-road (annual and OSD) emissions.
- CO, NH_3, NO_x, SO_2, PM_{10}, $PM_{2.5}$, and VOC
- Mid-Atlantic and Northeastern states (MANE-VU states + VA, WV, NC).
- County level density maps for total, point, area, onroad, and nonroad (annual and OSD).
- Compare 1999 with previous inventories.

Purpose (cont'd)

- Identify (SCC based) source categories comprising at least 90% of the emissions.
- Detect those categories where gaps and data abnormalities.
- Detect inconsistencies in calculation methods.
- Establish transparency.

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- A large 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. Comments are invited.
- http://www.marama.org/visibility/NEI1999/

or

- http://www.marama.org/
  - Regional Haze
  - Visualization and QA/QC of 1999 NEI

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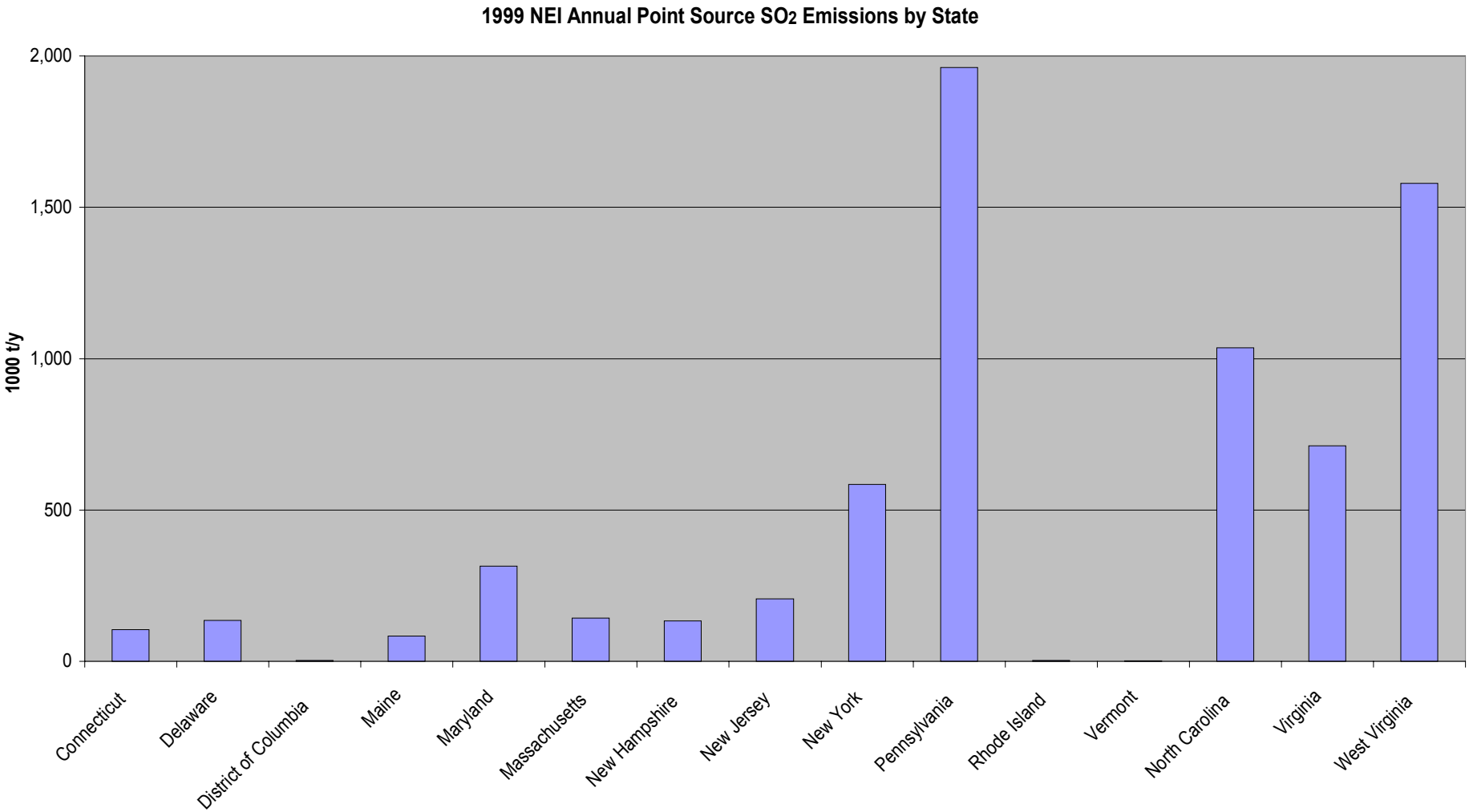
- The 1999 National Emissions Inventory (NEI) version 2 has been used for this study.
- Version 3 of the 1999 NEI will be available in May 2003, and further state revisions are expected.
- A few states in the Mid-Atlantic and Northeast region (i.e. New Jersey, New York, and probably some others) will have improved data in version 3, especially for point sources.
- Emissions presented in this study do not necessarily reflect the most up to date NEI data corrected by some of the states.
- However, QA/QC and visualization of the NEI take time, and one must initiate this process in parallel with preparation of new versions of inventories.

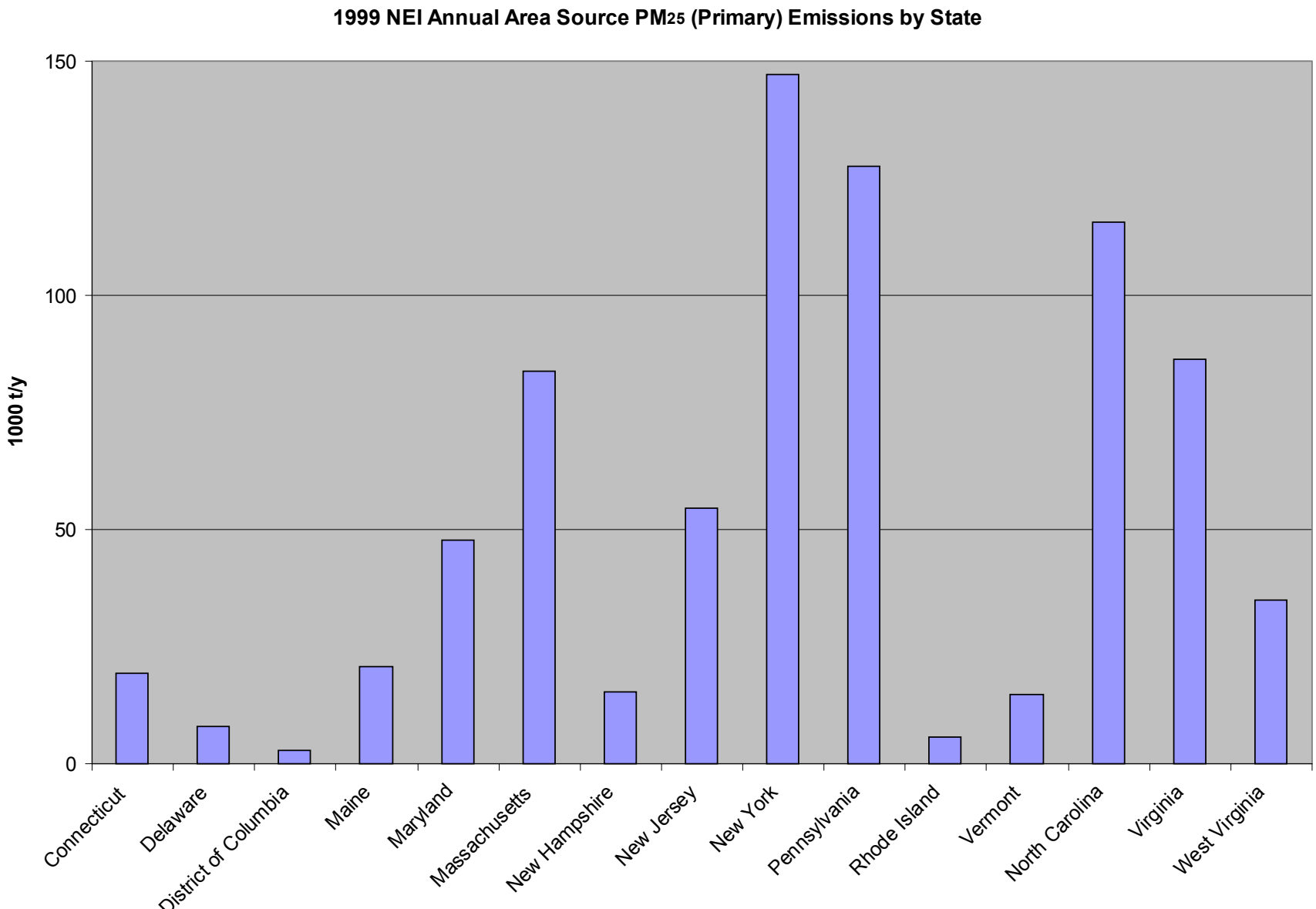
Summary Plots by Major Source Category, Pollutant, and State (Annual and OSD)

1999 NEI Summary by Region and States (annual and OSD)								
Source Category								
Point Sources	CO	NH3	NOx	PM10	PM2.5	SO2	VOC	all pollutants
Area Sources	CO	NH3	NOx	PM10	PM2.5	SO2	VOC	all pollutants
Non-Road Sources	CO	NH3	NOx	PM10	PM2.5	SO2	VOC	all pollutants
Highway Mobile Sources	CO	NH3	NOx	PM10	PM2.5	SO2	VOC	all pollutants
Total	CO	NH3	NOx	PM10	PM2.5	SO2	VOC	all pollutants

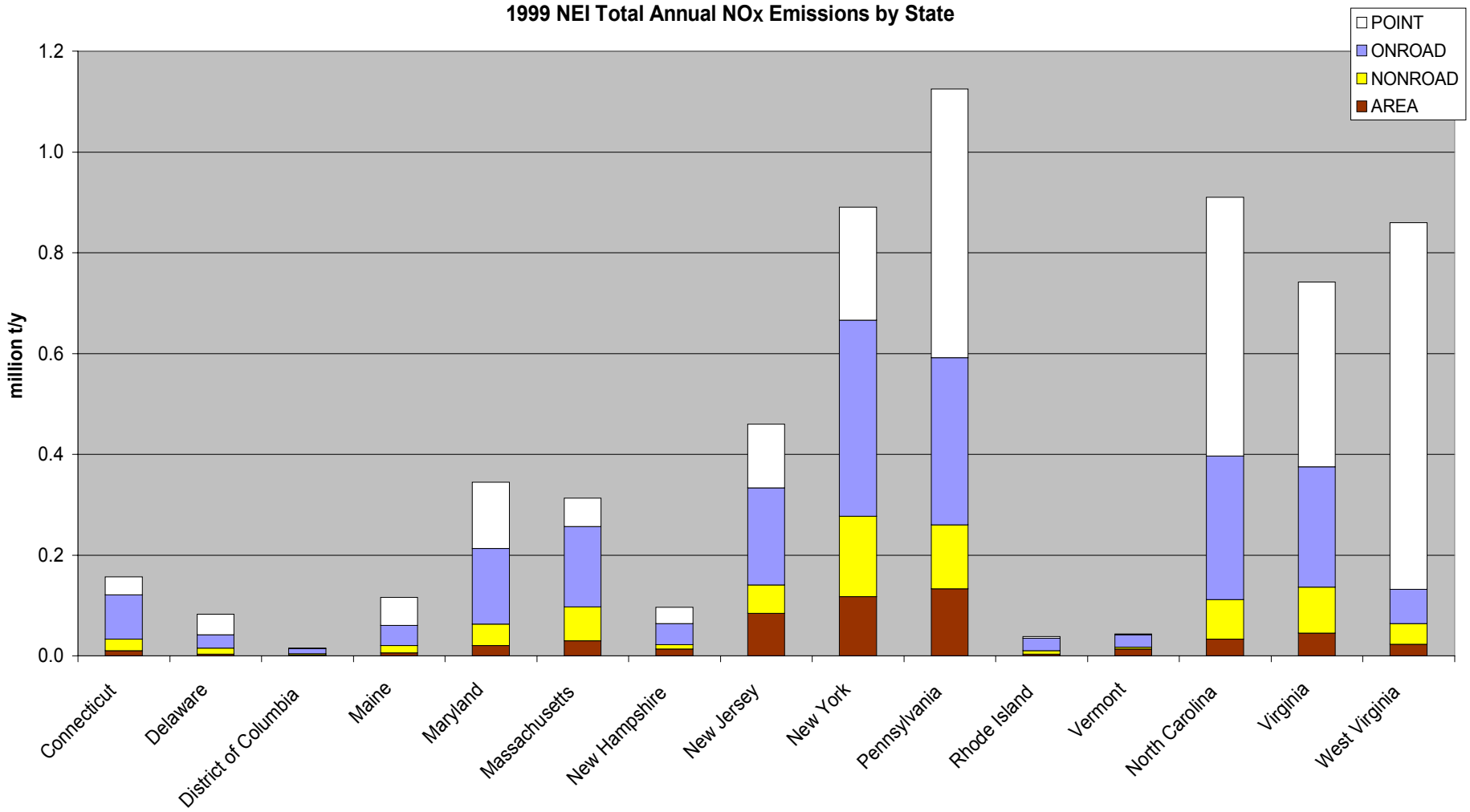
1999 NEI Annual Point Source SO_2



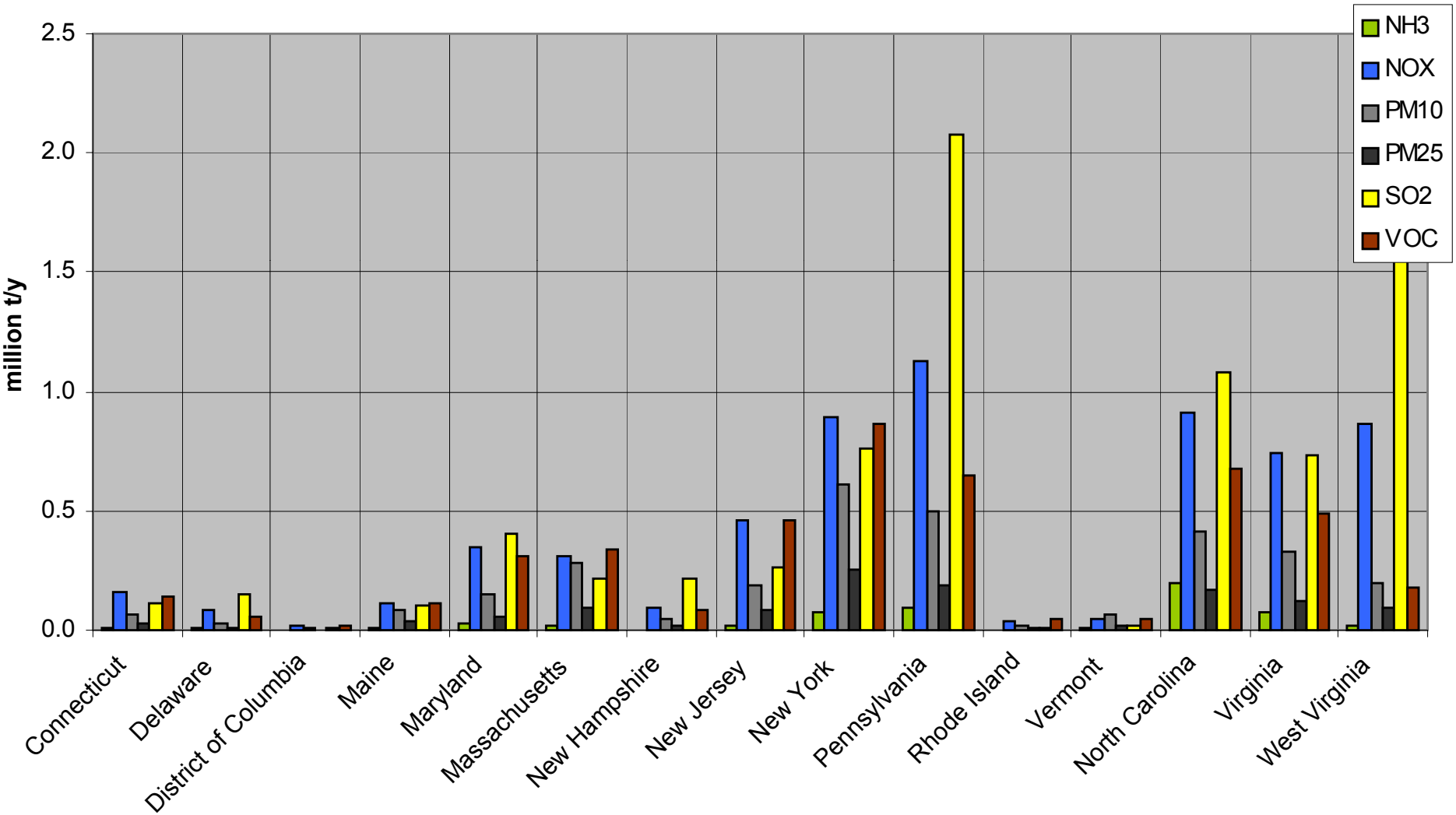
1999 NEI Annual Point Source $PM_{2.5}$



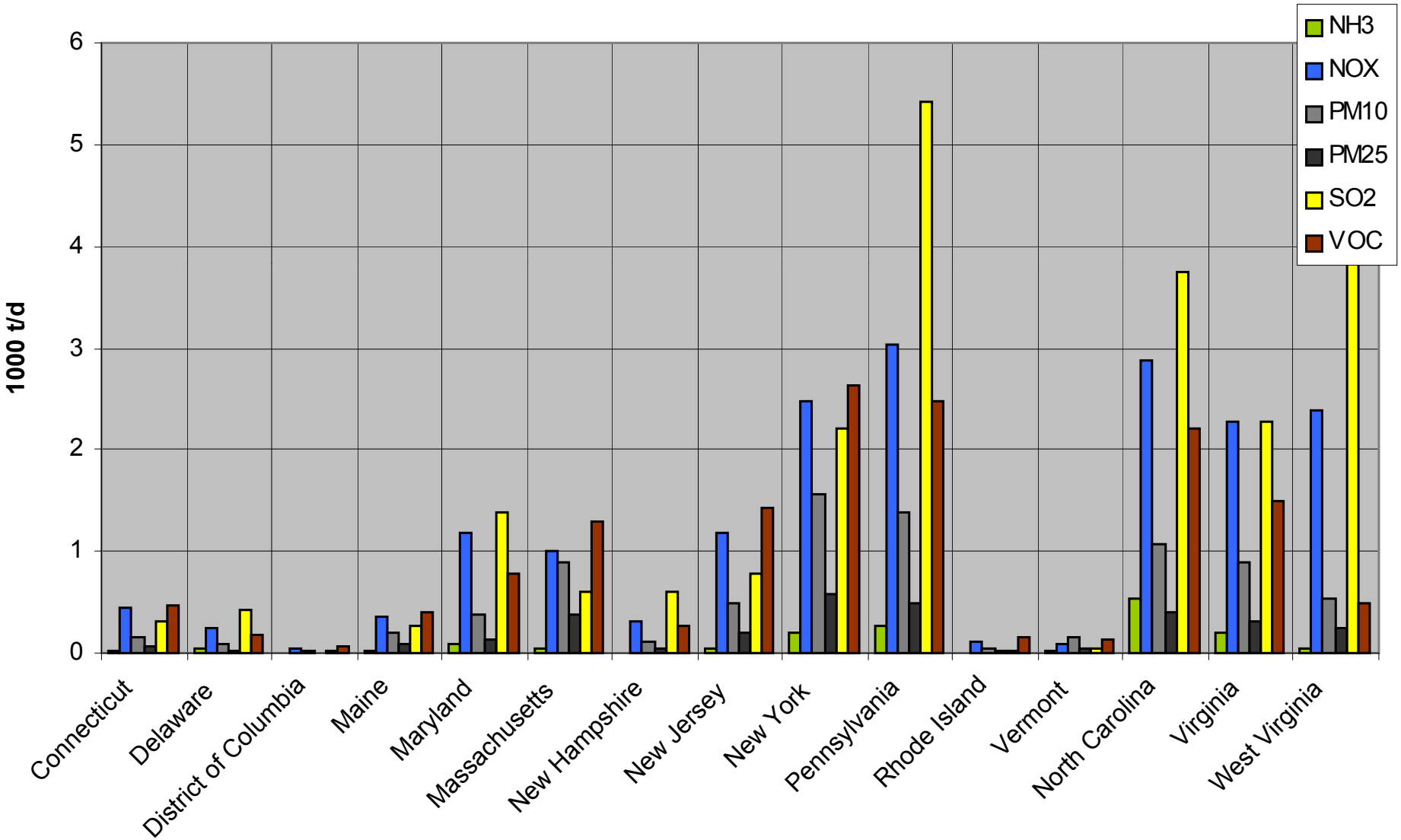
Total NOx Emissions by State



1999 NEI total annual emissions by state



1999 NEI total OSD emissions by state



Major Source Category Summary Tables by Pollutant, Region and State (Annual and OSD)

1999 NEI Summary by Source Category							
MANE-VU Total	CO	NH_3	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
MARAMA + NESCAUM Total	CO	NH_3	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC

SO_2 Emissions – MANE-VU States

Source Category	Source Type	ANNUAL		OSD	
		Emissions (tons/year)	Percent of Total	Emissions (tons/day)	Percent of Total
External Comb. Boilers – Electric Generation	Point	3,050,520	70.4	8,428	69.8
External Comb. Boilers – Industrial	Point	416,377	9.6	1,364	11.3
Stationary Source Fuel Combustion – Industrial	Area	279,004	6.4	894	7.4
Stationary Source Fuel Combustion – Comm./Inst.	Area	134,856	3.1	284	2.4
Stationary Source Fuel Combustion – Residential	Area	120,120	2.8	67	0.6
External Combustion Boilers – Comm./Inst.	Point	53,909	1.2	134	1.1
Highway Vehicles – Gasoline	Onroad	38,402	0.9	113	0.9
Off-Highway Vehicle Diesel	Nonroad	31,119	0.7	139	1.2
Marine Vessels – Commercial	Nonroad	20,695	0.5	57	0.5
Industrial – Primary Metal Production	Point	15,822	0.4	58	0.5
Top 10 Categories		4,160,824	96.1	11,538	95.6
Other Point Sources	Point	140,351	3.2	451	3.7
Other Nonroad Sources	Nonroad	5,549	0.1	13	0.1
Other Onroad Sources	Onroad	17,999	0.4	48	0.4
Other Area Sources	Area	5,712	0.1	16	0.1
Total SO_2 Emissions		4,330,434	100	12,066	100

NO_x Emissions – MANE-VU States

Source Category	Source Type	ANNUAL		OSD	
		Emissions (tons/year)	Percent of Total	Emissions (tons/day)	Percent of Total
External Comb. Boilers – Electric Generation	Point	798,421	21.7	2,371	22.7
Highway Vehicles – Gasoline	Onroad	771,019	20.9	2,144	20.5
Highway Vehicles – Diesel	Onroad	706,468	19.2	1,892	18.1
Stationary Source Fuel Combustion – Residential	Area	297,778	8.1	174	1.7
Off-highway Vehicles – Diesel	Nonroad	229,526	6.2	1,107	10.6
External Comb. Boilers – Industrial	Point	162,316	4.4	539	5.1
Marine Vessels, Commercial	Nonroad	137,475	3.7	350	3.3
Industrial - Mineral Products	Point	65,302	1.8	226	2.2
Stationary Source Fuel Combustion – Industrial	Area	52,998	1.4	175	1.7
Railroad Equipment	Nonroad	50,996	1.4	136	1.3
Internal Combustion Engines – Electric Generation	Point	25,227	0.7	158	1.5
Internal Combustion Engines – Industrial	Point	27,539	0.7	102	1.0
Top 12 Categories		3,325,064	90.3	9,373	89.6
Other Point Sources	Point	163,098	4.4	528	5.0
Other Nonroad Sources	Nonroad	107,610	2.9	344	3.3
Other Onroad Sources	Onroad	0	0.0	0	0.0
Other Area Sources	Area	86,029	2.3	219	2.1
Total NO_x Emissions		3,681,802	100	10,464	100

NH_3 Emissions – MANE-VU States

Source Category	Source Type	ANNUAL		OSD	
		Emissions (tons/year)	Percent of Total	Emissions (tons/day)	Percent of Total
Agricultural Production – Livestock – Cattle	Area	101,309	36.2	275	35.5
Highway Vehicles – Gasoline	Onroad	46,473	16.6	137	17.7
Agricultural Production – Livestock – Poultry	Area	33,279	11.9	90	11.7
Misc. Area Source – Agricultural Production – Crops	Area	29,896	10.7	82	10.6
Wastewater Treatment	Area	26,644	9.5	73	9.4
Agricultural Production – Livestock – Hogs	Area	13,548	4.8	37	4.7
Industrial - Chemical Manufacturing	Point	4,800	1.7	14	1.7
Agricultural Production – Livestock – Other	Area	3,954	1.4	-	-
Stationary Source Fuel Combustion – Residential	Area	2,336	0.8	-	-
Petroleum Industry	Point	1,818	0.6	-	-
CNG	Nonroad	-	-	18	2.3
External Comb. Boilers – Electric Generation	Point	-	-	17	2.1
Top 10 Categories		264,056	94.4	743	95.8
Other Point Sources	Point	6,515	2.3	12	1.5
Other Nonroad Sources	Nonroad	6,037	2.2	0	0.0
Other Onroad Sources	Onroad	1,052	0.4	2	0.3
Other Area Sources	Area	1,980	0.7	19	2.4
Total NH_3 Emissions		279,639	100	776	100

$PM_{2.5}$ Emissions – MANE-VU States

Source Category	Source Type	ANNUAL		OSD	
		Emissions (tons/year)	Percent of Total	Emissions (tons/day)	Percent of Total
Paved Roads (2294000000-2294015002)	Area	122,619	15.1	337	16.3
Stationary Source Fuel Combustion – Residential Wood Comb.	Area	116,242	14.4	197	9.5
Open Burning – Waste Disposal., Treatment, Recovery	Area	77,417	9.6	212	10.3
Unpaved Roads	Area	68,410	8.4	188	9.1
External Comb. Boiler – Industrial	Point	58,352	7.2	151	7.3
Industrial – Construction (SIC 15-17)	Area	53,814	6.6	146	7.1
Industrial Processes – Mineral Products	Point	29,247	3.6	89	4.3
External Comb. Boiler – Electric Generation	Point	29,203	3.6	115	5.6
Misc. Area Source – Agricultural Production – Crops	Area	25,826	3.2	70	3.4
Off-highway Vehicle – Diesel	Nonroad	22,845	2.8	103	5.0
Highway Vehicles – Diesel	Onroad	22,261	2.7	57	2.8
Stationary Source Fuel Combustion – Comm./Inst.	Area	19,438	2.4	35	1.7
Industrial - Primary Metal Production	Point	17,786	2.2	48	2.3
Highway Vehicles – Gasoline	Onroad	9,844	1.2	-	-
On-site Incineration – Waste Disposal, Treatment, Recovery	Area	3,906	0.5	-	-
Industrial – Mining and Quarrying (SIC 14)	Area	-	-	30	1.4
Top 15 Categories		677,211	83.6	1,777	86.2
Other Point Sources	Point	52,552	6.5	149	7.2
Other Nonroad Sources	Nonroad	20,118	2.5	53	2.6
Other Onroad Sources	Onroad	0	0.0	27	1.3
Other Area Sources	Area	59,791	7.4	56	2.7
Total $PM_{2.5}$ Emissions		809,673	100	2,062	100

VOC Emissions – MANE-VU States

Source Category	Source Type	ANNUAL		OSD	
		Emissions (tons/year)	Percent of Total	Emissions (tons/day)	Percent of Total
Highway Vehicles – Gasoline	Onroad	910,263	28.9	2,584	25.2
Stationary Source Fuel Combustion – Residential	Area	328,297	10.4	360	3.5
Consumer Solvents	Area	249,763	7.9	1,166	11.4
Industrial Surface Coating	Area	164,432	5.2	729	7.1
Pleasure Craft	Nonroad	156,045	4.9	459	4.5
Off Highway Vehicles – Gasoline 4 stroke	Nonroad	123,901	3.9	482	4.7
Architecural Coating	Area	106,348	3.4	368	3.6
Degreasing	Area	94,702	3.0	485	4.7
Gas Marketing Stage I	Area	68,846	2.2	199	1.9
Open Burning – Waste Disposal., Treatment, Recovery	Area	58,369	1.9	188	1.8
Graphic Arts	Area	48,365	1.5	180	1.8
Gas Marketing Stage II	Area	49,557	1.6	194	1.9
Highway Vehicles – Diesel	Onroad	43,263	1.4	115	1.1
Off Highway Vehicles – Gasoline 2 stroke	Nonroad	-	-	356	3.5
		2,402,150	76.2	7,865	77
Other Point Sources	Point	251,407	8.0	828	8.1
Other Nonroad Sources	Nonroad	214,781	6.8	281	2.7
Other Onroad Sources	Onroad	0	0.0	0	0.0
Other Area Sources	Area	284,971	9.0	1,289	12.6
Total VOC Emissions		3,153,309	100.0	10,263	100

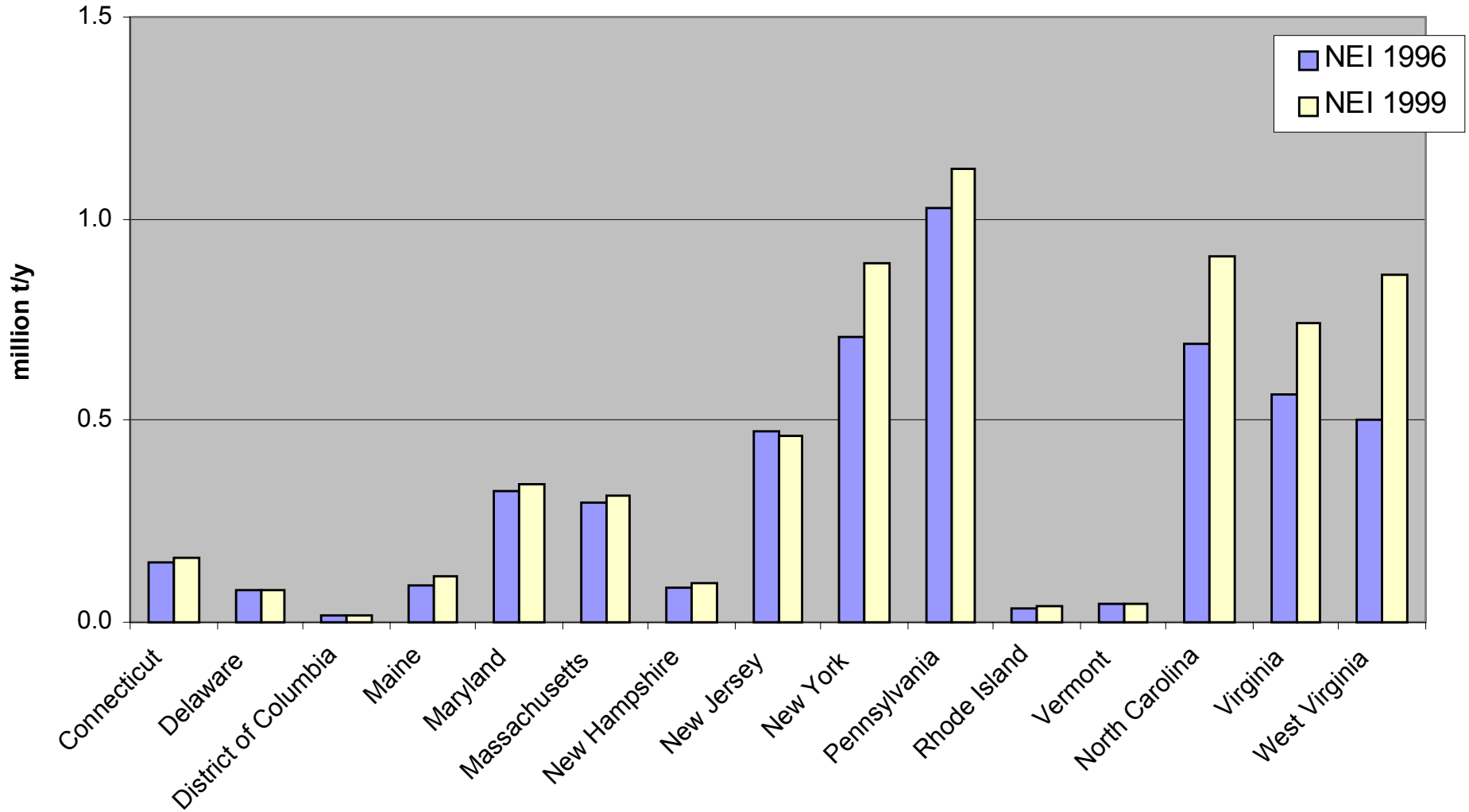
Emissions Density Maps by Pollutant and County for Major Source Categories (Annual and OSD)

1999 NEI Ozone Season Daily Emissions Density Maps							
Source Category							
Point Sources	CO	NH_3	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
Area Sources	CO	NH_3	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
Non-Road Sources	CO	NH_3	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
Highway Mobile Sources	CO	NH_3	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
Total	CO	NH_3	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
High. Vhl. - Gasoline	CO	NH_3	-	-	-	-	VOC
Off High. Vhl. - Gas. 4 stroke	CO	-	-	-	-	-	-
Agr. Prod. Livestock - Cattle	-	NH_3	-	-	-	-	-
Agr. Prod. Livestock - Poultry	-	NH_3	-	-	-	-	-
Agr. Prod. - Crops	-	NH_3	-	-	-	-	-
Waste Water Treatment	-	NH_3	-	-	-	-	-
Ext. Comb. Boil. - EGU	-	-	NOx	-	-	SO_2	-
Ext. Comb. Boil. - Industrial	-	-		-	-	SO_2	-
High. Vhl. - Diesel	-	-	NOx	-	-	-	-
Paved Roads	-	-	-	PM_{10}	$PM_{2.5}$	-	-
Unpaved Roads	-	-	-	PM_{10}	$PM_{2.5}$	-	-
Industrial Construction	-	-	-	PM_{10}	-	-	-
Residential Wood Comb.	-	-	-	-	$PM_{2.5}$	-	-
Open Burning	-	-	-	-	$PM_{2.5}$	-	-
Residential Combustion	-	-	-	-	-	-	VOC
Consumer Solvents	-	-	-	-	-	-	VOC

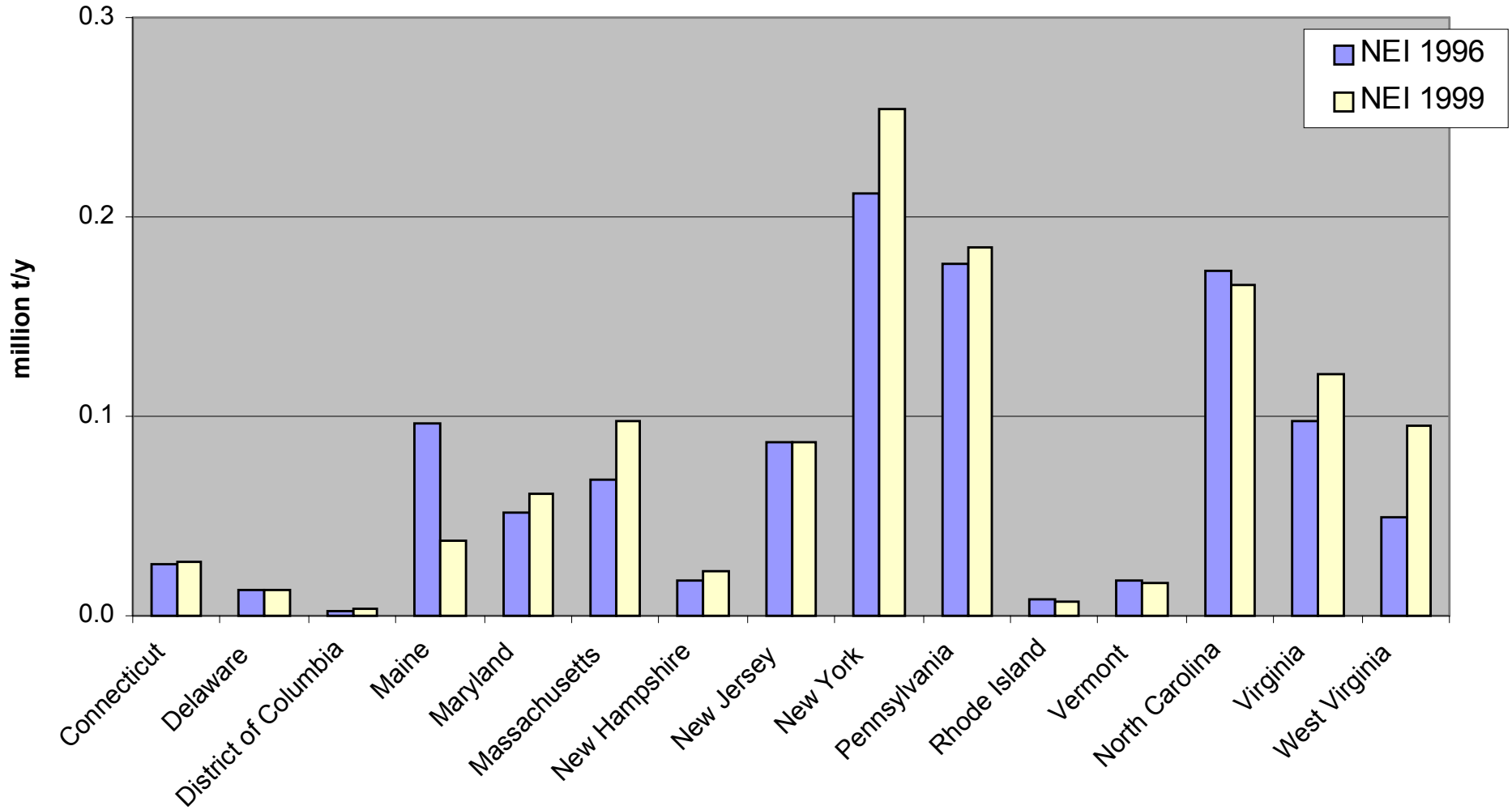
Comparison of 1996 and 1999 NEI

Comparison of 1996 and 1999 NEI					
Annual Total					
MARAMA + NESCAUM	NH_3	NOx	PM_{10}	$PM_{2.5}$	SO_2

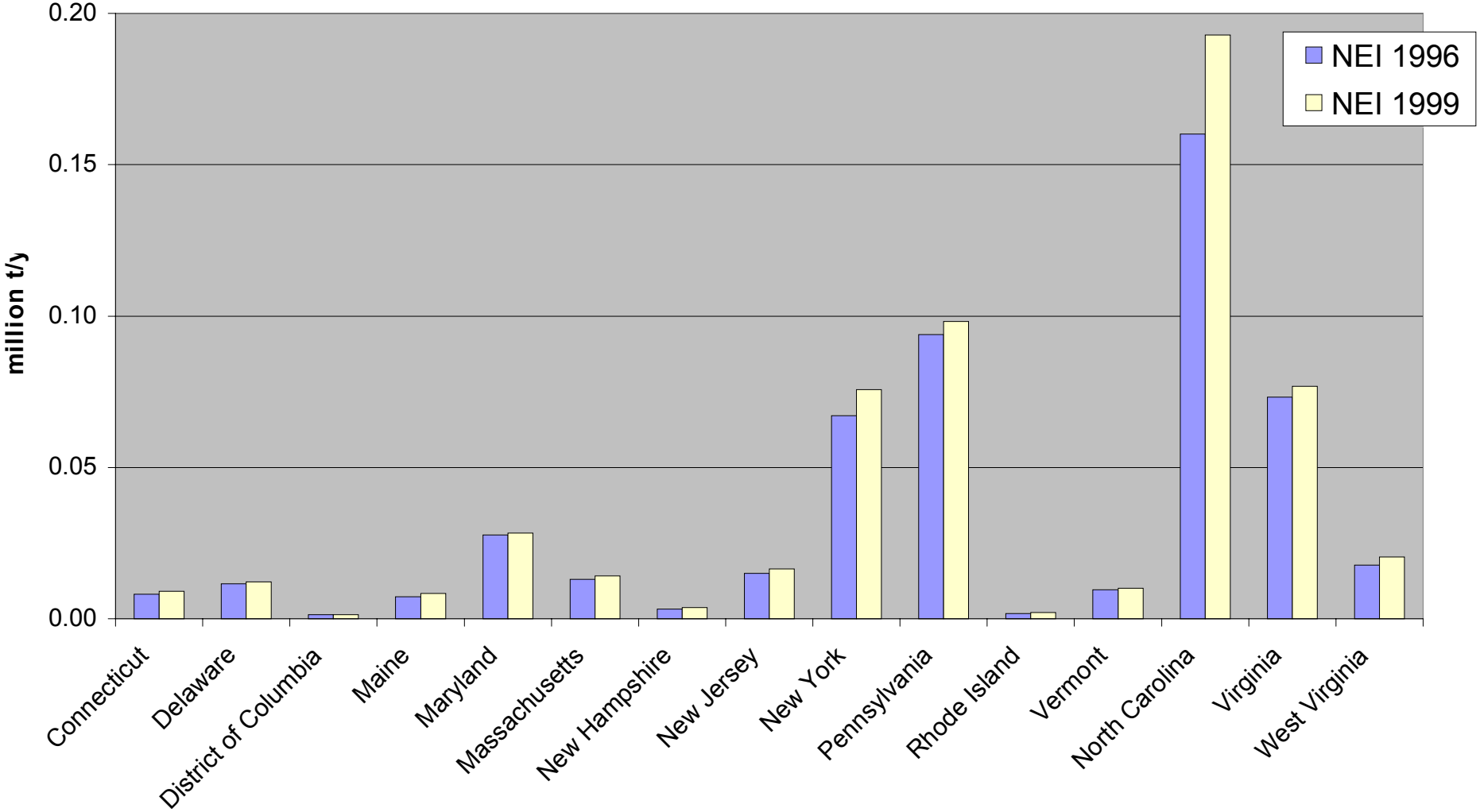
Comparison of 1996 and 1999 NEI total annual NOx emissions by state



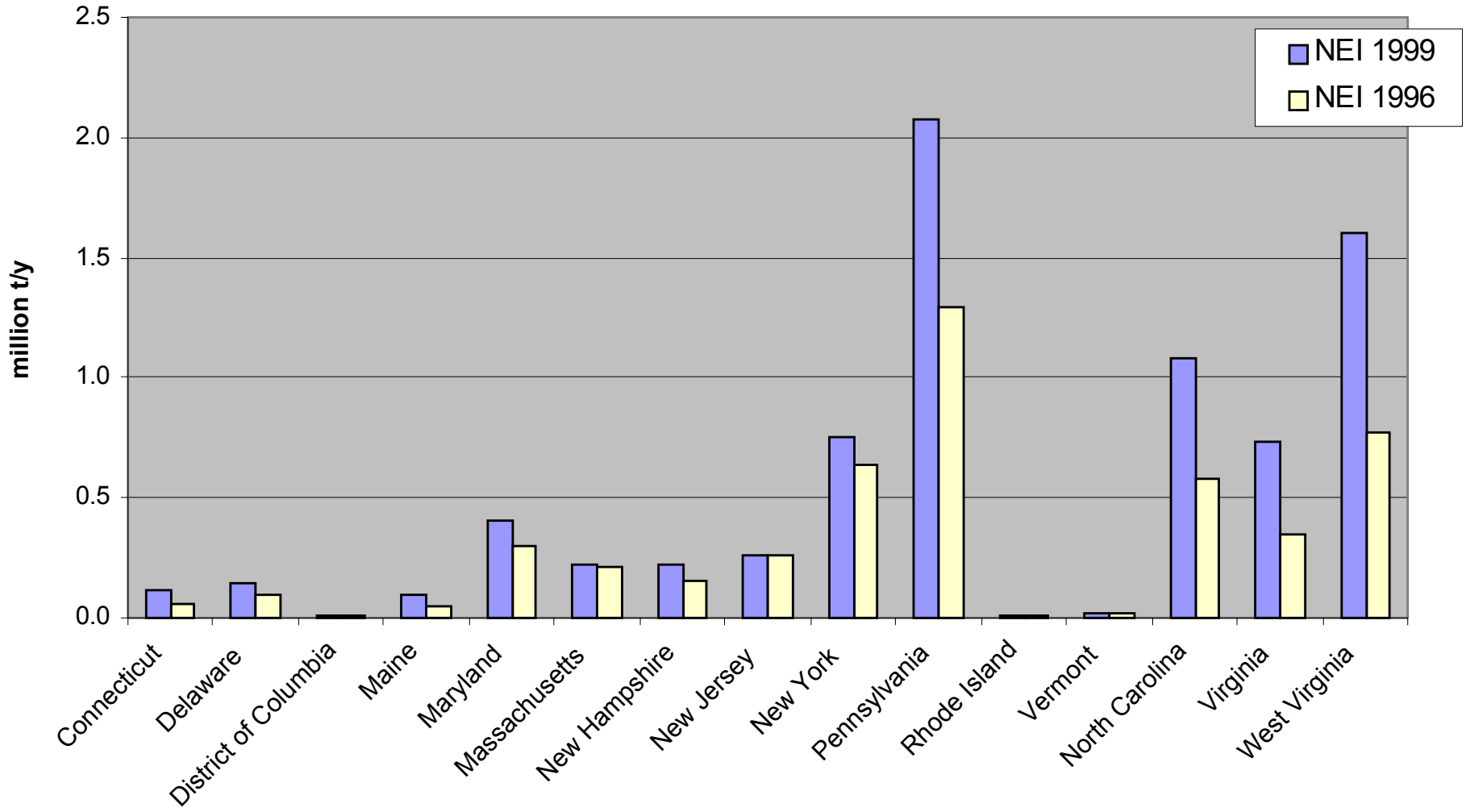
Comparison of 1996 and 1999 NEI total annual $PM_{2.5}$ (primary) emissions by state



Comparison of 1996 and 1999 NEI total annual NH_3 emissions by state



Comparison of 1996 and 1999 NEI total annual SO_2 emissions by state



Conclusions

- Both $PM_{2.5}$ and regional haze modeling will require seasonal analyses, since atmospheric processes differ and monitored data show different source contribution by season.
- Emissions among different source categories for each pollutant in summer only slightly differs from annual emissions.
- However, the amount of emissions may differ substantially by season, and this is not reflected.

Conclusions

- NEI lacks the data needed to identify seasonal emissions variations.
- Currently, seasonal and other temporal allocation of emissions is done through emissions modeling processes prior to air quality modeling.
- It is crucial for the emissions inventory and modeling community to scrutinize the seasonal profiles, as well as monthly and daily profiles, used in those models.

Conclusions

- QA/QC of emissions inventories is a non-trivial and ambiguous task.
- Emissions modeling tools (SMOKE and EMS) have visualization capabilities, only for the processed emissions.
- Visualization of raw NEI data is beneficial to detect errors, data gaps, abnormalities, and inconsistencies.
- To help detect those problems and to prevent them in the upcoming 2002 inventory, MARAMA visualized and summarized the 1999 NEI. This is a step in the right direction, however, it is time consuming.

Conclusions

- EPA's AIRDATA is very useful, however, it was not possible to use for our specific purpose.
  - Only creates regional maps for EPA regions, or for a total of 10 states.
  - Only allows mapping of prescribed large SCC groupings.
  - Only allows the visualization of certain 1996 and 1999 NEI versions.

Conclusions

- An enhancement of the existing AIRDATA tool could be a resource-effective option.
- AIRDATA has capabilities of browsing and summarizing the data, and generating on-the-fly plots and maps.
- Modifying the tool to accommodate
  - more flexible geographic coverage options
  - a more detailed SCC selection options
  - the creation of emissions density maps in addition to emissions distribution maps

  will be of great value.

Acknowledgements

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