Modeling of Mobile Source Air Toxic Emissions Using EPA's National Mobile Inventory Model

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Abstract

- The National Mobile Inventory Model (NMIM) creates national, county-level emission inventories.
- NMIM can estimate emissions of all mobile source air toxics in the 1999 National Emissions Inventory (NEI)
  - 13 gaseous hydrocarbons
  - 16 PAHs
  - 4 metals
  - 17 dioxin/furan cogeners
- Paper discusses how database was developed and how tool will be used to develop national inventories

Introduction

- Components of Modeling System:
  - MOBILE6.2
  - NONROAD
  - County Level Database
    - temperatures
    - fuel properties
    - vehicle registration distributions
    - IM programs
    - toxics inputs (toxic to VOC ratios, toxic to PM ratios, or toxic emission factors)
- JAVA framework
- Results can be postprocessed into several formats, including NIF3

Data and methods

- Highway mobile sources
  - MOBILE6.2 explicitly estimates emissions for the following HAPs when the AIR TOXICS command is selected:
    - benzene
    - 1,3-butadiene
    - formaldehyde
    - acetaldehyde
    - MTBE
    - acrolein

Data and methods

- A number of fuel parameters are required, including benzene, aromatics, olefins, and oxygenate content
  - For base years (1999 and 2000) these parameters come from fuel surveys
  - For all other years, fuel parameters were projected from base year using refinery modeling

Data and methods

- Highway mobile sources
  - For other pollutants, ADDITIONAL HAPS command used
    - user enters emission factors or air toxic ratios for additional air toxic pollutants
    - input files developed for several fuel types:
      - baseline gasoline
      - reformulated gasoline with MTBE
      - reformulated gasoline with ethanol

Data and methods

- Nonroad sources
  - HAPs not currently included in NONROAD
  - HAPs are estimated for each equipment type in NONROAD using data sources and methods developed for the 1999 NEI for HAPs
  - 3 approaches used
    - Gaseous HAPs – Apply toxic to VOC ratios to NONROAD VOC estimates. Vary by fuel type.
    - PAHs – Apply toxic to PM ratios to NONROAD PM estimates
    - Metals, Dioxins and Furans – Multiply HAP gram per gallon emission factors by county level fuel consumption estimates

Nationwide Nonroad Inventory for 1999 and 2002

- NMIM has recently been used to develop HAP inventories for equipment in the NONROAD model in 1999 and 2002.
  - NMIM has not been used to develop nationwide highway mobile source inventories yet
- For most gaseous HAPs, NMIM predicts inventory totals for 1999 that are very similar to what is in the 1999 NEI final version 3 for HAPs
  - NMIM predicts a significantly higher MTBE inventory
    - due to differences in the criteria used to determine which toxic to VOC ratios are used

Tons of Nonroad Gaseous HAPs, NMIM versus NEI

Pollutant	**1999 NMIM**	**2002 NMIM**	**1999 NEI final version 3**	**1999 NMIM/NEI**	**2002/1999 NMIM**
Acetaldehyde	15,453	13,949	15,819	0.98	0.90
Acrolein	1,432	1,337	1,572	0.91	0.93
Benzene	60,534	57,361	62,498	0.97	0.95
1,3-Butadiene	8,266	7,828	8,619	0.96	0.95
Formaldehyde	36,277	32,902	36,868	0.98	0.91
MTBE	67,174	64,617	38,894	1.73	0.96
2,2,4-Trimethylpentane	89,233	87,839	98,859	0.90	0.98
Ethyl Benzene	39,431	38,709	43,633	0.90	0.98
Hexane	29,703	28,813	28,828	1.03	0.97
Propionaldehyde	3,826	3,470	3,749	1.02	0.91
Styrene	2,420	2,375	2,496	0.97	0.98
Toluene	205,746	202,379	209,190	0.98	0.98
Xylene	179,048	175,499	185,034	0.97	0.98
Total	**738,543**	**717,080**	**736,058**	**1.00**	**0.97**

Tons of Nonroad PAHs, NMIM versus NEI

Pollutant	1999 NMIM	2002 NMIM	1999 NEI final version 3	1999 NMIM/NEI	2002/1999 NMIM
Acenaphthene	22.14	20.36	22.59	0.98	0.92
Acenaphthylene	41.19	39.25	41.36	1.00	0.95
Anthracene	8.76	8.64	8.76	1.00	0.99
Benz(a)anthracene	2.85	2.82	2.85	1.00	0.99
Benzo(a)pyrene	2.46	2.44	2.46	1.00	0.99
Benzo(b)fluoranthene	1.74	1.72	1.74	1.00	0.99
Benzo(g,h,i)perylene	8.91	8.85	8.92	1.00	0.99
Benzo(k)fluoranthene	1.59	1.56	1.59	1.00	0.99
Chrysene	2.22	2.18	2.24	0.99	0.98
Dibenzo(a,h)anthracene	0.07	0.07	0.07	1.00	1.00
Fluoranthene	25.12	24.68	25.16	1.00	0.98
Fluorene	41.54	39.62	41.62	1.00	0.95
Indeno(1,2,3,c,d)pyrene	2.70	2.68	2.70	1.00	0.99
Naphthalene	545.39	526.54	546.85	1.00	0.97
Phenanthrene	74.02	69.28	74.28	1.00	0.94
Total	**781**	**751**	**783**	**1.00**	**0.96**

Tons of metals, NMIM versus NEI

Pollutant	1999 NMIM	2002 NMIM	1999 NEI final version 3	1999 NMIM/NEI	2002/1999 NMIM
Chromium (Cr3+)	0.47	0.48	0.56	0.84	1.02
Chromium (Cr6+)	0.24	0.25	0.29	0.84	1.02
Manganese	0.53	0.57	0.57	0.94	1.06
Nickel	0.96	1.01	1.04	0.92	1.05
Dioxins and furans (17 cogeners)	8.9075E-04	9.6851E-04			1.09

Conclusions

- NMIM:
  - uses a combination of toxic to VOC ratios, toxic to PM ratios, and emission factors
  - in conjunction with activity data
  - develops HAP inventories for highway vehicles and nonroad mobile sources in the NONROAD model
- This capability streamlines the development process for the NEI and reduces costs.
- NMIM has been used to develop nonroad equipment inventories for HAPs
  - produces results very similar to the NEI for most pollutants

Future Use of NMIM

- Estimate HAPs in subsequent NEI development efforts
- make tool publicly available in the near future
  - with written guidance to States on how to provide improved local and regional data inputs for the model
- develop projected inventories to inform the regulatory decision-making process
- help support local assessments
- measure progress toward achieving reduction goals the Agency has set in compliance with the Government Performance Results Act (GPRA)