Preparation of Fine Particulate Emissions Inventories

Chapter 6 – Nonpoint Sources

How Do I Identify and Estimate Nonpoint Sources of PM Fine or NH_3 Emissions?

- The nonpoint source inventory includes any stationary source that is not included in the point source inventory

How Do I Identify and Estimate Nonpoint Sources of PM Fine or NH_3 Emissions? (cont.)

- EIIP Area Source Guidance (Volume III)
  - Lists PM fine categories for which EIIP guidance is available
- AP-42
- Existing inventories
  - National Emission Inventory (NEI)
  - Toxics Release Inventory (TRI)

How Do I Identify and Estimate Nonpoint Sources of PM Fine or NH_3 Emissions? (cont.)

- EIIP Area Source Guidance (Volume III) for Sources of PM Emissions
  - Chapter 2: Residential Wood Combustion, Revised Final, Jan. 2001
  - Chapter 16: Open Burning, Revised Final, Jan. 2001
  - Chapter 18: Structure Fires, Revised Final, Jan. 2001
  - Chapter 24: Conducting Surveys for Area Source Categories, Dec. 2000

How Do I Identify and Estimate Nonpoint Sources of PM Fine or NH_3 Emissions? (cont.)

- Area Source Category Method Abstracts for Sources of PM Emissions
  - Charbroiling, Dec. 2000
  - Vehicle Fires, May 2000
  - Residential and Commercial/Institutional Coal Combustion, April 1999
  - Fuel Oil and Kerosene Combustion, April 1999
  - Natural Gas and Liquefied Petroleum Gas (LPG) Combustion, July 1999

PM 1-Pagers: Nonpoint Sources

- PM 1-Pagers: Overview
  - Location: PM Resource Center
    - Web site: http://www.epa.gov/ttn/chief/eiip/pm25inventory/areasource.html
  - Purpose:
    - Summarize nonpoint source NEI methods for specific categories of PM_{10}, $PM_{2.5}$, and NH_3

PM 1-Pagers: Nonpoint Sources (cont.)

- Contents:
  - Source Category Name, SCC
  - Pollutants of Most Concern
  - Current NEI Methodology
  - How can States, Locals, and Tribes improve upon methodology?
  - Uncertainties/Shortcomings of Current Methods
  - Activity Variables Used to Calculate Emissions:
  - Current Variables/Assumptions Used
  - Suggestions for Improved Variables
  - Where can I find Additional Information and Guidance?
  - References

PM 1-Pagers: Nonpoint Sources (cont.)

- Open Burning
  - Residential Yard Waste (Leaves) and Household Waste
  - Residential, Nonresidential, and Road Construction Land Clearing Waste
  - Structure Fires
  - Wildfires & Prescribed Burning
  - Managed Burning - Slash

PM 1-Pagers: Nonpoint Sources (cont.)

- Fugitive Dust
  - Paved and Unpaved Roads
  - Residential Construction
  - Mining and Quarrying
- Residential Combustion - Fireplaces and Woodstoves

Typical Source Categories of Filterable PM Emissions

- Fugitive Dust Sources (Crustal PM Fine)
  - Construction
  - Mining and quarrying
  - Paved/unpaved roads
  - Agricultural tilling
  - Beef cattle feedlots

Typical Categories of Filterable and Condensible PM Emissions

- Open Burning Sources (Carbonaceous PM Fine)
  - Open burning
    - Residential municipal solid waste burning
    - Yard waste burning
    - Land clearing debris burning
  - Structure fires
  - Prescribed fires
  - Wildfires
  - Agricultural field burning

Typical Categories of Filterable and Condensable PM Emissions (cont.)

- External/Internal Fuel Combustion (Carbonaceous PM Fine):
  - Residential wood combustion
  - Other residential fuel combustion
  - Industrial fuel combustion
  - Commercial/institutional fuel combustion

Typical Source Categories of NH_3 Emissions

- Typical source categories of NH_3 emissions include:
  - Animal husbandry
  - Agricultural fertilizer application
  - Agricultural fertilizer manufacturing
  - Wastewater treatment

How Do I Estimate Emissions?

- Emissions data prepared and reported by Source Classification Code (SCC)
  - 10-digit SCC defines an nonpoint emission source
  - EPA SCCs located at: http://www.epa.gov/ttn/chief/codes/index.html#scc
- Report actual emissions; not allowable or potential emissions

How Do I Estimate Emissions? (cont.)

- Calculate emissions using:
  - Activity data
  - Emission factors
  - Control efficiency data
  - Rule effectiveness/rule penetration
- Follow EIIP methods when available
  - Provides preferred and alternative methods for collecting activity data and use of emission factors
  - Improve on existing inventory methods

How Do I Estimate Emissions? (cont.)

- Emission estimation equation:

$$CAE_A = (EF_A)(Q)\ [(1- (CE)(RP)(RE)]$$

CAE_A = Controlled nonpoint source emissions of pollutant A
EF_A = Uncontrolled emission factor for pollutant A
Q = Category activity
CE = % Control efficiency/100
RE = % Rule effectiveness/100
RP = % Rule penetration/100

How Do I Estimate Emissions? (cont.)

- Obtain activity data from:
  - Published sources of data
    - National, regional, or state-level activity data often require allocation to counties using county-level surrogate indicator data
  - Survey performed to obtain local estimate of activity

How Do I Estimate Emissions? (cont.)

- Sources of PM and NH_3 emission factors
  - Factor Information Retrieval (FIRE) System
    http://www.epa.gov/ttn/chief/software/fire/index.html
  - AP-42
    http://www.epa.gov/ttn/chief/ap42/index.html
  - Emission factor ratios
    - $PM_{2.5}$ emissions calculated from PM_{10} emissions using ratio of $PM_{2.5}$-to-PM_{10} emission factors
  - State or local emission factors are preferred

How Do I Estimate Emissions? (cont.)

- Control efficiency (CE)
  - Percentage value representing the amount of a source category's emissions that are controlled by a control device, process change, reformulation, or management practice
  - Typically represented as the weighted average control for an nonpoint source category

How Do I Estimate Emissions? (cont.)

- Rule effectiveness (RE)
  - Adjustment to CE to account for failures and uncertainties that affect the actual performance of the control
- Rule penetration (RP)
  - Percentage of the nonpoint source category that is covered by the applicable regulation or is expected to be complying with the regulation

Spatial and Temporal Allocation

- Available national, regional, or state-level activity data often require allocation to counties or subcounties using surrogate indicators
- S/L/T agencies should review estimates developed in this manner (e.g., NEI) for representativeness
- Available temporal profiles to estimate seasonal, monthly, or daily emissions for specific categories may be limited
- States are encouraged to reflect local patterns of activity in their emission inventories

EI Development Approaches

- Approaches Available to State, Local, and Tribal (S/L/T) Agencies:
  - S/L/T Agency develops its own inventory following EIIP procedures
  - Compare S/L/T activity data and assumptions to NEI Defaults – Use S/L/T data to replace NEI defaults if data will improve estimates
  - Use NEI default estimates

Triage Approach to Improving the EI

- Consider each NEI Category - Is it important ?
  - What's its potential impact on AQ, considering emissions, receptor modeling & other available info
  - May give *some weight* to emission reductions potential
- If yes, focus improvement efforts on the important categories
- Review the available guidance (Course materials, one pagers, EIIP guidance)
- Decide what is feasible in the near and long term

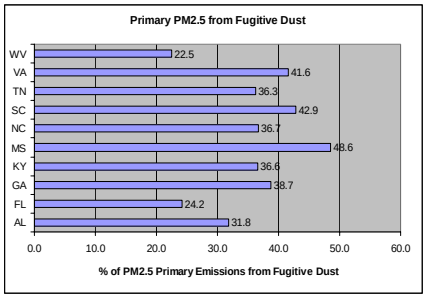
Crustal Materials (Mainly Fugitive Dust)

- Main Sources:
  - Unpaved roads
  - Agricultural tilling
  - Construction
  - Windblown dust, Fly ash

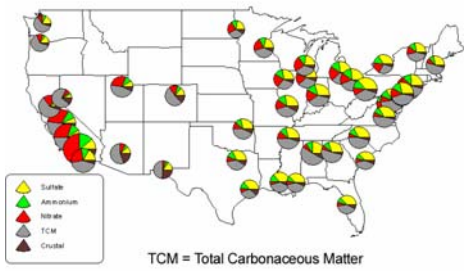
Crustal Materials (Mainly Fugitive Dust) (cont.)

- Huge Disparity Between EI & Ambient Data
  - Ambient Data
    - < 1 ug/m3 in most of US
    - Exception: > 1 ug/m3 in much of Southwest, California
  - Emissions: 2.5M TPY (comparable to Carbon Emissions)
- Fugitive Dust has low "Transportable Fraction"

Fugitive Dust Emissions in VISTAS States



Urban (EPA STN) Annual Averages Sep 2001-Aug 2002



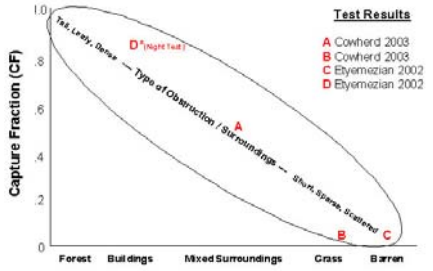
Role of Surface Cover (Vegetation & Structures) in Fugitive Dust Removal

- Early work by AQ Modelers
  - Stilling Zone – Lower 3/4 of canopy
- Windbreaks – wind erosion "staple"
  - Traditionally to slow wind on leeward side
  - Research by Raupach
    - Entrapment effects
    - Dust transmittance through a windbreak is close to the optical transmittance

Role of Surface Cover (Vegetation & Structures) in Fugitive Dust Removal (cont.)

- Capture Fraction (CF)
  - Portion of Fugitive Dust Emissions (FD) removed by nearby surface cover
- Transport Fraction (TF)
  - Portion that is transported from the source area

Capture Fraction ~ Conceptual Model and Field Measurement Results



Estimates of CF for Specific Surface Conditions

Surface Cover Type	CF (Estimated)
Smooth, Barren or Water	0.03 – 0.1
Agricultural	0.1 - 0.2
Grasses	0.2 - 0.3
Scrub and Sparsely Wooded	0.3 - 0.5
Urban	0.6 - 0.7
Forested	0.9 - 1.0

Example CF's for Counties in NV & GA

- CF (County) = ∑ CF (Land Use Types) * County Fractional Land Use
  - Types
    - TF = 1 - CF

Land Use Type	Barren & Water	Agri-culture	Grass	Urban	Scrub & Sparse Vegetation	Forest	CF	TF
CF	.03	.15	.2	.6	.3	.95		
Fractional Land Use in Churchill Co NV	.33	.03	.2	0	.36	.05	0.23	0.77
Fractional Land Use in Oglethorpe Co GA	0	.1	.14	0	0	.76	0.76	0.24

Fugitive Dust Modeling Issues

- Gaussian Models
  - Have many CF removal mechanisms built-in
    - rarely utilized
  - Application requires empirical coefficients ~
    - limited data & guidance
- Grid Models
  - Remix particles w/in lowest layer at each time step (underestimates removal by gravitational settling)
  - Ignore removal processes in initial grid
    - Very significant omission (unless grid is VERY small)

Cautions on Use of the TF in Emissions Inventory & Modeling Applications

- Do NOT use to reduce the emissions inventory
- Do NOT use with Gaussian Models
  - Instead, use features of model properly
- Use with Grid Models (with proper caveats)
  - There ARE other issues with the inventory – the TF concept should NOT be expected to fully account for overestimation of crustal fraction of ambient measurements
- TF concept is evolving
  - Grid Model modifications could (over time) eliminate need for TF concept

Crustal Materials ~ Conclusions

- Crustal materials are a relatively small part of PM2.5 in the ambient air
- Fugitive dust is released near the ground and surface features often capture the dust near its source
- The **Capture / Transport Fraction** concept *does* provide a useful way to account for near source removal when used with Grid Models
  - This area of research offers many opportunities to improve model performance
  - There is much work to do to refine the concept