
Session I

PM Composition & Sources

Ambient Composition

What are the Important Sources

EPA Nat'l EI Conference

New Orleans, LA

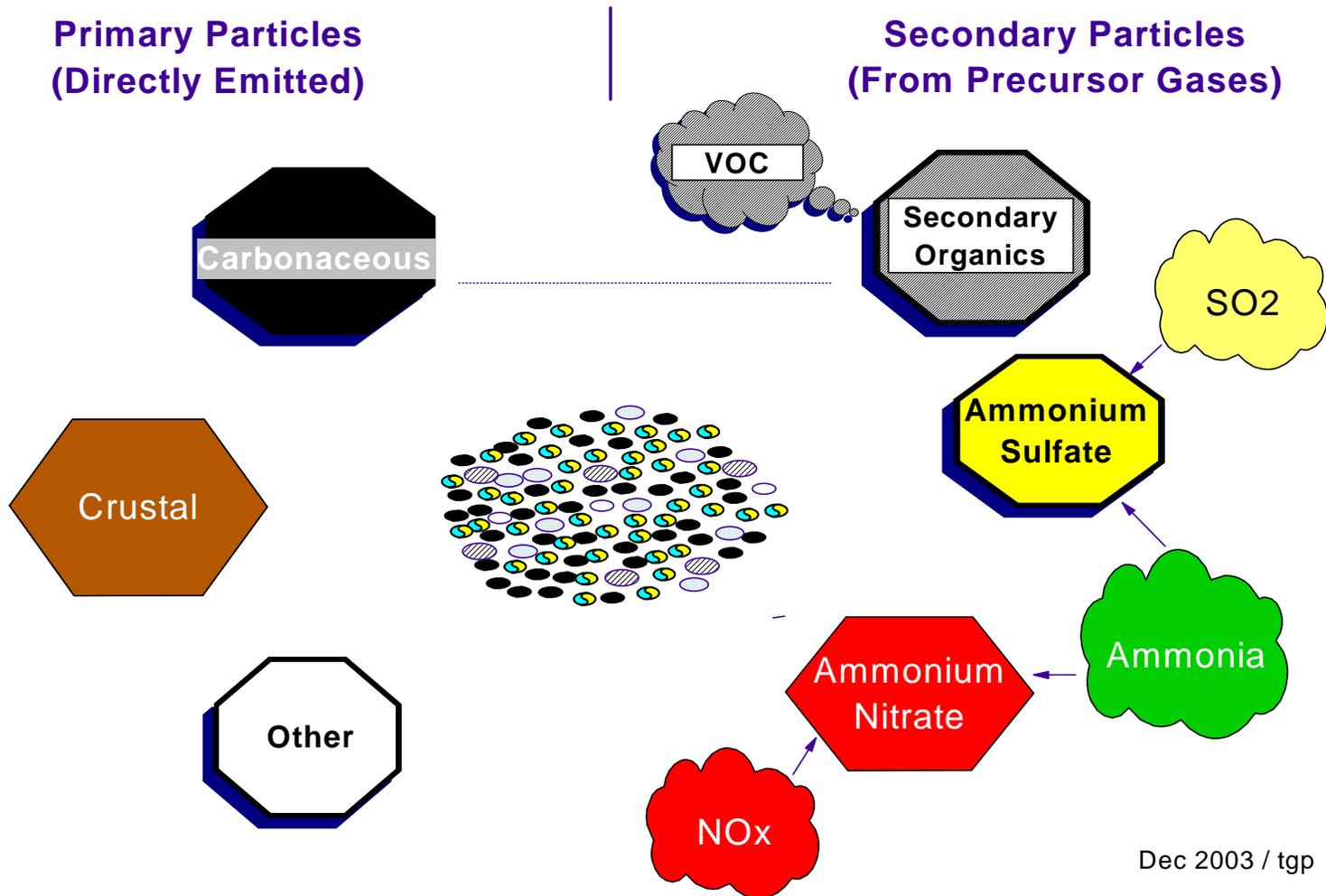
May 15, 2006

Thompson G. Pace

OAQPS

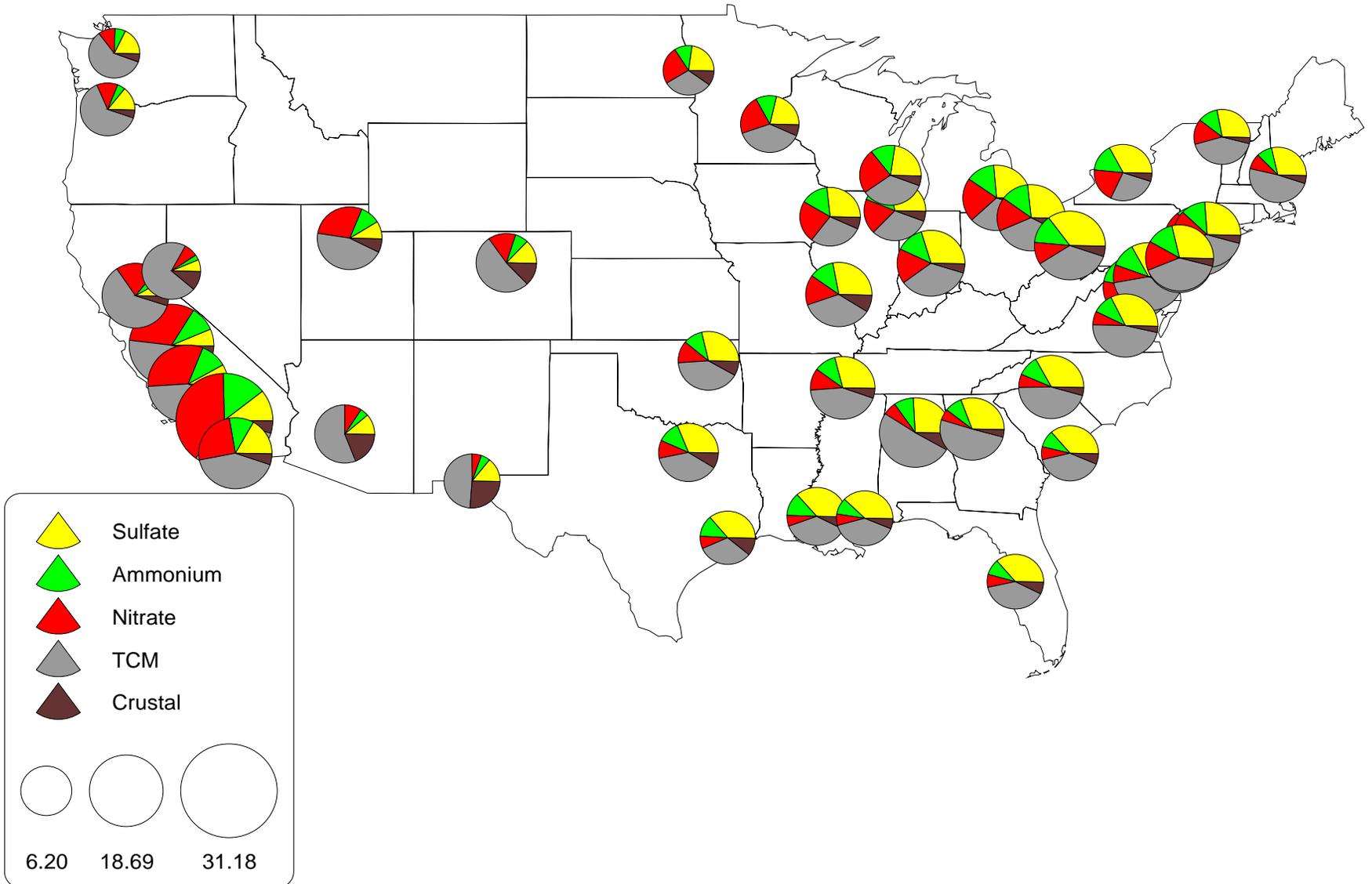
US EPA

PM 2.5 In Ambient Air - A Complex Mixture



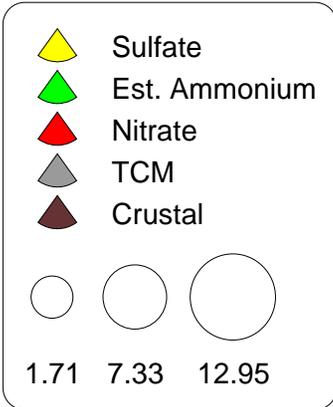
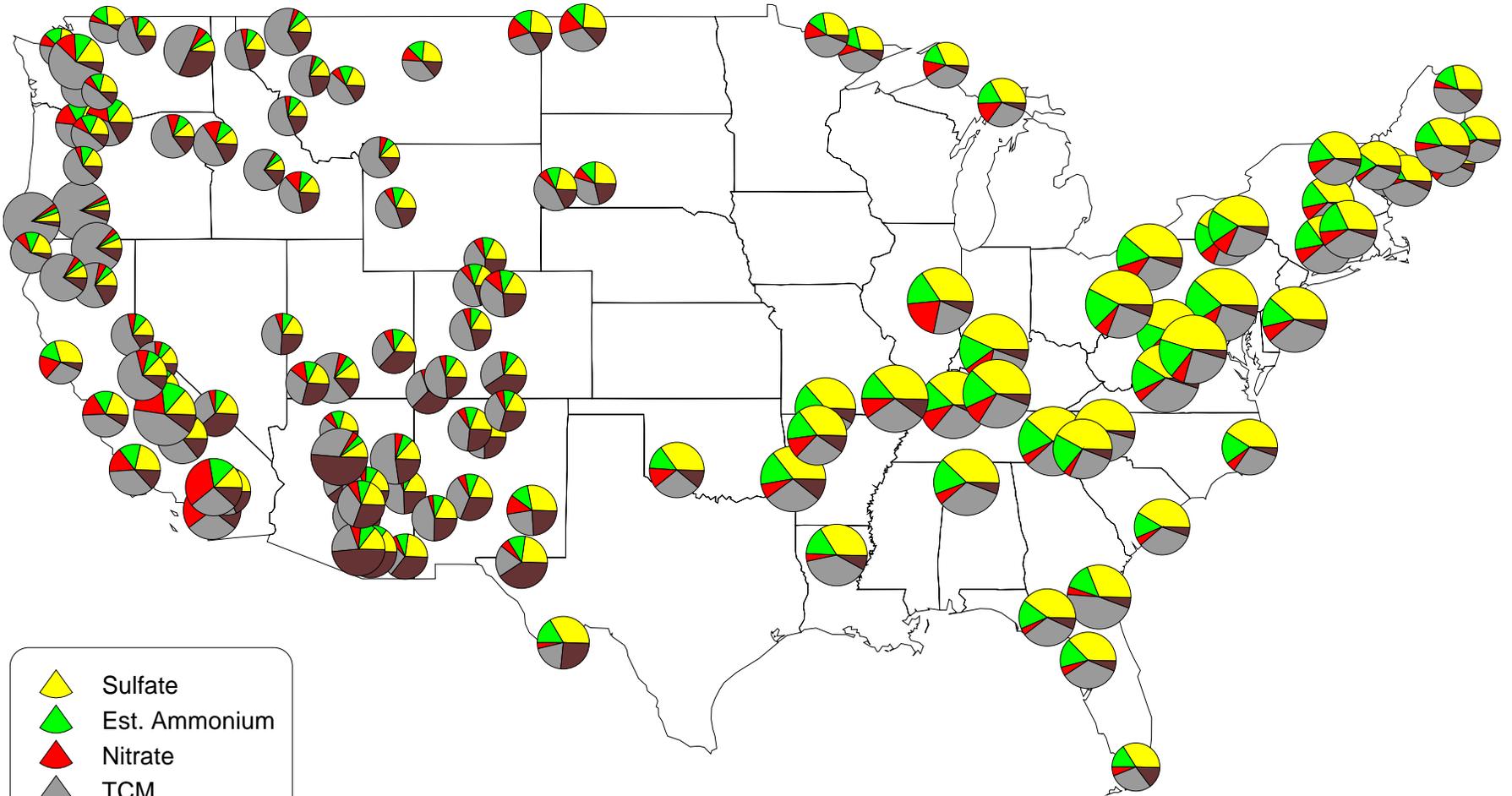
Dec 2003 / tgp

URBAN (EPA STN) ANNUAL AVERAGES Sep 2001--Aug 2002



RURAL (IMPROVE) ANNUAL AVERAGES

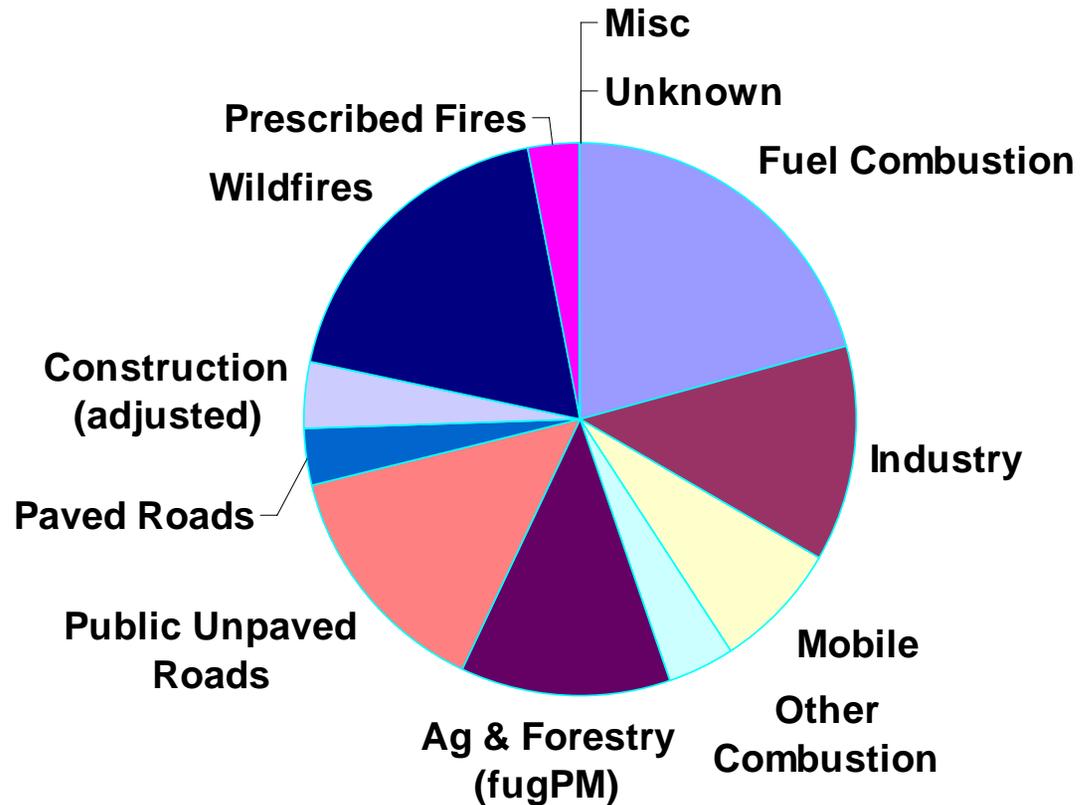
Sep 2001--Aug 2002



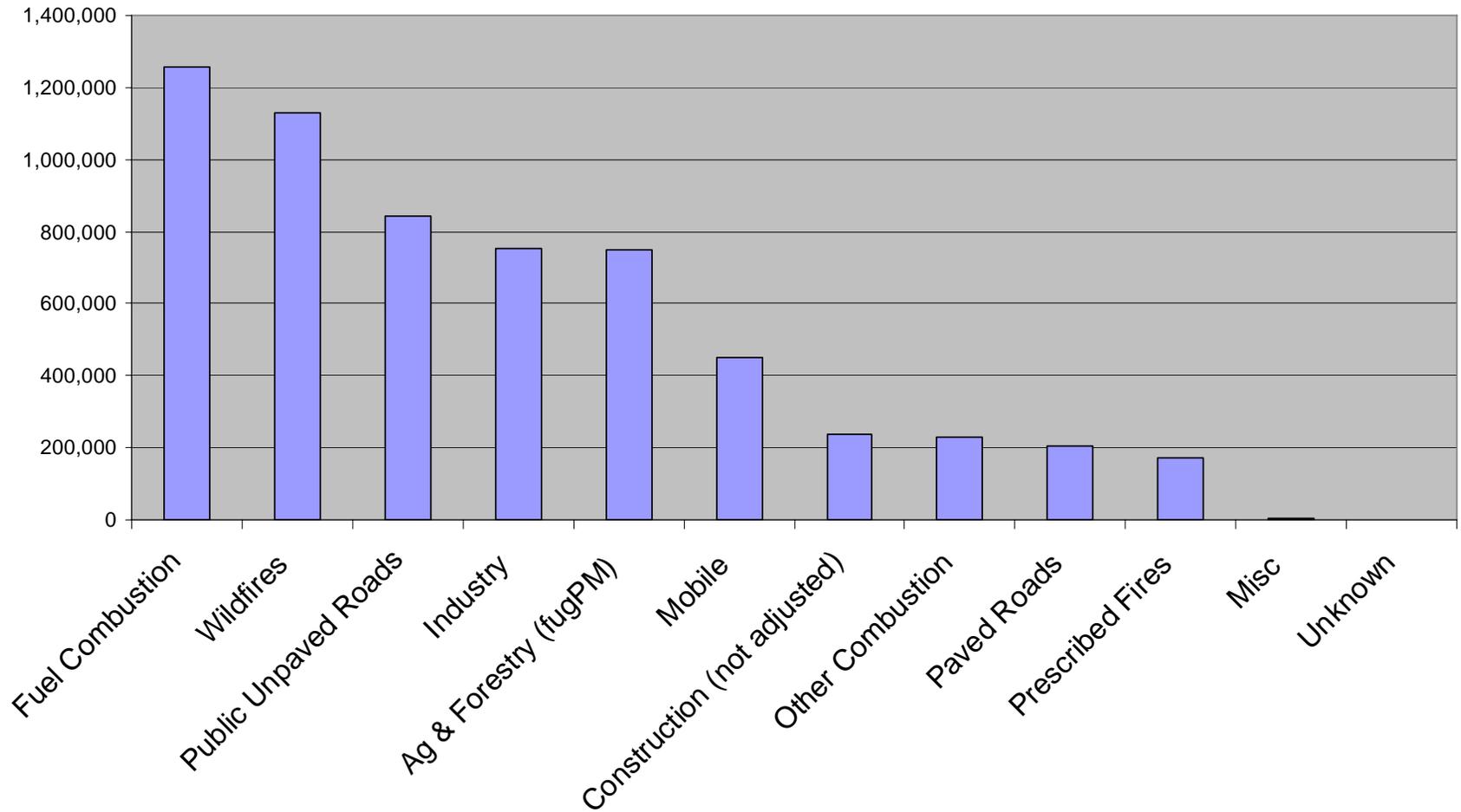
PM Emissions

| PM Size Fraction | TPY |
|-------------------------|------------|
| Total PM10 | 21,816,904 |
| Total PM Coarse | 15,783,641 |
| Total PM2.5 | 6,033,263 |

PM25-PRI Emissions 2002 NEI with WF&PB



PM25-PRI Emissions 2002 NEI with WF&PB



PM 2.5 Fugitive Dust Emissions

| PM2.5 Fugitive Dust | TPY | % of PM2.5 |
|----------------------------|------------|-------------------|
| Unpaved | 842,524 | 14.0% |
| Paved | 203,491 | 3.4% |
| Construction | 237,152 | 3.9% |
| Ag Tilling | 717,451 | 11.9% |
| Livestock | 30,619 | 0.5% |
| | 2,031,238 | 33.7% |

PM2.5 Open Fires Emissions

| PM2.5 - Open Fires | TPY | % of PM2.5 |
|-----------------------------|------------|-------------------|
| Agricultural Burning | 224,697 | 3.7% |
| Prescribed Fires | 171,398 | 2.8% |
| Wild Fires | 1,131,242 | 18.8% |
| Land Clearing Debris | 114,384 | 1.9% |
| Residential Burning | 131,000 | 2.2% |
| | 1,772,000 | 29.2% |

PM2.5 Other Key Emission Categories

- Mobile (7.5%)
- Residential Wood Combustion (7.4%)
- Coal-fired Utility Boilers (6.5%)
- Coal-fired Industrial Boilers (2.6%)
- Mineral Products (2.1%)

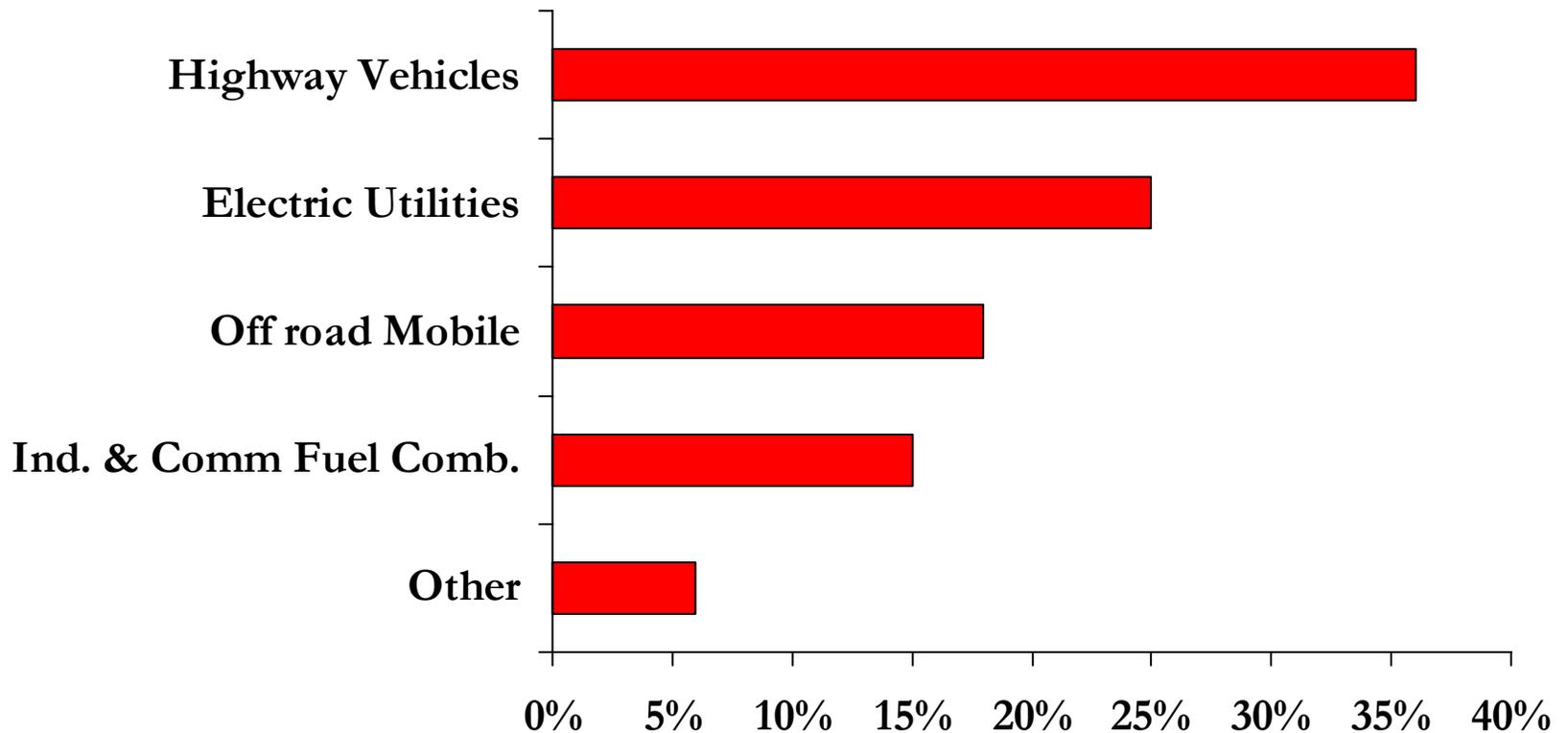
Sulfates, Nitrates & Ammonia

Sources and Spatial Extent

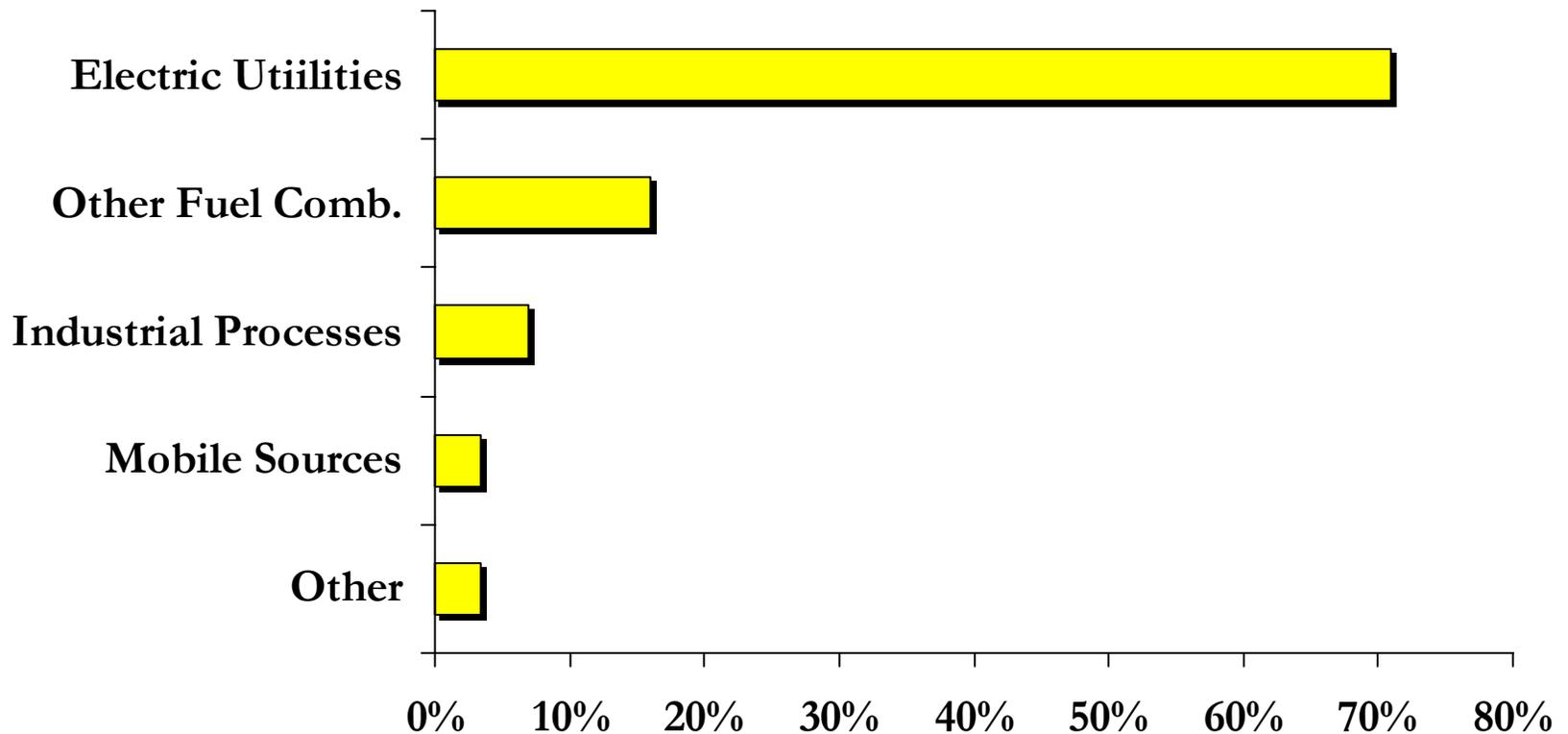
Sulfates & Nitrates

- Formed in atmosphere from SO_2 & NO_x
- Usually found as Ammonium Sulfate / Nitrate

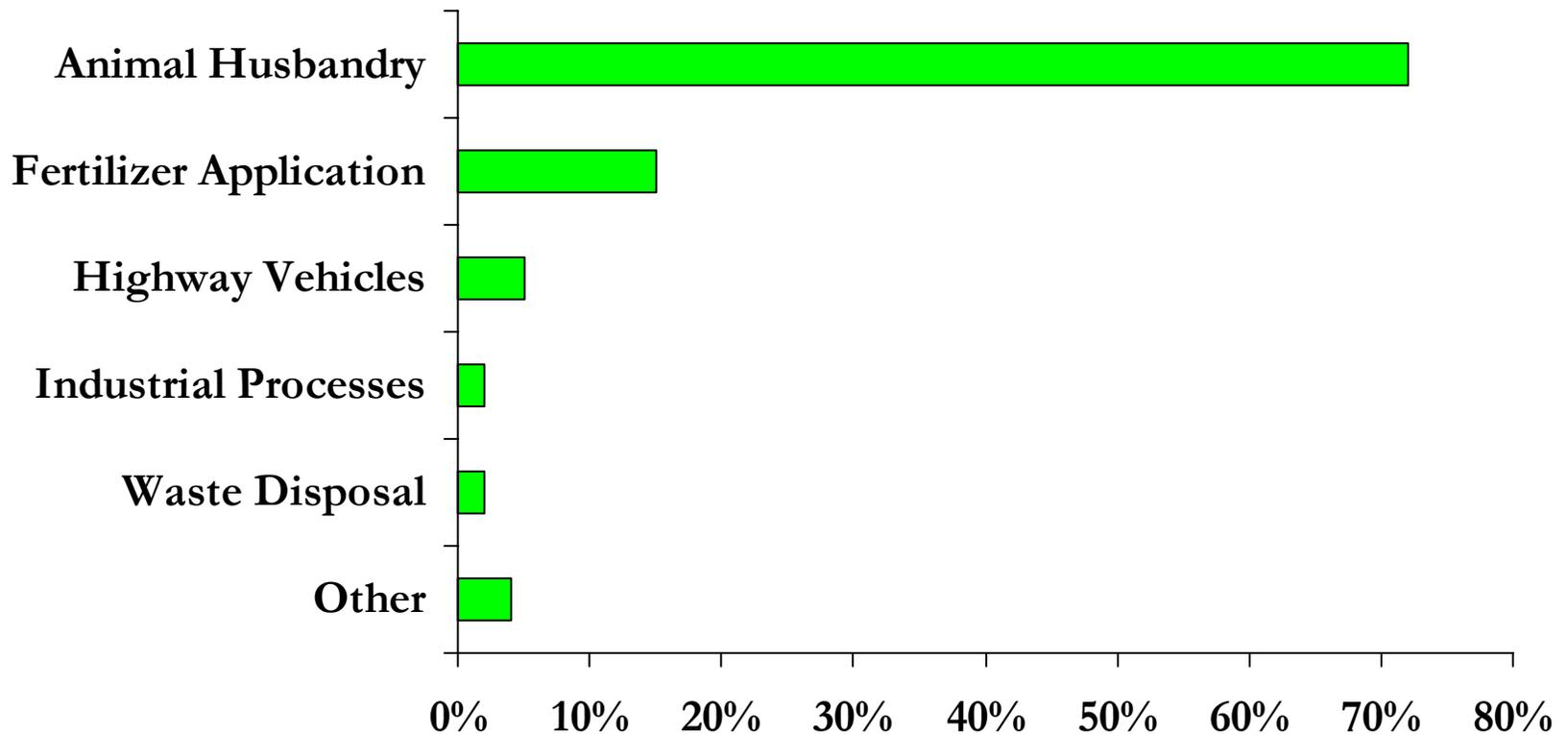
NO_x – Precursor to Ammonium Nitrate and Ozone (National Emissions ~ 23M TPY)



SO₂ – Precursor to Ammonium Sulfate Formation (National Emissions ~ 17.6 M TPY)



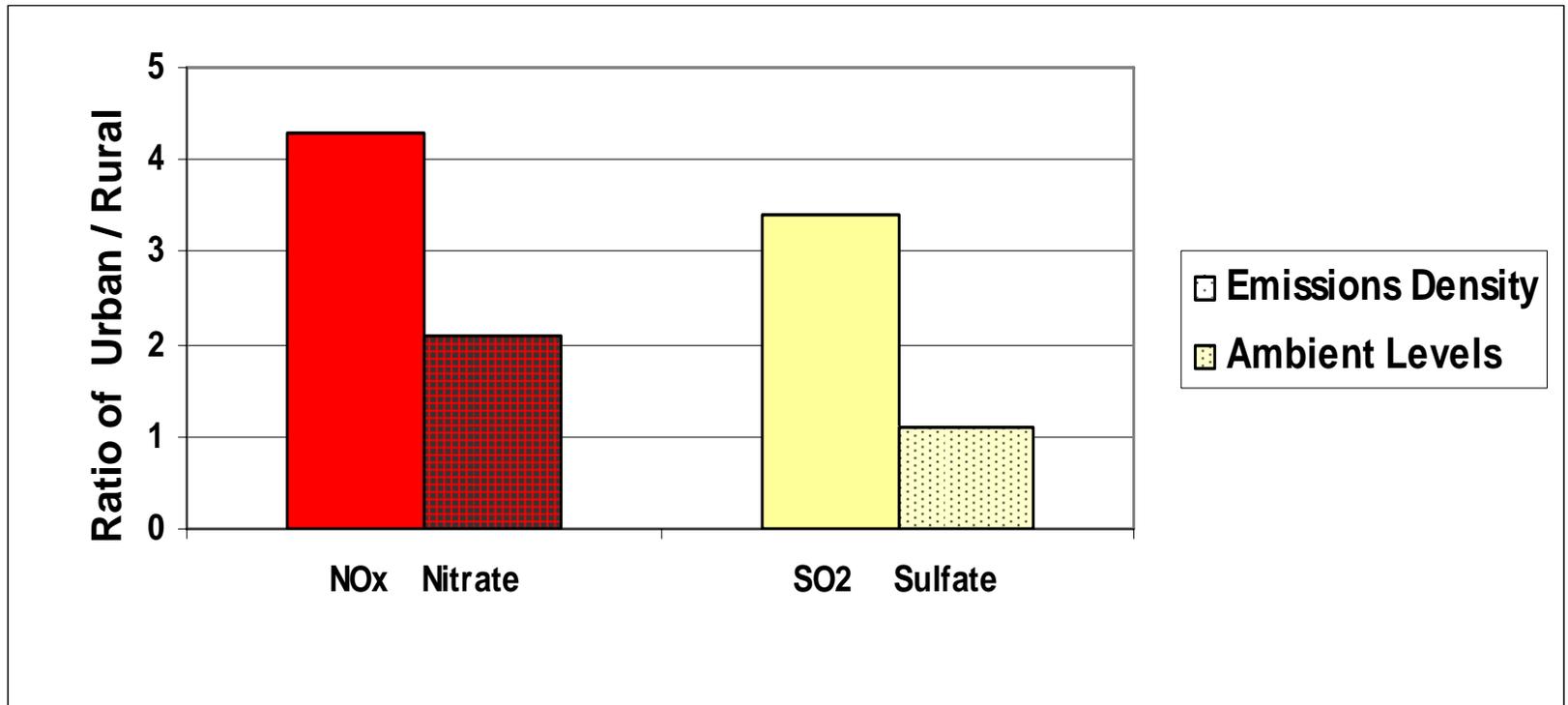
NH₃ – Precursor to Ammonium Sulfate & Nitrate (National Emissions ~ 4.8 M TPY)



Sulfates & Nitrates

- Urban ~ Rural Patterns
 - Emission densities of both SO₂ & NO_x:
 - > in urban than in rural areas
 - Ambient Nitrate:
 - “urban excess” (urban nitrate > rural nitrate)
 - Ambient Sulfate:
 - NO “urban excess” (urban sulfate ~ = rural sulfate)
 - Why ? Sulfate is more stable ~ longer “lifetime”

Comparison of Urban~Rural Ratios of SO₂, NO_x Emissions & Ambient Sulfate, Nitrate



Note: Sulfate particles are more stable and thus have longer lifetime in the atmosphere than Nitrate. Sulfate is therefore more subject to transport

Crustal & Carbon

**Their Sources & Regional
Extent**

Crustal Materials (Mainly Fugitive Dust)

■ Main Sources:

- Unpaved roads
- Agricultural tilling
- Construction
- Windblown dust, Fly ash

Crustal Materials (Mainly Fugitive Dust)

■ Main Sources:

- Unpaved roads
- Agricultural tilling
- Construction
- Windblown dust, Fly ash

■ 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 (w/o windblown): *Was ~3M TPY* (comparable to Carbon)
- *Now ~2M TPY* (after applying new PM_{2.5}*PM₁₀ multiplier data)

Crustal Materials (Mainly Fugitive Dust)

■ Main Sources:

- Unpaved roads
- Agricultural tilling
- Construction
- Windblown dust, Fly ash

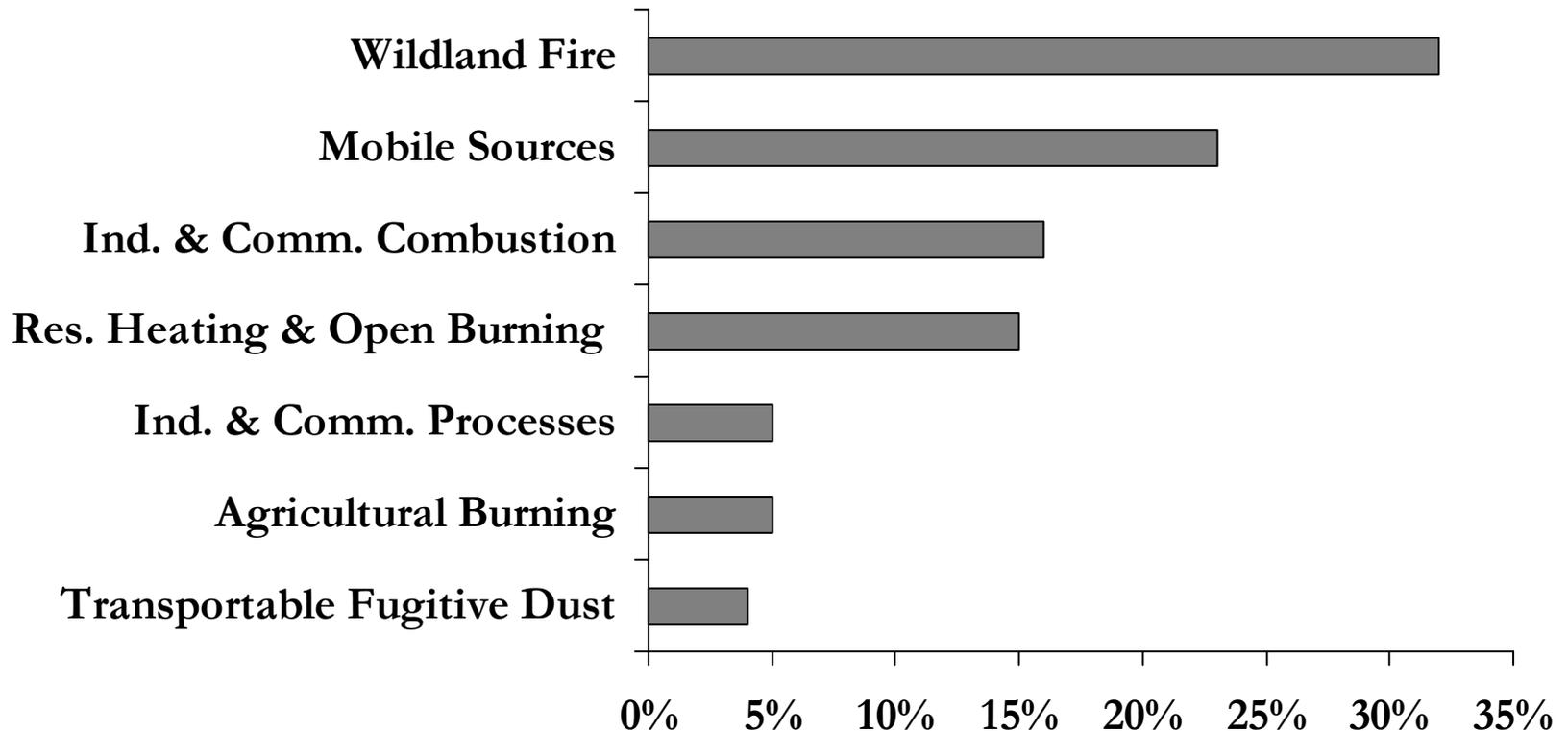
■ Huge Disparity Between EI & Ambient Data

- Ambient Data
 - $< 1 \text{ ug/m}^3$ in most of US
 - Exception: $> 1 \text{ ug/m}^3$ in much of Southwest, California
- Emissions (w/o windblown): Was $\sim 3\text{M TPY}$ (comparable to Carbon)
- Now $\sim 2\text{M TPY}$ (after applying new PM_{2.5}:PM₁₀ data)

■ Also, Fugitive Dust has low “Transportable Fraction”

- More on this later !

Primary Carbon in PM2.5



**% of PM2.5 Primary Carbon Emissions
(National Emissions ~ 2M TPY)**

Carbon Particles

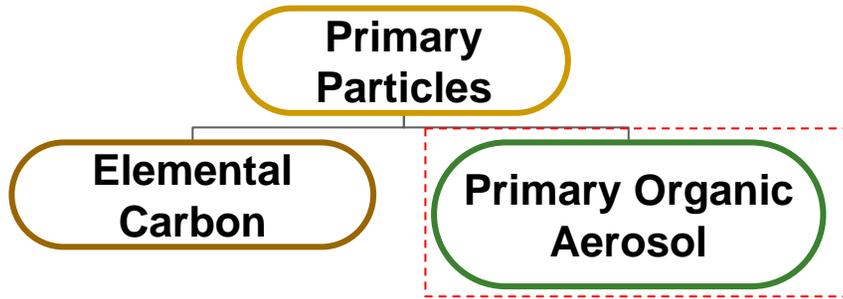
**Primary
Particles**

+

**Secondary
Particles**

- **Primary & Secondary Particles**

Carbon Particles: Composition & Terminology



- **Primary Carbon Particles**
 - **Elemental (Black) Carbon**
 - **Primary Organic Aerosol (POA)**
 - **Primary Carbon = EC (BC) + Primary Organic Aerosol (POA)**

POA & EC Characteristics of Primary Carbon Emissions

| Category | Ratio of organic carbon mass* to elemental carbon mass (average) | Potential range of ratios |
|---|--|---------------------------|
| Forest Fires | 9.9 | 6 – 28 |
| Managed Burning | 12 | 6 – 28 |
| Agricultural Burning | 12 | 2.5 – 12 |
| Open Burning - Debris | 9.9 | |
| Non-road Diesel Engines & Vehicles | 0.4 | 0.4 – 3 |
| On-road Diesel Vehicles | 0.4 | 0.4 – 3 |
| Trains, Ships, Planes | 0.4 | 0.4 – 25 |
| Non-road Gas Engines & Vehicles | 14 | 0.25– 14 |
| On-road Gas Vehicles | 4.2 | 0.25 – 14 |
| Fugitive Dust - Roads | 22 | 3 – 65 |
| Woodstoves | 7.4 | 3 – 50 |
| Fireplaces | 7.4 | 3 – 50 |
| Residential Heating - Other | 26 | |
| Commercial Cooking | 111 | 13 – 111 |

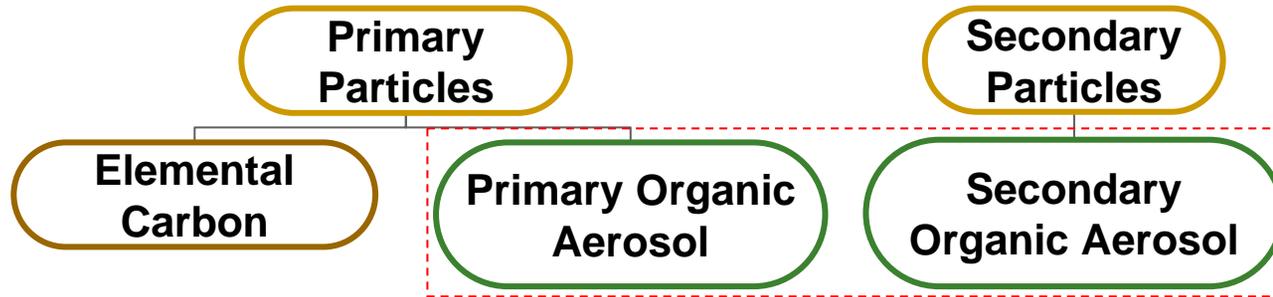
Emissions-weighted average: POA = 80% EC = 20% (4:1)

Comparison of Emission Density Ratios (Urban~Rural) ~ Primary Carbon Emissions in Eastern US



Primary Carbon emissions are concentrated in *Urban Areas* in the Eastern US

Carbon Particles: Composition & Terminology



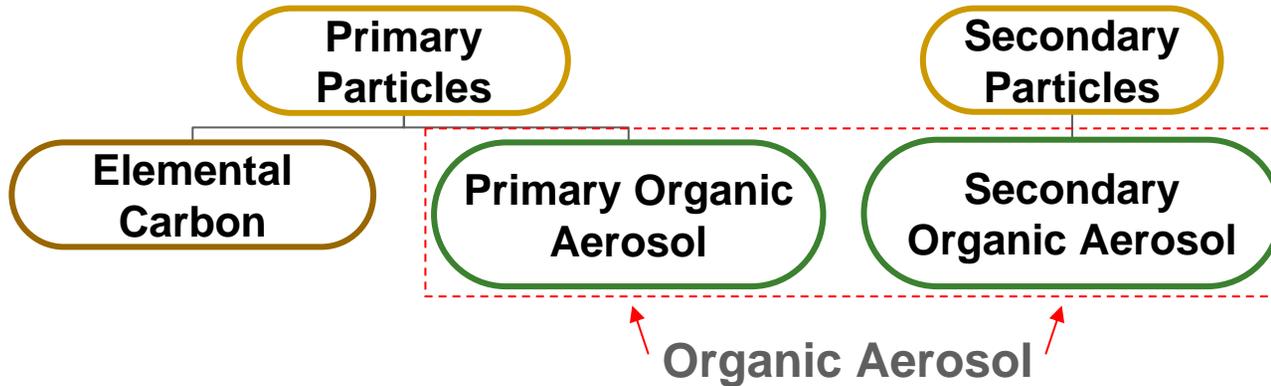
■ Primary Particles

- Elemental (Black) Carbon
- Primary Organic Aerosol (POA)
- **Primary Carbon = EC (BC) + Primary Organic Aerosol (POA)**

■ Secondary Particles

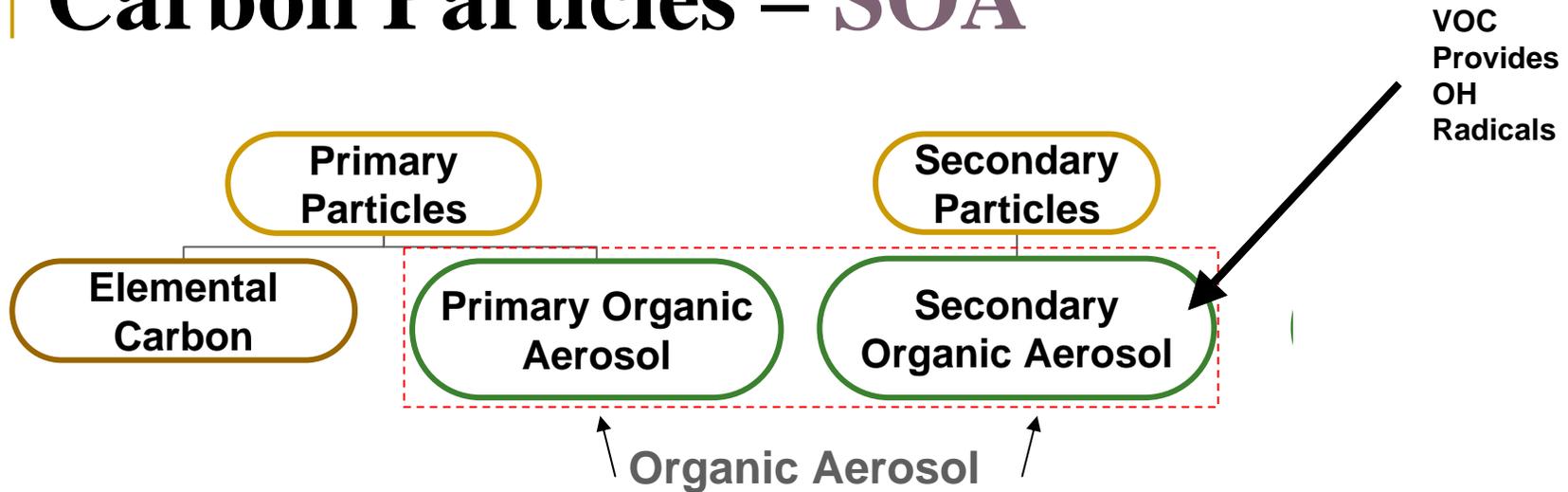
- Secondary Organic Aerosol (SOA)

Carbon Particles: Composition & Terminology



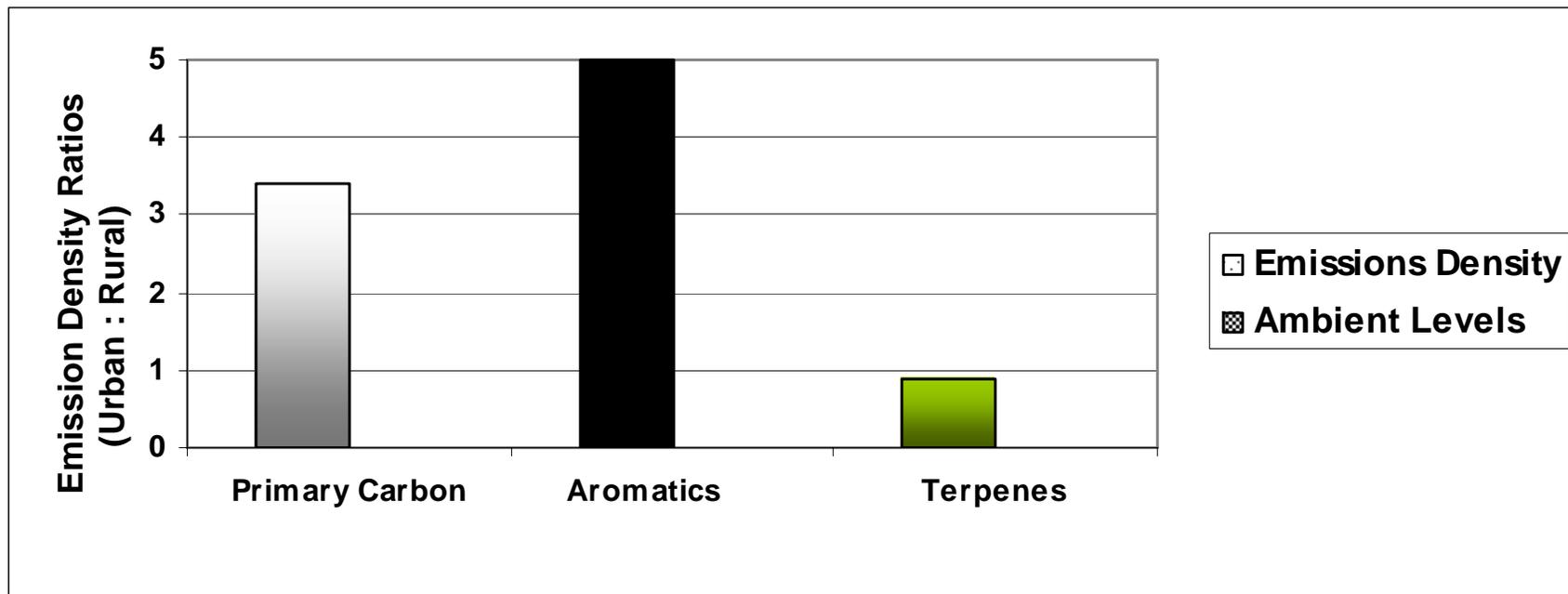
- **Primary Particles**
 - **Elemental (Black) Carbon**
 - **Primary Organic Aerosol (POA)**
 - **Primary Carbon = EC (BC) + Primary Organic Aerosol (POA)**
- **Secondary Particles**
 - **Secondary Organic Aerosol (SOA)**
- **Organic Aerosol (OA) = POA & SOA**
- **OA aka Organic Carbonaceous Matter (OCM)**

Carbon Particles – SOA



- SOA formed in atmosphere from VOC's
- Lighter VOC's provide the oxidants (OH)
- Aromatics & Terpenes provide the reactants
- Acidic particles may increase SOA formation
- Note: Heaviest organic gases may condense to form OC
 - Condensibles considered Primary ~ Not SOA

Comparison of Emission Density Ratios (Urban~Rural) ~ Primary Carbon vs Precursor Emissions



80% POA
20% EC

70% Mobile

Biogenic

Emissions: 2.2M tpy (Ann)

3.7 M tpy (Ann)

.35 M tpy (July)

In East, Aromatics are concentrated in urban areas ~ NOT true for Terpenes

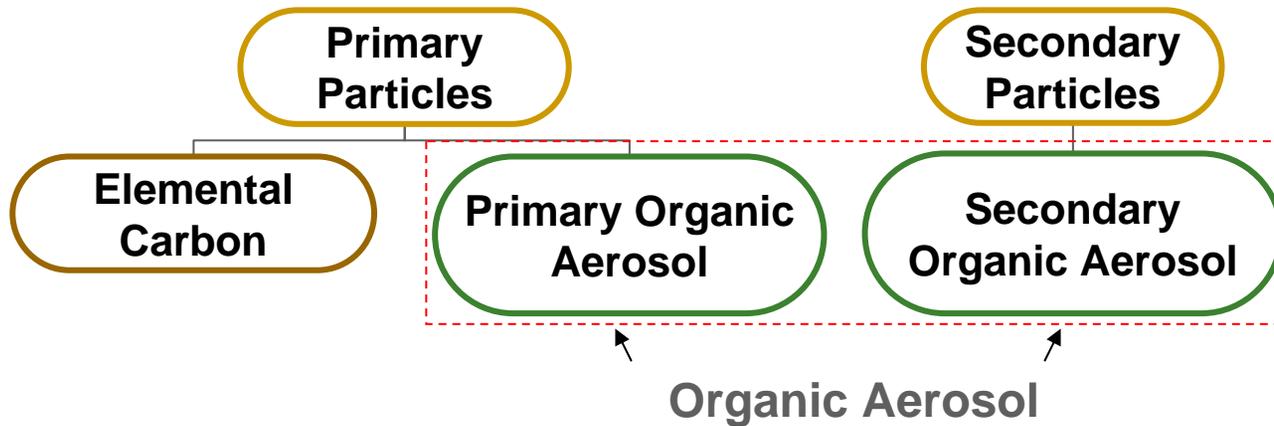
Monoterpene Emission Densities by County, kg/m²: - July



□ Kg/Km² by County

- 301 to 1,000
- 151 to 300
- 76 to 150
- 0 to 75

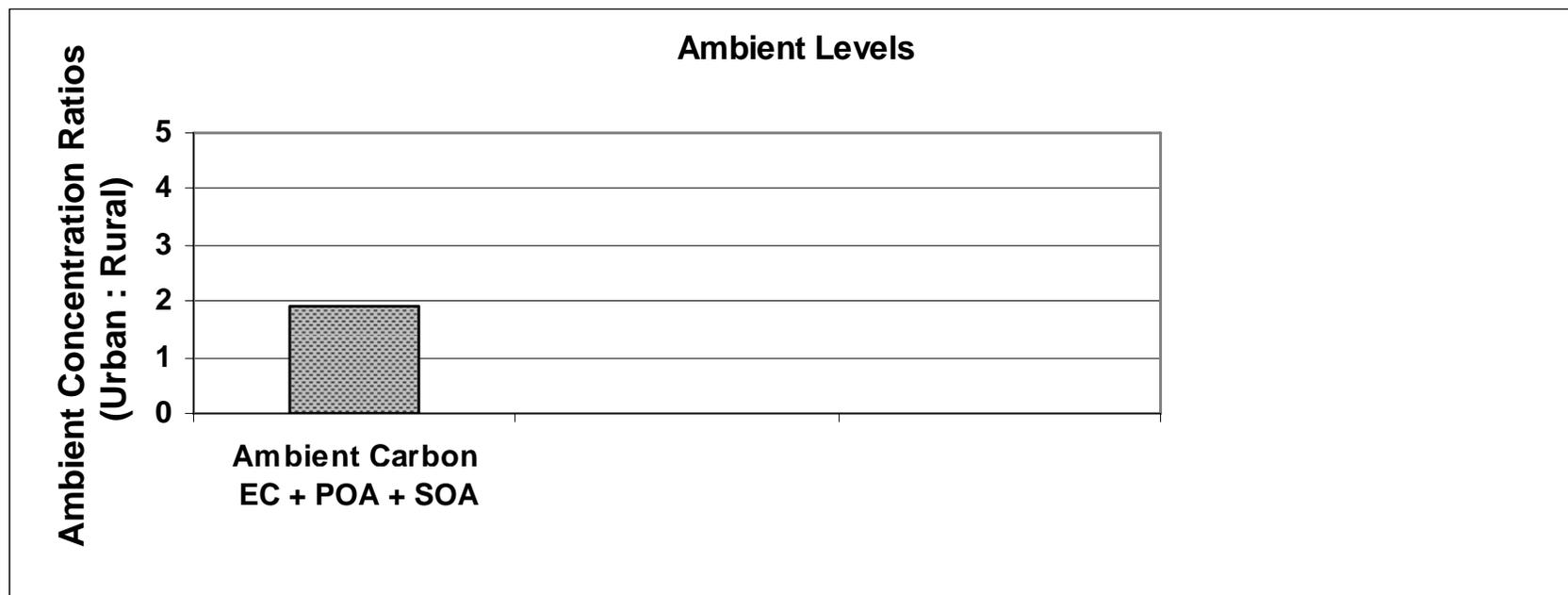
Carbon Particles – SOA



| Compound | VOC Precursor – Chemical Formula | Description |
|--|--|---|
| VOC (provides free radicals) | C1 – C6 (formaldehyde – hexane) | Promotes O ₃ and SOA formation by providing oxidizing free radicals (OH) |
| Precursor to secondary organic aerosol (SOA) | C7 – C15 (toluene, xylene, biogenic terpenes, etc.) | Precursor that reacts with oxidizing agents to produce secondary aerosols. SOA formation increases with higher temperatures. |
| Primary organic aerosol / matter | C16 + | Direct emissions of organic carbon particles or heaviest organic gases which condense as liquids onto existing particles (e.g. from combustion sources, meat cooking, etc.) |

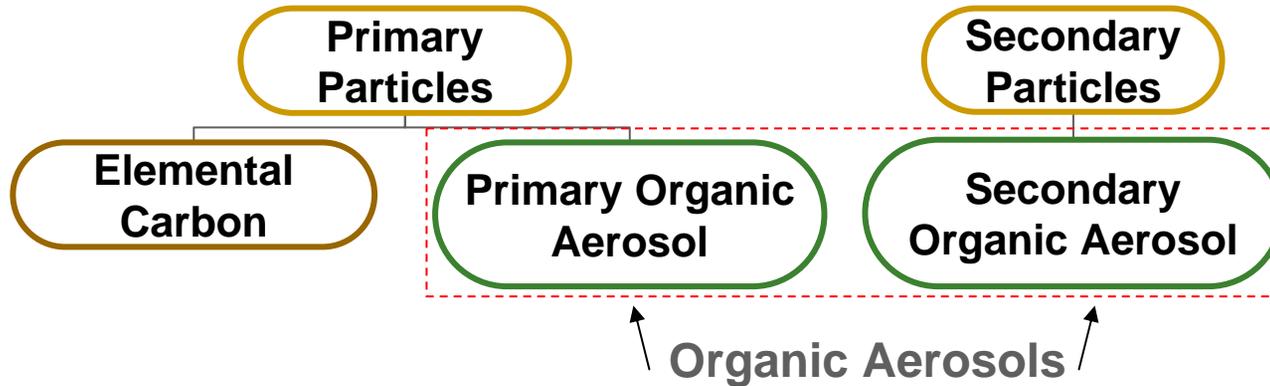
Urban Excess of Ambient Carbon in Eastern US

(Ambient Carbon = EC + POA + SOA)



- What we breathe is comprised of EC, POA & SOA
- Ambient Carbon is 2x Higher in Urban Areas
- We call this the Carbon “*Urban Excess*”

Carbon Particles – “*Urban Excess*”



- **Urban vs Rural ~ Total Carbon’s “*Urban Excess*”**
 - Ambient Measurements ~ 2X higher in Urban Areas
 - Emission Density
 - Primary ~ 3 to 4 X higher in urban areas
 - Aromatics ~ 5 X higher in urban areas
 - Terpinenes ~ ubiquitous

PM 2.5 In Ambient Air - A Complex Mixture

Review of Precursor Interrelationships

Secondary Organics

- VOC from Vegetation (Terpenes)
Relatively fast reaction
- VOC from Mobile Sources (Aromatics)
Slower than Terpenes
- Reducing Aromatics >> lower SOA

Ammonium Sulfate

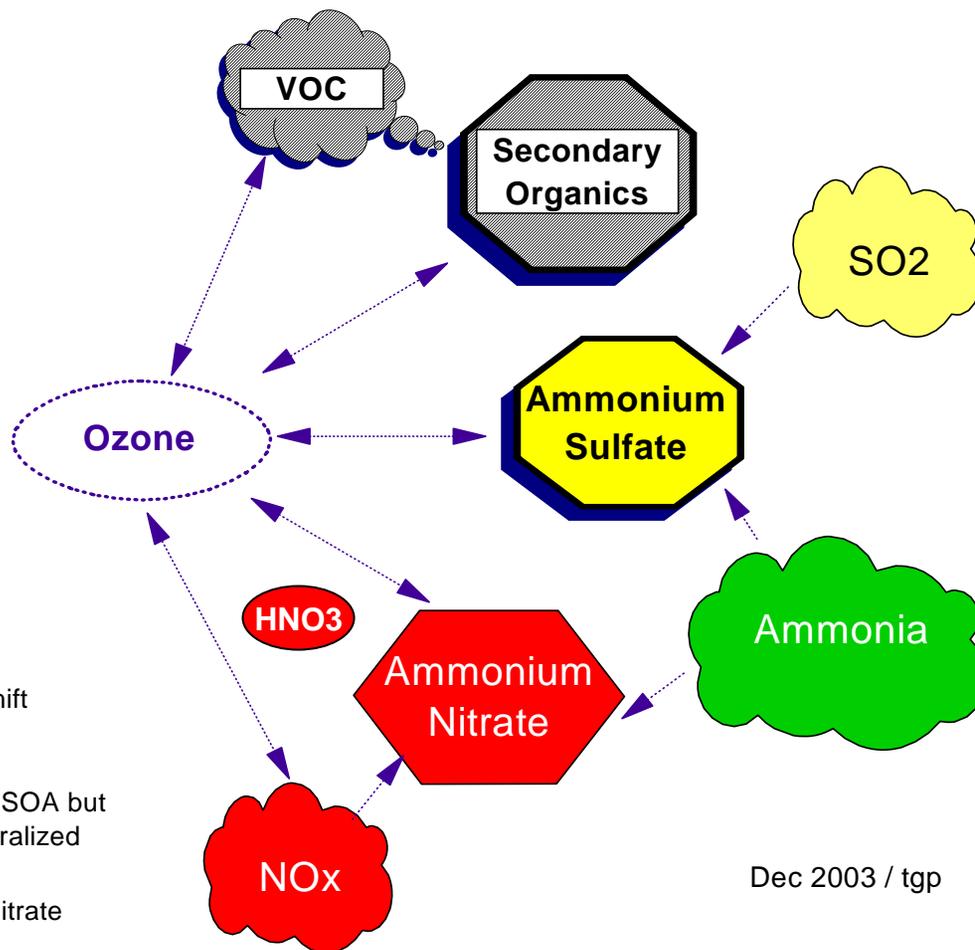
- SO₂ from Sulfur in Fuels
- Compared to Ozone:
 - Sulfate forms & deposits more slowly
 - If insufficient Ammonia ~
Ammonium bisulfate or Sulfuric acid
- Reducing SO₂ >> lower Ammonium Sulfate

Ammonium Nitrate

- NO_x from fuel combustion
- Relatively fast reaction
- If insufficient Ammonia ~
Sulfate formed before nitrate
- Higher temperatures, lower rH >> Equilibrium shift
Less nitrate - more nitric acid
- Sampling losses
- Reducing NO_x **may** reduce Nitrates, Sulfates & SOA but
outcomes very complicated, cannot be generalized

Ozone

- Generally, less Ozone >> less SOA, Sulfate & Nitrate



PM is Complex -- Any Questions ?



Session II

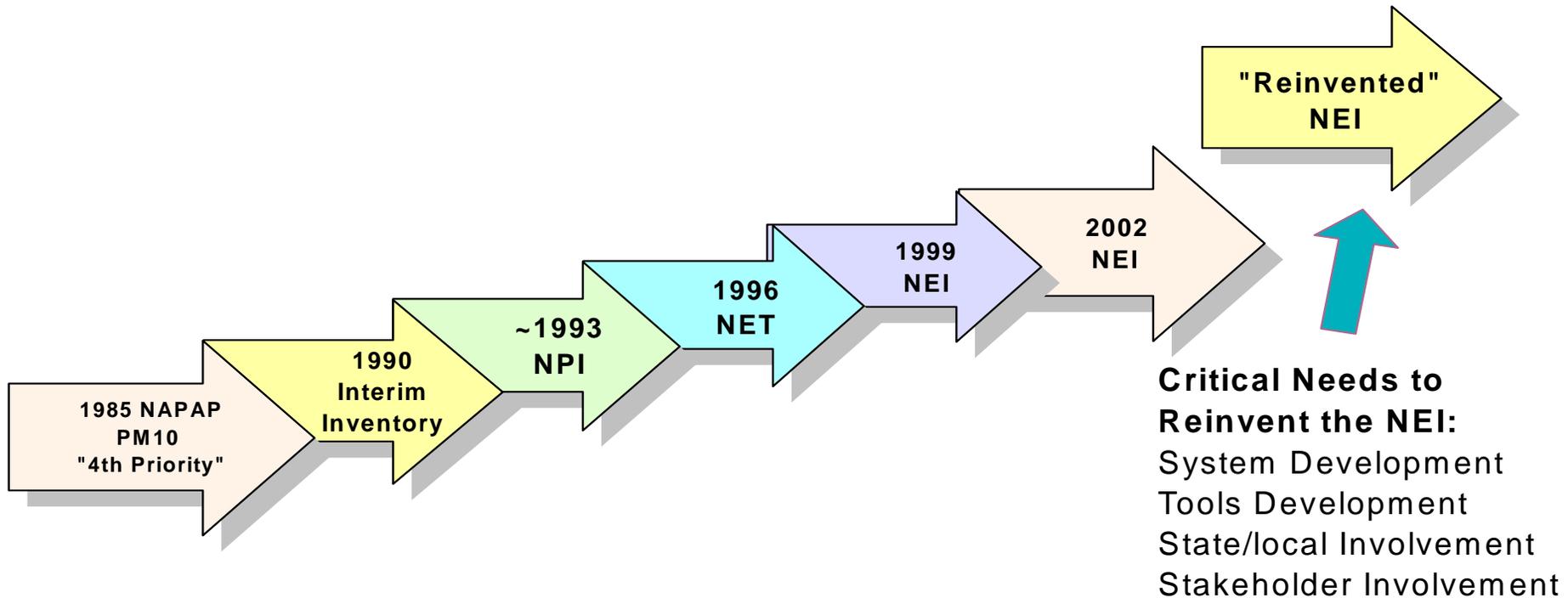
The NEI & Emission Inventory Tools

-
- **What is contained in the NEI**
 - **Reinventing the NEI**
 - **Emissions Inventory Preparation Tools**
 - **Emissions Processing**
 - **Process-based Emissions Models**

What Info is Contained in the NEI ?

- **Nat'l tabulation of emissions of PM2.5, SO2, NOx, Ammonia, VOC & HAPs.**
 - Point sources by Lat-long: 52,000 facilities, each containing multiple emission points.
 - Over 4500 types of processes represented
 - Available CEM data
 - Area & Mobile by County: 400 categories of Highway & Non road Mobile and over 300 categories of Area sources
- **Annual emissions, start / end dates, stack parameters**
- **Estimates for each year (some years “grown”)**
- **Also, in the NEI**
 - HAPs emissions for over 6000 types of processes
- **Currently Available:** 1999, 2000, 2001, 2002 (v03/06/06)

Evolution of EPA's National Emission Inventory



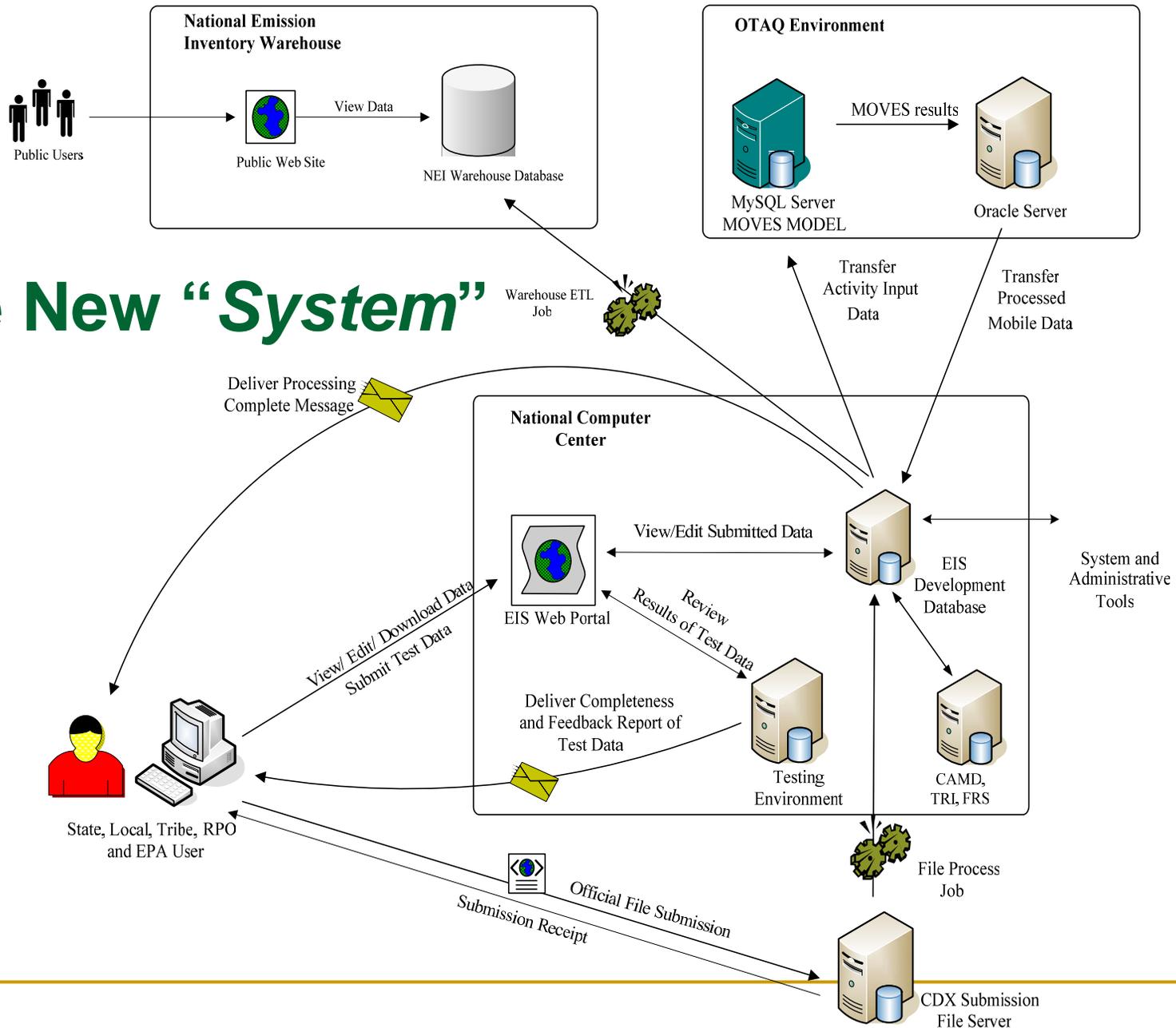
NAPAP - National Acidic Precipitation Assessment Program

NPI - National Particulate Inventory

NET - National Emission Trends Inventory

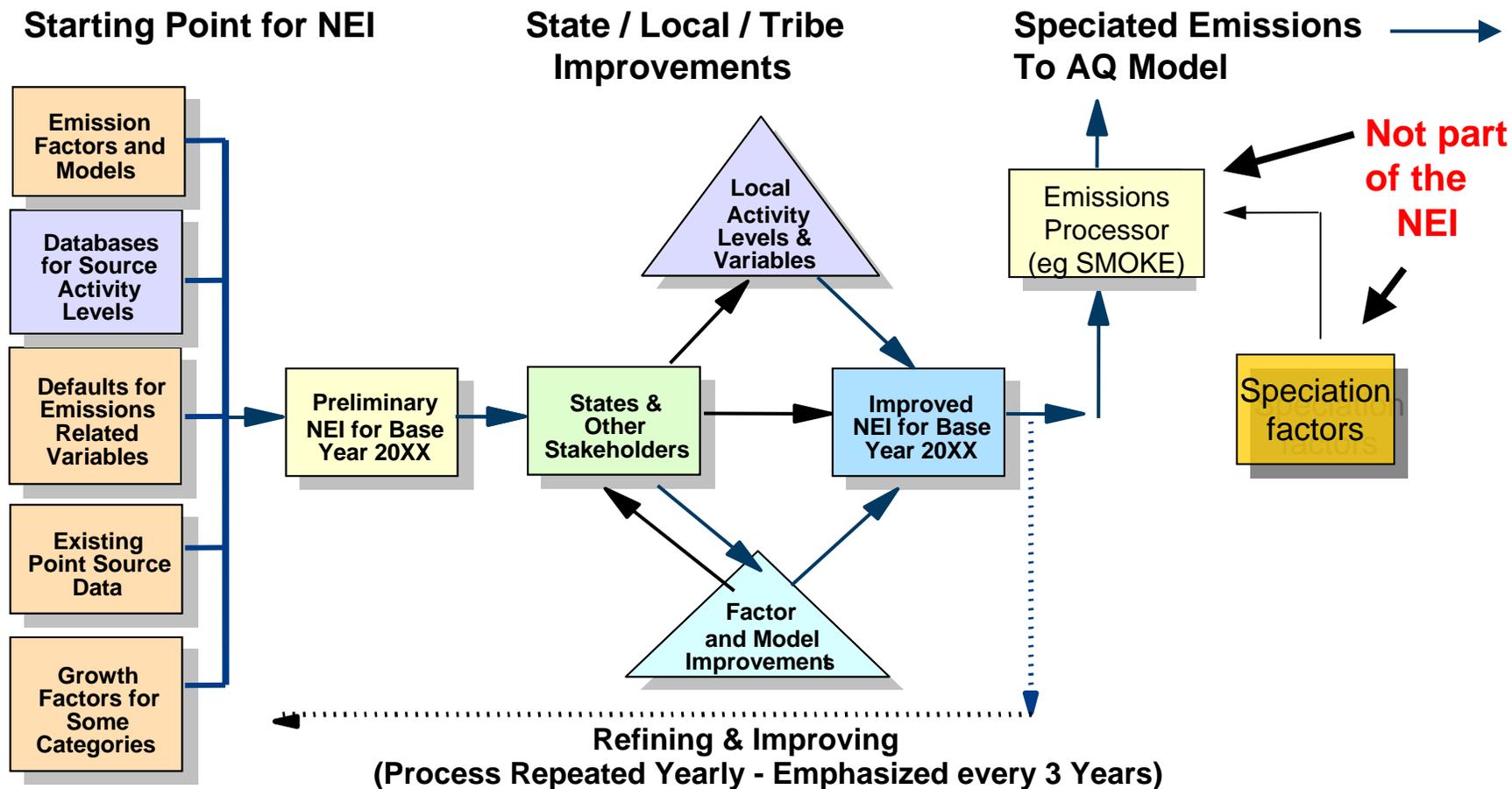
NEI - Merger of NET and Nat'l Toxics EI

The New "System"

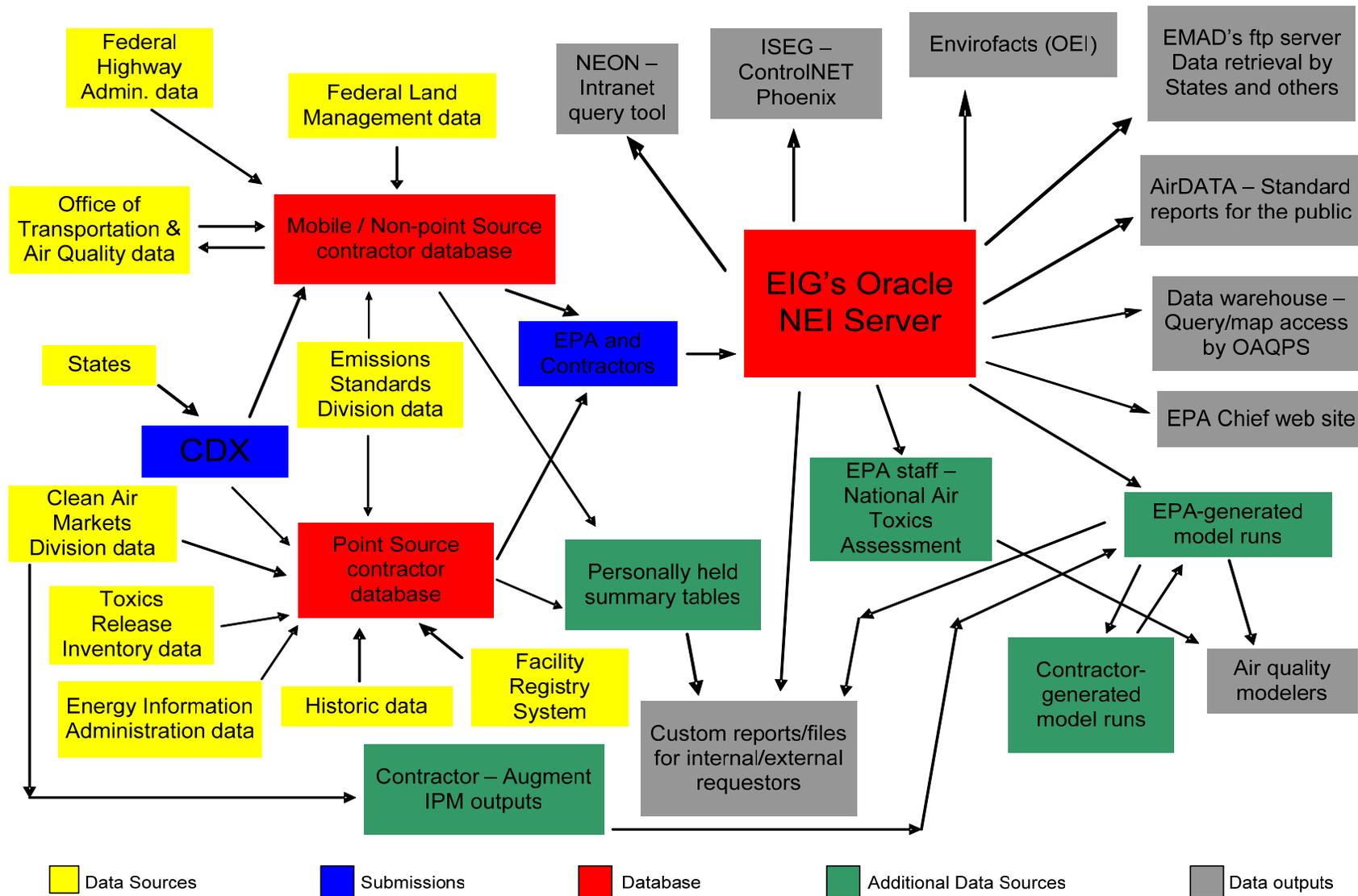


The OLD NEI Development "Process" (Concept)

Cooperative & Iterative



The OLD NEI Development "Process" (Reality)



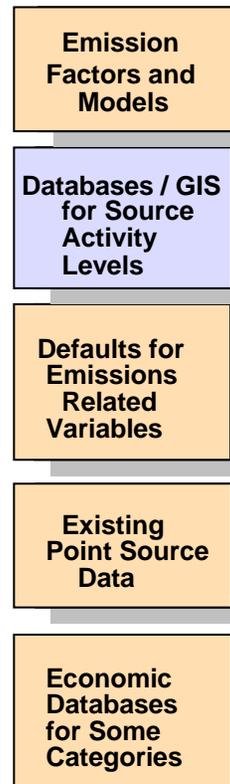
The NEW NEI Development “Process”

Transparent & Interactive

Data Available for NEI

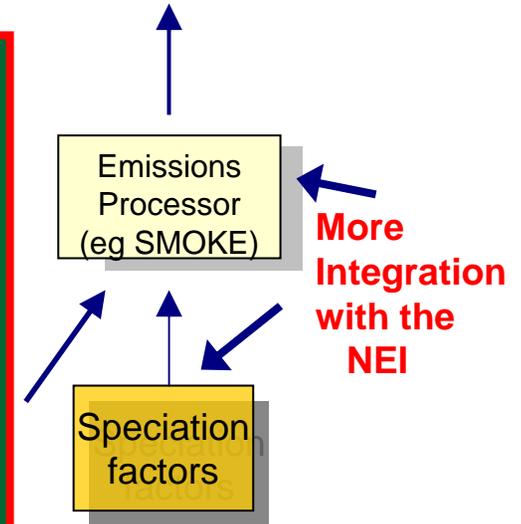
State / Local / Tribe / EPA
Interactive NEI Development

Speciated Emissions To AQ Model



Features (In Planning Stage)

- Interactive “On-line” Data Editing
- Shape File & Database Availability
- “Appropriate” Update Frequencies
- Transparent Data & Calc Methods
- S-L-T data “in lieu of ” EPA
- Strive for Balance of Flexibility vs Consistency



Inventory Preparation Tools

- **Emission Factors & Activity Data**
 - (~ 20,000 factors in FIRE)
 - Processes vary over time ~ Activity and Factor representativeness

Specific PM2.5 Categories Generally Needing Input from Federal / State / Local / Tribes

- **Wildland Burning**
 - *Forests, Rangeland & especially private & State / tribal burners*
 - *(acreages burned, fuel loadings for largest fires, timing)*
- **Residential Open Burning**
 - *Household Waste, Yard waste (volumes & burning practices)*
 - *Regulations & their effectiveness, local surveys of burn activities)*
- **Construction Debris & Logging Slash**
 - *Regulations & their effectiveness, local surveys of burn activities*
- **Agricultural Field Burning**
 - *Acreages, fuel loadings, timing*
- **Residential Wood Combustion**
 - *Fireplaces, Wood Stoves*
 - *local surveys of fuel burned, fireplace vs wood stoves, local regulations*
- **Specific industrial process sources (as needed locally)**
- **Fugitive Dust as indicated by local conditions**

Inventory Preparation Tools

■ Emission Factors & Activity Data

- (~ 20,000 factors in FIRE)
- Processes vary over time ~ Activity and Factor representativeness

■ Emissions Models

- Tanks
- Mobile, Non-Road
- BlueSky EM, CMU Ammonia Model, BIES, Others

Inventory Preparation Tools

- **Emission Factors & Activity Data**

- (~ 20,000 factors in FIRE)
- Processes vary over time ~ Activity and Factor representativeness

- **Emissions Models**

- Tanks
- Mobile, Non-Road
- BlueSky EM, CMU Ammonia Model, BIES, Others

- **Spatial Characterization & Locator Aides**

- GIS
- GPS
- Satellites

Inventory Preparation Tools

- **Emission Factors & Activity Data**

- (~ 20,000 factors in FIRE)
- Processes vary over time ~ Activity and Factor representativeness

- **Emissions Models**

- Tanks
- Mobile, Non-Road
- BlueSky EM, CMU Ammonia Model, BIES, Others

- **Spatial Locator Aides**

- GIS
- GPS
- Satellites

- **Emissions Processing, including Speciation**

Overview of Emissions Processing

- **Processors include:**
 - SMOKE, EPM, CONCEPT
- **Processor output**
 - Gridded, hourly emissions file
 - Speciation of Primary Emissions (EC, Organics, SO₄, Nitrates)
 - Model-ready
- **Processor inputs**
 - Annual, county-level area source EI
 - Annual point source data (except for CEM data)
- **Alternative Input files from:**
 - CEM database
 - Process-based emissions models (new approach)
- **Processor contains default factors & profiles, including:**
 - County-to-Grid Allocation Factors
 - Temporal Allocation Profiles (hourly & seasonal)
 - Speciation Profiles

Speciation of PM_{2.5} & VOC

- **EC, POA, Primary Sulfate, Primary Nitrate, PM “Other”**
 - Derived *in the Emissions Processor* from PM_{2.5} using speciation profiles
 - NOT part of the NEI
- **Updating of Speciation Database & Profiles**
 - EPA-ORD / Pechan project
 - Updates for PM & VOC (MS Access)
 - Speciate v4.0 ~ 2700 profiles (v3.2 ~ 900)
 - Also, over 500 new species included in the new profiles
 - Work underway to refine “simplified” PM Profiles for AQ modelers
 - New database also very useful to Receptor Modelers
 - New profiles will be added periodically
 - Database @: <http://projects.pechan.com/speciate/Versions.html>
 - Contact: beck.lee@epa.gov
- **Issues**
 - EC – POA Split, carbon analysis methods
 - Simplified profiles
 - OC – POA compound adjustment
 - Speciation of **PM “Other”** into Crustal, Other

Inventory Preparation Tools

- **Emission Factors & Activity Data**
 - (~ 20,000 factors in FIRE)
 - Processes vary over time ~ Activity and Factor representiveness
- **Emissions Models**
 - Tanks
 - Mobile, Non road
 - BlueSky EM, CMU Ammonia Model, BIES, Others
- **Spatial Locator Aides**
 - GIS
 - GPS
 - Satellites
- **Emissions Processing**
- **Process-based Emissions Models**

Process-based Emissions Models

- **Space- & time-** sensitive emissions reflective of real time conditions, e.g.,
 - wind, temperature,
 - RH, vegetation types,
 - soil type & moisture
- **Linkages:**
 - MM5,
 - GIS coverages,
 - Emission algorithms
- **Currently** ~ BEIS3, On road (optional), BS-EM (soon)
 - No other categories currently linked to real time conditions
 - Model speed is an issue with the mobile models

Process-based Emissions Models

- Process-based emission models ***needed***:
 - **Ammonia** (fertilizer application, animal husbandry, removal)
 - **Fugitive Dust** (wind, unpaved roads, construction, tilling, removal)
 - **Wildland Fires** (fuels, fuel consumption, plume rise)
 - **Residential Wood Burning**
 - **Evaporative Loss ?**
 - **Others ?**
- Stay tuned ~ More discussion to follow

Status of Process-based Emissions Models (Integrated w/ Emissions Processor)

- **Biogenics** (always integrated w/ EP)
- **On-Road** (optional integration w/ EP)
- **More info later today on Status of:**
 - **Wildland Fire** (under development – EPA/ORD)
 - **Ammonia** (under development - RPOs)
 - **Windblown Dust** (under development - WRAP)
 - **Other Fugitive Dust** (on hold)

Inventory Preparation Tools

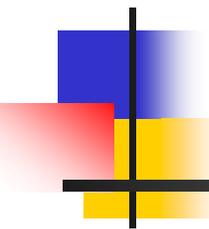
- **Emission Factors & Activity Data**
- **Emissions Models**
 - Tanks, Mobile, Non-Road
 - BlueSky-EM, CMU Ammonia Model, BEIS
 - WRAP Windblown dust model, Others
- **Spatial Locator Aides**
 - GIS
 - GPS
 - Satellites
- **Emissions Processing**
- **Process-based Emissions Models**
- **Receptor Models**
 - Inventory refinement, bounding uncertainties
 - Fossil vs Contemporary Carbon
 - Gas vs diesel
 - Cold starts, smokers

Summary of Key Issues in PM2.5 EI

- **Near-source removal processes & changes to PM2.5 multipliers**
 - Crustal Materials
- **Spatial & Temporal Allocation**
 - County to grid; Annual to daily, hourly
- **Speciation Issues**
 - Carbon ~ EC / OC Split & OC to Organic Aerosol Conversion
 - PM “Other”
- **Receptor Models**
 - Carbon ~ Fossil vs Contemporary; Gas vs Diesel; Smokers; Cold Starts
- **Representativeness of Emission Factors**
 - Especially Industrial Processes
 - Transient, Cyclic & Atypical Operation
- **Process Models & “*real time*” Effect of Meteorology, Climatology**
 - BEIS, Wildland Fires, Windblown Dust, Ammonia

Questions ?





Point Sources of Fine PM & NH₃

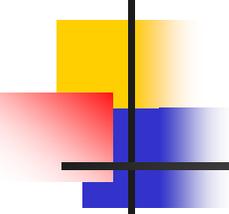
Roy Huntley

Huntley.Roy@EPA.gov

EPA, OAQPS, EIAG

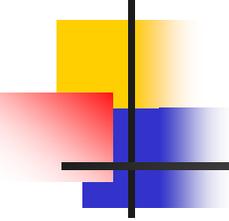
May 15, 2006

New Orleans, LA



How Do I Define a Point Source of PM Fine or NH₃ Emissions?

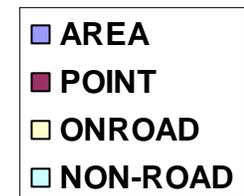
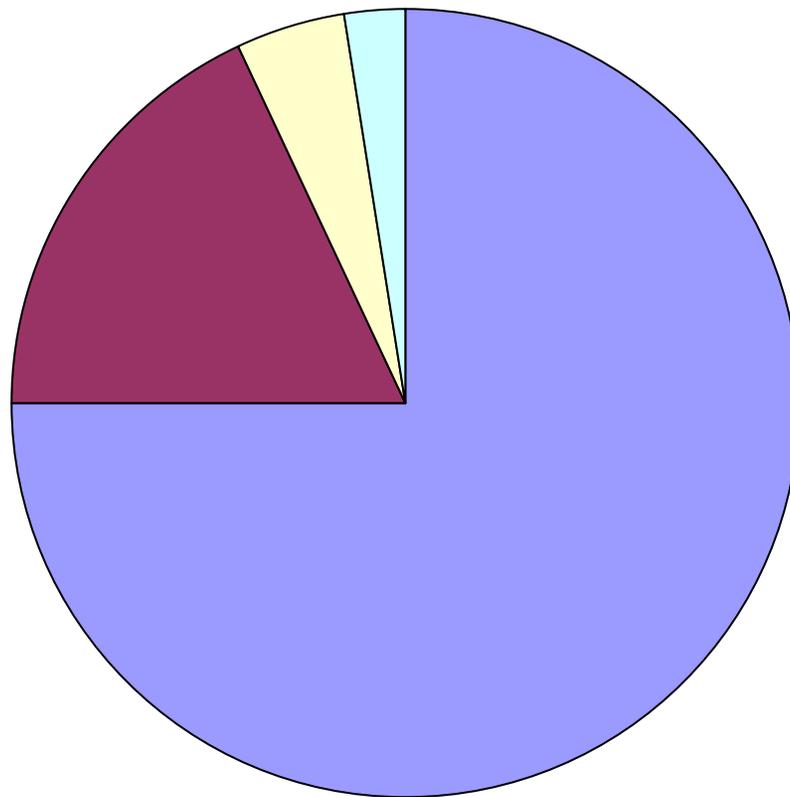
- Point sources are stationary sources that are included in a point source inventory.
- Criteria for including a stationary source in a point source inventory is either determined by:
 - State, Local, or Tribal regulations or policy; and/or
 - Consolidated Emissions Reporting Rule (CERR)
- Total facility emissions for a given pollutant is usually the criterion for deciding what sources to include in a point source inventory.



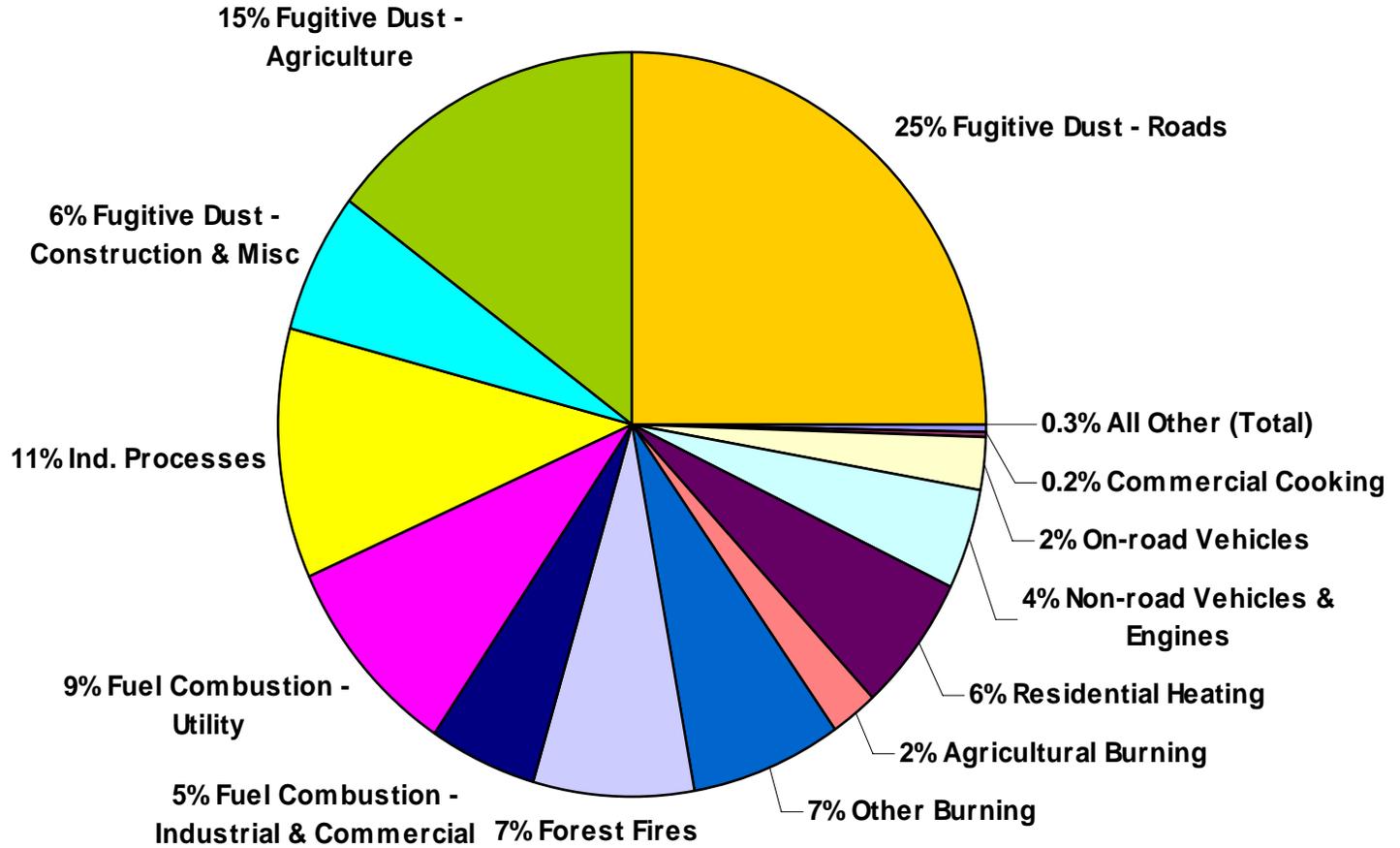
Overview

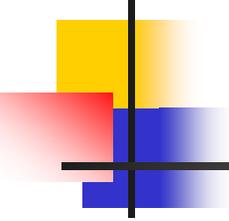
- Point sources of:
 - PM & NH₃
- Definitions of forms of PM for the NEI
 - Filterable vs Primary; Condensable
- Verification of the form of PM in your emissions inventory (EI)
- Point and area source EI overlap issues

PM25-PRI, 1999 NEI FV3



PM-2.5 Emissions in 2001 EI

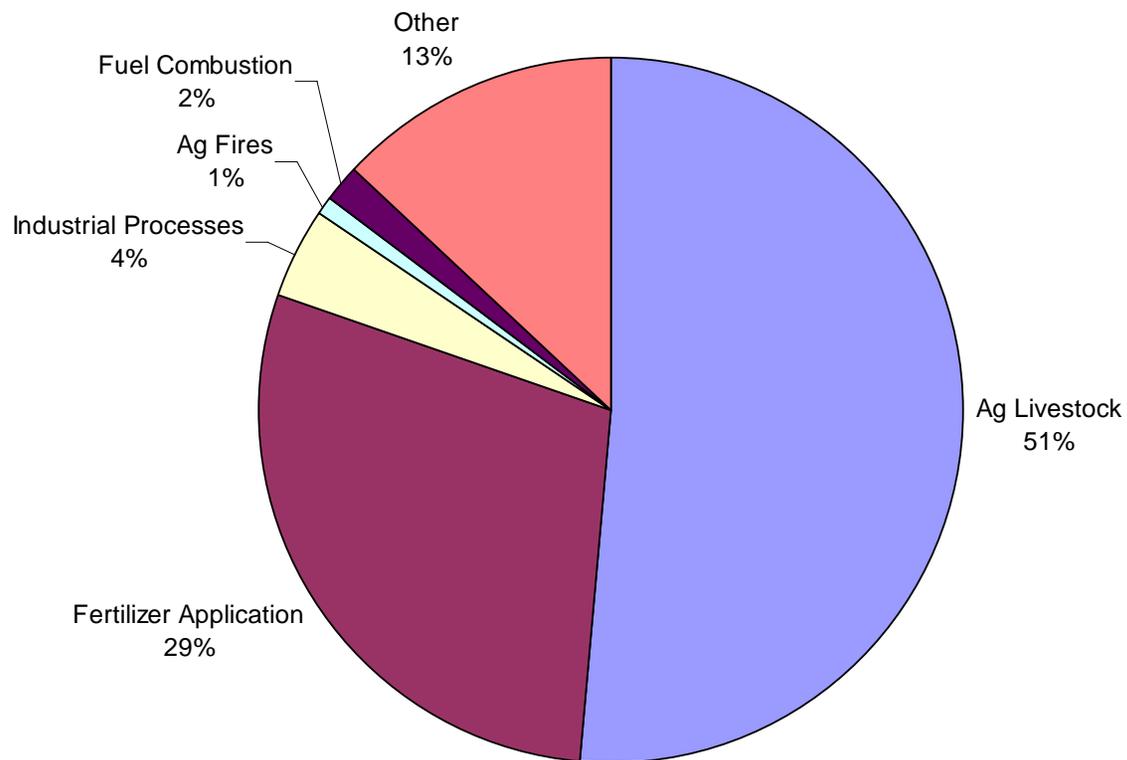


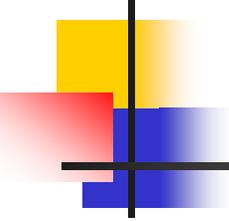


Sources of PM Emissions in Point Sector

- Fuel Combustion
- Industrial Processes
 - Pulp and Paper
 - Petroleum Refinery
 - Cement Manufacturing
 - Fiberglass Manufacturing
 - Etc.

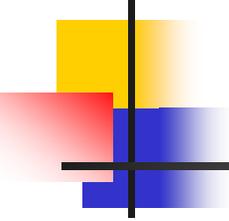
NH3 Emissions in the 02 NEI by Tier Category





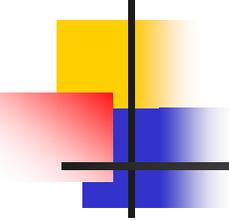
Sources of NH₃ Emissions from Industrial Sources

- Industrial NH₃ emissions can be placed into 3 broad categories related to the nature of the emissions source:
 - Emissions from industrial processes
 - Use of NH₃ as a reagent in NO_x control
 - Refrigeration losses



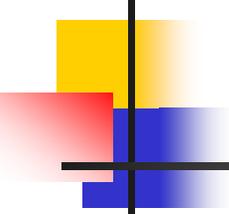
Sources of NH₃ Emissions from Industrial Processes (Cont'd)

- Examples of industrial processes that emit NH₃ include:
 - Combustion sources
 - Ammonium nitrate & ammonium phosphate production
 - Petroleum refining
 - Pulp and paper production
 - Beet Sugar Production



Emissions Factors for NH₃

- **Estimating Ammonia Emissions From Anthropogenic Nonagricultural Sources**
 - EIIP document
 - EI guidance for sources such as Industrial refrigeration, POTW's, composting, Bakeries, pulp&paper, landfills, portland cement, and combustion of fossil fuels
 - http://www.epa.gov/ttn/chief/eiip/techreport/volume03/eiip_areasourcesnh3.pdf



PM Definitions for the NEI

- **Filterable (PM-FIL):**

Particles directly emitted as a solid or liquid at stack or release conditions and captured on the filter of a stack test train. Filterable PM may be PM_{2.5} or PM₁₀.

- **Condensible (PM-CON):**

Material that is vapor phase at stack conditions, but condenses and/or reacts upon cooling and dilution in the ambient air to form solid or liquid PM immediately after discharge from the stack. EPA considers condensible PM = PM_{2.5}.

- **Primary (PM-PRI) = (PM-FIL) + (PM-CON):**

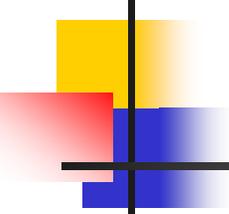
All particles directly emitted from a stack or an open source.

- **Secondary (PM-SEC):**

Particles that form through chemical reactions in the ambient air well after dilution and condensation have occurred. Secondary PM formed downwind of source.

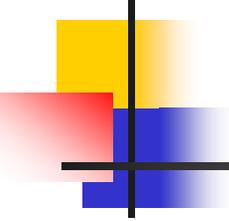
Precursors to **PM-SEC** are in the NEI: SO₂, NO_x, NH₃, VOC

PM-SEC should **NOT** be reported in the emission inventory.



Sources of Filterable versus Condensible Emissions

- Combustion sources typically emit both filterable and condensible PM emissions
 - Boilers
 - Furnaces/kilns
 - Internal combustion engines (reciprocating & turbines)



Sources of Filterable versus Condensible Emissions

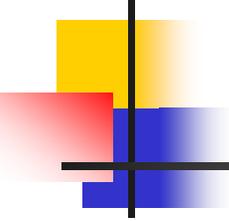
- Fugitive dust sources emit filterable emissions only
 - Storage piles
 - Unpaved roads at industrial sites
- Labeled as Primary in the NEI for consistency





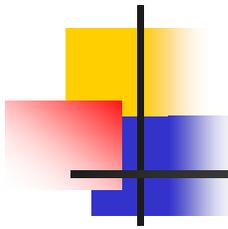


How Do I Identify Point Sources of PM Fine and NH₃?



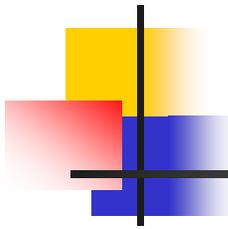
- EIIP Point Source Guidance (Volume II)
 - Table 1.3-1 list potential point sources for each criteria pollutant
(http://www.epa.gov/ttn/chief/eiip/techreport/volume02/ii01_may2001.pdf)
- AP-42 (<http://www.epa.gov/ttn/chief/ap42/index.html>)
- Existing Inventories
 - National Emissions Inventory
(<http://www.epa.gov/ttn/chief/eiinformation.html>)
 - Toxics Release Inventory (TRI) for NH₃
(<http://www.epa.gov/tri/>)

What to Report to EPA – Old Guidance

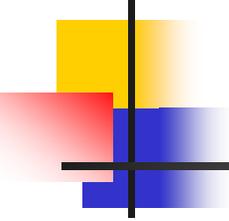


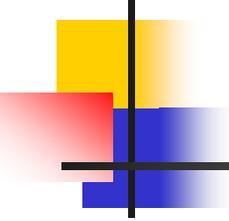
- EPA can take all forms of PM, but prefer Primary
 - PM₂₅-PRI (or PM₂₅-FIL & PM-CON individually)
 - Note that all PM-CON is assumed to be PM_{2.5} size fraction)
 - PM₁₀-PRI (or PM₁₀-FIL & PM-CON individually)
- If submit other than Primary, then EPA creates PM₁₀-PRI and PM₂₅-PRI records

What to Report to EPA – New Guidance



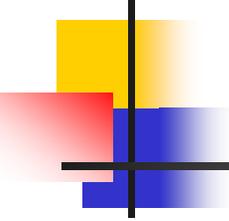
- EPA can take all forms of PM, but prefer ~~Primary~~ **Filterable!!**
 - ~~PM25-PRI~~ (or PM25- FIL & PM-CON individually)
 - Note that all PM-CON is assumed to be PM_{2.5} size fraction)
 - ~~PM10-PRI~~ (or PM10-FIL & PM-CON individually)
- If submit other than Primary, then EPA creates PM10-PRI and PM25-PRI records

- 
-
- EPA does not keep or track “PM” anymore



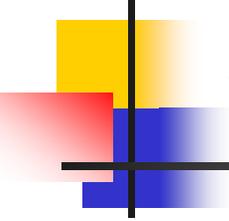
Implications

- Need to use the NIF 3.0 PM pollutant code extensions that identify the forms of PM (i.e., –PRI, –FIL, or –CON)
- Verify the form of the PM:
 - Emission factors you use to calculate emissions; and
 - PM emissions facilities report to you.
- Update your database management system to record these pollutant codes in NIF 3.0



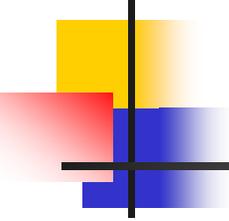
AP-42 Particle Size Data

- **Provides particle size distribution data and particle-size-specific emission factors**
 - Use AP-42 if source-specific data are not available
 - Use data in chapters for specific source categories first
 - Use Appendix B-1 data next
 - Use Appendix B-2 data last
 - AP-42 chapters not always clear on what source test methods were used to develop particle size data
 - See background documents for AP-42 chapters for details
 - AP-42 available on EPA/OAQPS CHIEF web site
 - <http://www.epa.gov/ttn/chief/ap42/index.html>



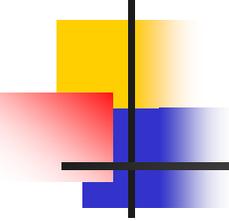
AP-42 Particle Size Data (Cont'd)

- **Appendix B-1 (Particle Size Distribution Data and Sized Emission Factors for Selected Sources)**
 - Based on documented emission data available for specific processes
- **Appendix B-2 (Generalized Particle Size Distributions)**
 - Based on data for similar processes generating emissions from similar materials
 - Generic distributions are approximations
 - Use only in absence of source-specific distributions



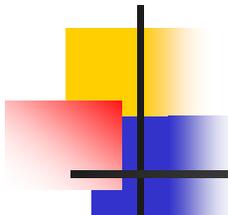
Factor Information REtrieval (FIRE) Data System

- Newest version now available
 - Sept 2004 (Version 6.25)
<http://www.epa.gov/ttn/chief/software/fire/index.html>



PM Calculator

- EPA tool for calculating uncontrolled/controlled filterable $PM_{2.5}$ and PM_{10} emissions using AP-42 particle size distributions
- For point sources only
- Contains 2,359 SCCs with PM_{10} emissions in 1996 NEI
- Limitations
 - AP-42 particle size data not available for many sources; generic AP-42 profiles are used for many source categories
- Available on EPA/OAQPS CHIEF web site
 - <http://www.epa.gov/ttn/chief/software/index.html>

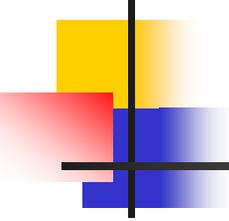


Point & NonPoint Source Emissions Inventory (EI) Overlap Issues

- For categories included in Point and NonPoint EIs:
 - Must subtract total point activity from total state activity to obtain total nonpoint activity (see EIIP Area source document)

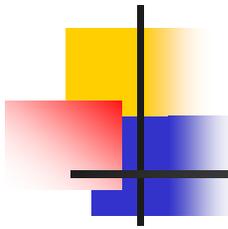
$$\text{Total NP Activity} = \text{Total Activity} - \Sigma \text{Total Point Activity}$$

- Example for Fuel Combustion Sources:
 - Point activity: fuel throughput from point source EI survey
 - Total activity: fuel throughput from State/local gov. agencies or U.S. DOE/EIA State Energy Data reports



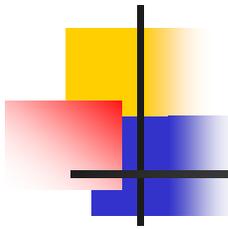
Point & Area Source EI Overlap Issues (Cont'd)

- Basis of Point Source Subtraction
 - Activity-based calculation is preferred
 - Emissions-based calculation is acceptable when activity is not available:
 - Total source category activity and point activity need to be on same control level (usually uncontrolled)
 - Back-calculation of uncontrolled emissions for controlled processes may overstate uncontrolled emissions



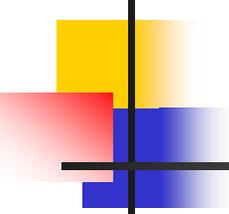
Point & Area Source EI Overlap Issues (Cont'd)

- Geographic level of calculation may affect results:
 - Issue when using surrogate activity data (e.g., employment, housing, population) to allocate total State activity to counties
 - Subtracting county totals may produce negative results due to inaccuracy of allocation method
 - Subtracting State totals less likely to produce negative results at county level
 - Point source adjustments to surrogate allocation data (e.g., employment) should be done if available from point EI survey



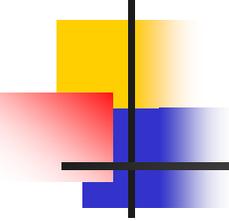
Point & Area Source EI Overlap Issues (Cont'd)

- QA/QC Results
 - Review county-level area source estimates for reasonableness
 - Make adjustments based on experience of your agency's personnel:
 - For example, if allocation method places area source activity in a county for which you know there is no activity, exclude the county from your allocation, or
 - If all of a county's activity is covered by the point EI, set the activity for the county to zero.



Point & Area Source EI Overlap Issues (Cont'd)

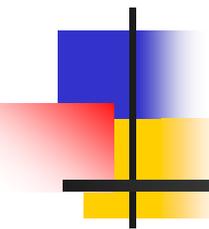
- Reporting of small point sources in area CERR submittal:
 - If your point EI includes sources with emissions below the CERR point EI reporting thresholds, you may include the emissions for these small sources in the area EI
 - To avoid double counting in the area EI, subtract total point source activity or emissions from total State-level activity or emissions before rolling up emissions for small point sources to be included in your area EI



Reading List

- *Stationary Source Control Techniques Document for Fine Particulate Matter*, EPA/OAQPS, Oct. 1998
<http://www.epa.gov/ttn/oarpg/t1/meta/m32050.html>
- *Emission Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) AND Regional Haze Regulations*, EPA/OAQPS
<http://www.epa.gov/ttn/chief/eidocs/eiguid/index.html>
- *Introduction to Stationary Point Source Emission Inventory Development*, EIIP Vol. 2, Chapter I, May 2001
<http://www.epa.gov/ttn/chief/eiip/techreport/volume02/index.html>
- *How to Incorporate Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates*, EIIP Vol. 2, Chapter 12, July 2000
<http://www.epa.gov/ttn/chief/eiip/techreport/volume02/index.html>





Non Point Sources

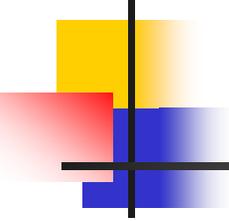
Roy Huntley

EPA, OAQPS, EIG

Huntley.Roy@EPA.gov

New Orleans, LA

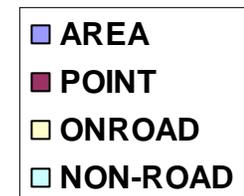
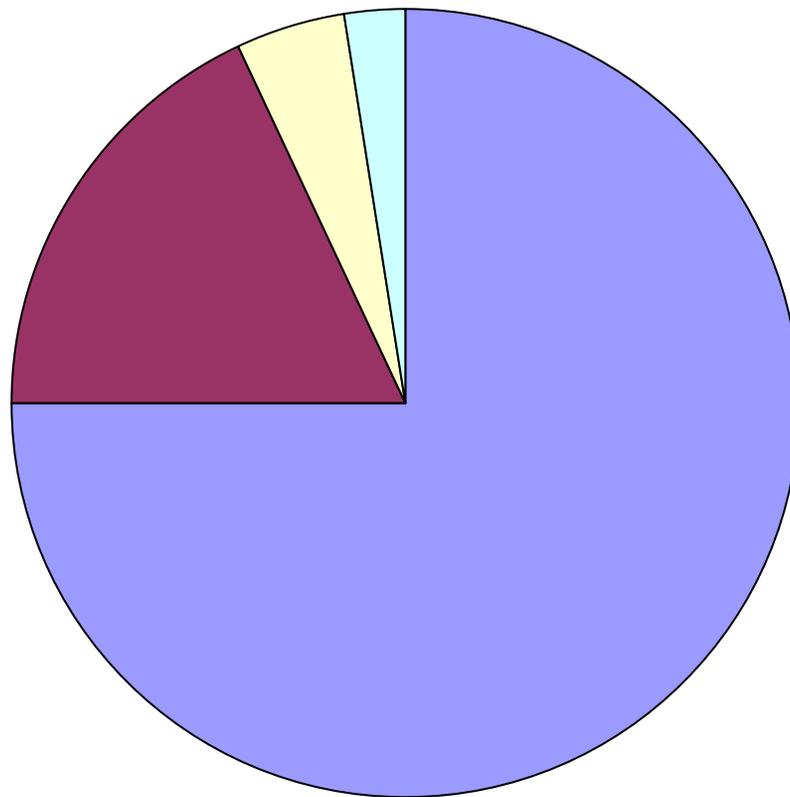
May 15, 2006



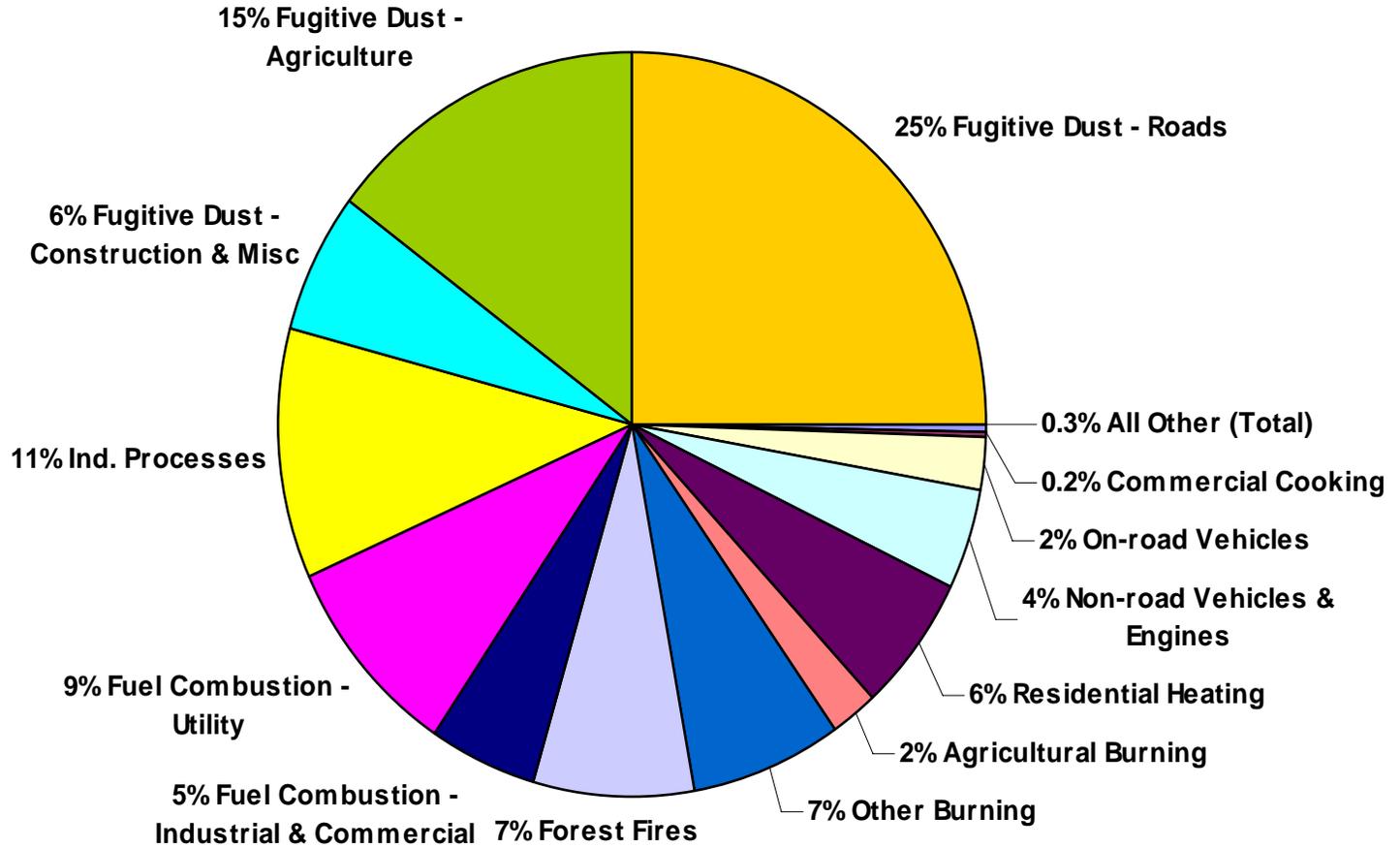
Overview

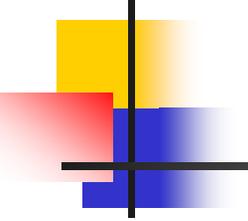
- What is the Non Point Sector?
 - What to Report to EPA?
 - Federal reporting requirements
- Resources for Inventory Developers
- What are the Major Sources in the NP Sector?
- EI development approaches

PM25-PRI, 1999 NEI FV3



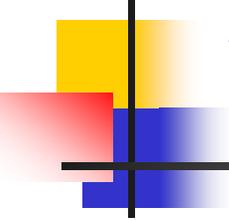
PM-2.5 Emissions in 2001 EI





What is the Non Point Sector?

- The non-point source inventory includes stationary sources that are not included in the point source inventory
- Non-point source tend to be small but numerous
 - Commercial & residential fuel combustion
 - Paved & unpaved roads
 - Animal husbandry
 - Fires; wild (pt sector for 2002), prescribed, home heating (includes residential wood combustion), construction debris burning, Ag burning, & open burning of waste



What to Report to EPA?

Consolidated Emissions Reporting Rule (CERR)

- Must report actual annual emissions
- Must report non-point sources for entire State triennially (3-year cycle)
- First Reporting for Base Year 2002
 - Inventories due June 1, 2004
 - Criteria Pollutants & Precursors (including PM₁₀, PM_{2.5}, NH₃)
- AERR will supercede the CERR
 - Proposed Jan 3, 2006 - 71 FR page 69
 - Comment period ends May 3, 2006

Resources -

<http://www.epa.gov/ttn/chief/eiip/pm25inventory/index.html>

The screenshot shows a Microsoft Internet Explorer browser window. The title bar reads "EPA | PM2.5 Inventory Resource Center | Emission Inventory Improvement Program (EIIP) | Technol - Micro...". The address bar contains the URL "http://www.epa.gov/ttn/chief/eiip/pm25inventory/". The page content includes a navigation menu on the left, a search bar, and a main content area with sections for "RESOURCES" and "USEFUL INFORMATION".

Getting Started
Inventory Preparation
Tools
Emissions QC, Preprocessing and Projections
PM Research and Field Studies
Recent Additions
Related Site Links
Comments
Site Map

[Contact Us](#) | [Print Version](#) Search: **GO**

[EPA Home](#) > [Technology Transfer Network](#) > [Clearinghouse for Inventories & Emissions Factors](#) > [Emission Inventory Improvement Program](#) > [PM 2.5 Inventory Resource Center](#)

PM 2.5 Inventory Resource Center

This site provides links to resources used for developing PM 2.5 emission inventories.

RESOURCES

[Getting Started](#)
Introduction to PM2.5 inventories, standards, and data.

[Inventory Preparation](#)
Inventory concepts, guidance and procedures.

[Tools](#)
Emission Estimation Tools and Activity Data.

[Emissions QC, Preprocessing and Projections](#)
Quality Control (QC) and model preprocessing resources.

USEFUL INFORMATION

[PM Research and Field Studies](#)
Information on ongoing PM2.5 Research Projects.

[Recent Additions](#)
The latest on PM2.5 emission inventory guidance, tools, data and conferences.

[More EI links](#)
Links to potentially useful web sites.

[Site Map](#)
Find your way around the PM2.5 web site.

Trusted sites

EPA | PM2.5 Inventory Resource Center - Getting Started | Emission Inventory Improvement Progra - Micros...

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites Media Print Mail News RSS People

Address <http://www.epa.gov/ttn/chief/eiip/pm25inventory/beginpm.html> Go

PM 2.5 Inventory Resource Center

Getting Started

This page provides information on issues related to PM2.5 and links to Internet pages that have summary emissions inventory data. Information related to the NAAQS, health effects of PM2.5, visibility and haze, are available here.

Links

- [Inventory Concepts](#)
Defines emission factors(EFs) and their uses; Describes how to obtain AP-42 information and updates.
- [PM2.5 - Getting Started Document](#)
This document is an essential reference for those with limited familiarity to PM2.5.
- [Ambient Data](#)
Monitoring networks, summaries and data analysis; speciation and particulate chemistry
- [Existing Inventory Information](#)
Emission trends reports, and procedures, GCVTC reports, and inventory procedures.
- [NAAQS and Haze](#)
Describes the NAAQS, and NAAQS for PM2.5; effects of PM2.5;Haze programs;effects of Haze.
- [Stakeholders](#)
Regional Groups, Planning Bodies and Associations.

Trusted sites

Getting Started
Inventory Preparation
Tools
Emissions QC, Preprocessing and Projections
PM Research and Field Studies
Recent Additions
Related Site Links
Comments
Site Map

EPA | PM2.5 Inventory Resource Center - More Links | Emission Inventory Improvement Program (EI - Micros...

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites Media Print Mail News RSS People

Address <http://www.epa.gov/ttn/chief/eiip/pm25inventory/morelinks.html> Go

Projections resources already available on this site.

PM Research and Field Studies

Recent Additions

Related Site Links

Comments

Site Map

U.S. State Agencies

[EXIT disclaimer](#)

- [Alabama](#)
- [Alaska](#)
- [Arizona](#)
- [Arkansas](#)
- [California](#)
- [Colorado](#)
- [Connecticut](#)
- [Delaware](#)
- [Florida](#)
- [Georgia](#)
- [Hawaii](#)
- [Idaho](#)
- [Illinois](#)
- [Indiana](#)
- [Iowa](#)
- [Kansas](#)
- [Kentucky](#)
- [Louisiana](#)
- [Maine](#)
- [Maryland](#)
- [Massachusetts](#)
- [Michigan](#)
- [Minnesota](#)
- [Mississippi](#)
- [Missouri](#)
- [Montana](#)
- [Nebraska](#)
- [Nevada](#)
- [New Hampshire](#)
- [New Jersey](#)
- [New Mexico](#)
- [New York](#)
- [North Carolina](#)
- [North Dakota](#)
- [Ohio](#)
- [Oklahoma](#)
- [Oregon](#)
- [Pennsylvania](#)
- [Rhode Island](#)
- [South Carolina](#)
- [South Dakota](#)
- [Tennessee](#)
- [Texas](#)
- [Utah](#)
- [Vermont](#)
- [Virginia](#)
- [Washington](#)
- [West Virginia](#)
- [Wisconsin](#)
- [Wyoming](#)

Trusted sites

EPA | PM2.5 Inventory Resource Center - Inventory Preparation | Emission Inventory Improvement - Micros...

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites Media Mail Print Mailbox Favorites

Address <http://www.epa.gov/ttn/chiep/eiip/pm25inventory/invprep.html> Go

Inventory Preparation

This page provides background and basic information about how emission inventories are developed and used. Users who are new to the process of preparing emissions inventories for air quality planning purposes will find information on this page useful to establish the framework for their programs.

Links

- [Inventory Process](#)
A comprehensive discussion of the inventory planning steps.
- [PM2.5 Area Source Preferred and Alternative Methods](#)
EIIP documents for open burning, structural fires and residential wood burning.
- [Inventory Guidance](#)
EIIP guidance for estimating emissions from various point, area and mobile sources. Discusses inventory needs and emission data reporting options.
- [Preparing 2002 Regional PM2.5 Emission Inventories](#) (PDF 10M)
Presentation developed to assist with PM2.5 Emission Inventories. Updated March 2004.

Trusted sites

Tools
Emissions QC, Preprocessing and Projections
PM Research and Field Studies
Recent Additions
Related Site Links
Comments
Site Map

EPA | PM2.5 Inventory Resource Center - Inventory Tools | Emission Inventory Improvement Progra - Micros...

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites Media Mail Print Mailbox Favorites

Address <http://www.epa.gov/ttn/chief/eiip/pm25inventory/tools.html> Go

PM 2.5 Inventory Resource Center

Inventory Tools

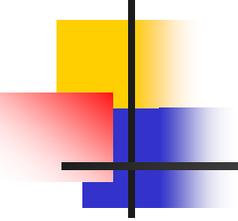
The Inventory Tools page includes some available reports, databases and software that you will find useful in the preparation of PM2.5 emission inventories.

Links

- [Stationary Sources Software and Document Tools](#)
Emission estimation software tools for stationary sources.
- [Activity Data](#)
Links to sources of activity data.
- [EPA Vehicle and Engine Emissions Modeling Software](#)
Highway vehicle and non-road emission modeling software - estimates PM2.5 and precursor emissions from most mobile source categories.

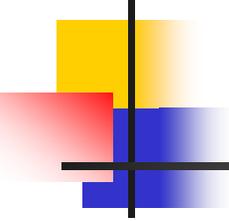
[Office of Air Quality Planning & Standards](#) | [Technology Transfer Network](#) | [Clearinghouse for Inventories & Emissions Factors](#)

<http://www.epa.gov/otaq/models.htm> Trusted sites



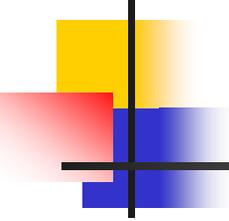
Resources

- EIIP - Introduction to Area Source Emission Inventory Development (Volume III)
 - Lists PM fine categories for which EIIP guidance is available - <http://www.epa.gov/ttn/chief/eiip/>
- AP-42
 - Available on CHIEF web site – <http://www.epa.gov/ttn/chief/>
- Existing inventories
 - National Emission Inventory (NEI) - <http://www.epa.gov/ttn/chief/net/>
 - Toxics Release Inventory (TRI) - <http://www.epa.gov/tri/>



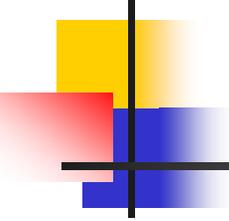
Resources

- EIIP Area Source Guidance (Volume III) for Sources of PM Emissions
- Introduction to Area Source Emission Inventory Development
 - <http://www.epa.gov/ttn/chief/eiip/>
 - Table 1.2-1 lists potential Non-point sources
- Other Documents
 - 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 non-point Source Categories, Dec. 2000



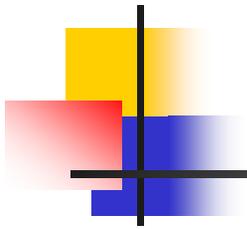
Resources

- Non-point 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 One-Pagers: Non-point Sources

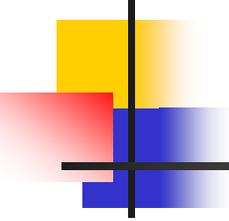
- PM One-Pagers: Overview
 - Location: PM Resource Center
 - Web site:
<http://www.epa.gov/ttn/chief/eiip/pm25inventory/areasource.html>
 - Purpose:
 - Summarize non-point source NEI methods for specific categories of PM₁₀, PM_{2.5}, and NH₃



PM One-Pagers: Non-point Sources (Continued)

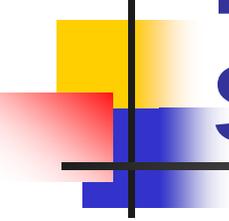
■ Contents:

- 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



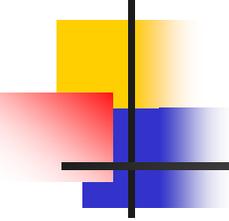
PM One-Pagers: non-point Sources (Continued)

- 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



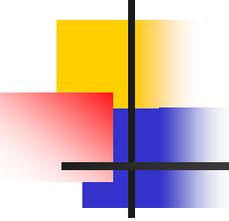
PM One-Pagers: Non-point Sources (Continued)

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



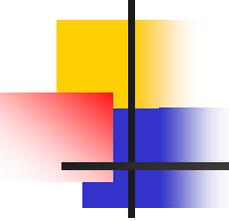
What are Major Sources of PM in NP Sector?

- Fugitive Dust Sources (Crustal PM Fine)
 - Unpaved Roads
 - Agricultural tilling
 - Construction Activities
 - Beef cattle feedlots



What are Major Sources of PM in NP Sector? (Cont.)

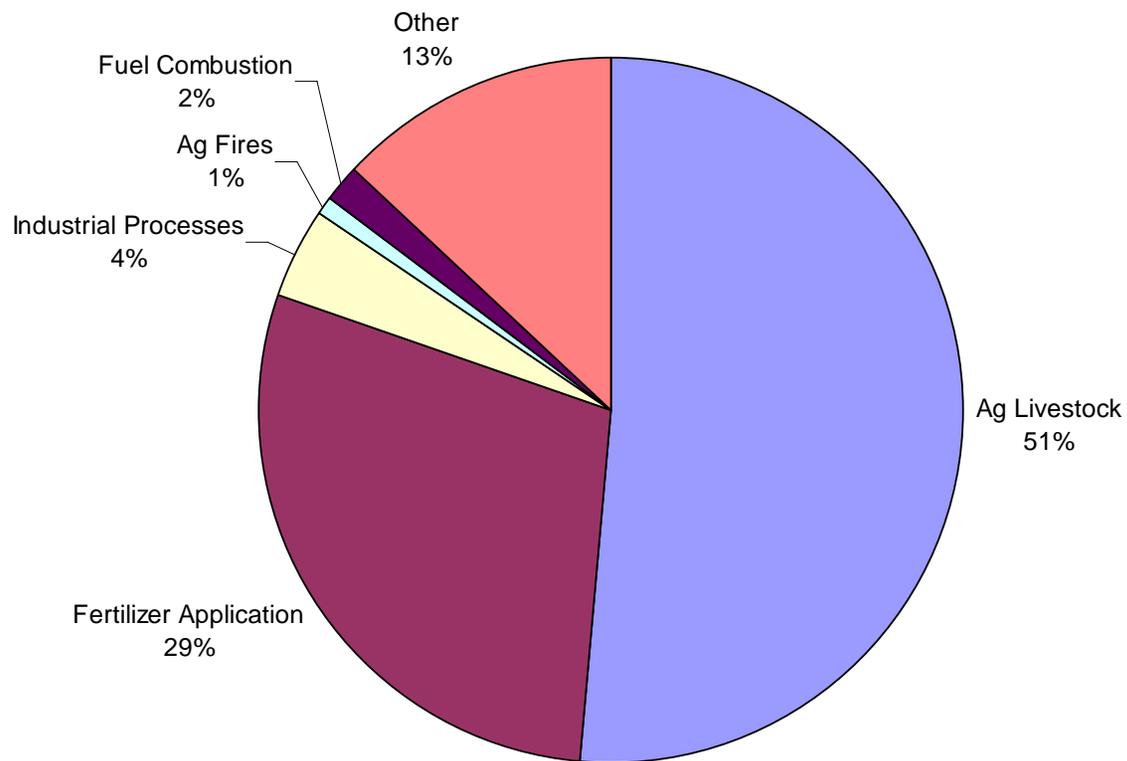
- Fires/Burning
 - Wild & Prescribed Fires
 - Open burning
 - Residential municipal solid waste burning
 - Yard waste burning
 - Land clearing debris burning
 - Agricultural field burning
 - Structure Burning

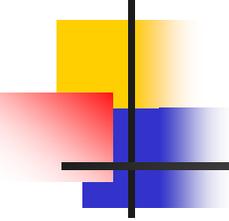


What are Major Sources of PM in NP Sector? (Cont.)

- External/Internal Fuel Combustion
 - Residential wood combustion
 - Other residential fuel combustion
 - Industrial fuel combustion
 - Commercial/institutional fuel combustion

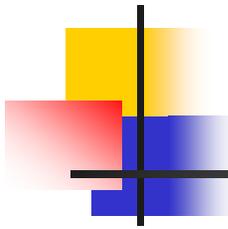
NH3 Emissions in the 02 NEI by Tier Category





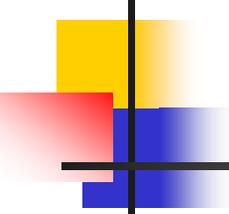
What are Major Sources of NH₃ in NP Sector?

- Typical source categories of NH₃ emissions include:
 - Animal husbandry (cattle, swine, poultry, etc)
 - Agricultural fertilizer application
 - Agricultural fertilizer manufacturing
 - Wastewater treatment



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
 - Use NEI default estimates
- Hybrid Approach
 - 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



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, what does the Workshop suggest on where to focus improvement efforts
- Can you make real improvements to the NEI approach?
- Review the available guidance (Workshop materials, one pagers, EIIP guidance).
- Decide what's doable in the near and longer term.
- Get to work !

Any Questions?



Session V

Fugitive Dust –

Recent Changes

Thompson G Pace
US EPA

New Orleans, LA
May 15, 2006



Crustal Materials (Mainly Fugitive Dust)

■ Main Sources:

- Unpaved roads
- Agricultural tilling
- Construction
- Windblown dust, Fly ash

■ Recent Advances to Address Huge Disparity Between EI & Ambient Data

- PM2.5 Ambient Data
 - < 1 ug/m³ in most of US
 - Exception: > 1 ug/m³ in much of Southwest, California
- PM2.5 FD Emissions (w/o windblown): *Was* ~3M TPY
- *Now* ~2M TPY (after applying new PM2.5:PM10 data)

Changes to the PM_{2.5}:PM₁₀ Multiplier

| | | Current Multiplier (k) Pre-2/2006 Versions of 2002 NEI | Revised Multiplier (k) Recommended by WRAP and EPA | |
|--|--|---|--|--|
| Category | | | | |
| Wind Erosion (All) | | NA | 0.15 ¹ | |
| Ag Crops | | 0.20 | No Change ² | |
| Ag Livestock | | 0.15 | No Change ² | |
| Aggregate Handling & Storage Piles (Transfer) | | NA ¹ | 0.15 | |
| Construction | | 0.2 | 0.1 | |
| Paved Roads | | 0.25 | 0.15* | |
| Unpaved Roads | | 0.15 | 0.1 | |

* Non-linear relationship -- Must re-calculate

Crustal Materials (Mainly Fugitive Dust)

■ Main Sources:

- Unpaved roads
- Agricultural tilling
- Construction
- Windblown dust, Fly ash

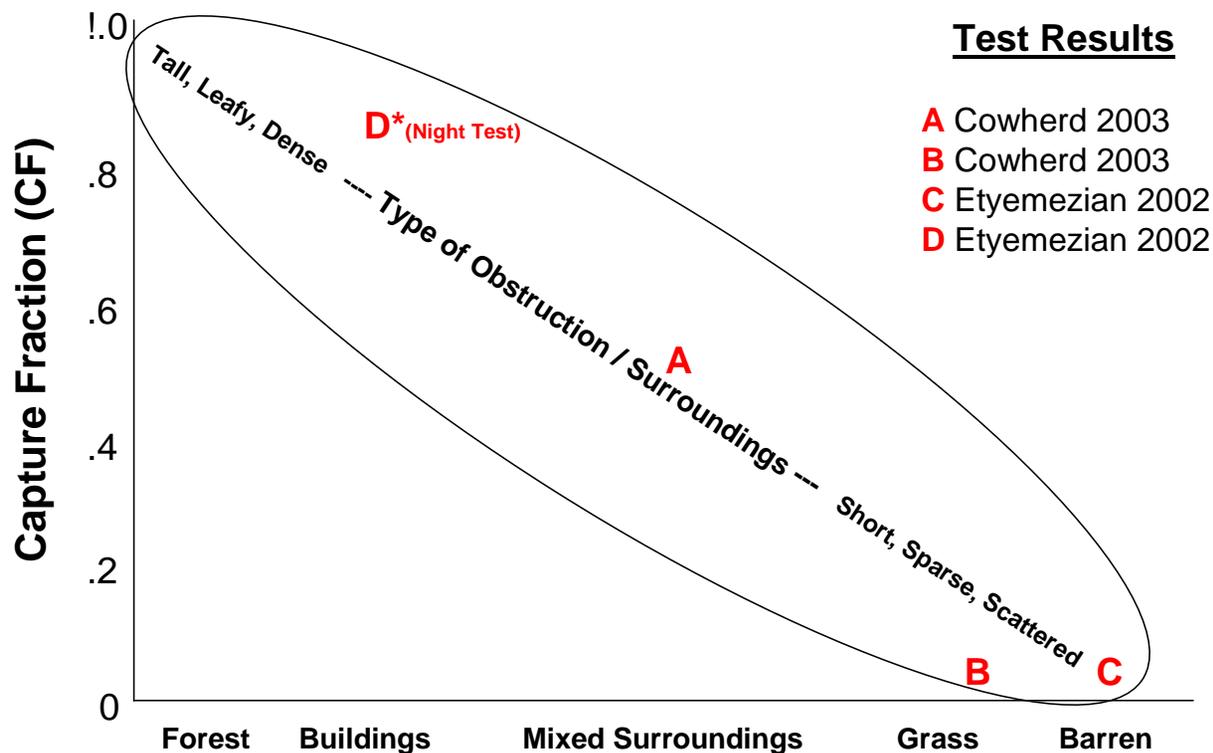
■ Recent Advances to Address Huge Disparity Between EI & Ambient Data

- PM2.5 Ambient Data
 - < 1 ug/m³ in most of US
 - Exception: > 1 ug/m³ in much of Southwest, California
- PM2.5 FD Emissions (w/o windblown): *Was* ~3M TPY
- *Now* ~2M TPY (after applying new PM2.5:PM10 data)
- *Now* estimate “capture” of FD on surface features

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

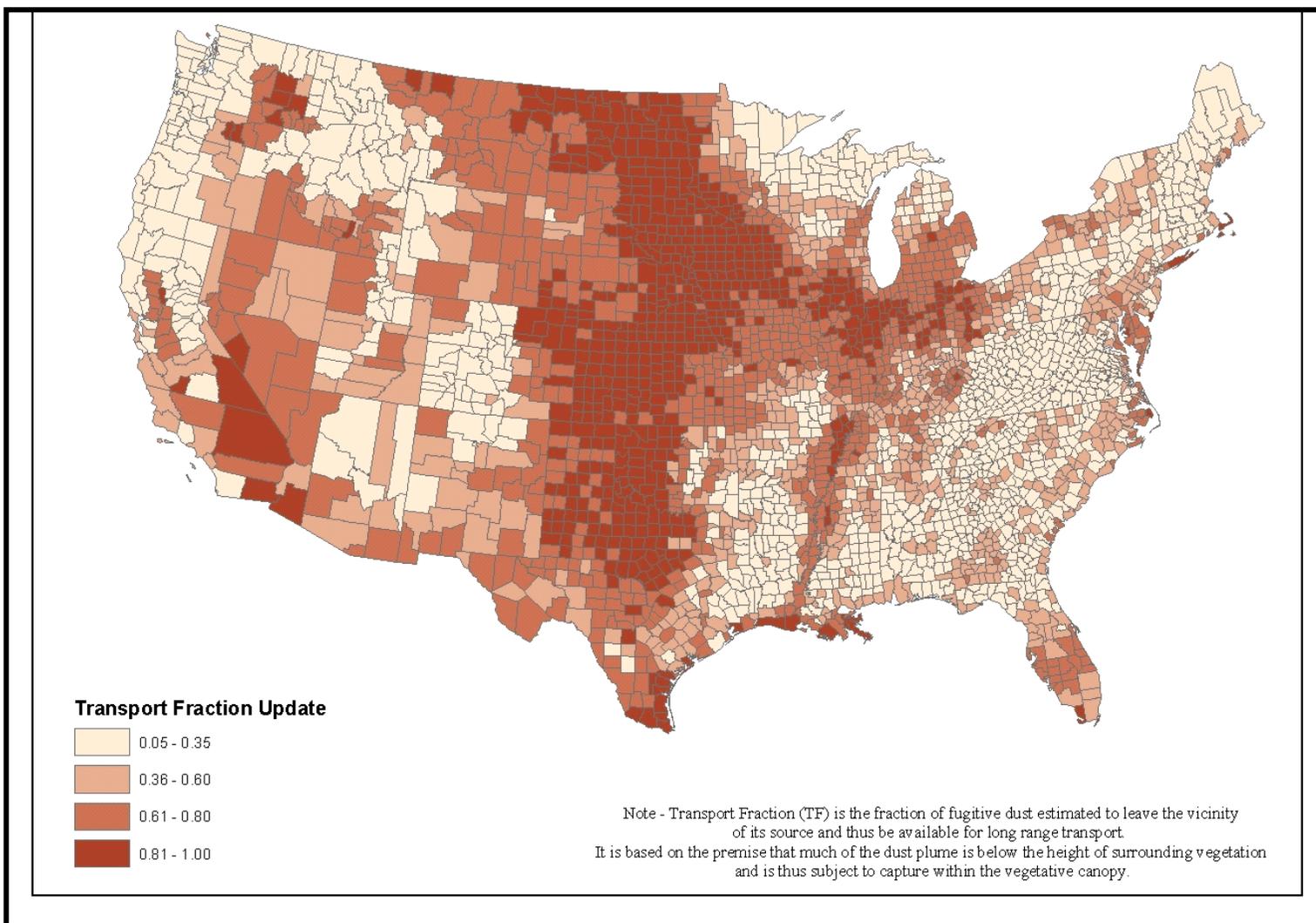
- **Early work by AQ Modelers**
 - Stilling Zone – Lower 3/4 of canopy
- **Windbreaks** – wind erosion “staple”
 - Traditionally to slow wind on leeward side
 - Research by Raupach
 - Entrapment effects
 - Dust transmittance through a windbreak is close to the optical transmittance
- **Capture Fraction (CF)**
 - Portion of FD Emissions removed by nearby surface cover
- **Transport Fraction (TF)**
 - Portion that is transported from the source area
 - **TF = 1.0 – CF (conservation of mass)**

Capture Fraction ~ Conceptual Model and Field Measurement Results



See: http://www.epa.gov/ttn/chief/emch/invent/statusfugdustemissions_082203.pdf
Also: <http://www.epa.gov/ttn/chief/emch/invent/>

Transport Fraction by County



Applying the CF/TF in Fugitive Dust Modeling

- **Emissions Inventory** ~ CF/TF is NOT used to adjust the EI
- **Gaussian Models**
 - CF/TF concept is not used to adjust the Emissions Inventory that's input to Gaussian Models
 - Many CF removal mechanisms are “built-in”, but rarely utilized
 - – Why? – 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)
 - CF/TF concept is applied in the EP (at as fine as 1 km resolution)
- **Future** – Evolve / improve BOTH Models *and* CF/TF Concept

Fugitive Dust Emissions Model

(on hold)

- **Modular input to Emission Models (e.g., SMOKE, OpEM) to interface with the CMAQ modeling system. It will**
 - establish consistent database of resource info (soil map, land use, vegetation cover, moisture, precipitation, wind speed) for making emission estimates for use with grid models.
 - demonstrate proof-of-concept of emission models for wind erosion, unpaved roads, construction, other dust sources,
- **Evaluate the capability of the Fugitive Dust Emissions Module**
 - Sensitivity testing & identify key areas for improvement.
- **Integrate, Test & Release Module (lacks funding)**

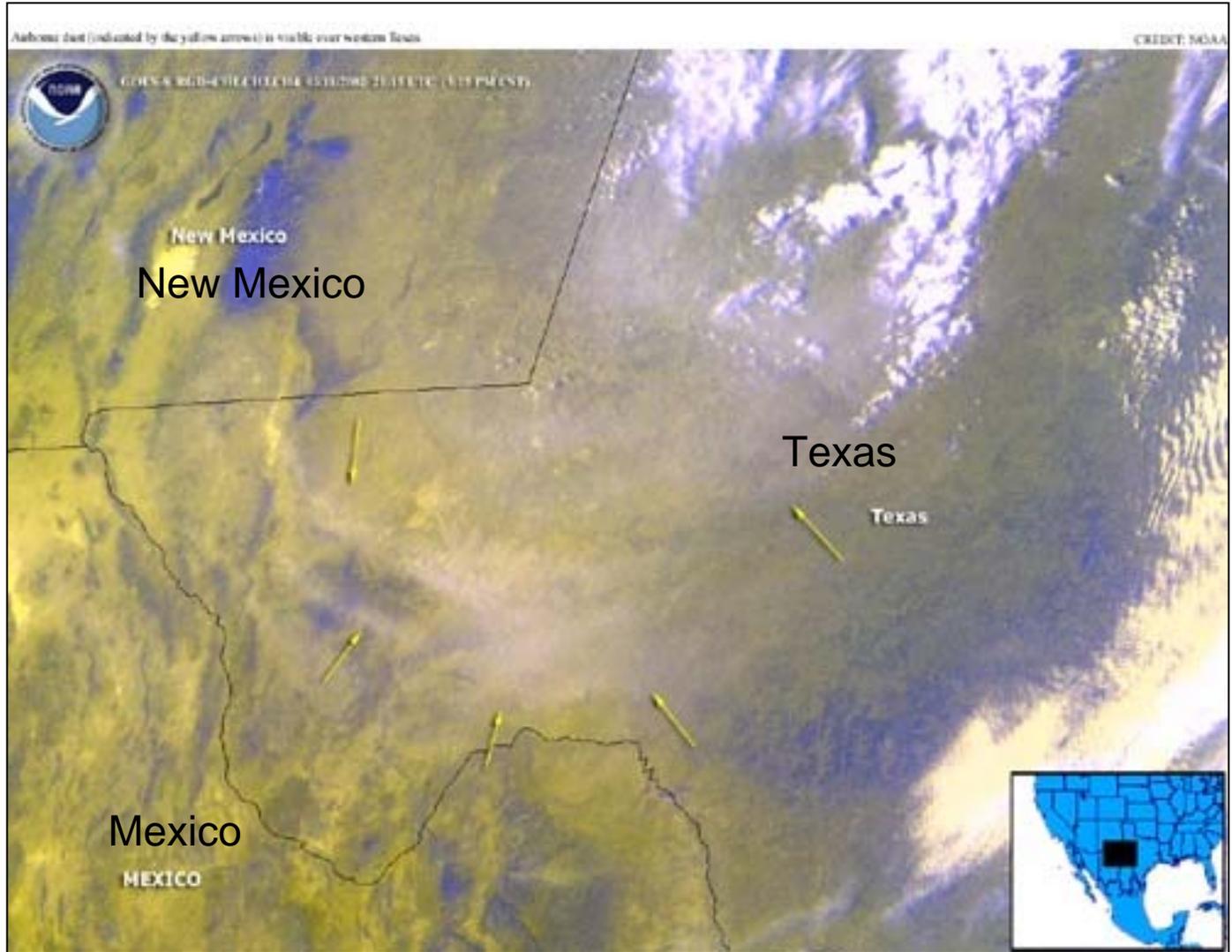
The WRAP's Work on a Windblown Dust Model

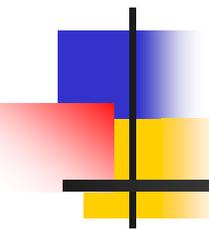
- Draft – undergoing evaluation
- Covers WRAP domain @ 36 &/or 12 km resolution
- Limited by
 - MM5 shortcomings (e.g., snow cover)
 - Land use / cover data (e.g., not current, spatial resolution)
 - Simplicity of Treatment of Reservoirs
 - Assumptions of soil stability / disturbance
- Provides reasonable estimates given limitations ^

Crustal Materials ~ Conclusions

- ❑ Crustal materials are a relatively small part of PM_{2.5} in ambient air – **Fugitive Dust EI historically too high.**
- ❑ Fugitive dust is released near the ground and nearby surface features often capture the dust.
 - The **Capture / Transport Fraction** concept *does provide* a useful way to account for near source removal when used with Grid Models
- ❑ “Old” PM_{2.5}:PM₁₀ multiplier biased high due to measurement biases
 - Recent changes to the **PM_{2.5}:PM₁₀ multiplier** lowers the fugitive dust emission estimates
- ❑ **PM_{2.5} EI is now more consistent with ambient measurements.**

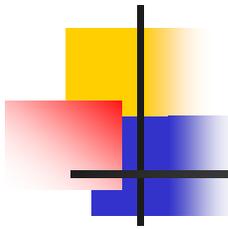
Questions ?





PM2.5 Emissions from Residential Open Burning, Construction Activities

Roy Huntley
Huntley.Roy@EPA.gov
EIAG, USEPA
May 15, 2006
New Orleans, LA



Residential Open Burning

New as of 1999

SCCs:

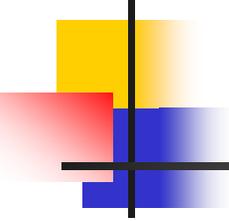
2610030000 - Residential Municipal Solid Waste
(MSW) Burning

Pollutants: PM10, PM2.5, CO, NO_x, VOC, SO₂,
32 HAPs

2610000100 - Residential Leaf Burning

2610000400 - Residential Brush Burning

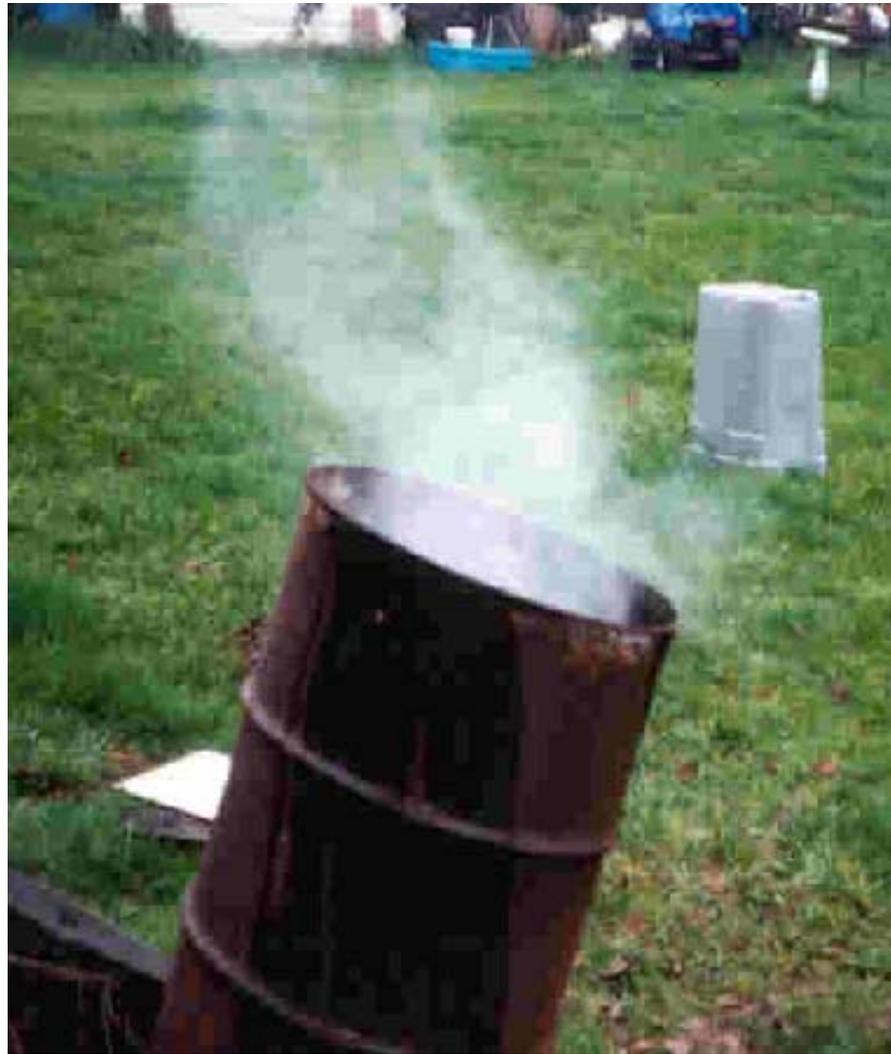
Pollutants: PM10, PM 2.5, CO, VOC, 6 HAPs

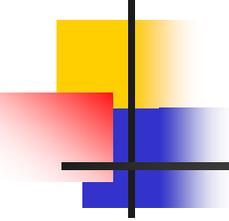


Residential MSW Combustors

- Aka, Backyard Barrel Burning
 - 55-gallon drum

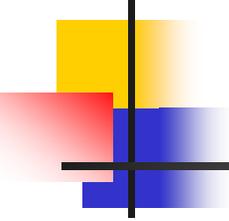






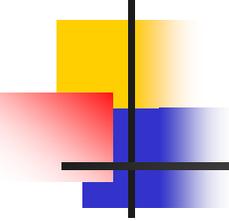
Residential MSW Combustors

- Emissions from BYB burning of residential solid waste are released at ground level resulting in decreased dilution by dispersion.
- The low combustion temperature and oxygen-starved conditions result in incomplete combustion and increased pollutant emissions.
- In contrast, modern refuse combustors have tall stacks, specially designed combustion chambers, and high efficiency flue gas cleaning systems



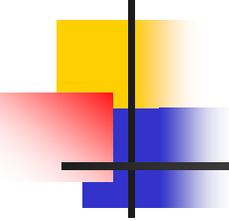
Emissions from BYB of MSW

- Emissions are higher on a per Unit Mass Refuse Burned Basis
 - PM emissions may be 40 times higher than from an uncontrolled incinerator.
 - PCDDs/PCDFs - up to 17 times higher than a controlled MW incinerator
 - Metal emissions are many times higher than those of a controlled incinerator



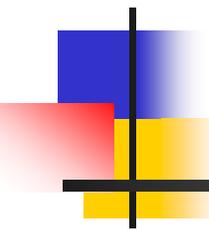
Residential MSW Burning

- $E_{cty} = (P_{cty} \times R_{frac}) \times W \times B_{frac} \times (EF)$
- **Pcty** is pop of county
- **Rfrac** is fraction of county that is rural
- **W** is per capita waste gen (0.60 tons/person/year)
- **Bfrac** is fraction of waste gen (0.28) that is burned
- **EF** is 34.8 lbs PM_{2.5}/tons waste burned



Residential MSW (cont.)

- Accounts for Burning Bans
 - No burning in county if urban population exceeds 80 percent of total population



Residential Yard Waste Combustion

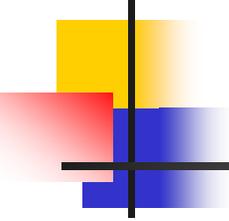
Leaves and Brush





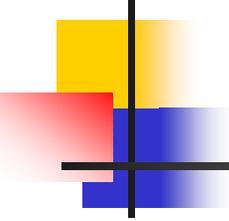
Thank you Bob
West of Yakima
County





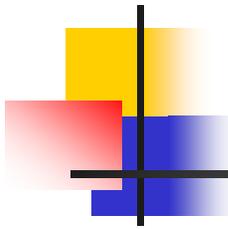
Residential Yard Waste Burning

- $E_{cty} = (P_{cty} \times R_{frac}) \times (YW \times Ywfrac) \times CF \times Bfrac \times EF$
- **YW** is per capita yard waste gen (0.10 tons/person/year)
- **Ywfrac** is fraction of yard waste components (0.25 for leaves, 0.25 for brush)
- **CF** is correction factor



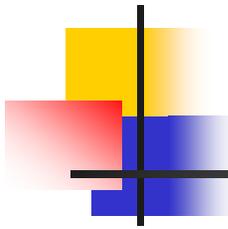
Residential Yard Waste Burning (Cont.)

- $E_{cty} = (P_{cty} \times R_{frac}) \times (YW \times Yw_{frac}) \times CF \times B_{frac} \times EF$
- **Bfrac** is fraction of waste burned (0.28)
- **EF** is 38 for leaves, 17 for brush (lbsPM_{2.5}/tons burned)



CF - Differences in Biomass Ground Cover

- Used BELD3 database from BEIS to determine # of acres of forest, ag land, and miscellaneous vegetation per county
- Subtract out Ag lands before determining percent forested acres.
- Determine % forested



Correction Factor (CF)

Percent Forested
Acres per county

<10%

>=10% & <50%

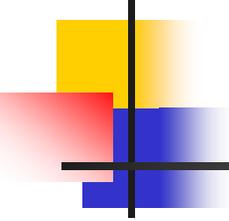
>=50%

Correction Factor
(CF)

Zero

0.5

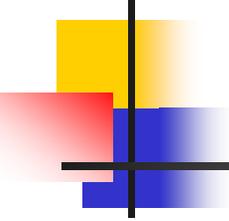
1.0



Slash Burning

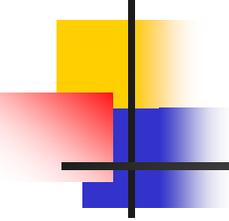
(Burning of logging waste)

- EPA uses state-supplied data.



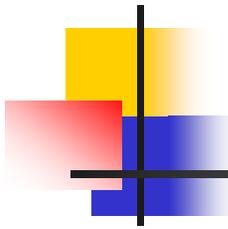
Land Clearing Debris Burning

- Emissions = Acres x LF x EF
- Acres cleared for Construction
- LF is fuel loading factor
- EF is emission factor



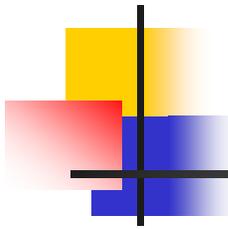
Land Clearing Debris Burning (cont.)

- Acres Cleared
 - discuss later (fugitive dust from construction)



Fuel Loading for Land Clearing Debris Burning

- Used BELD3 database to determine proportion of hardwoods, softwoods, and grass in each county
- USFS factors for piled residue.
 - Fuel loading factors from Forest Service for hardwoods, softwoods, and grass
- Adjusted USFS fuel loading factors by 1.5 to account for additional mass (tree roots)



Fuel Loading Factors

(US Forest Service)

Fuel Type

**Fuel Loading
(tons/acre)**

Hardwood

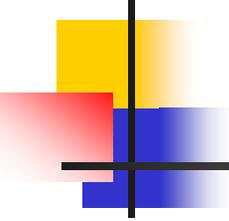
99

Softwood

57

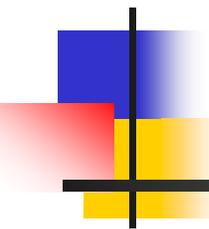
Grass

4.5



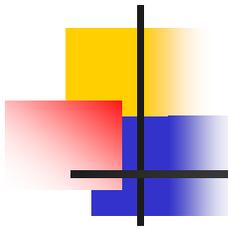
Emission Factors

- Obtained from US Forest Service
- $PM_{10} = PM_{2.5}$
- 17 lbs $PM_{2.5}$ /ton of fuel



Improvements to NEI Estimates

How can State/Local Agencies
Improve on the NEI Estimates?

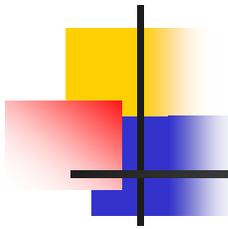


Land Clearing Debris Burning

Improvements to NEI Method

- Review EIIP section on Open Burning
 - EIIP Volume III, Ch. 16
 - Preferred methods rely on direct measure of mass of waste or debris burned
 - Mass amounts may be available from permits issued
- Improve estimates of the acres cleared (see fugitive dust construction categories for suggestions).
- Develop improved estimate of the “average loading factor”

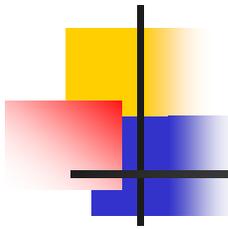
Sources: Local Foresters, Construction Companies



Land Clearing Debris Burning

Improvements to NEI Method

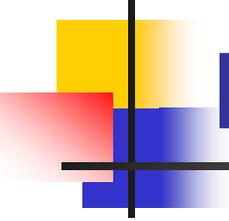
- Identify specific counties with burning bans
 - *Sources: Air Agency, Solid Waste Management Organization*
- State or local estimates of the percentage or amount of waste burned per construction event.
 - *Source: Solid Waste Management Organization*



Residential Open Burning

EIIP Alternative for Yard Waste

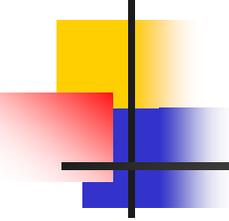
Identify records of burning permits or violations, coupled with data (or assumptions) on typical volumes and material composition



Residential Open Burning

Improvements to NEI Methods

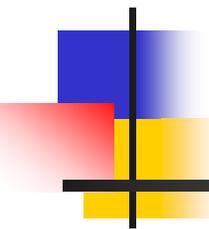
- Identify rules prohibiting or limiting open burning, and the organization that enforces those rules
- For areas that have burning prohibitions, consider performing rule effectiveness (RE) surveys
- Level of enforcement/compliance can be a significant variable in calculating controlled emissions



Residential Open Burning

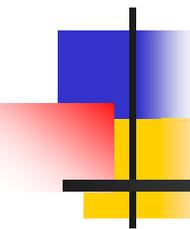
Improvements to NEI Methods

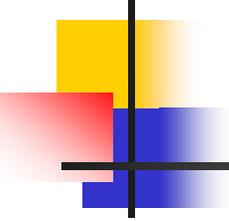
- Review EIIP Volume III, Ch. 16 Open Burning
- Obtain State/local estimates of per-capita waste generation
- Use State/local estimates for amount or percentage of waste burned
- Obtain State/local estimates of months when yard wastes are burned
- Sources
 - *Solid Waste Agency*
 - *Air Agency*
 - *Health Department*
 - *Solid Waste Management Organization*
 - *Local Survey*



End of Open Burning Discussion

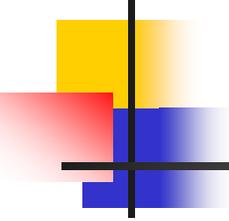
Fugitive Dust from Construction Activities





Construction Categories

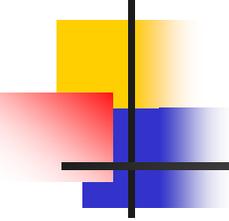
- Residential
- Road
- Non-residential (commercial, industrial, government, public works)



Adjustments

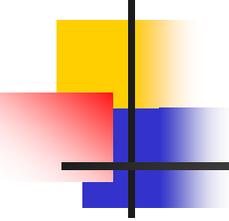
- Soil Moisture
- Silt Content





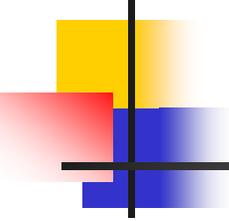
Residential Construction

- SCC = 2311010000
 - Industrial Processes Construction: SIC codes 15-17, General Building, Construction, Total



Residential Construction

- $E_{cty} = EF \times B \times f \times m$
- **EF** = Emission factor
- **B** = # of units by county
- **f** = building-to-acres conversion factor
- **m** = duration of construction activity (months)



Buildings to Acres Conversion Factor

Housing Type

Acres Disturbed

Single-Family

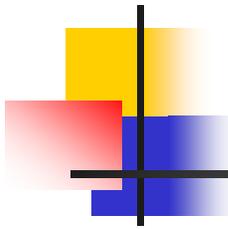
'1/4 acre/building

Two-Family

'1/3 acre/building

Apartment

'1/2 acre/building



Duration

Housing Type

Duration

Single-Family

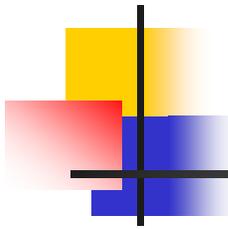
6 months

Two-Family

6 months

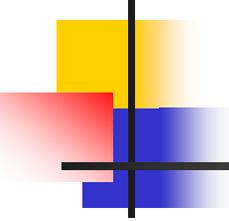
Apartment

12 months



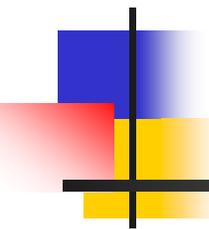
Adjustment for Basements

- Houses built with basements move more dirt
 - Assume 2000 ft² footprint, basement depth of 8 feet, add 10% more dirt for peripherals (652 cubic yards)
 - Add to equation
- Regionally specific building practice
 - DOC has % of houses with basements per census region



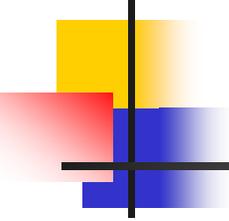
Known Shortcomings

- Does not include trackout
- Double counts diesel emissions from construction equipment



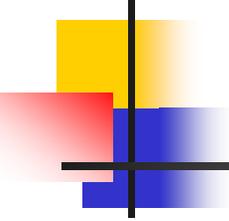
Road Construction





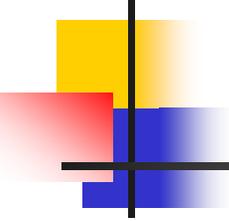
Road Construction

- SCC = 2311030000
 - Industrial Processes, Construction: SIC codes 15-17, Road Construction, Total

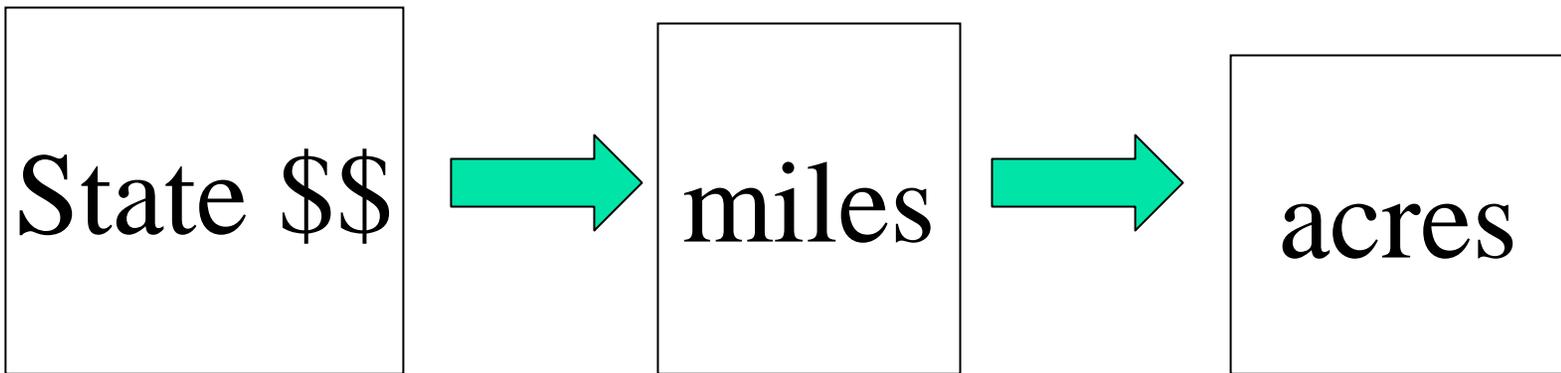


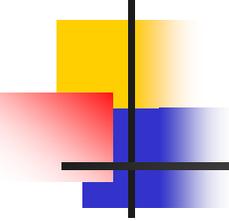
Roadway Construction

- $E = EF \times \$ \times f1 \times f2 \times m$
- **EF** = emission factor
- **\$** = State Expenditures for road construction
- **f1** = \$ to miles conversion
- **f2** = miles to acres conversion
- **m** = duration (12 months)



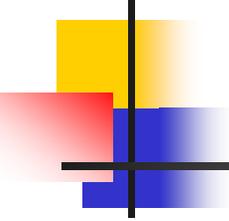
Roadway Construction





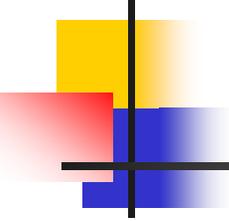
FHWA State Expenditure Data for Capital Outlay

- Interstate; urban
- Interstate; rural
- Other arterial; urban
- Other arterial; rural
- Collectors; urban
- Collectors; rural



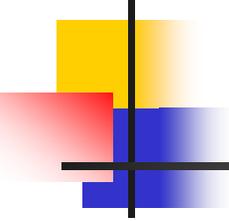
FHWA Data includes:

- Buying right of way
- Road construction
- Major widening
- Building bridges
- NO RESURFACING
- NO PRIVATE ROAD CONSTRUCTION



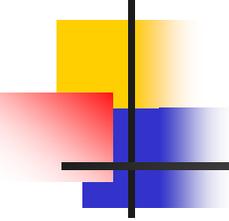
\$\$ to Miles

- \$4 million/mile for interstates
- \$1.9 million/mile for arterial and collectors



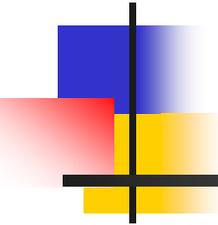
Miles to Acres

- 15.2 acres/mile for interstates and urban arterial
- 12.7 acres/mile for rural arterial
- 9.8 acres/mile for urban collectors
- 7.9 acres/mile for rural collectors

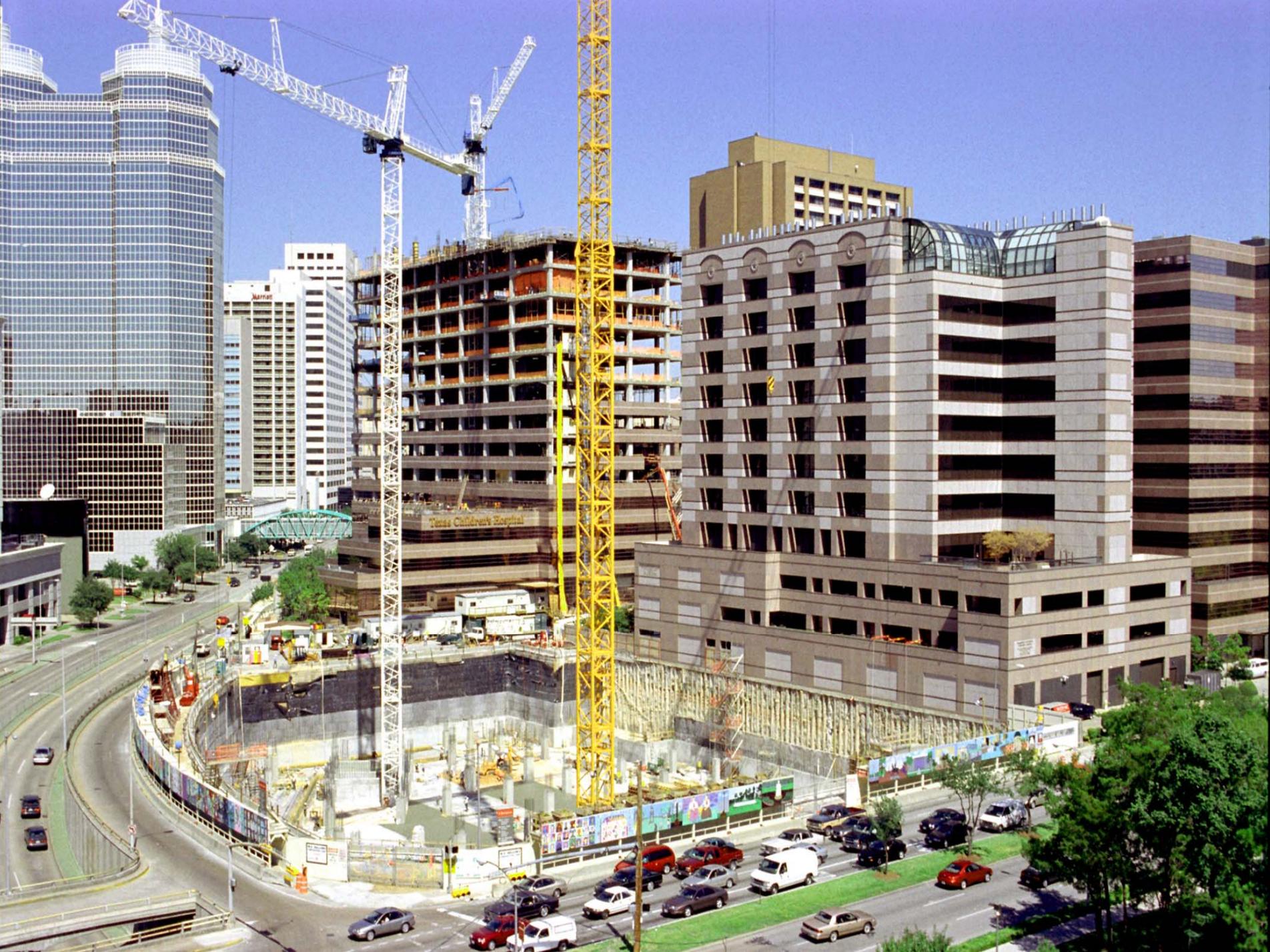


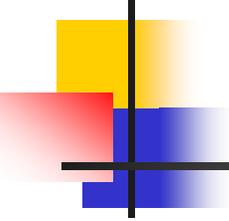
Assumptions

- Uses North Carolina cost figures
- Does not include privately constructed roads



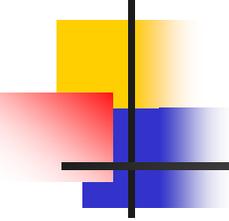
Non-Residential Construction





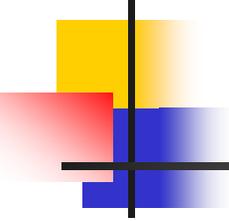
Non-Residential

- Uses the **National** value of construction put in place
- \$\$ allocated to counties using construction employment data



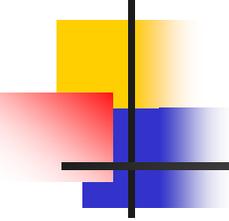
Non-Residential Construction

- $E = EF \times \$ \times f \times m$
- **EF** = Emission factor (tons/acre/month)
- **\$** = county \$
- **f** = dollars-to-acres conversion (1.6 acres/million dollars (1992 value adjusted for inflation to 1999))
- **m** = duration (11 months)



Last Point

- Some opportunities for improvement
 - State/local data
- AP-42 Section 13.2.3, Heavy Construction Operations
 - On Web at
<http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s02-3.pdf>



Fugitive Dust Nonpoint Sources

Paved and Unpaved Roads

Paved Roads



PAVED ROADS

Overview

- SCC: 2294000000
- Pollutants -- PM₁₀, PM_{2.5}
- Method
- Activity Data
- Emission Factors
 - Change in AP42
- Emissions Allocation to Counties

PAVED ROADS

NEI Method (Cont'd)

- Emission Factor

- Empirical emission factor equation from AP-42

$$EF = k * (sL/2)^{0.65} * [(W/3)^{1.5} - C] * [1 - P/(4*N)]$$

where: EF = paved road dust emission factor for all vehicle classes combined (grams per mile)

k = constant for particles of less than 10 microns in diameter (7.3 g/VMT for PM₁₀, 1.1 g/VMT for PM_{2.5}) (was

sL = road surface silt loading (g/m²)

W = average weight of all vehicle types combined (tons)

C = Constant to account for EF fraction that is vehicle fleet brake, tire, and exhaust (lb/VMT)

P = number of days in the month with at least 0.01 inches of precip

N = number of days in the month

PAVED ROADS

NEI Method

- Activity Data [vehicle miles traveled (VMT) on paved roads]
 - State-Level Activity Data

*State/road type level VMT from paved roads =
Total State/road type-level VMT - State/road type-level
unpaved road VMT*

PAVED ROADS

NEI Method

- AP-42 changes (draft available, comment period ends in June 06)
- Activity Data [vehicle miles traveled (VMT) on paved roads]
 - State-Level Activity Data

*State/road type level VMT from paved roads =
Total State/road type-level VMT - State/road type-level
unpaved road VMT*

PAVED ROADS

NEI Method (Cont'd)

- Emission Calculation

$$EM_{s,r,m} = VMT_{s,r,m} * EF_{s,r,m}$$

where: EM = PM₁₀ emissions, tons per month
VMT = VMT, miles per month
EF = tons per mile
m = month
s = State
r = road type class

PAVED ROADS

NEI Method (Cont'd)

- Allocation of State Emissions to County Level
 - Paved road emissions are allocated to the county level according to the fraction of total State VMT in each county for the specific road type.

$$PVDEMIS_{X,Y} = PVDEMIS_{ST,Y} * VMT_{X,Y}/VMT_{ST,Y}$$

where: $PVDEMIS_{X,Y}$ = paved road PM emissions (tons) for county x and road type y
 $PVDEMIS_{ST,Y}$ = paved road PM emissions (tons) for the entire State for road type y
 $VMT_{X,Y}$ = total VMT (million miles) in county x and road type y
 $VMT_{ST,Y}$ = total VMT (million miles) in entire State for road type y

PAVED ROADS

NEI Method (Cont'd)

■ Controls

- Control efficiency of 79 percent applied to:
 - Urban and rural roads in serious PM NAAs; and
 - Urban roads in moderate PM NAAs
 - Corresponds to vacuum sweeping on paved roads twice per month

- Rule penetration varies by road type and NAA classification (serious or moderate).

PAVED ROADS

Improvements to NEI Method

- VMT on paved roads for local area

(Source: State Dept. of Transportation, Mobile Source Section of Environmental Dept)

- Local registration data representing the average weight of vehicles (since this variable is weighted most heavily)

(Source: State Dept. of Motor Vehicles, Mobile Source Section of Environmental Dept)

- Perform sampling to refine value used for silt content
 - Only consider if you can collect enough samples to give a good representation of roads in your area

- Obtain and use local precipitation values

(Source: National Weather Bureau)

Unpaved Roads



UNPAVED ROADS

Overview

- SCC 2296000000
- Pollutants - PM₁₀ and PM_{2.5}
- NEI Method
 - Activity (VMT on unpaved roads)
 - Emission factor (tons per mile)
 - Note that AP-42 section has been revised and is available as a draft. Comment period concludes June 16 2006

UNPAVED ROADS

NEI Method

■ **Activity**

- State level VMT from U.S. DOT, Federal Highway Administration allocated to counties by population
- Activity Data (VMT on unpaved roads)
- State-level activity for urban and rural local functional classes

UNPAVED ROADS

NEI Method (Cont'd)

$$\text{Unpaved VMT}_{\text{Roadtype}} = \text{Mileage}_{\text{Roadtype}} * \text{ADTV} * \text{DPY}$$

Where:

Unpaved VMT = road type specific unpaved VMT miles/year)

Mileage = total number of miles of unpaved roads by functional class (miles)

ADTV = Average daily traffic volume (vehicle/day)

DPY = number of days per year

UNPAVED ROADS

NEI Method (Cont'd)

■ Emission Factor

- AP-42 emission factor equation

$$EF = \frac{(k * (s/12)^a * (SPD/30)^b}{(M/0.5)^c} - C$$

where:

k, a, b, and c are empirical constants given in AP-42 by particle size (PM₁₀ and PM_{2.5})

EF = size specific emission factor (lb/VMT)

s = surface material silt content (%)

SPD = mean vehicle speed (mph)

M = surface material moisture content (%)

d = number of days in a particular month

C = Constant to account for EF fraction that is vehicle fleet brake, tire, and exhaust (lb/VMT)

UNPAVED ROADS

NEI Method (Cont'd)

- Correction Factor for Precipitation

$$E_{\text{corr}} = E * [(D - p)/D]$$

E_{corr} = unpaved factor for precip

E = uncorrected emission factor

D = # days in month

p = # days in month with .01 in rain or more

UNPAVED ROADS

NEI Method (Cont'd)

- $E_{\text{emis}} = E_{\text{corr}} \times \text{VMT}$

UNPAVED ROADS

NEI Method (Cont'd)

- Allocation to Counties:

$$EMIS_{x,y} = (CL_x/SL) * EMIS_y$$

EMIS_{x,y} = emissions for county x and roadway class y

CL_x = rural population in county x

SL = rural population in the state

EMIS_y = unpaved road emission in entire state for roadway class y

UNPAVED ROADS

NEI Method (Cont'd)

- **NEI Default Emission Factor Input Values**
 - Surface material silt content (s)
 - Average state-level values developed are available in the 2002 nonpoint documentation appendix C
<http://www.epa.gov/ttn/chief/net/2002inventory.html#nonpoint>
 - Vehicle Speed (SPD)
 - Nonpoint doc gives speeds assumed by roadway type
 - Surface material moisture content (M)
 - 0.5% was used as national default in 2002 NEI
 - Number of days exceeding 0.01 inches of precipitation (p)
 - Precipitation data from one meteorological station in state used to represent all rural areas of the state
 - Local climatological data available from National Climatic Data Center at <http://www.ncdc.noaa.gov/oa/ncdc.html>

UNPAVED ROADS

Improvements

- **Summary**

- Review defaults for representativeness
- Use local data when possible for activity and emission factor inputs
- If resources are limited, focus on collecting data for:
 - Local precipitation data
 - Local VMT estimates

Session VIII

Update on Ammonia Emission Estimation

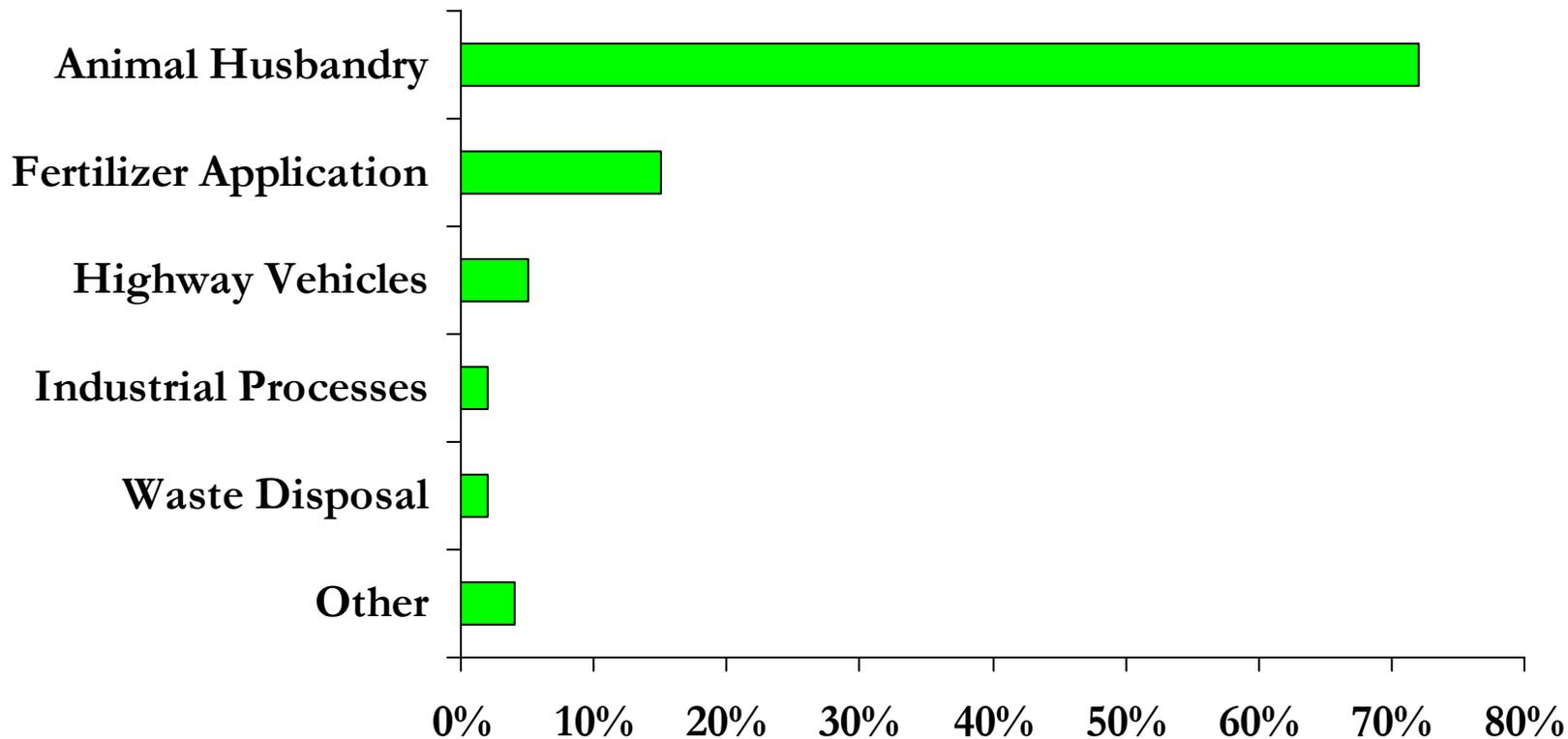
Tom Pace,
US EPA

New Orleans, LA
May 15. 2006

Ammonia - Key Sources & Issues

- **Key categories in current EI**
 - Livestock (Animal husbandry) ~75%
 - Fertilizer application ~15%
 - Point Sources (could be large locally), Mobile Sources
- **NEI Does NOT Include** (May not all be major sources)
 - Native soil
 - Humans, domestic and wild animals
 - Open burning
- **Soils and Vegetation**
 - Can be source or sink -- Work ongoing: TX, CA, EPA/ORD
- **Ammonia is Important to AQ Analyses**
 - Involved in formation of Sulfate, Nitrate
- **Relatively New:**
 - **ERG EI (Livestock)**
 - **WRAP Ammonia EI**
 - **Inter-RPO Ammonia Model**

NH₃ – Precursor to Ammonium Sulfate & Nitrate (National Emissions ~ 4.8 M TPY)



Improvements to Animal Husbandry Ammonia EI are Underway

■ Shortcomings of 1999 NEI

- Probable errors in emission factor selections, especially for beef.
- Does not use information on variability of emissions due to different manure handling practices (*Manure Management Train concept*) within a given animal industry.
- Does not make total use of information of available National Agricultural Statistics Service (NASS) data on different animal populations, by average live weight.

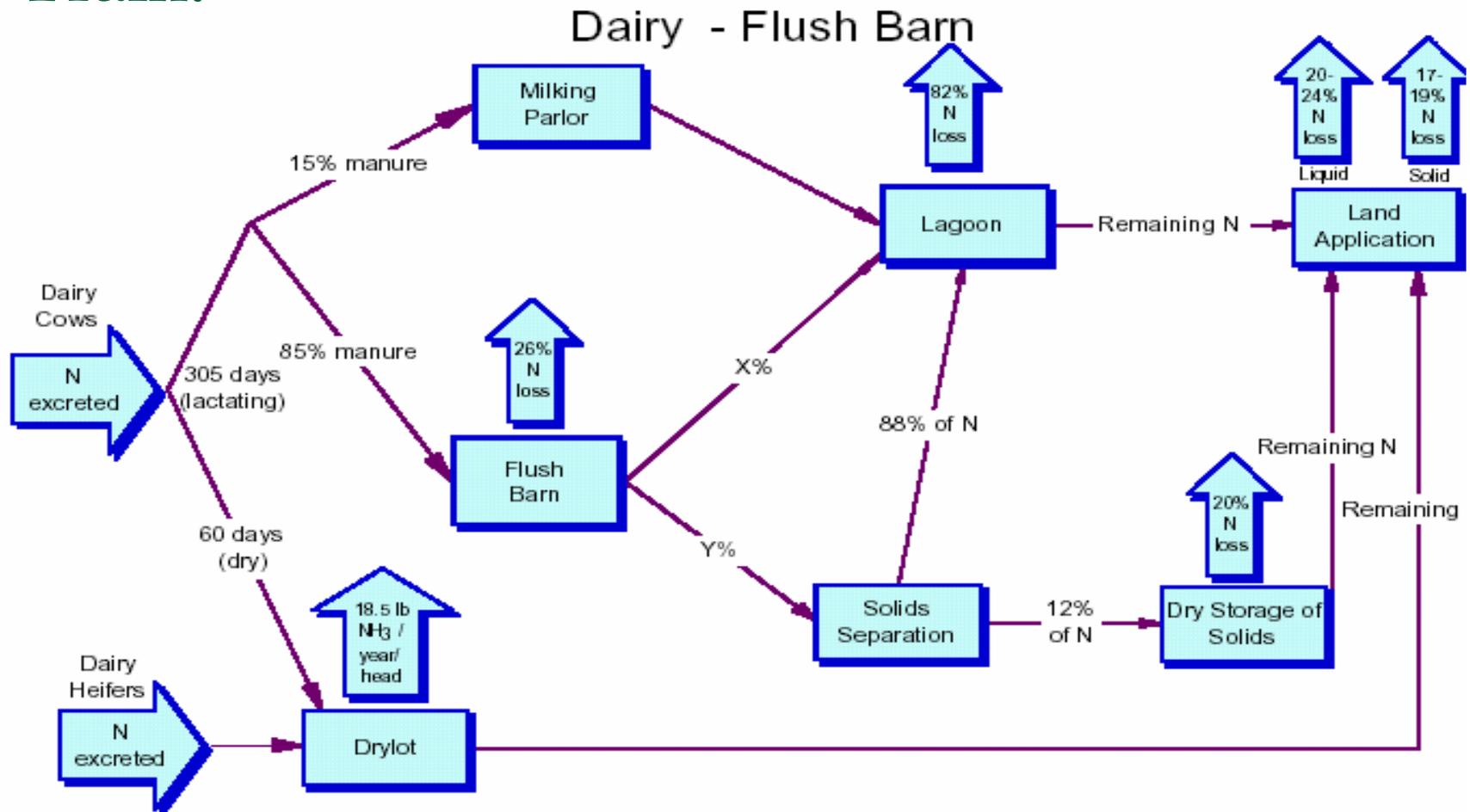
■ Inverse modeling suggested ammonia was overestimated in '99

- **2002 NEI** makes some improvements over 1999 NEI
 - Incorporated MMT approach





Advanced Example of Manure Management Train:



The percentage of nitrogen lost is calculated based on the amount of nitrogen managed in that component.
 The amount of nitrogen leaving the solids separator is based on the amount of nitrogen managed in the separator.
 X% and Y% vary by size of operation, and represent the proportion of production using each type of system.

Animal Husbandry – Overview of Manure Management Train Concept

- **Step 1:** Estimate average annual animal **populations** by animal group, state, and county.
- **Step 2:** Identify **Manure Management Trains (MMT)** used by each animal group and then estimate the distribution of the animal population using each MMT.
- **Step 3:** Estimate the amount of **nitrogen excreted** from the animals using each type of MMT, using general manure characteristics.
- **Step 4:** Identify or develop **emission factors** for each component of each MMT.
- **Step 5:** Estimate **ammonia emissions** from each animal group by MMT and county for 2002.







New Emission Estimates are Lower

Comparison of 1999 and 2002 Ammonia NEIs

| Animal Group | 1999 NEI | | | 2002 NEI | | |
|--------------------------------|---------------|-----------------------------|---------------------|---------------|-----------------------------|---------------------|
| | Population | Emission Factor lb/head /yr | Emissions Tons/year | Population | Emission Factor lb/head /yr | Emissions Tons/year |
| Cattle and Calves Composite | 100,126,106 | 50.5 | 2,476,333 | 100,939,728 | 23.90 | 1,205,493 |
| Hogs and Pigs Composite | 63,095,955 | 20.3 | 640,100 | 59,978,850 | 14.32 | 429,468 |
| Poultry and Chickens Composite | 1,754,482,225 | 0.394 | 345,325 | 2,201,945,253 | 0.60 | 664,238 |
| Total | 1,917,704,286 | N/A | 3,461,758 | 2,362,863,831 | N/A | 2,299,199 |

Comparison of EPA & CMU Animal Ammonia Model Estimates (2002)

| Animal | CMU Model Ammonia Emissions, tons/yr | EPA NEI Ammonia Emissions, tons/yr |
|----------------|---|---|
| Beef | 660,672 | 679,632 |
| Dairy | 563,557 | 546,487 |
| Swine | 422,957 | 384,188 |
| Poultry | 597,982 | 549,636 |
| Sheep | 22,094 | 24,835 |
| Goats | 17,659 | 14,028 |
| Horses | 49,057 | 71,285 |

- CMU results total ~ 3% higher
- CMU derived EF's from NEI – some differences
- Also, some population & MMT differences

CMU vs EPA Animal Population Data

| Animal | CMU Model Input, Annual Average Number of Head | EPA NEI Input, Annual Average Number of Head |
|----------------|---|---|
| Beef | 82,306,960 | 87,929,962 |
| Dairy | 13,092,090 | 13,070,796 |
| Swine | 60,427,423 | 60,015,450 |
| Poultry | 2,046,186,734 | 2,090,023,111 |
| Sheep | 6,322,340 | 6,685,000 |
| Goats | 2,524,699 | 1,989,799 |
| Horses | 3,638,498 | 5,300,000 |

Data Sources

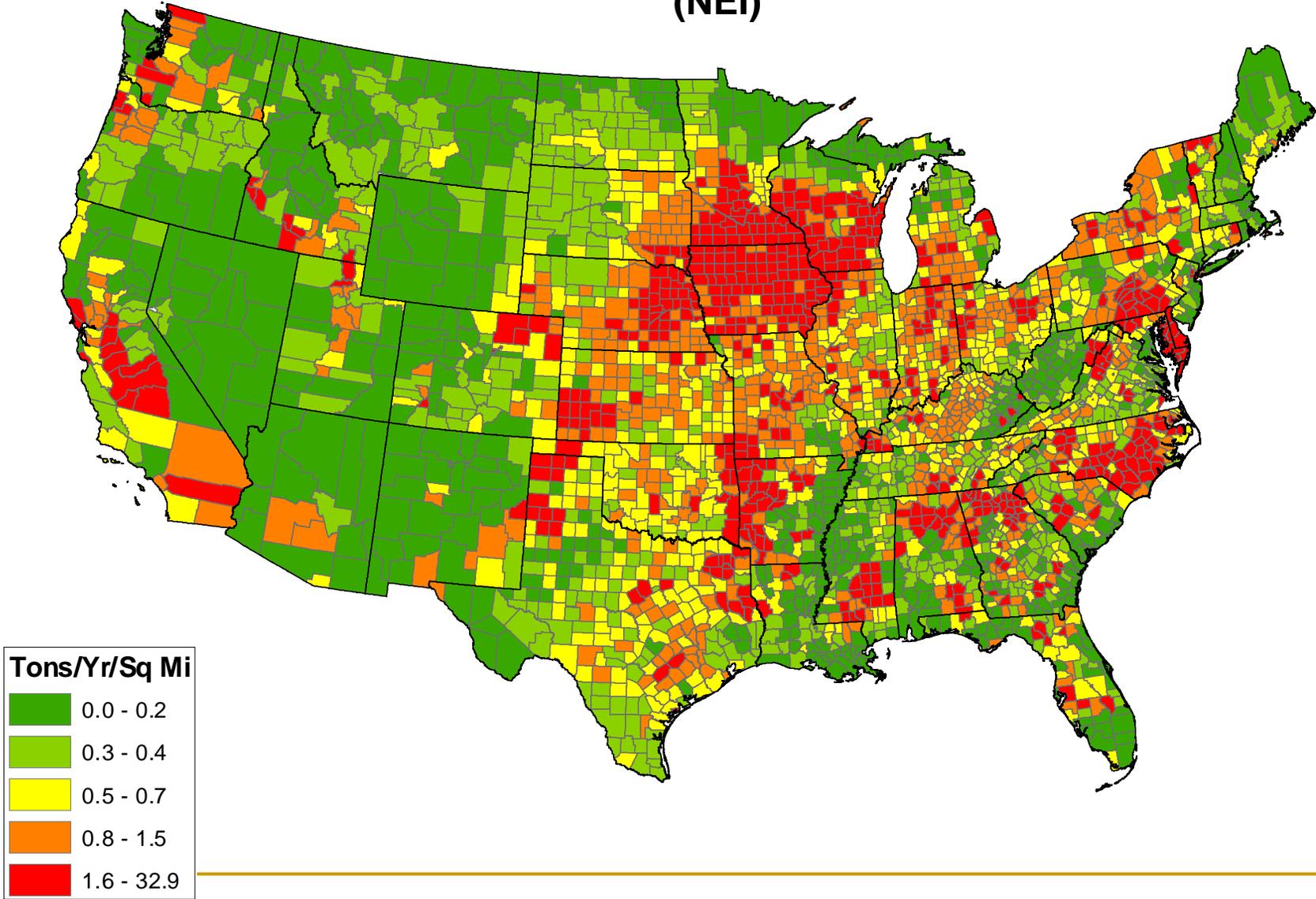
EPA: Nat'l Ag Statistical Service

CMU: 2002 Census of Agriculture

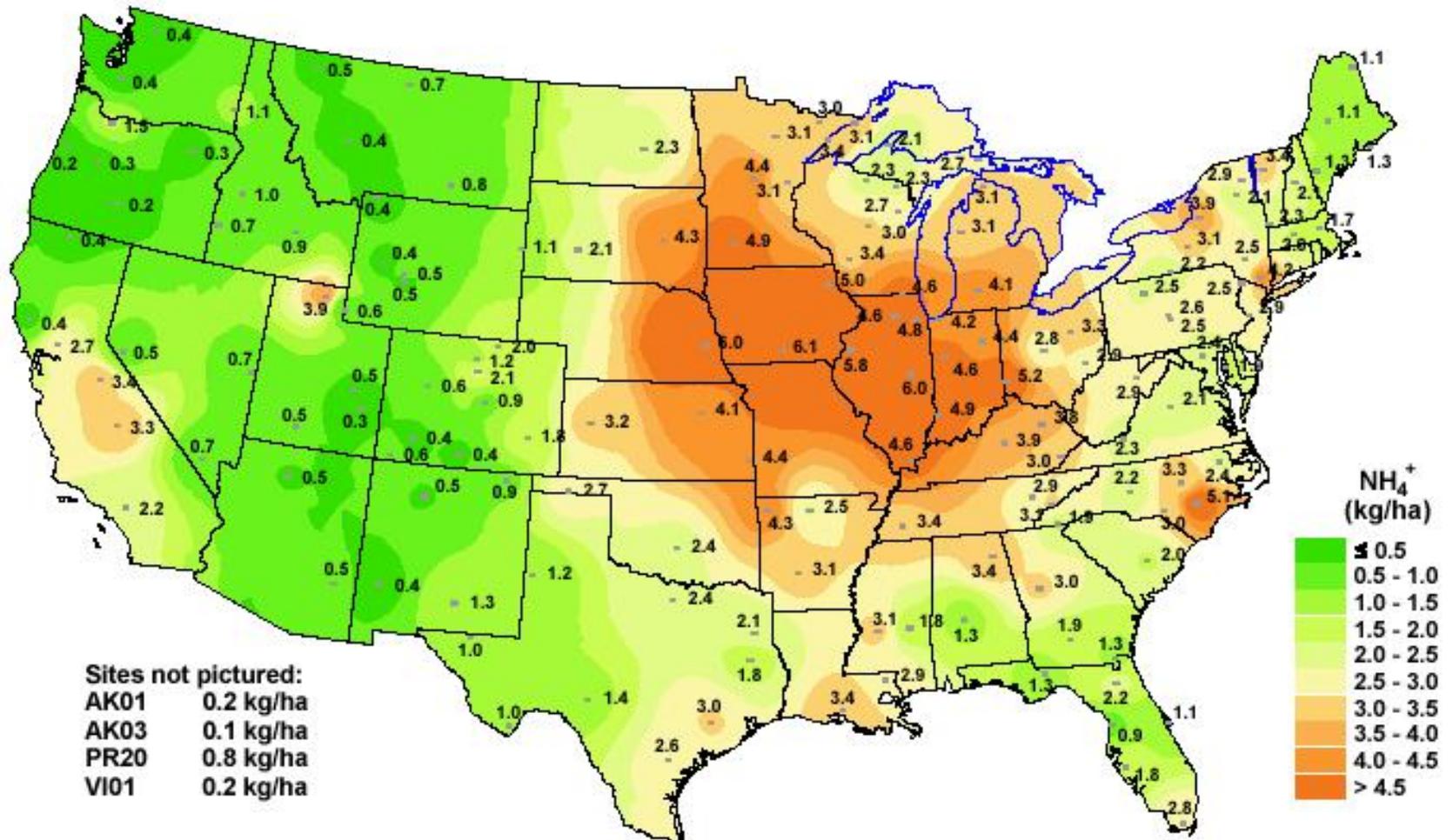
CMU vs EPA MMT Assumptions

| Animal | MMT | Distribution | |
|----------------|----------------------------|--------------|-------|
| | | CMU | EPA |
| Beef | Pasture/Range | 82% | 85% |
| | Feedlot | 18% | 15% |
| | Composite | 0.24% | 0.06% |
| Dairy | Barn with Deep Pit | 1.4% | 0.95% |
| | Drylot | 44% | 44% |
| | Flush Barn | 12% | 19% |
| | ScrapeBarn | 36% | 34% |
| | Composite | 6.5% | 3.0% |
| Swine | House with Lagoon System | 43% | 47% |
| | House with Deep Pit System | 51% | 51% |
| | Pasture/Range | 0.77% | 0.52% |
| | Composite | 4.9% | 1.4% |
| Poultry | Broiler House and Outdoor | 67% | 75% |
| | Turkey House and Outdoor | 4.1% | 4.0% |
| | Dry Layers | 14% | 18% |
| | Wet Layers | 2.5% | 3.1% |
| | Composite | 5.0% | 0.4% |

2002 NH3 Emissions from Animal Husbandry (NEI)



Estimated ammonium ion deposition, 1998



National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

NH4: Recent Work & Works-in-Progress

- **NEI 2002 (Livestock – MMT approach; Fertilizer – CMU Model)**
 - Native soil emissions (non agricultural land) NOT included
 - Contact – Bill Schrock 919-541- 5032 schrock.bill@epa.gov

- **CMU 2002 (Livestock, Wild Animals, Domestic Sources, Fertilizer)**
 - Contact – Cliff Davidson <http://www.cmu.edu/ammonia/register.html>

- **Battye 2004 (Report: Ammonia from Native Soils)**
 - Contact Benjey.william@epa.gov

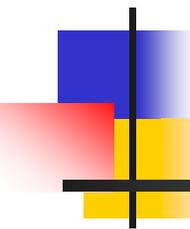
- **WRAP 2002 (Animals, Wild Animals, Domestic Sources, Fertilizer, Native Soil)**
 - Livestock (NOT Process/MMT specific) – 1.7M TPY ~ 500k TPY < NEI or CMU
 - Fertilizer – 1.5M TPY (Similar calc to CMU, but considered soil pH)
 - Native Soil – 1.6M TPY (based on Potter Method – Emissions by soil type & pH)
 - Livestock, fertilizer & soil emissions modulated by temperature & moisture
 - Tech Memo (August 2004), Users Guide (March 2005), Final Report (March 2005)
 - Contacts – Tom Moore 970.491.8837 MooreT@cira.colostate.edu
Gerard Mansell 415-899-0777 gmansell@environcorp.com

Recent NH4 Work & Works-in-Progress

- NEI 2002 (Livestock uses MMT approach, Fertilizer uses CMU)
 - Contact – Bill Schrock 919-541- 5032 schrock.bill@epa.gov
- Battye 2004 (Ammonia from Native Soils – Issue is controversial)
 - Contact Benjey.william@epa.gov
- CMU 2002 (Livestock, Wild Animals, Domestic Sources, Fertilizer)
 - Contact – Cliff Davidson <http://www.cmu.edu/ammonia/register.html>
- WRAP 2002 Ammonia EI
 - Contact: MooreT@cira.colostate.edu
- UC-D / UC-R / MWRPO Ammonia Emissions Model
 - UC-R & UC/Davis
 - Process-based for Livestock
 - Capable of more process description than MMTs (60-70 farm types vs ~ dozen MMTs)
 - Uses temperature & other environmental drivers: initially will use statewide daily temperature info
 - Will initially be run with default “synthetic farms” but some states DO have detailed farm-type info
 - Currently runs slow – working on programming fixes
 - Preliminary comparisons show annual EI +/- 20% of CMU approach; daily differences *very large*
 - Nat’l livestock runs probably a year away
 - Placeholder for Fertilizer but may offer module that improves on CMU approach; Not now planning to incorporate a module for non ag soil emissions
 - Contact: Mark Janssen Janssen@LADCO.org

Questions ?





Combustion Area Sources

Residential Wood Combustion

Roy Huntley
Huntley.Roy@EPA.gov
EIAG/OAQPS/US EPA
May 15, 2006
New Orleans, LA

Conventional Wood Stoves



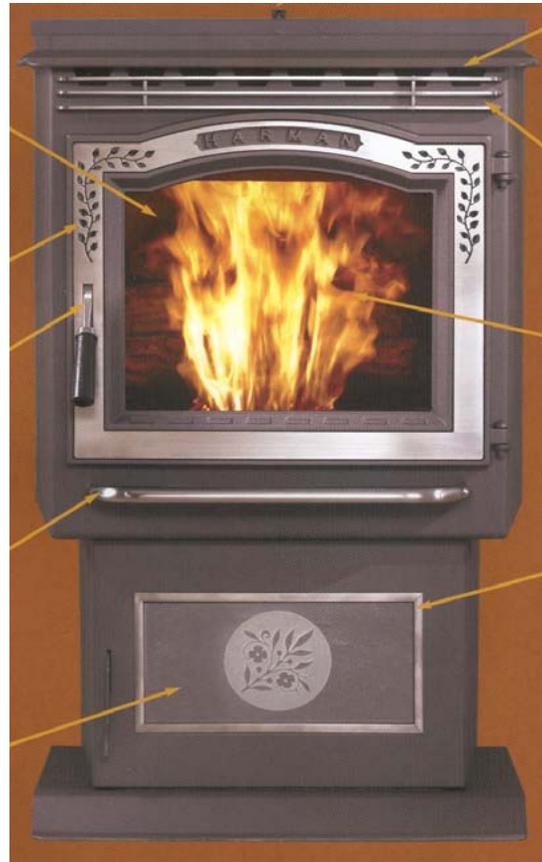
Advanced Wood Stoves (EPA Certified)



Fireplace



Pellet Stove



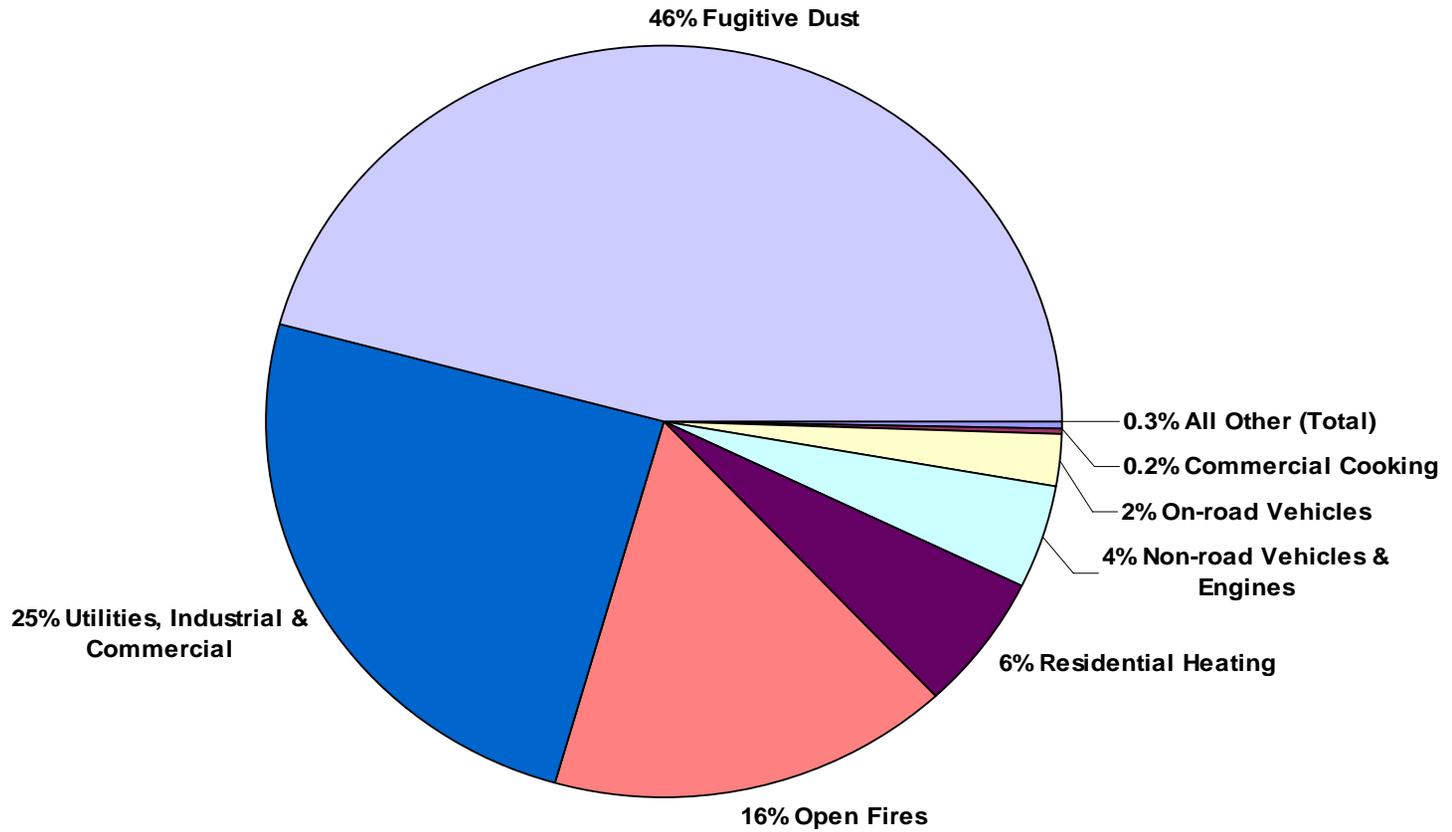
Hydronic Heaters

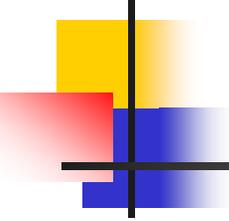


Hydronic Heaters 2



PM-2.5 Emissions in 2001 EI

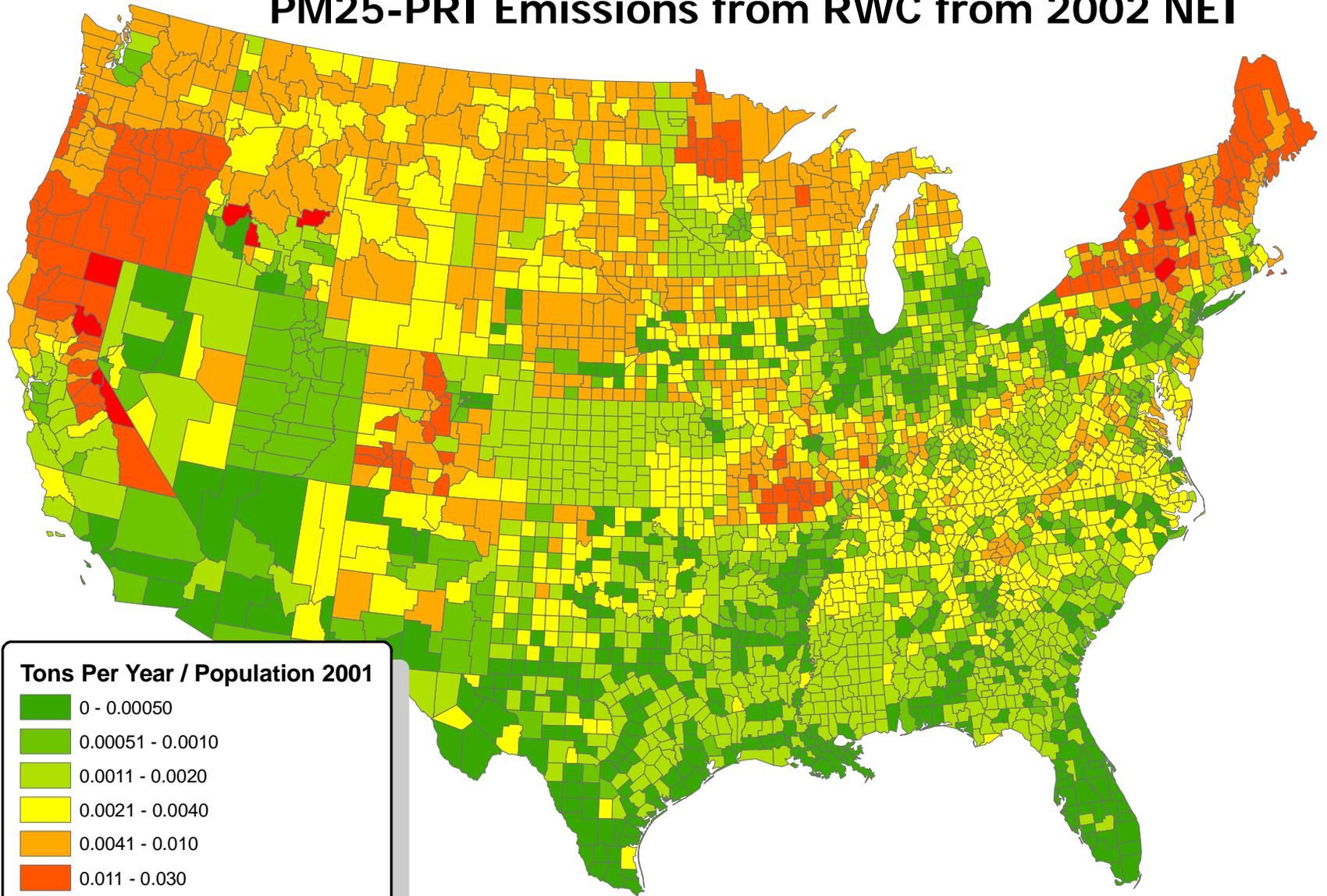




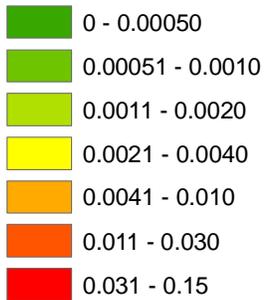
What's in wood smoke?

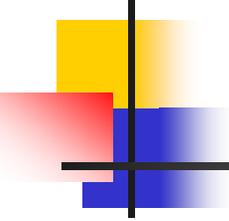
- Organics
 - Benzene
 - Toluene
 - Formaldehyde
 - Polycyclic organic matter
 - Dioxin
- CO, NO_x, and SO₂

PM25-PRI Emissions from RWC from 2002 NEI



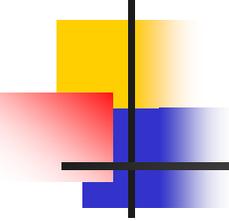
Tons Per Year / Population 2001





EPA's RWC New Source Performance Standard

- Phase I Stoves - All stoves manufactured after 07/01/88 and sold after 07/01/90 had to be certified to Phase I PM emission levels
- Phase II Stoves - All stoves manufactured after 07/01/90 and sold after 07/01/92 had to be certified to Phase II PM emission levels
 - All certified WS have tag
- WS made and sold prior to NSPS dates called "conventional"
 - WS have life of 40+ years
- Exempt - cookstoves, furnaces, appliances with air-to-fuel ratio >35:1, & appliances weighing more than 800 kilograms, (masonry heaters, outdoor boilers)



Revise NSPS?

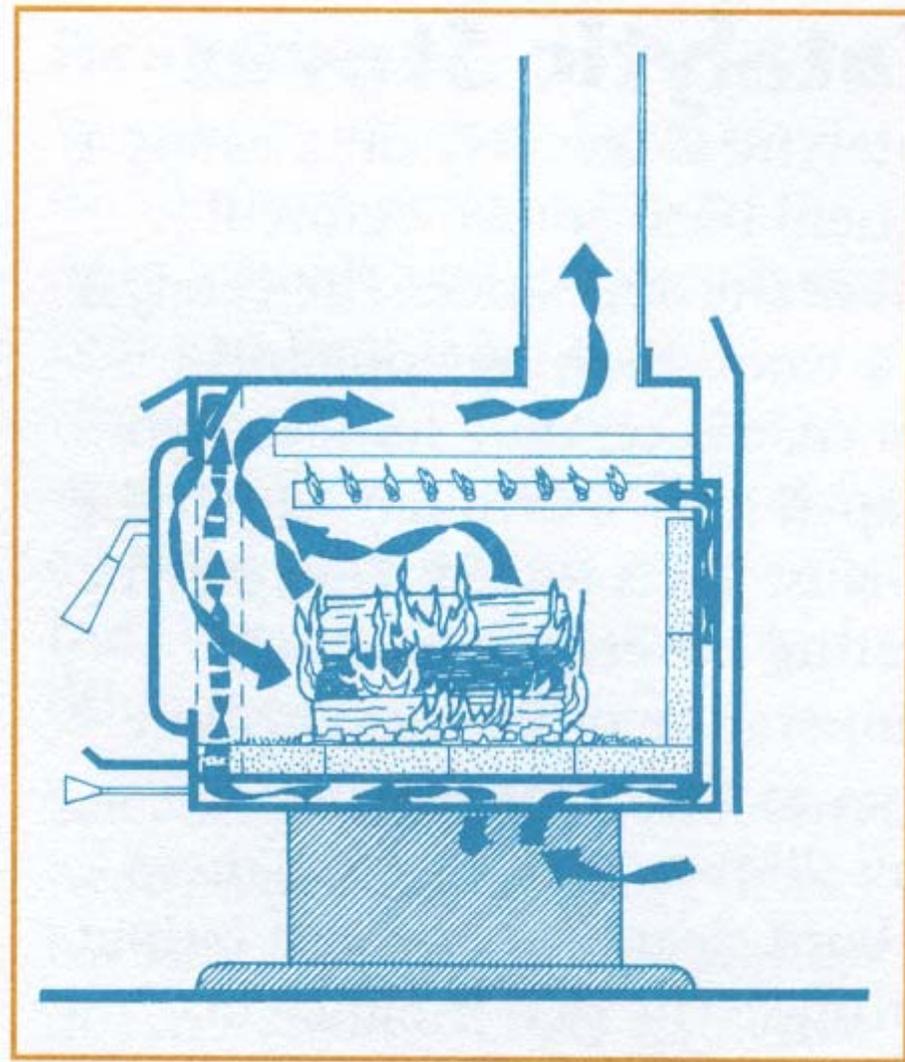
- EPA considering revising NSPS
 - Possibly include outdoor wood-fired boilers

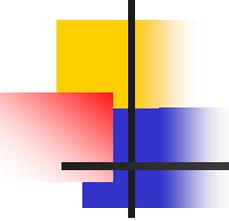
EPA Certified Woodstove

Non-Catalytic

- Non-catalytic Woodstoves
 - Increase temperature of fire
 - Insulate firebox
 - Preheat combustion air
 - Increase retention time
 - Use of baffles
 - Introduce secondary combustion air
 - More complete burn

Non-Catalytic Woodstove



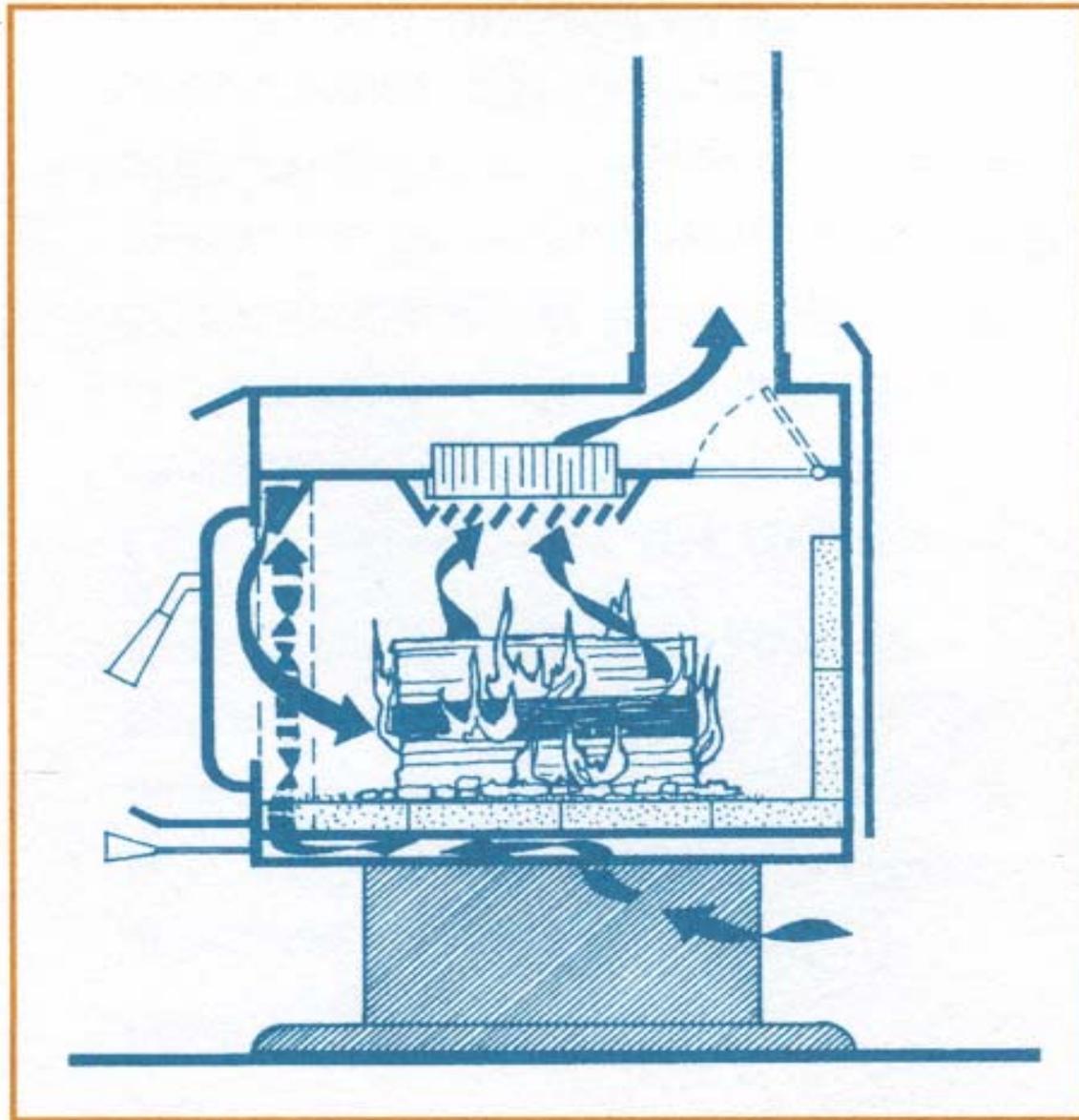


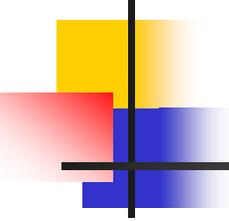
EPA Certified Woodstove

Catalytic

- Catalyst
 - Low emissions, but catalyst needs replacing in 3-5 years
 - Catalyst needs to be hot before it works
 - Can operate stove in bypass mode
 - Not as popular, does not sell as well as the non-catalytic WS

Catalytic Woodstove

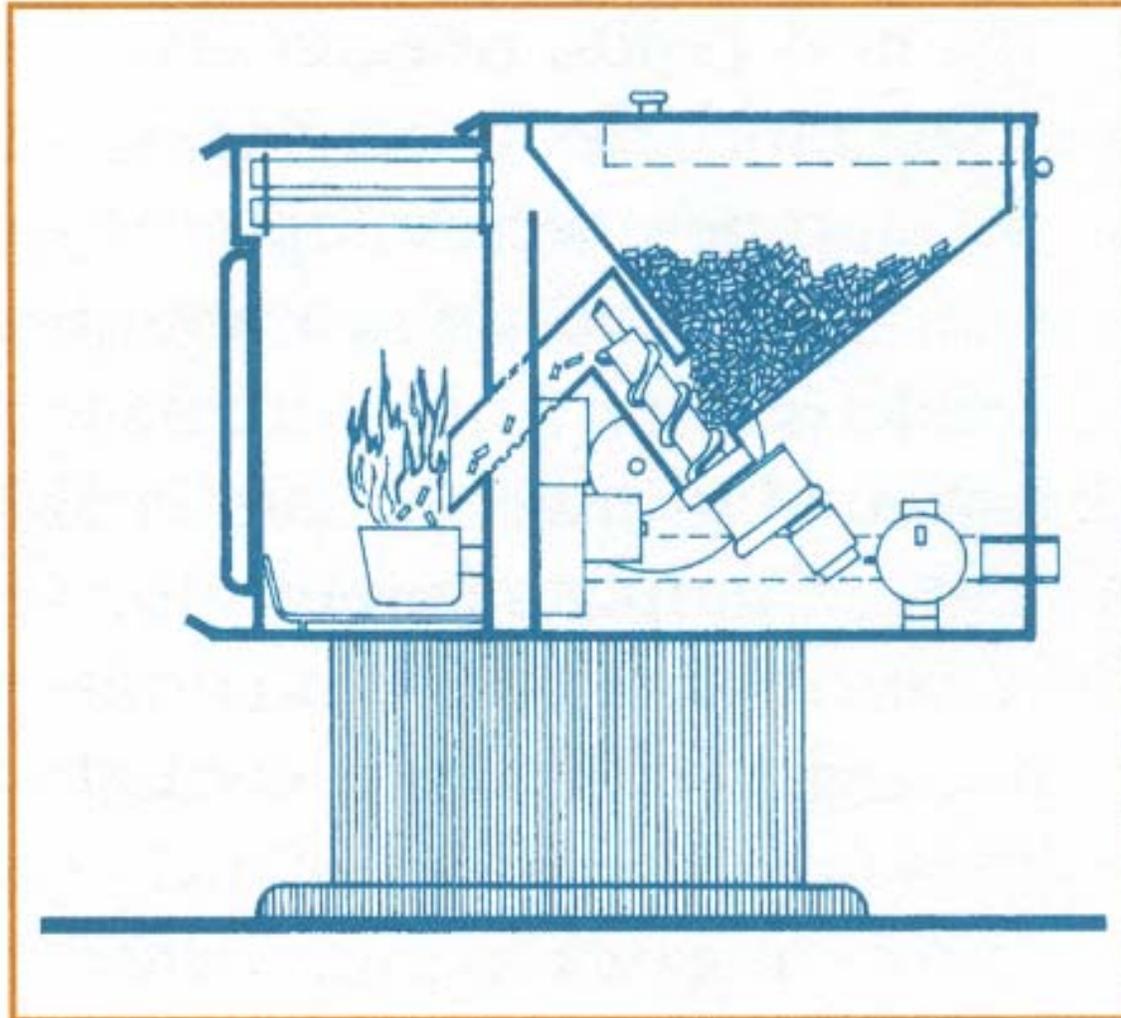


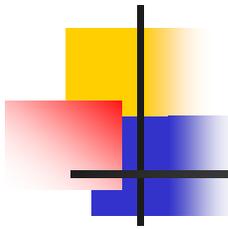


Pellet Stove

- Burns pelletized wood
 - sawdust, shavings and fines leftover after processing trees for lumber and other wood products.
 - the material is dried, compressed, and formed into small eraser-sized bits

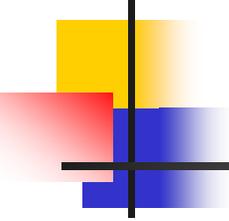
Pellet Stove





Key Facts

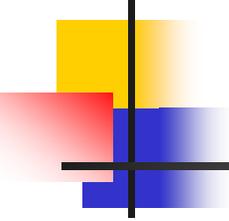
- 40-45 million wood burning appliances in U.S
- 15 million of those are wood stoves, either free standing or fireplace inserts
 - 80% - 90% are pre-NSPS (prior to 1988)
 - WS population could be different locally
 - Some vendors report strong pellet stove sales
 - Cordwood stove sales in 1997 less than half than in 1990
- Fireplaces exempt from NSPS (>35:1 air to fuel ratio)



Key Facts (continued)

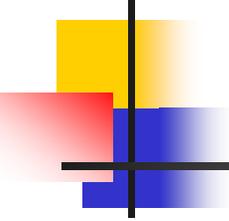
Masonry heaters

- Exempt from NSPS
- Not many of these
- Fireplace inserts treated like woodstoves
- All RWC PM emissions are PM10
 - PM2.5 (~93%)
 - About 50% of PM emissions occur during startup



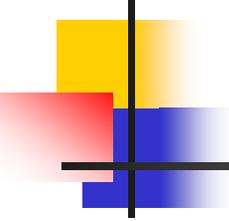
Many Factors Affecting Emissions

- Many types and models of RWC units
 - As of 1997, 121 non-catalytic WS models and 87 catalytic WS models (including fireplace inserts) were listed as certified to Phase II standards
- Different types of fuel (i.e. tree species)
 - Variation in wood seasoning and storage practices
- Draft characteristics vary considerably
 - Chimney and temperature conditions
- Household altitude varies
- Wide variation in operating practices
 - Burn rate, burn duration, damper setting, kindling approach, etc.



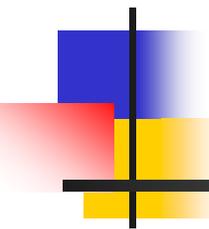
Fireplace SCC's

- 2104008000-Total; FP & WS
- 2104008001-FP, General
- 2104008002-FP, w/insert, catalytic
- 2104008003-FP, w/insert, non-cat, certified
- 2104008004-FP, w/insert, cat, certified

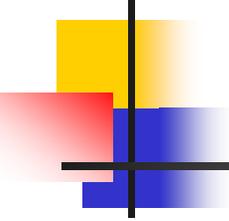


Woodstove SCC's

- 2104008010-WS, general
- 2104008030-WS, catalytic
- 2104008050-WS, non-cat, EPA certified
- 2104008051-WS, non-cat, non-certified
- 2104008052-WS, non-cat, Low Emitting
- 2104008053-WS, non-cat, Pellet Fired
- 2104008070-Outdoor Wood Burning Equipment (hydronic heaters)

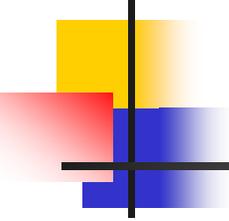


Do Not Double Count Your
Emissions!



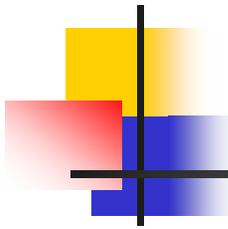
NEI Method; Fireplaces

- Start with Total Wood Burned in Residential Sector (DOE)
- Determine FP consumption by counting fireplaces and assuming activity
 - Determine the # of homes w/fp (DOC)
 - Some homes have more than 1 fp (multiply by 1.17)
 - Some people burn gas (74% burn wood, 26% burn gas)



NEI Method; Fireplaces

- Some fp not used (42% not used)
- Subtract out fp with inserts (DOC)
 - Fp with inserts treated like woodstoves
- Divide into 2 categories; fp used for heating, fp used for aesthetics



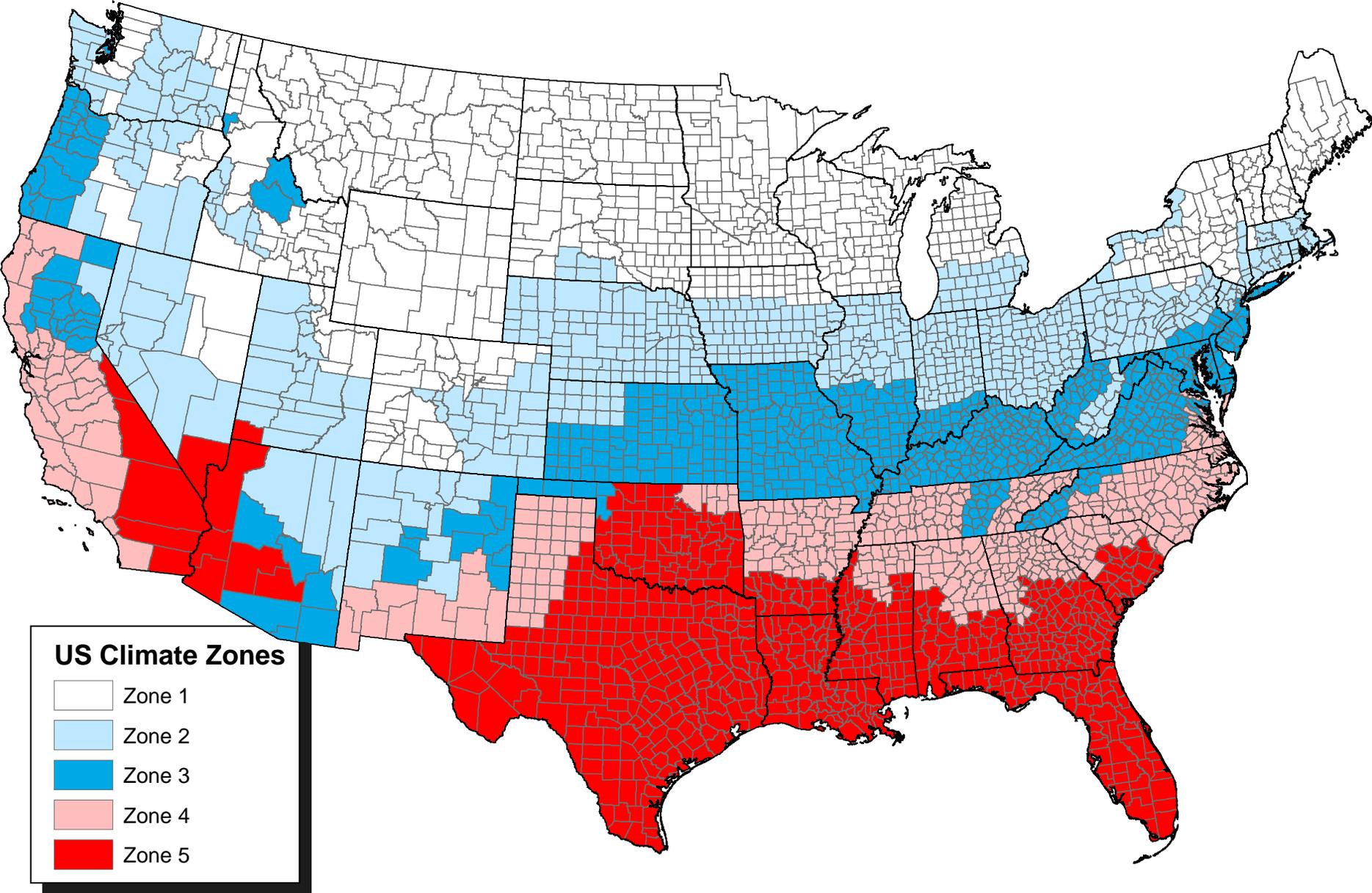
NEI Method; Fireplaces

- Determine wood consumption for each fireplace type
 - Assume wood consumption rates
 - 0.656 cords/unit/year for heating
 - 0.069 cords/unit/year for aesthetics
- Allocate wood consumption to climate zone and then to county

Climate Zone Definition Criteria

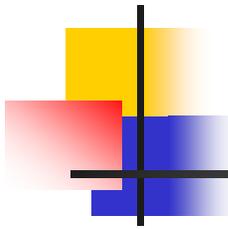
| Climate Zone Number | Heating Degree Days | Cooling Degrees Days |
|---------------------|---------------------|----------------------|
| 1 | >7000 | |
| 2 | 5500-7000 | |
| 3 | 4000-5499 | |
| 4 | <4000 | <2000 |
| 5 | <4000 | >2000 |

US Climate Zones



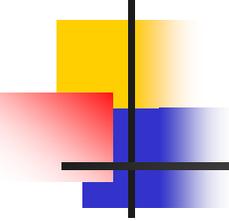
Allocating Wood Consumption to Climate Zones

| Climate Zone | Wood Burned (EIA/DOE Residential Energy Consumption Database) |
|--------------|---|
| 1 | 36% |
| 2 | 19% |
| 3 | 21% |
| 4 | 15% |
| 5 | 9% |



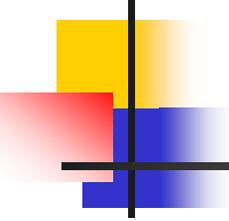
NEI Method; Fireplaces

- Adjust urban and rural wood consumption to match DOC data (73% of wood burned in fireplaces is burned in urban counties)
- Use iterative procedure until urban/rural split is 68/32.



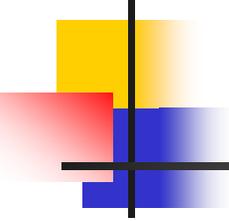
NEI Method; Woodstoves and Fireplaces with Inserts

- Start with total wood burned and subtract out wood burned in fireplaces
- Allocate wood consumption to climate zones
 - Use # of single family detached homes as surrogate



NEI Method; Woodstoves and Fireplaces with Inserts

- Sum the wood consumption in each zone and compare to the urban/rural split
 - For WS, 65% rural, 35 urban
 - For inserts, 43% rural, 57% urban
- Adjust until split matches



NEI Method; Woodstoves and Fireplaces with Inserts

- Now have cordwood consumption
- Conversion; 1 cord = 1.163 tons wood
- Woodstove Population (Hearth Products Association Data)
 - 92% conventional ws
 - 5.7% non-catalytic ws, EPA-certified
 - 2.3% catalytic ws, EPA-certified
- Use emission factors to determine emissions



Session XI

Emissions Estimation for Biomass Fires (Agricultural & Forest/Rangeland)

US EPA Emissions Inventory Conference
New Orleans, LA
May 15, 2006

Thompson G. Pace
USEPA

Agricultural Burning



AGRICULTURAL BURNING

- SCC 2801500000 (135k TPY)
- SCC 2801500xxx (143k TPY)
- PM10-PRI and PM25-PRI
- Both condensibles and filterables
- NEI contains *ONLY* RPO or State-submitted estimates
 - 19 States submitted for 2002 (up from 10 in '99) - AL, AR, CA, FL, IA, ID, KS, LA, MN, MO, MS, NE, NJ, OK, OR, SC, TX, UT, WA
- General Approach
 - Activity (acres of crop burned)
 - Loading factor (tons of biomass or vegetation per acre burned)
 - Emission factor (pounds per ton)

AGRICULTURAL BURNING

What can you do?

- Coordinate with burners and permit authorities
- Start building a system and relationships with the burners/ permitting authorities to enable an improved inventory in the future
- Focus on larger fires (> 100 acres) as events with a start and stop date and time; lump smaller fires into monthly acreages

AGRICULTURAL BURNING

What can you do? (Cont'd)

- ❑ Obtain local acres of crops burned data from:
 - Burn permits
 - Survey of county agricultural extension offices

- ❑ Verify that burns actually occurred

- ❑ Obtain fuel loading data
 - Local data preferred from county agricultural extension offices, local Natural Resources Conservation Service Center

Wildland Fires



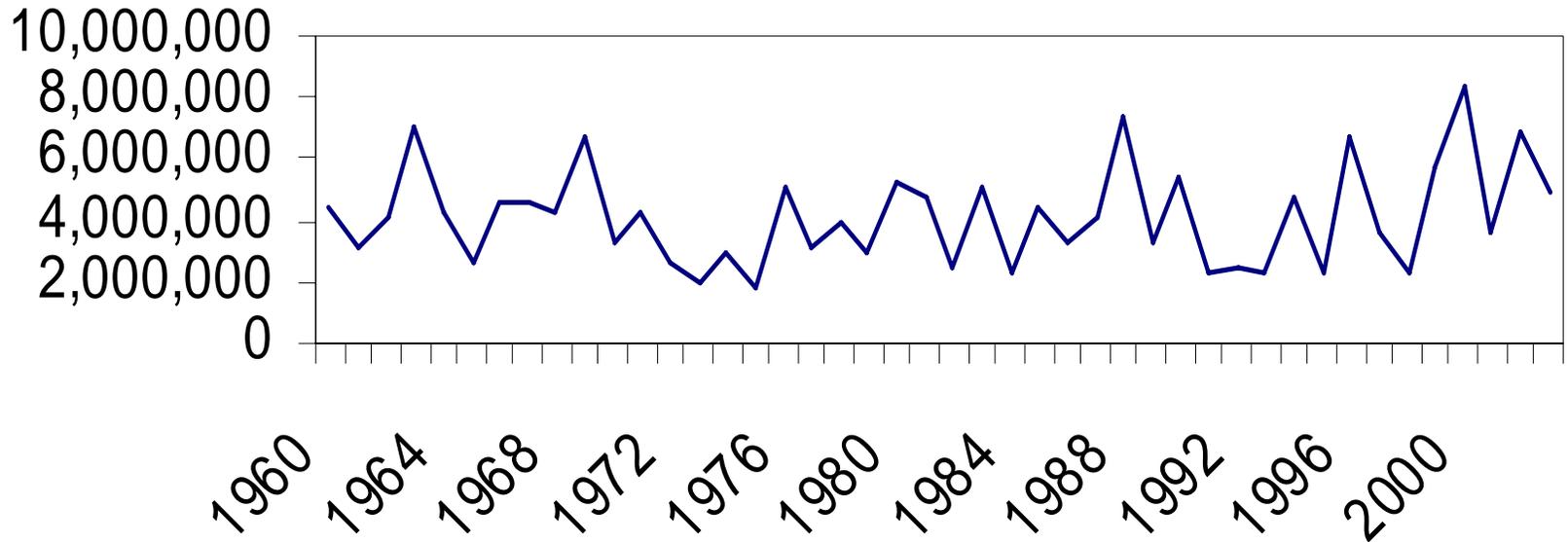
Overview of Wildland Fire Inventory

- **Who Burns ?**
 - **NPS, USFS, BLM, USFWS, State & Tribal Forests, Private burners**
 - **Fire Types: Wildfires, Managed (Prescribed) Burns**
- **Why is this so complicated / important**

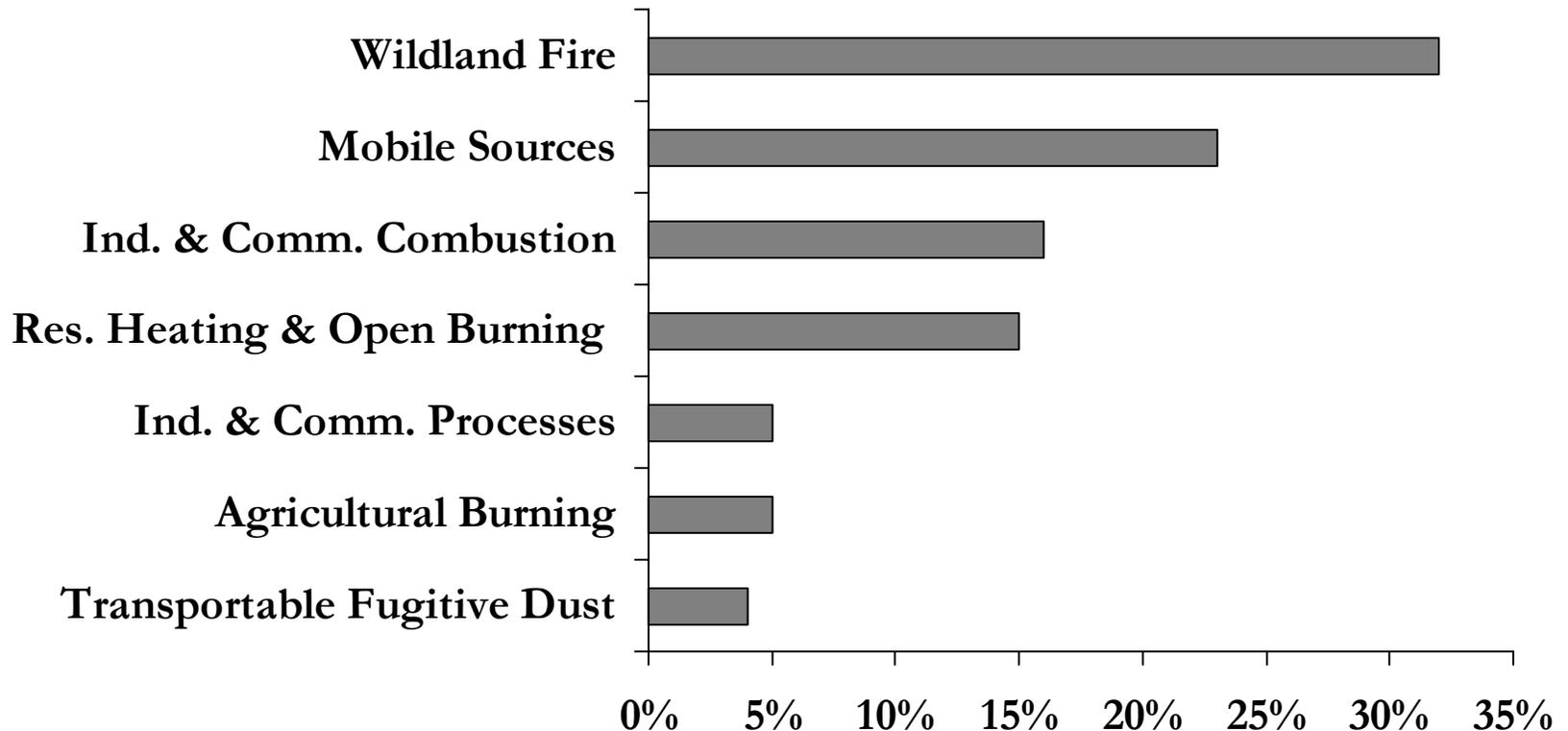
Summary of Wildfire Occurrence in VISTAS States 2002

| Acre range | # of fires | # % | Acres | Acres % |
|-------------------|-------------------|---------------|----------------|----------------|
| 0-1 | 14,657 | 49.00% | 6,251 | 1.30% |
| 1-5 | 8,606 | 28.80% | 24,275 | 5.20% |
| 5-10 | 2,486 | 8.30% | 19,413 | 4.10% |
| 10-50 | 3,166 | 10.60% | 74,911 | 15.90% |
| 50-100 | 547 | 1.80% | 41,119 | 8.70% |
| 100-1000 | 431 | 1.40% | 97,570 | 20.70% |
| >1000 | 32 | 0.10% | 207,341 | 44.00% |
| Totals | 29,925 | | 470,879 | |

National Wildfire Acres Burned



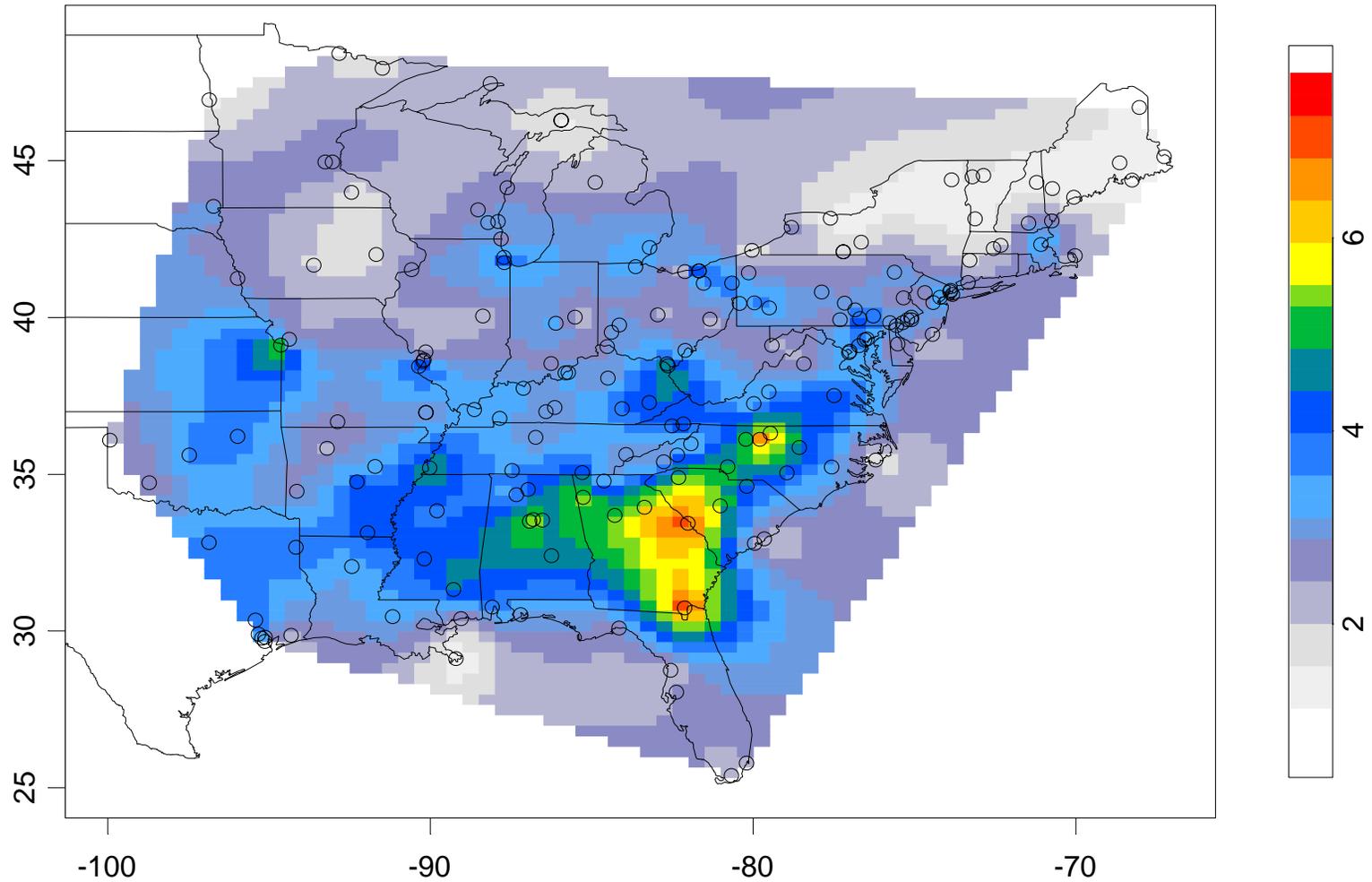
Primary Carbon in PM2.5



**% of PM2.5 Primary Carbon Emissions
(National Emissions ~ 2M TPY)**

Seasonal Average Ambient Concentration of OC in Eastern US

Organic Carbon (April - June 2002)



Overview of Wildland Fire Inventory

- **Who Burns ?**
 - **NPS, USFS, BLM, USFWS, State & Tribal Forests, Private burners**
 - **Fire Types: Wildfires, Managed (Prescribed) Burns**
- **Why is this so complicated / important**
- **What's being done?**
 - **How *were / are* Wildland Burning emissions estimated in NEI ?**
 - **What's Happening Nationally & Regionally ?**
 - **BlueSkyRAINS**
 - **Wildfire Emissions Module / CMAQ**

How were Wildfire Emissions Estimated *prior to* the '02 NEI?

A very rudimentary approach

Note: Prescribed fire approach is similar (but not identical)

- **Pollutants**
 - PM₁₀, PM_{2.5}, NO_x, CO, VOC, SO₂, 30 HAPS
- **Emission Factors (AP-42)**
- **Regional Fuel Loading Factors (AP-42)**
- **Annual Activity Data ~ State (or regional) level**
 - USFS, BIA, BLM, NPS, FWS
 - Some States provide private / State burn data
 - Spatial allocation to counties using forested area
- **Emissions Processor ~ Allocates Diurnal & Monthly**

What *IS* Happening Nationally / Regionally to Improve Wildland Fire Emissions ?

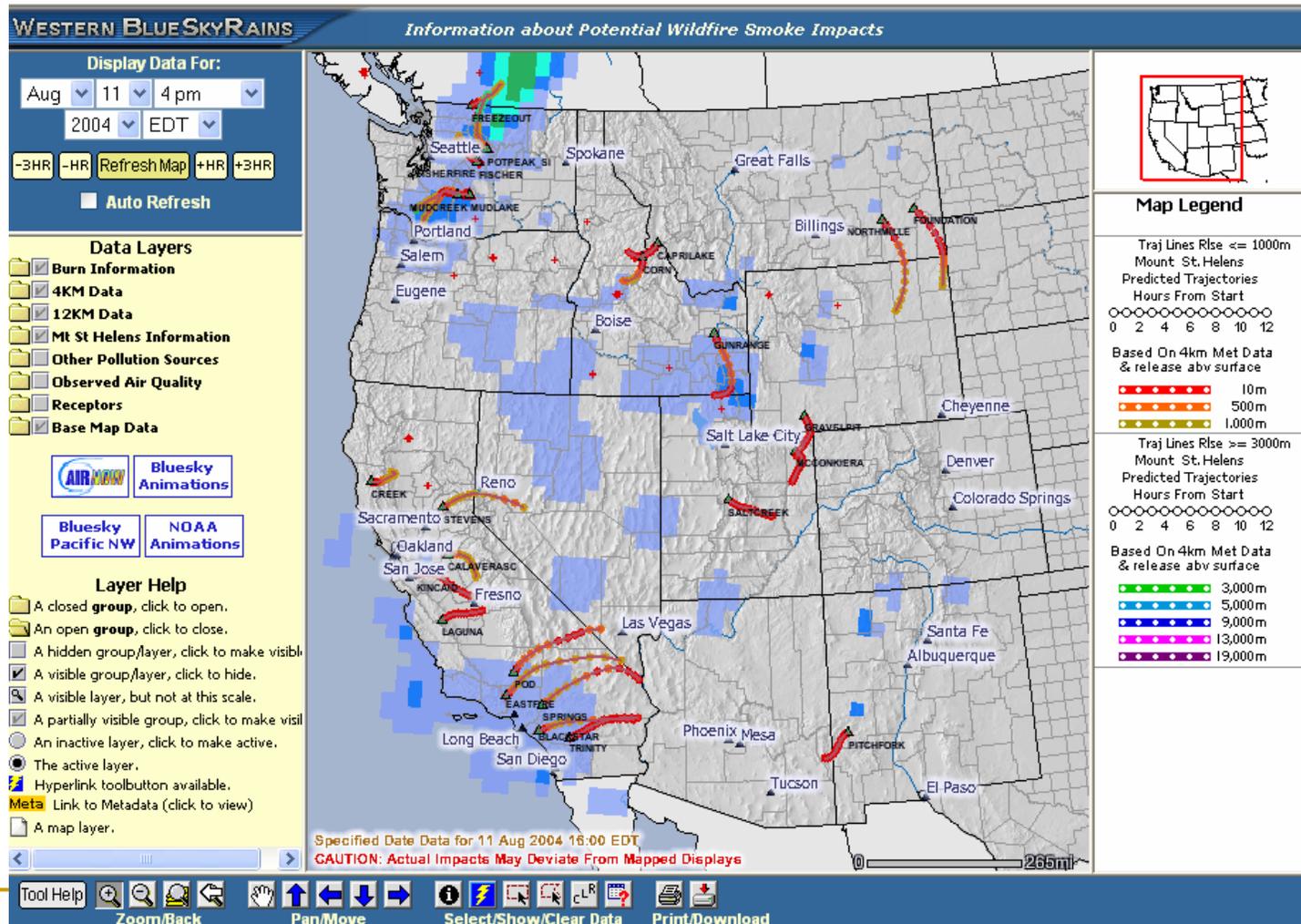
- ***National Fire Workshop (New Orleans – May '04)***
- ***BlueSky EM***
- ***InterRPO project ~ WRAP / Air Sciences / ECR***
 - ***Fire Events Database Development***
 - **Actual fire locations, acres burned and start/stop dates**
 - ***Fire Location & Fuel Consumption***
 - **Spatial: Lat / Long (TRS & County Centroid as fall-back)**
 - **Fuel Loading / Consumption Hybrid Approach:**
 - **Sub region-specific loading / FEPS Consumption**
 - ***Plume Rise:***
 - **Calculated for each event & included in EI File**

What About Prescribed Burning ?

- **EPA ~ EC/R ~ Air Sciences**
- **Activity Data Sets** ~ *less availability than for WF*
 - EC/R obtained with help of RPOs
- **Fuel Consumption:**
 - *Used similar approach to that used for WF Fuel Consumption*
 - Values will be different from wildfires
- **Emission Factors:** No changes
- **Plume Rise:**
 - *Some new work req'd*
 - *Less plume rise – fires not as hot*

BlueSkyRAINS Western Prototype

- Fire Forecasting Tool – Western Prototype Shakedown 2005-6



Wildland Fire Emissions Module (BS-EM)

(under development by EPA ORD)

- **Module to enable Emission Models (e.g., SMOKE, OpEM) to Estimate Fire Emissions AND... Interfaces with the CMAQ modeling system.**
- **User Inputs:** Fire locations, duration, size
- **Model Components (Modules from the BlueSky system)**
 - Fuel loading default: NFDRS / FCC map
 - Fuel Moisture: Calculates using MM5 met data
 - Fuel Consumption: CONSUME / FOFEM
 - Emissions & Heat Release: FEPS technology
 - Plume Rise (improved plume rise algorithms under development)
- **Outputs:** Gridded hourly emissions, plume characteristics
- **Module released for testing and limited use (w/ caveats)**
- **Contacts:**
 - Tom Pierce pierce.tom@epa.gov
 - George Pouliot pouliot.george@epa.gov



Questions?

