PM Fine Emission Inventory Preparation

- Sources & Composition
- PM2.5 National Emissions Inventory
- Inventory Tools
- Ammonia Update
- Fugitive Dust Update
- Carbon Update

Thompson G. Pace
US EPA OAQPS

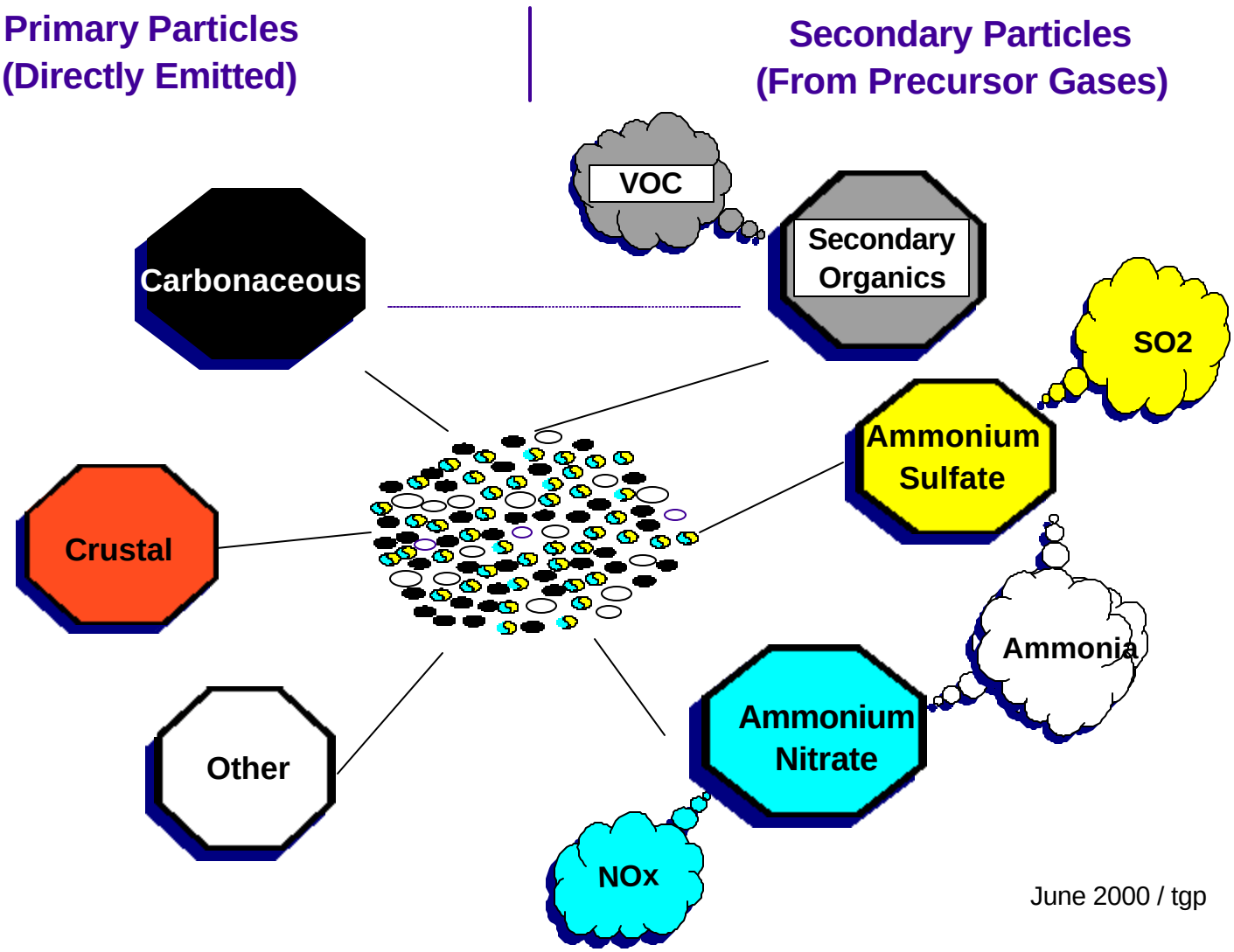
EPA Emissions Inventory Workshop
Atlanta GA
April 15, 2002

PM2.5 Sources & Composition

Thompson G. Pace
US EPA

EPA EI Conference
Atlanta GA
April 15, 2002

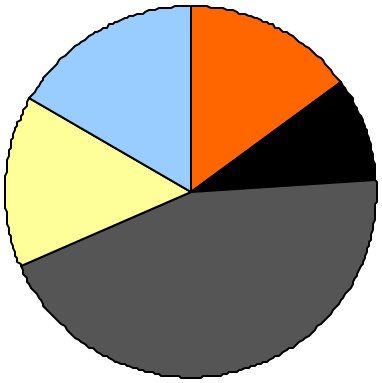
PM 2.5 In Ambient Air - A Complex Mixture



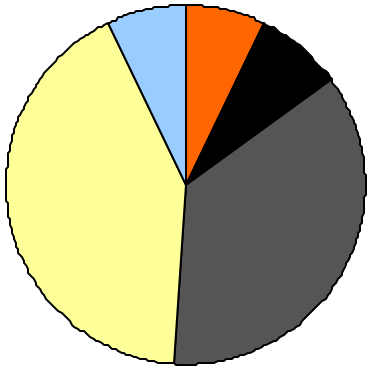
June 2000 / tgp

Sources of Fine Particles

Typical Western City



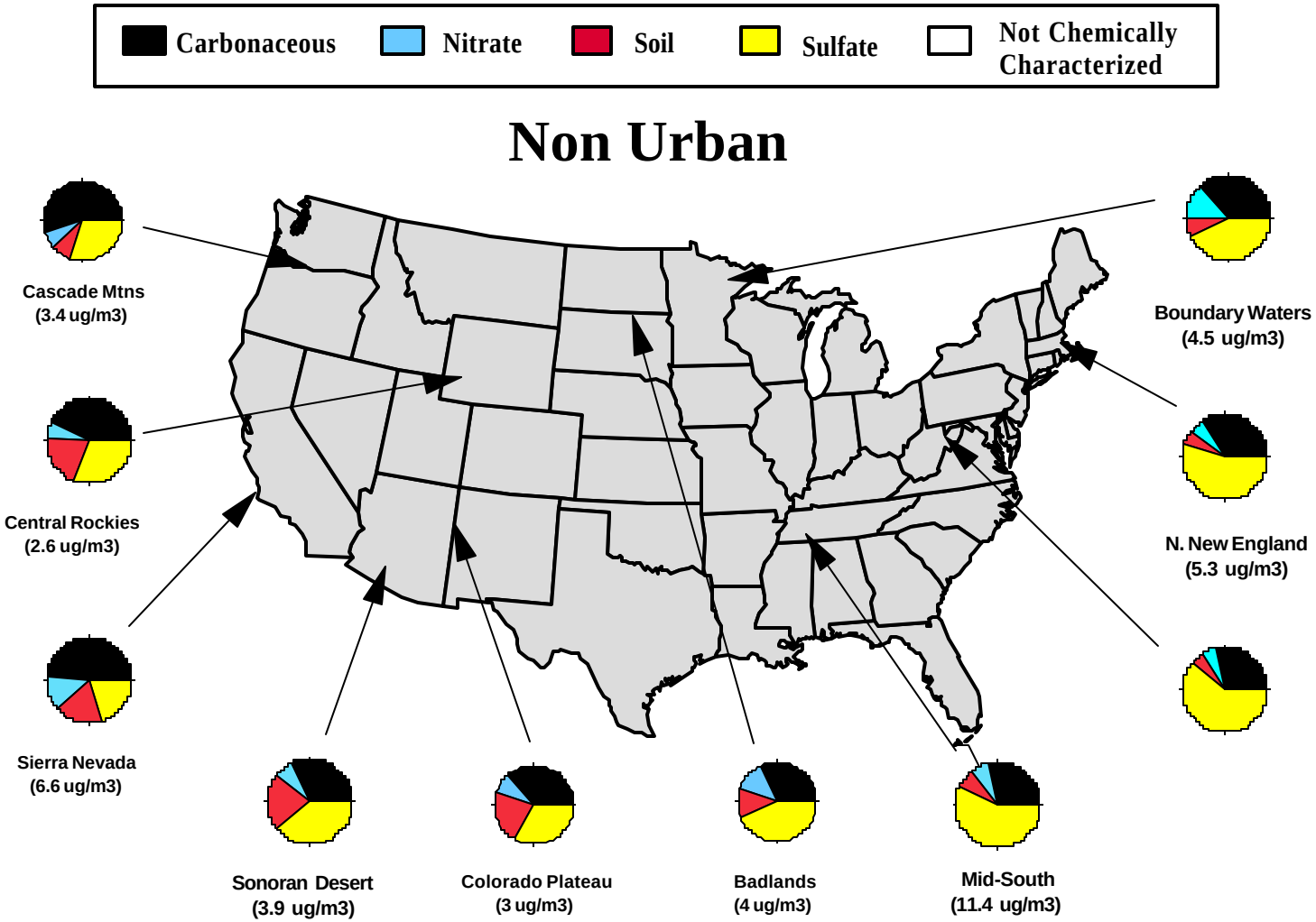
Typical Eastern City



Key Sources

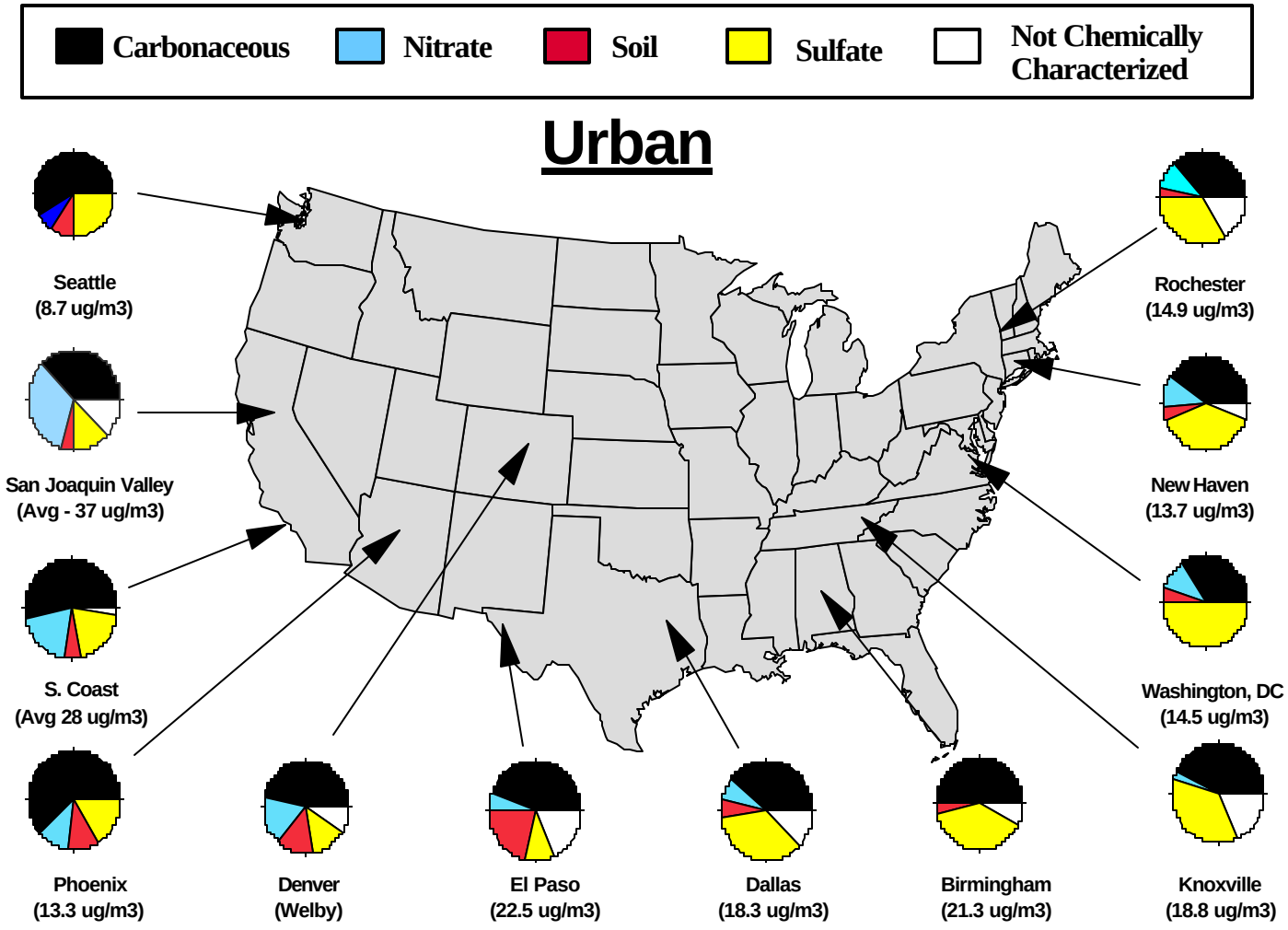
- From SO2 emitted by Power Plants and Coal & Oil-fired Boilers
- From NOx emitted by Cars, Trucks, Power Plants & Heavy Equipment
- Roads, Construction & Field Dust
- Diesel Engines (Heavy Equipment & Highway Vehicles)
- Wildland Fires, Waste Burning, Heavy Equipment Engines, Cars & Trucks

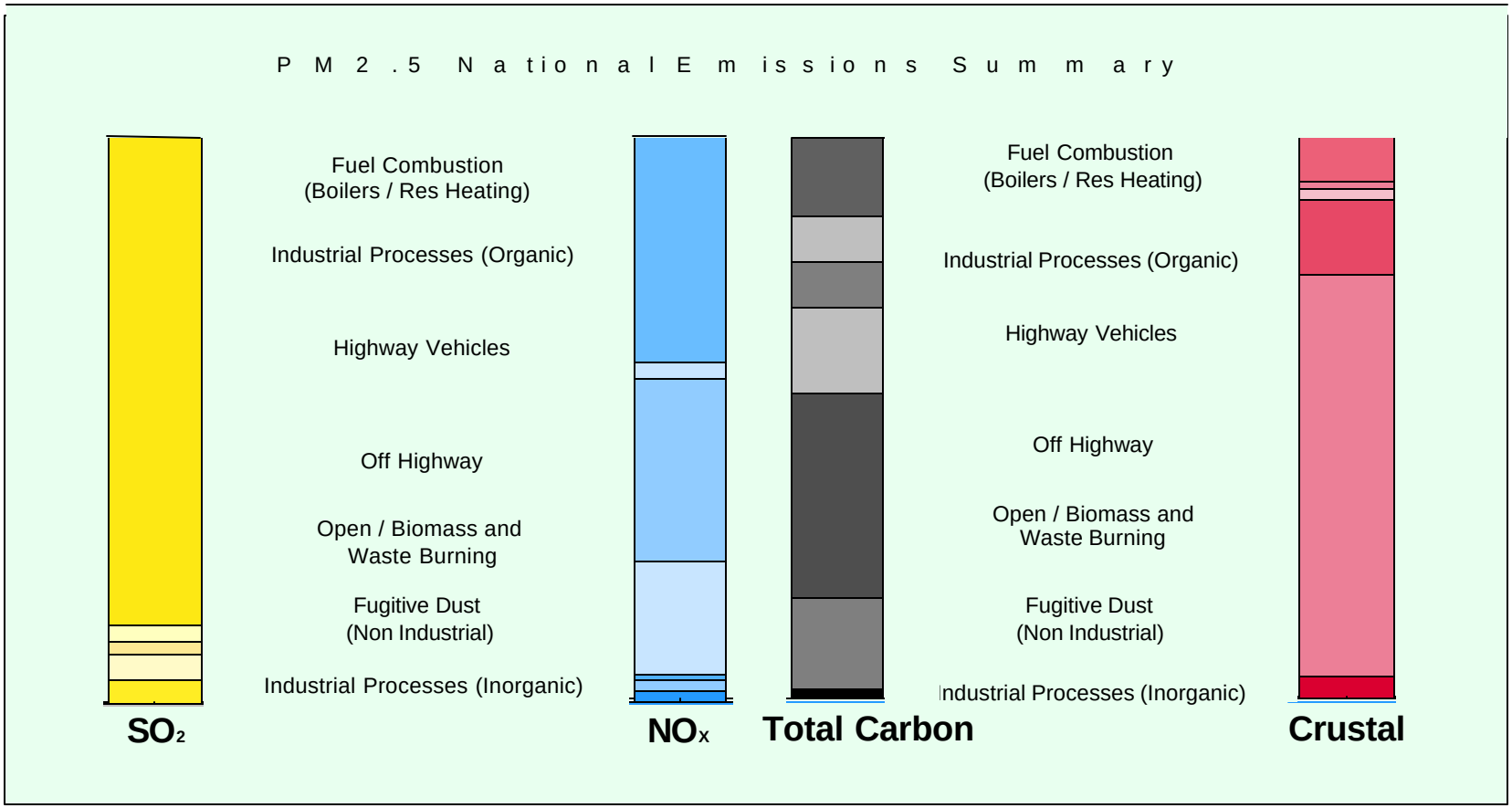
PM2.5 Ambient Composition



Note: PM-2.5 mass concentrations are determined using at least 1 year of monitoring at each location using a variety of sampling methods. They should not be used to determine compliance with the PM-2.5 NAAQS.

PM2.5 Ambient Composition




PM2.5 National Emissions Summary
Fuel Combustion (Boilers / Res Heating)
Industrial Processes (Organic)
Highway Vehicles
Off Highway
Open / Biomass and Waste Burning
Fugitive Dust (Non Industrial)
Industrial Processes (Inorganic)
SO2
NOx
Total Carbon
Crustal

Key Sources of Fine Particles (Nationwide)

DIRECT EMISSIONS

Smoke & Soot (Carbon Particles)[a]

- ***Wildfires***
- ***Open Burning of Waste***
- ***Heavy Equipment Engines***
- ***Residential Wood Burning***
- ***Forest & Field Burning***
- Industrial Processes
- Cars & Trucks
- Industrial Boilers
- Power Plants

Soils & Metals[b]

- ***Road, Construction & Field Dust***
- Mineral Products Industries
- Iron & Steel Industries

PRECURSOR EMISSIONS

SOx

- ***Coal-fired Power Plants***
- Industrial Boilers
- Industrial Processes
- Marine Vessels
- Heavy Equipment Engines

NOx

- ***Cars & Trucks***
- ***Power Plants***
- ***Heavy Equipment Engines***
- ***Industrial Boilers***
- Commercial & Residential Heating
- Mineral Products Industry

NH3

- ***Animal Waste***
- Fertilizer Use
- Cars & Trucks
- Fertilizer Mfg.
- Wastewater Treatment

VOC[d]

- ***Biogenics***
- Solvent use
- Cars & Trucks
- Heavy Equipment
- Wildfires

Note: ***Bold, Italicized*** source categories are most important

PM2.5 and the National Emissions Inventory
An Overview

Thompson G. Pace
USEPA
Atlanta GA
April 15, 2002

PM Definitions

- **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 PM_{10}.

- **Condensable (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. Condensable PM is almost always $PM_{2.5}$.

- **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.

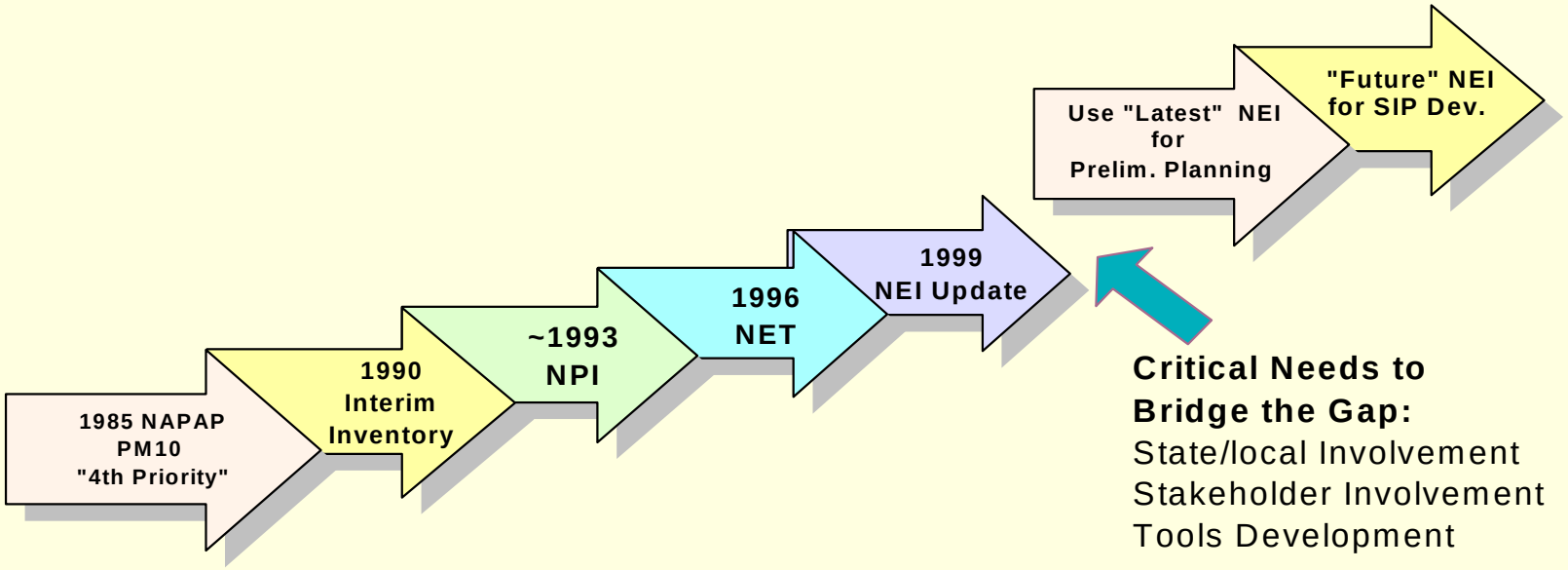
  Precursors to **PM-SEC** are in the NEI: SO2, NOx, NH3, VOC

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

What to Report to EPA

- $PM_{2.5}$-PRI (or $PM_{2.5}$- FIL & PM-CON individually.
  - Note that all PM-CON is assumed to be $PM_{2.5}$ size fraction)
- PM_{10}-PRI (or PM_{10}-FIL & PM-CON individually)
- In addition, States may also choose to report the following.
  - Total Primary PM Measured (or Filterable Total Primary PM Measured and Condensible PM individually).
  - These two PM components are the components measured by a stack sampling train such as EPA Method 5 and have no upper particle size limit.

Evolution of the PM2.5 Emissions Inventory



Critical Needs to Bridge the Gap:
State/local Involvement
Stakeholder Involvement
Tools Development

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 NEI

- **NEI:** National Emissions Inventory of point, area & mobile sources
  - Annual, County-level
- **Combines & harmonizes:**
  - National Toxics Inventory (NTI)
  - National Emissions Trends Inventory (NET)
- **Jointly developed**
  - From EPA, RPO, State & Tribal EI's
- **Evolutionary**
  - "PM" NEI builds on other pollutants & inventories

Using the NEI with Models

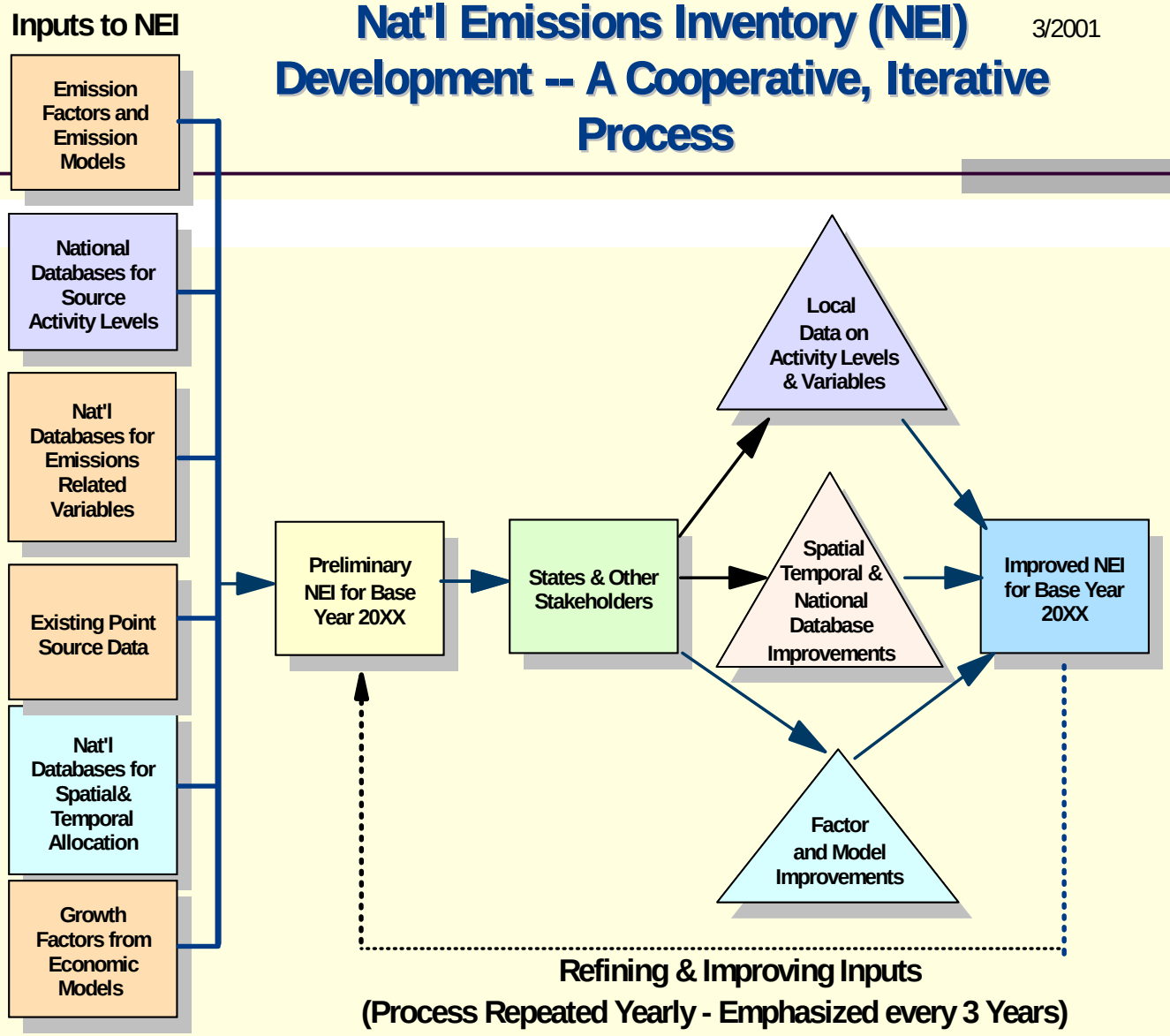
- **Start with:**
  - Annual, County-level Inventory (NEI)
  - Temporal Allocation Factors
  - County-to-Grid Allocation Factors
  - Speciation Factors
- **Apply Emissions Processor**
  - SMOKE/EPS
  - Emissions Modeling Clearinghouse (EMCH)
  - URL: http://www.epa.gov/ttn/chief/emch
- **Model input:**
  - Gridded inventory.....Temporally resolved
  - Speciated as needed (EC, Organics)
  - Some inventory added “on-the-fly”
    - Biogenics now...more to follow (e.g., wind erosion)

Overview of EI & NEI Development Process

- **EPA**: shares its plans, data with RPO's, States & Tribes.
- **EPA**: collects/creates additional data.
- **States/Locals/Tribes**: submit their data to EPA.
- **EPA**: selects and merges estimates.
- **RPOs/States/Locals/Tribes**: (and others) review EPA's draft inventory.
- **EPA**: makes corrections, resolves disputed estimates.
- **EPA**: releases NEI.
- **Note:** RPOs/States/Tribes have ongoing uses for their own EI's

Nat'l Emissions Inventory (NEI) Development -- A Cooperative, Iterative Process

3/2001



1999 NEI Development Cycle

- **1999 Base Year Cycle**
  - June 1, 2001 — S/L/T Inventories to EPA
  - June-October — EI Processing:
    - S/L/T EI's combined into one data set
    - QA issues identified/corrected if possible
    - Add PM_{10}, $PM_{2.5}$, and NH_3
    - Utilities reporting to ETS/CEM: Overwrite NO_x and SO_2
  - Oct. 1, 2001 — S/L/T Review of Processed EI
  - Feb. 1, 2001 — S/L/T Comments to EPA
  - June 1, 2002 — EPA Finalizes EI Incorporating Comments
  - Cycle Repeated:
    - June 1, 2001 to June 1, 2002
    - June 1, 2002 to June 1, 2003
- **2002 Base Year Cycle**
  - Begins June 1, 2004

Improving Upon the NEI

- **General Approach**
  - **Start with Current EI** - based on activity data and factors available to EPA at this time.
  - **Obtain Better Activity Data** - available locally for many categories.
  - **Check Emission factors** - are constantly being improved; local measurements may be better.
  - **Spatial & Temporal Allocation** - Submit local data
- **Fugitive Dust, Combustion & Ammonia**
  - Many “opportunities” for local input.
- **NEI:** Difficult, but doable by working together.

Strategy for a Better EI

- **Establish priorities** - what can you do?
- **Leverage resources** - States, Tribes, other RPO's.
- **"Ground truth"** - establish uncertainty bounds with:
  - Transport / transformation models
  - Ambient measurements
  - Chemical characterization & Source apportionment
- **Source Apportionment tools:**
  - Tracer compounds and physical properties
  - Data analytic techniques: UNMIX, PMF, CMB, MLR
- **Expand & enhance the research programs**
- **Pick your battles! -** Resources are limited

Consolidated Emissions Reporting Rule (CERR)

- First Reporting for Base Year 2002
  - Inventories due June 2004
  - Statewide Reporting Every 3 Years
  - Criteria Pollutants & Precursors (including PM_{10}, $PM_{2.5}$, NH_3)
  - NIF 2.0
- Final CERR to be signed by EPA Administrator soon
- URL: http://www.epa.gov/ttn/chief/cerr/

Accessing the NEI

- AIR DATA Website:
- www.epa.gov/air/data
- Summary Data
- EPA FTP Site:
- ftp.epa.gov/EmisInventory
- Entire NEI data files for ‘96 & ‘99
- NEON:
- Web-based Query tool
- Summary & Detailed Data

PM2.5 Inventory Tools

Thompson G. Pace
US EPA

EPA EI Conference
Atlanta GA
April 16-19, 2002

PM Inventory Tools

CHIEF

PM Inventory Tools (Cont.)

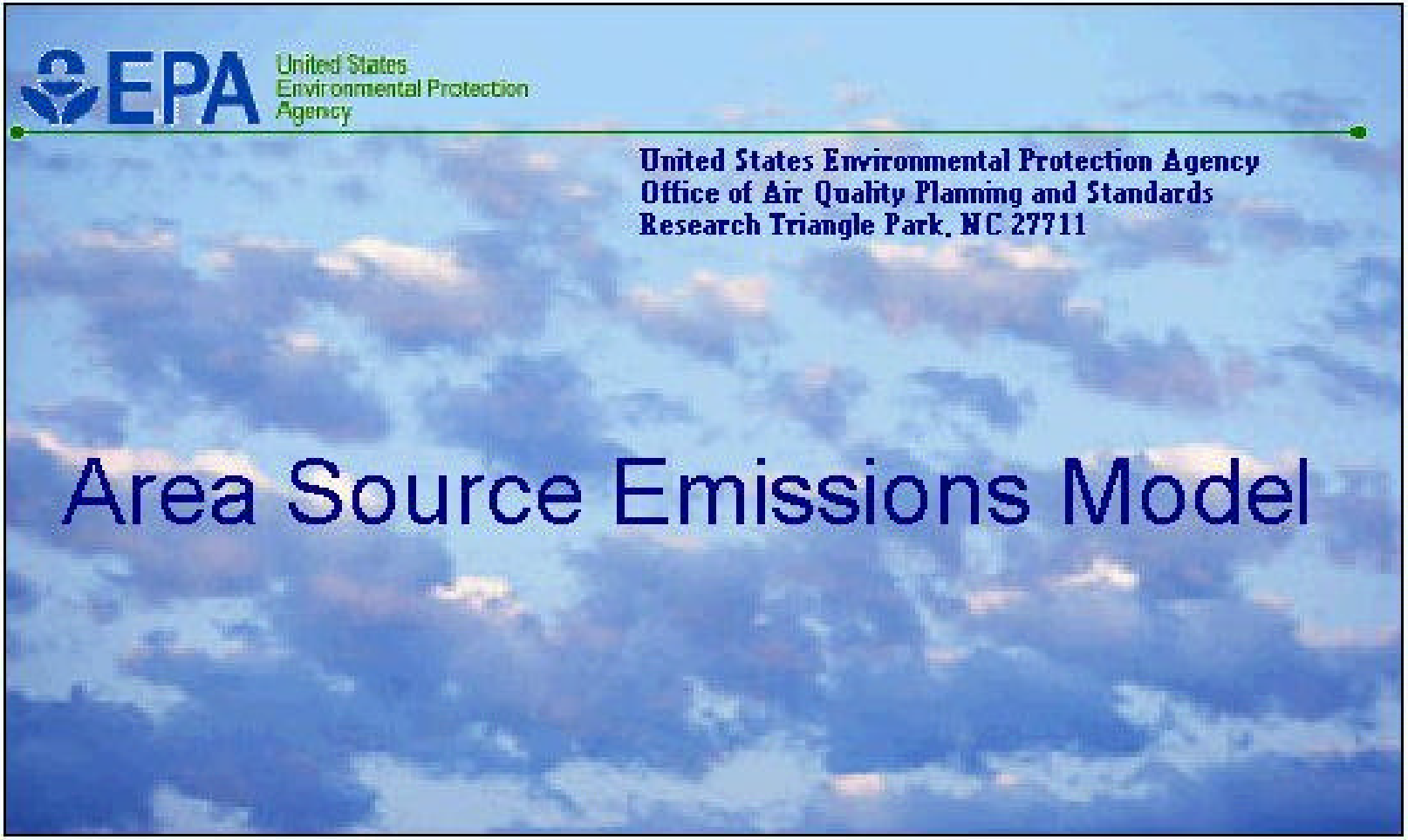
PM Calculator (Ver 2.02)

- **What does it do?**
  - **Estimates PM2.5 from PM10 for Point Sources**
  - **Considers up to 2 control devices**
- **"Built in…**
  - **Default size distribution for each SCC**
  - **Device default control efficiencies**
- **Batch mode – PC Windows**
- **On CHIEF**

http://www.epa.gov/ttn/chief/software/pmcalc/index.html

PM Inventory Tools (Cont.)

Area Source Emissions Model



ASEM (Cont.)

Edit Activity Information

Wildfires

FIPS State	FIPS County	SCC	Pollutant	Activity 1	Activity 2	Activity 3	Ac
37	063	2810001000	50000	7.78E+01	9.00E+00	5.00E-04	
37	063	2810001000	PM-25	7.78E+01	9.00E+00	5.00E-04	
37	063	2810001000	PM-10	7.78E+01	9.00E+00	5.00E-04	
37	063	2810001000	CO	7.78E+01	9.00E+00	5.00E-04	
37	063	2810001000	SO2	7.78E+01	9.00E+00	5.00E-04	
37	135	2810001000	50000	1.08E+02	9.00E+00	5.00E-04	
37	135	2810001000	PM-25	1.08E+02	9.00E+00	5.00E-04	
37	135	2810001000	PM-10	1.08E+02	9.00E+00	5.00E-04	
37	135	2810001000	CO	1.08E+02	9.00E+00	5.00E-04	
37	135	2810001000	SO2	1.08E+02	9.00E+00	5.00E-04	
37	183	2810001000	50000	2.07E+02	9.00E+00	5.00E-04	
37	183	2810001000	PM-25	2.07E+02	9.00E+00	5.00E-04	
37	183	2810001000	PM-10	2.07E+02	9.00E+00	5.00E-04	
37	183	2810001000	CO	2.07E+02	9.00E+00	5.00E-04	
37	183	2810001000	SO2	2.07E+02	9.00E+00	5.00E-04	

Sort By: FIPS County | SCC | Pollutant

Show Emissions
Edit Case
Import
Find/Replace
Allocation
Output Location
Close
Help

ASEM (Cont.)

View Emissions

Emissions

FIPS State	FIPS County	SCC	Pollutant	Emissions (tons)	CE (%)	RE (%)	RP (%)	Emis Fac
37	063	2810001000	50000	0.90	0	100	100	
37	063	2810001000	PM-25	4.10	0	100	100	
37	063	2810001000	PM-10	4.55	0	100	100	
37	063	2810001000	CO	49.04	0	100	100	
37	063	2810001000	SO2	0.05	0	100	100	
37	135	2810001000	50000	1.25	0	100	100	
37	135	2810001000	PM-25	5.70	0	100	100	
37	135	2810001000	PM-10	6.33	0	100	100	
37	135	2810001000	CO	68.22	0	100	100	
37	135	2810001000	SO2	0.07	0	100	100	
37	183	2810001000	50000	2.40	0	100	100	
37	183	2810001000	PM-25	10.92	0	100	100	
37	183	2810001000	PM-10	12.14	0	100	100	
37	183	2810001000	CO	130.72	0	100	100	
37	183	2810001000	SO2	0.14	0	100	100	

Edit Case
Edit Activity
Export
Help
Close

Sort By: FIPS County | SCC | Pollutant

PM Inventory Tools (Cont.)

PM Inventory Resource Center

EPA United States Environmental Protection Agency

Emission Inventory Improvement Program EIIP

pm2.5 inventory resource center

HELP & ? HINTS

This site provides LINKS to RESOURCES used for DEVELOPING PM2.5 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 info

PM Research and Field Studies
Information on ongoing PM2.5 Research Projects. Please send us info about ongoing or upcoming projects to add to this page.

What's New
The latest on PM2.5 emission inventory guidance, tools, data and conferences.

More EI links
Links to potentially useful web sites.

Comments
Send your comments to the Emission Factor and Inventory Group.

Site Map
Find your way around the PM2.5 web site.

EPA | OAR | OAQPS | CHIEF | EIIP | PM2.5 HOME | CHIEF Webmaster

Overview of EIIP Documents

- URL: http://www.epa.gov/ttn/chief/eiip/techreport/
- Volume I: Introduction to the EIIP, July 1997
- Volume II: Point Sources
- Volume III: Area Sources and Area Source Method Abstracts
- Volume IV: Mobile Sources
- Volume V: Biogenic Sources
- Volume VI: Quality Assurance/Quality Control
- Volume VII: Data Management Procedures
- Volume VIII: Greenhouse Gases
- Volume IX: Particulate Emissions
  - Chapter 1: Getting Started: Emission Inventory Methods for PM2.5, July 1999
- Volume X: Emission Projections

EIIP Point Source Guidance (Volume II)

- Chapter 1: Introduction to Stationary Point Source Emission Inventory Development, May 2001
- Chapter 12: How to Incorporate Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates, July 2000
- **Documents for Sources of PM_{10} and/or $PM_{2.5}$ Emissions**
  - Preferred and Alternative Methods for Estimating Air Emissions from:
    - Chapter 2: Boilers, Jan. 2001
    - Chapter 3: Hot Mix Asphalt plants, July 1996
    - Chapter 7: Surface Coating Operations, July 2001
    - Chapter 8: Paint and Ink Manufacturing, Aug. 2000
    - Chapter 9: Secondary Metal Processing, Feb. 2001
    - Chapter 10: Oil and Gas Field Production and Processing Operations, Sept. 1999
    - Chapter 11: Plastic Products Manufacturing, Dec. 1998
    - Chapter 13: Stone Mining and Quarrying Operations, May 1998

EIIP Area Source Guidance (Volume III)

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

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

PM 1-Pagers: Overview

- **Location:** PM Resource Center
  URL: http://www.epa.gov/ttn/chief/eiip/pm25inventory/areasource.htm
- **Purpose:**
  - Summarize area source NEI methodology for specific categories of PM_{10}, $PM_{2.5}$, and NH_3.
  - Review drafts posted August 2001 for comment
- **Contents:**
  - Source Category Name, SCC
  - Pollutants of Most Concern
  - Current NEI Methodology
  - Uncertainties/Shortcomings of Current Methods
  - How can States, Locals, and Tribes improve upon methodology?
  - Activity Variables Used to Calculate Emissions:
    - Current Variables/Assumptions Used
    - Suggestions for Improved Variables
  - Where can I find Additional Information and Guidance?
  - References (if available) for:
    - AP-42
    - NEI Methodology Document
    - EIIP Document

PM 1-Pagers: Area Sources

- Open Burning
  - Residential Yard Waste (Leaves and Brush) and Household Waste
  - Residential, Nonresidential, and Road Construction Land Clearing Waste
  - Structure Fires
  - Wildfires & Prescribed Burning
  - Managed Burning - Slash
  - Agricultural Field Burning
- Fugitive Dust
  - Paved and Unpaved Road
  - Highway, Residential & Commercial Construction
  - Beef Cattle Feedlots
  - Agriculture Tilling
  - Mining and Quarrying
  - Residential, Nonresidential, and Road Construction
- Residential Combustion - Fireplaces and Woodstoves
- Commercial Charbroiling
- Animal Husbandry - Cattle, Hogs, Poultry
- Synthetic Fertilizer Application

PM Inventory Tools (Cont.)

Satellite Imagery for Source Characterization

Draft EPA Report : *Examination of Application of Remote Sensing Data to Air Pollution Transport & Emissions*

- Describes current satellite systems & capabilities
- Lists future Satellite systems, capabilities & launch plans
- Lists researchers & websites for info about applying satellite data to air pollution issues
- Discusses potential applications
- Provides satellite image examples
- Draft available mid May

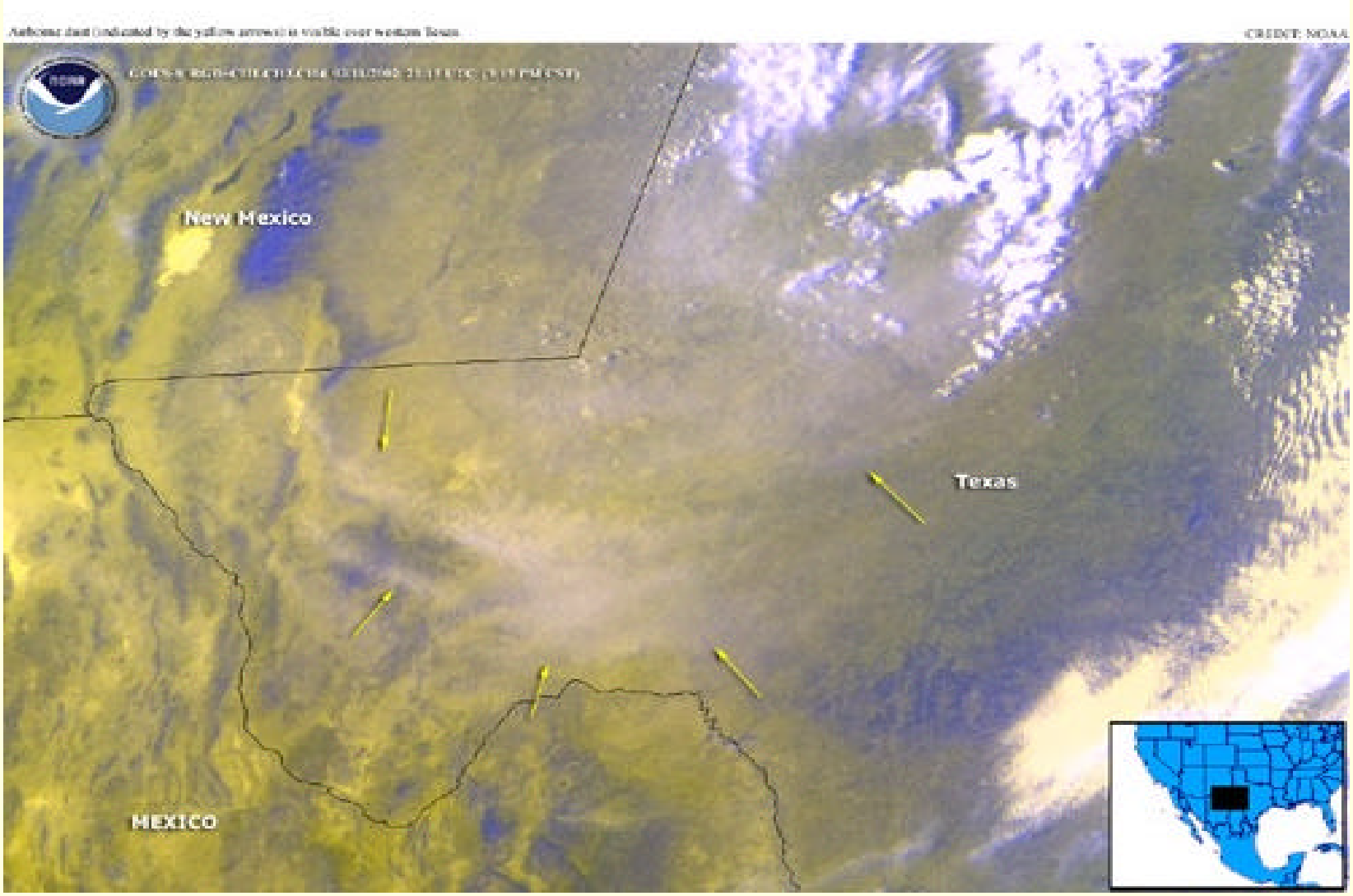
PM Inventory Tools (Cont.)

NOAA Satellite Imagery @ OSEI

- OESI - Operational Significant Event Imagery
  - Daily Updates for ~12 Event Categories
- Dust Storms
  - http://www.osei.noaa.gov/Events/Dust/
- Fires
  - http://www.osei.noaa.gov/Events/Fires/

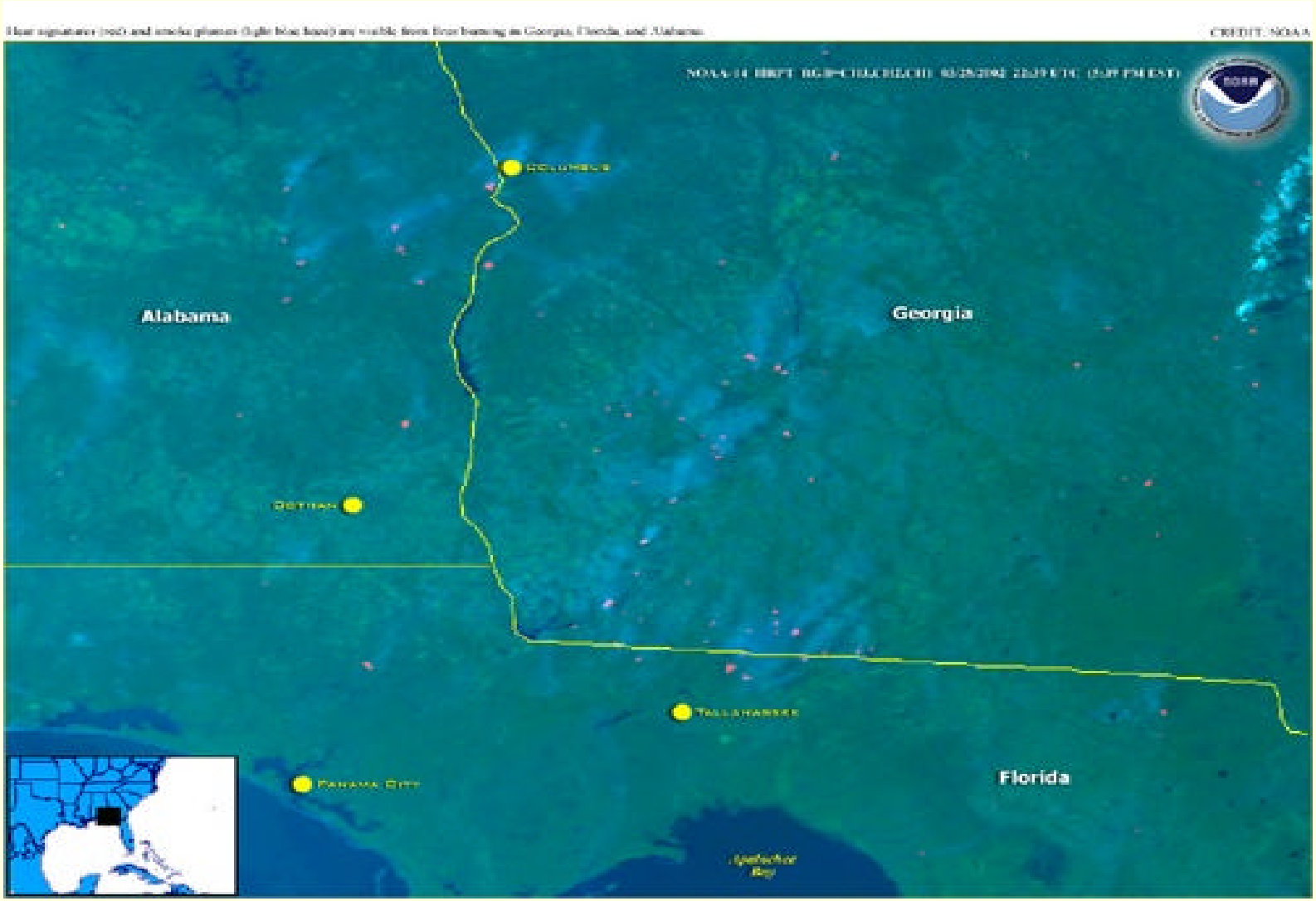
PM Inventory Tools (Cont.)

Example of U.S. Dust Storm Event



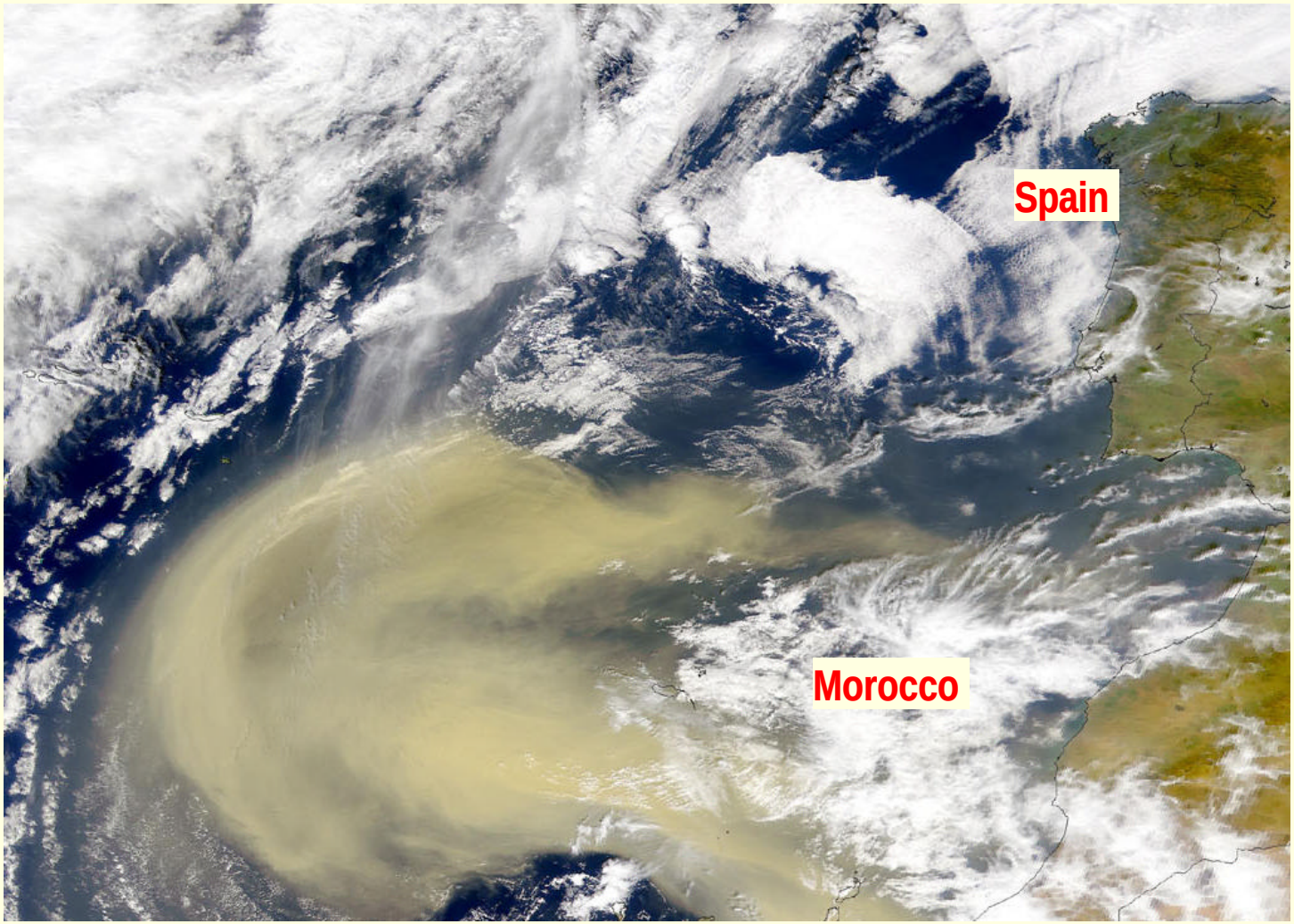
PM Inventory Tools (Cont.)

Example of Fire Event



PM Inventory Tools (Cont.)

Example of Sahara Dust Transport

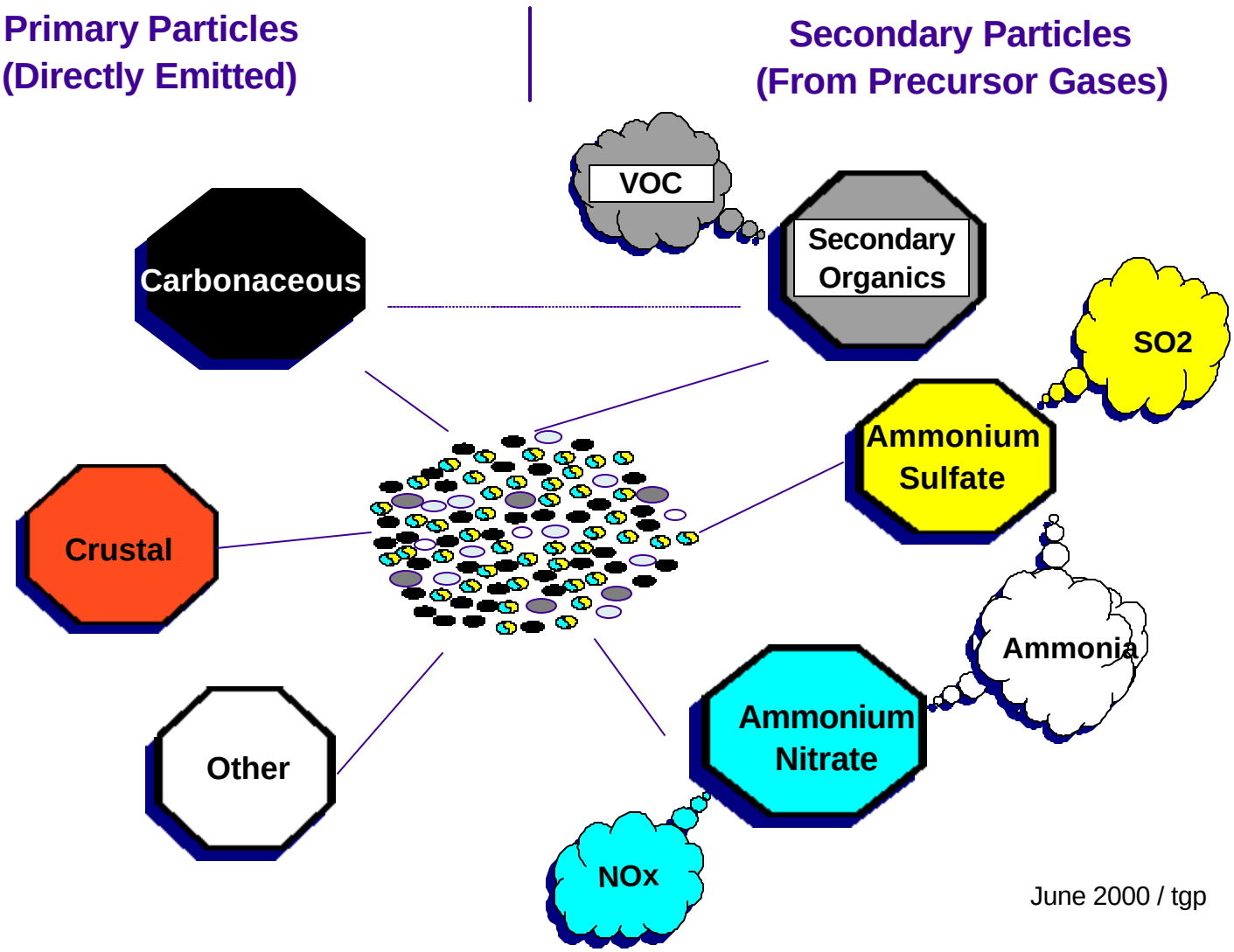


PM2.5: Ammonia Update

Thompson G. Pace
OAQPS

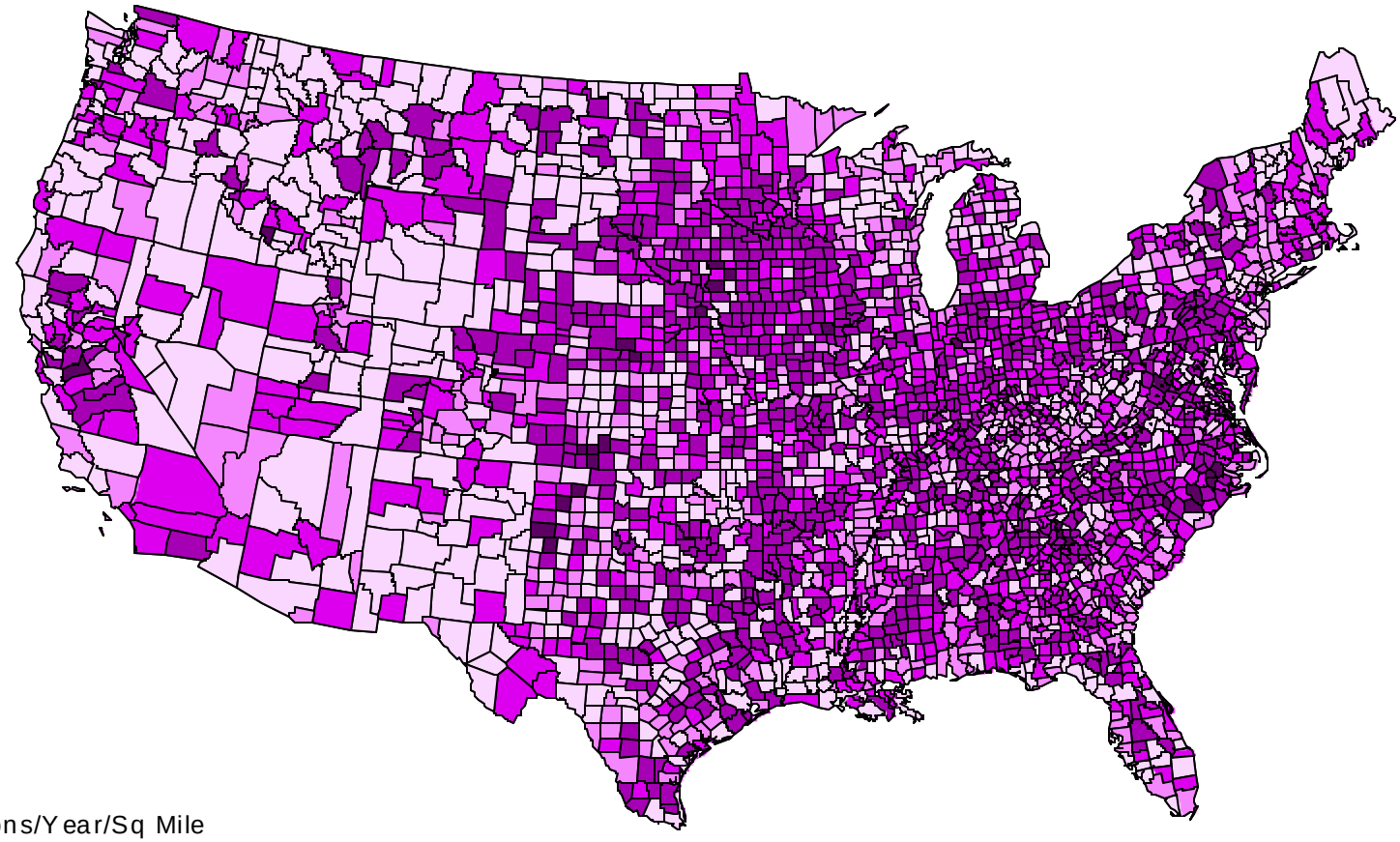
EPA Emission Inventory Conference
Atlanta GA
April 15-19, 2002

PM 2.5 In Ambient Air - A Complex Mixture



June 2000 / tgp

Animal Husbandry - 2805020000, 2805025000, 2805030000, 2805035002
NH3 Emission Density by County - 1999

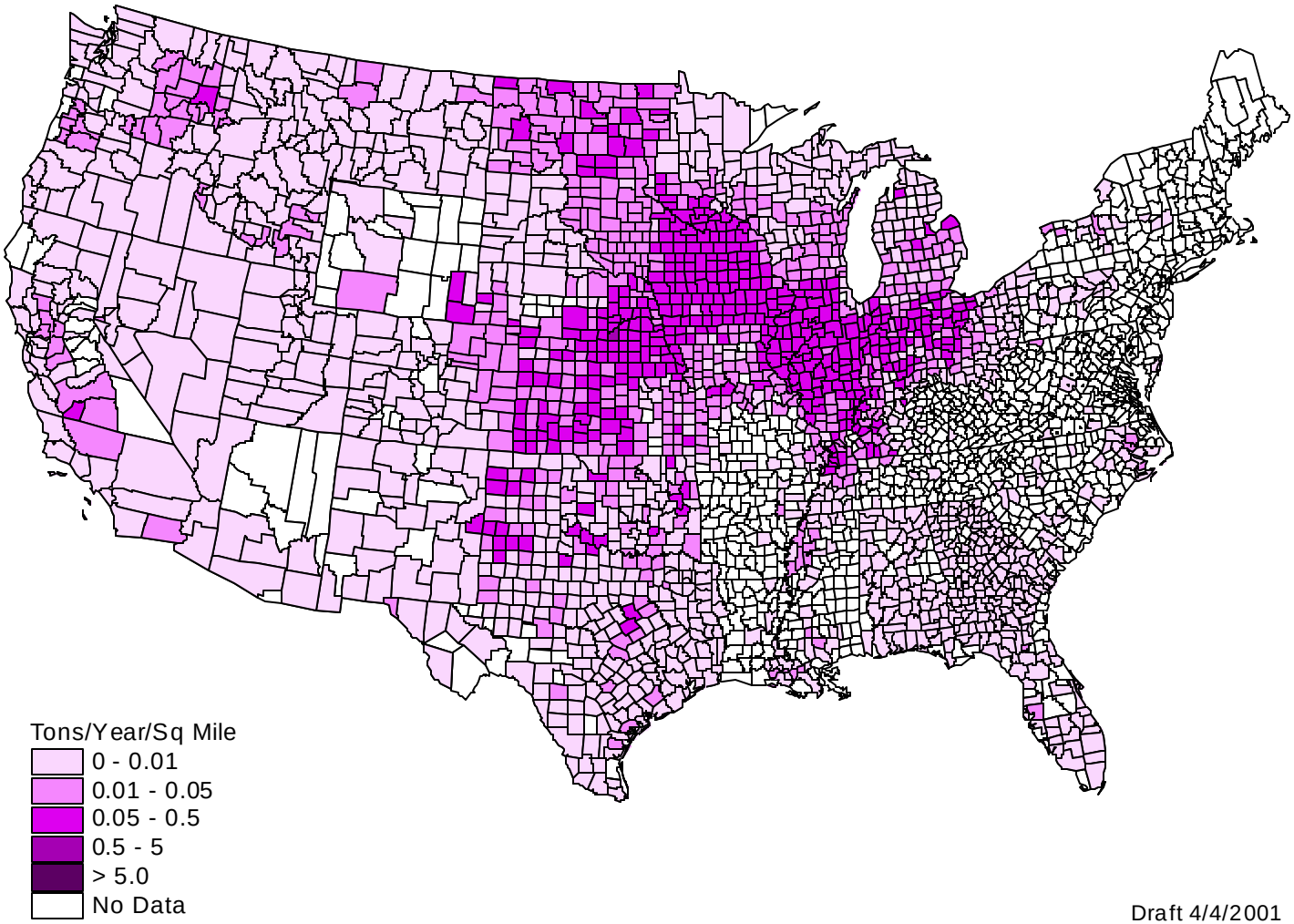


Tons/Year/Sq Mile

- 0 - 0.01
- 0.01 - 0.05
- 0.05 - 0.5
- 0.5 - 5
- > 5.0
- No Data

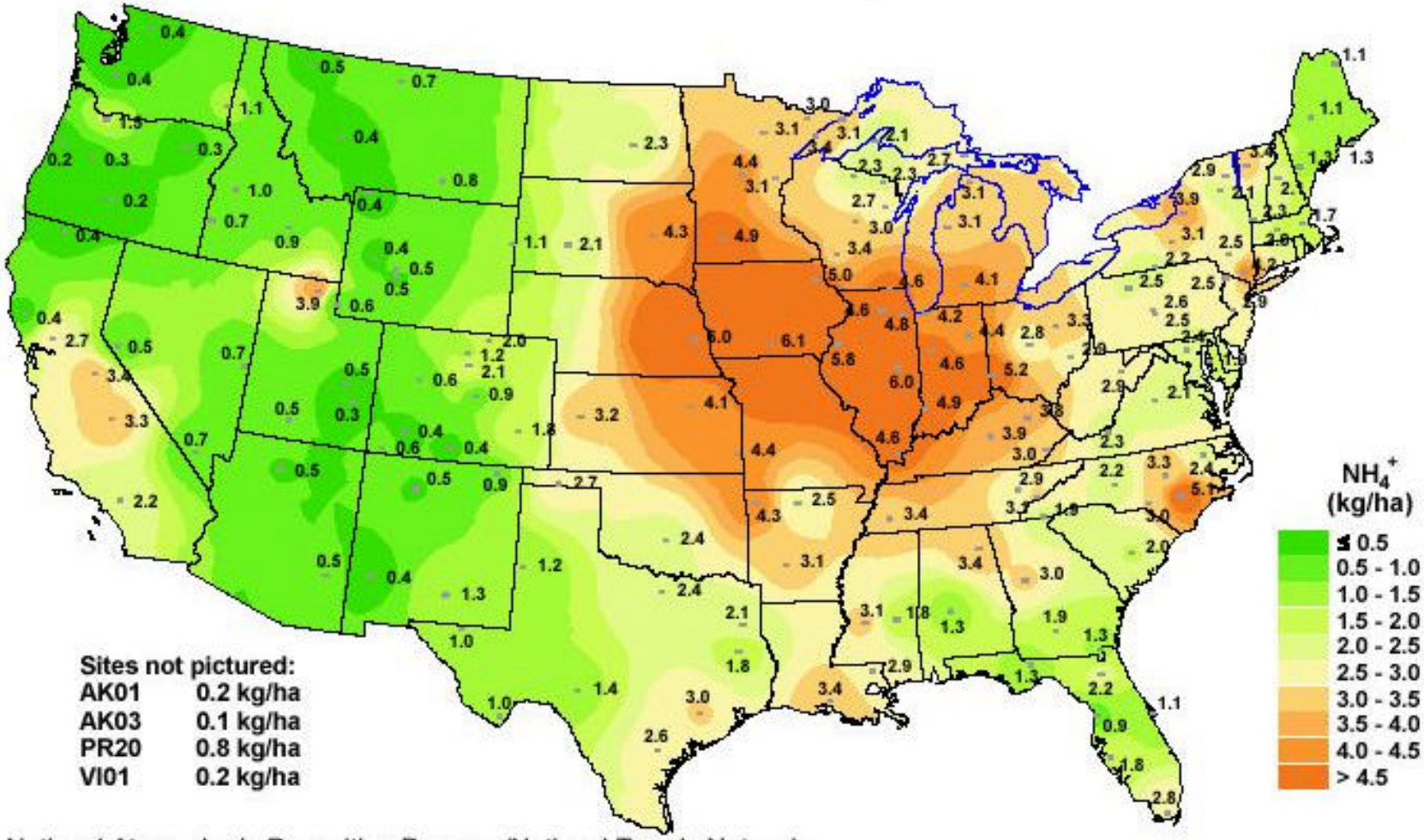
Draft 4/4/2001

Fertilizer Application 2801700001
NH3 Emission Density by County - 1999



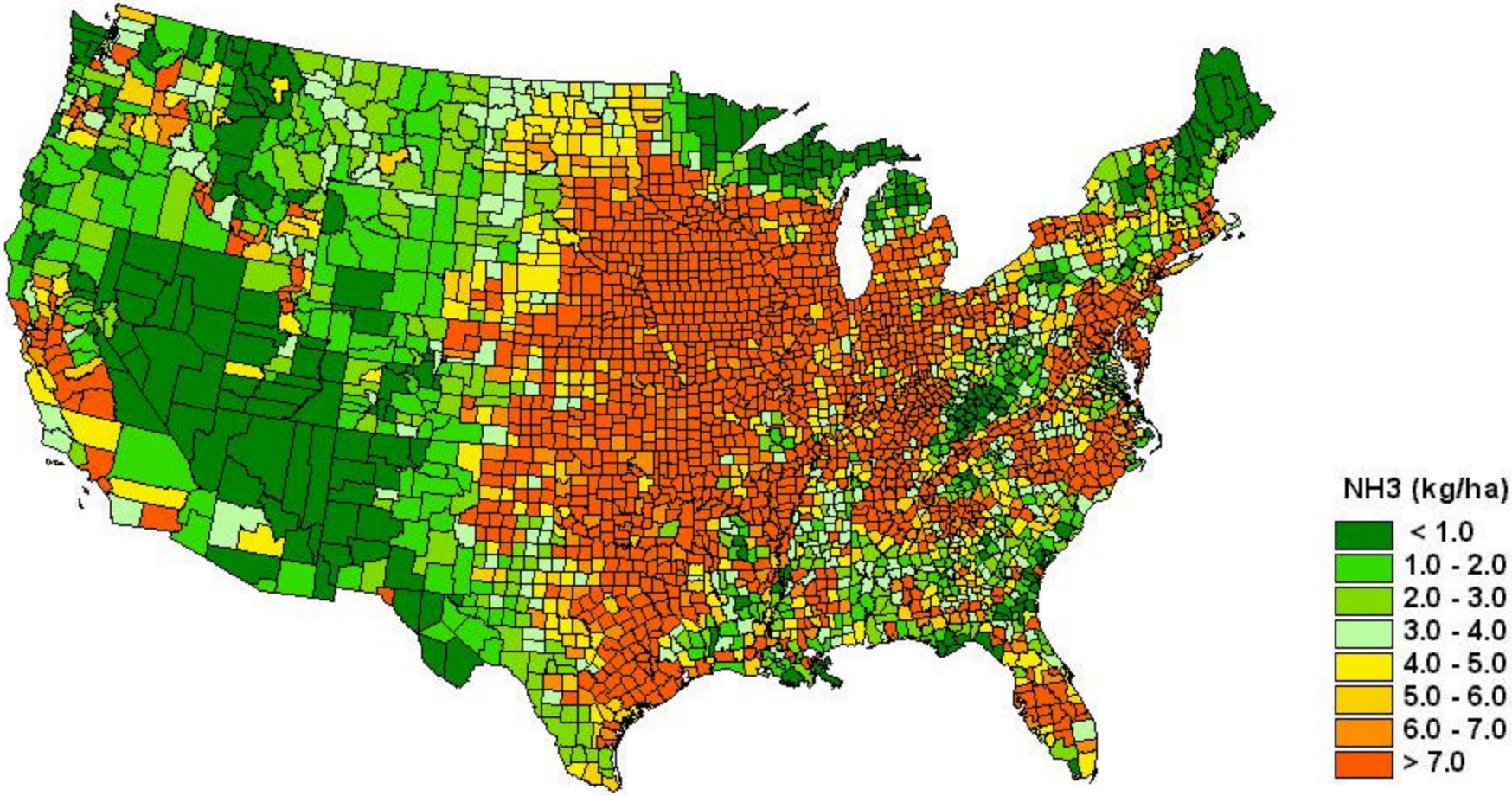
Draft 4/4/2001

Estimated ammonium ion deposition, 1998



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

Estimated Ammonia Emissions-NET Inventory



PM2.5: Ammonia Update

Current Methods for Estimating Ammonia Emissions

- 1994 Battye Report [for William Benjey, EPA/ORD (919-541-0821)]
  - http://www.epa.gov/ttnchie1/efdocs/ammonia.pdf
- National Emissions Inventory (NEI) Documentation
  - ftp://ftp.epa.gov/EmisInventory/draftnei99ver2/criteria/documentation/area99.pdf
- Carnegie Mellon University (CMU) Ammonia Emissions Model
  - Sponsored by MARAMA
  - Complete for Fertilizer – other categories under development
  - http://www.envinst.cmu.edu/nh3/

PM2.5: Ammonia Update

Recent Activities -- Estimating Ammonia Emissions

- Report for NAS Review
  - Presents Range & Average Emission Factors from current Literature, for model farms
  - Among Materials provided to an NAS panel charged with reviewing CAFO air quality issues, interim report on emissions due 4/30/2002
  - NEI plans to rely on any specific recommendations of the NAS
  - http://www7.nationalacademies.org/banr/US%20EPA%20Document.pdf

- Arcadis Report [for Susan Thorneloe, EPA/ORD (919-541-2709)]
  - Summarizes / Reviews Emission Factors and Methods to Estimate Ammonia Emissions from Animal Waste Handling
  - Currently being printed & added to EPA's Website

PM2.5: Ammonia Update

Issues Related to Estimating Ammonia Emissions

- US Census of Agriculture 1997
  - 2002 next "Census Year"
  - County level, some missing for confidentiality reasons
- Soil & Groundcover Emissions
  - Soil can be a sink or source; groundcover a sink
- Wild Animals
  - CMU includes
  - EPA / NEI excludes (assumes local reabsorbtion)
- Seasonality
  - Infer from inverse modeling (ORD)
  - Preliminary – signif. higher summer v. winter
- Mobile sources: OTAQ currently comfortable w/ estimates

PM2.5: Ammonia Update

- What can can be done by S/T/L to improve Ammonia EI?
  - Very large CAFO's – Specifics on animal size & number
  - CAFO locations (esp. for large counties)
  - Improve seasonality info on fertilizer use
  - RPO's - begin involving State Ag Agencies on their tech Committees

Fugitive Dust Update:

Emissions Estimation & Transport

Thompson G. Pace

US EPA

Fugitive Dust – What's the Problem?

Pollutant Transport Models Vs Ambient Data Analyses

- Models overestimate Fugitive Dust by 3 to 5 times (compared to a chemical analysis of what's on the ambient samples)

What's the Problem ?

- Modelers have traditionally "blamed" this on the emission factors
- But, its *much more complicated* than that !!!

Issues, Remedies & Status

- Activity Data
- Emission Factors
- Spatial & Temporal Allocation Methods
- Modeling & Transport Re: Removal Mechanisms

Which Fugitive Dust Categories are Most Important?

- **Unpaved Roads**
- **Paved Roads**
- **Construction**
  - *Highway*
  - *Residential*
  - *Commercial*
- **Agricultural Tilling**
- **Wind Erosion**

Fugitive Dust Activity Data Improvements

Paved Roads

- **Paved Roads:**
  - **Issue:**
    - Silt loading difficult to estimate
  - **Remedies:**
    - Improve default silt loadings
    - Use e.g., TRAKER or manual testing to improve silt loading data locally
  - **Status:**
    - Incorporating updated default silt loadings

Fugitive Dust Activity Data Improvements

Construction & Agricultural Tilling

Construction

- Recently updated Activity data methodology
- No new work planned

Agricultural Tilling

- Tilling Acreage – Needs to reflect current no/low till practices
- Tilling Passes – Needs to reflect current farming practices
- Crop Calendar – Need USDA input on when & where crops are grown currently
- Factors – Need to expand testing as funding is available

Fugitive Dust Activity Data Improvements

Wind Erosion

Issue

- Wind Erosion currently not being inventoried

Remedies

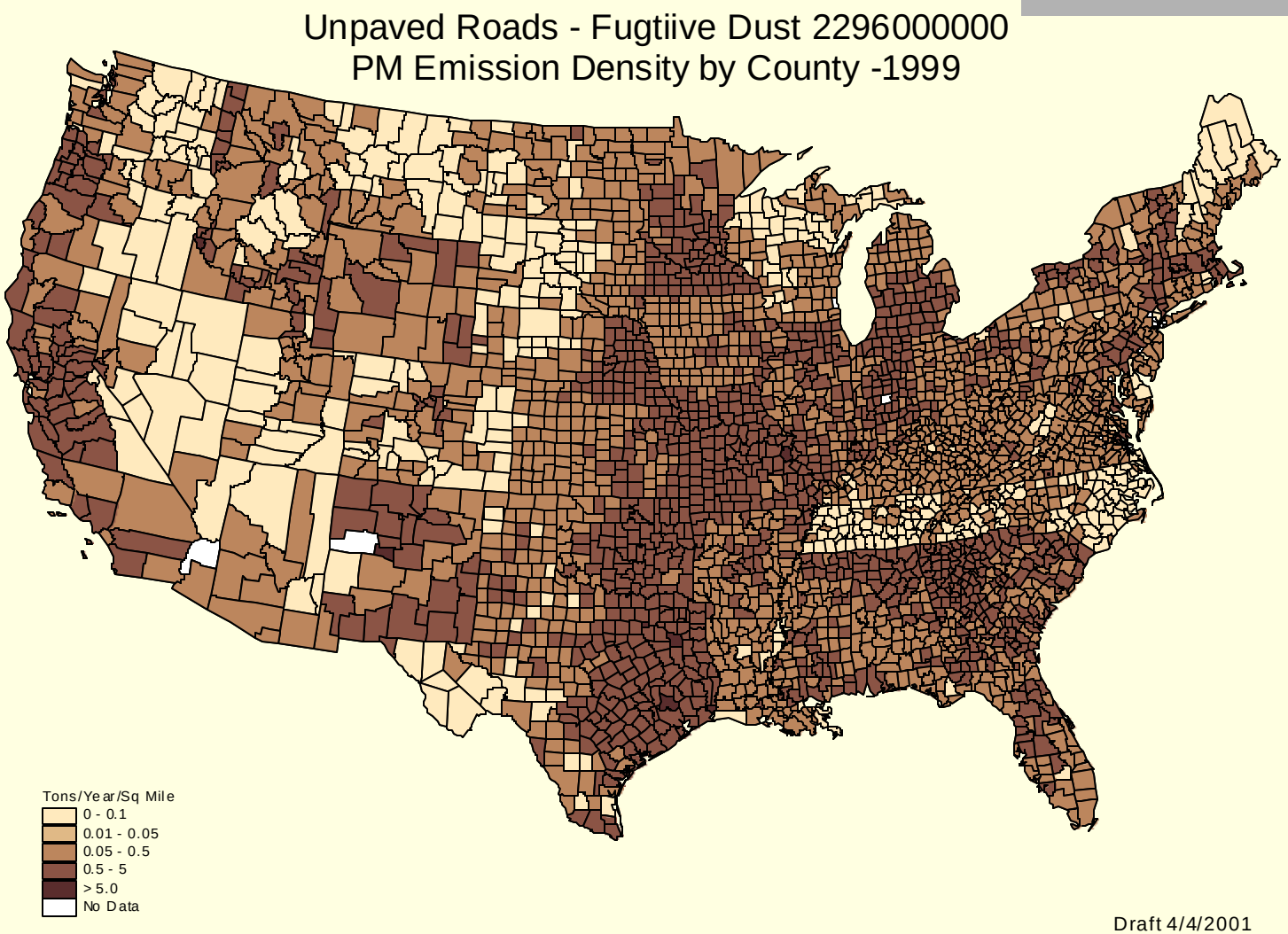
- WRAP Panel Recommended Use of Draxler et. al. (Atmospheric Environment, 2001) to estimate Wind Erosion

Status – Future

- Utilize channels of coordination w/ USDA
- Implement & Test
- Incorporate into Model / Emissions Processor

Case Study: Unpaved Roads

Emissions Density Map



Draft 4/4/2001

Case Study: Unpaved Roads
Overview

- **Activity data:**
  - Road Surface Soil Moisture
  - Road Surface Silt Loading
  - Miles of roads
  - Traffic, speed

- **Emission Estimation, Modeling & Transport Issues:**
  - Factors not perfect, but based on extensive testing
  - Factors include ALL particles measured, including those close to the ground
  - Particle behavior near the source (near the ground)
  - How we model emissions & simulate transport

Case Study: Unpaved Roads
Activity Data

- **Key Issues:**
  - Current State-to-County Allocation Procedure makes State boundaries very obvious
  - Road Mileages, ADT consistency also an issue
  - Some particles remain near the source
- **Remedies:**
  - Update Surface Silt Value Defaults
  - Update basis for Surface Moisture at County level
  - Incorporate new UPR AP-42 Equation when available
  - Improve method used to estimate ADT
- **Status:**
  - Silt, Moisture, Allocation issues: work in progress
  - Evaluating potential remedies for ADT (e.g., use rural population density)

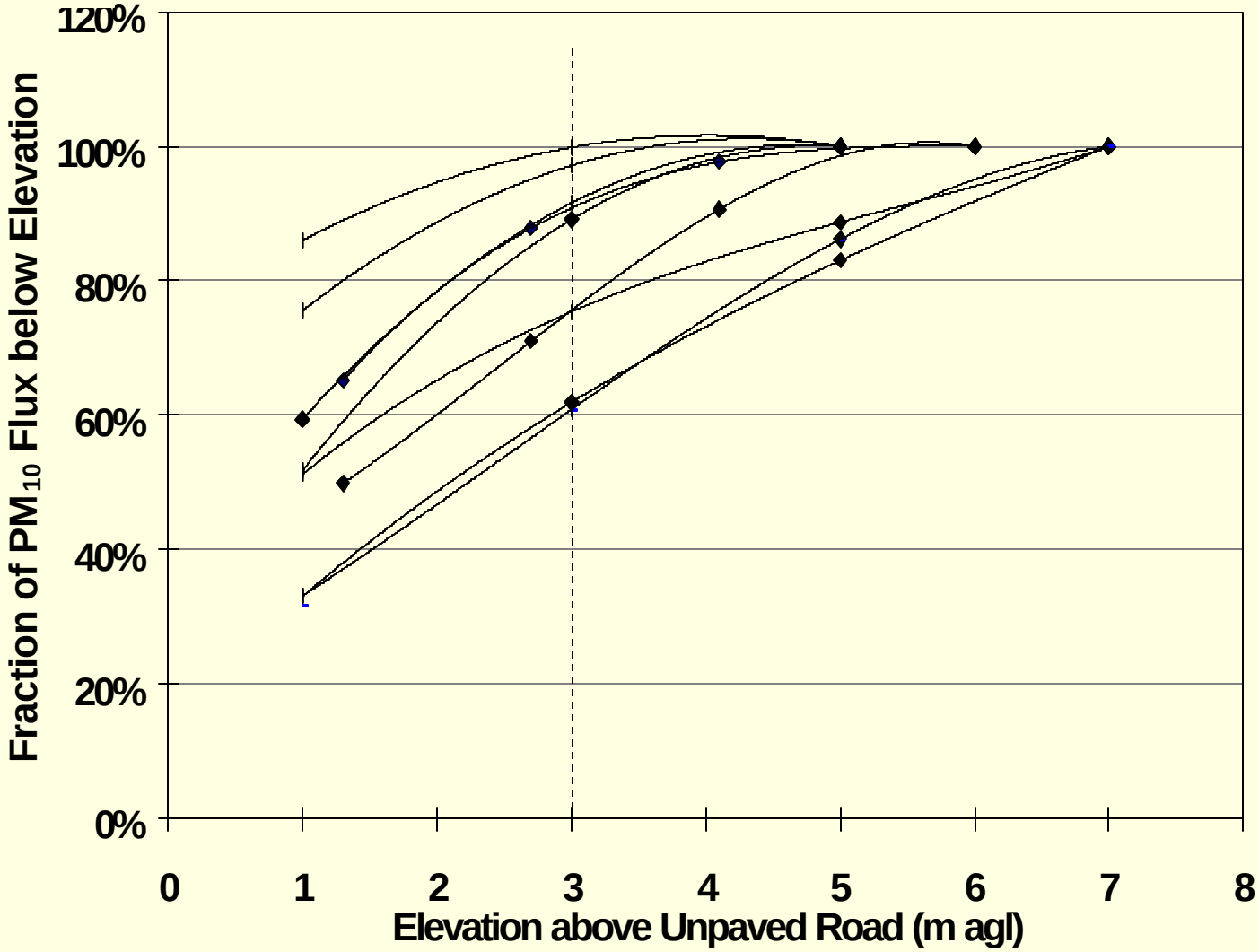
Case Study: Unpaved Roads

How do we Measure & Estimate Emissions?

- Emissions are measured 5 to 10m from the source using a vertical sampler array.
- These towers measure a vertical “profile” of the plume.
- Many of these emissions are very close to the ground when measured.
- > 60 field tests in 8 States
- We develop equations (emission models) to generalize these emissions measurements for use in other places & times.

Case Study: Unpaved Roads

Particles are very close to the ground when measured



Case Study: Unpaved Roads

Particle Behavior Near the Source & Surface)

- Dense plume enhances agglomeration
- Vehicle turbulence enhances particle deposition
- Thermal attraction of particles to cooler surfaces
- Surface roughness enhances deposition of dense ground level plume
- Vegetation is readily available near many roads
  - Vegetation enhances impaction & thermal removal
  - Much of the plume is **lower than** the nearby vegetative cover (crop land)
  - Plume may be **within** the vegetative cover (road in a forest)

- **Transport Fraction:** That fraction of the particles leaving the vicinity of the source (the grid cell) and thus subject to regional transport …

Case Study: Unpaved Roads

Why is the Transport Fraction important ?

- **Actual and Modeled** Transport Fractions should be consistent

- **Actual** Transport Fraction depends on:
  - Nearby vegetation & structures.
  - Diffusion, impaction, electrostatic & thermal dust removal processes near the source

- **Modeled** Transport Fraction:
  - *There are significant issues with model's handling of removal processes near the source & surface, e.g.,*
    - CMAQ (& other models) ***uniformly*** distribute FD into the lower layer (10 to 30m) of the "cell" where they're emitted
    - No allowance for influence of vegetative surfaces or electrostatic-induced agglomeration
    - No allowance for increased deposition due to either vehicle-induced turbulence or enhanced surface roughness near the source

- **Interim**… Augment the model's performance near the source & surface

Fine Particle Removal Enhanced Near Source

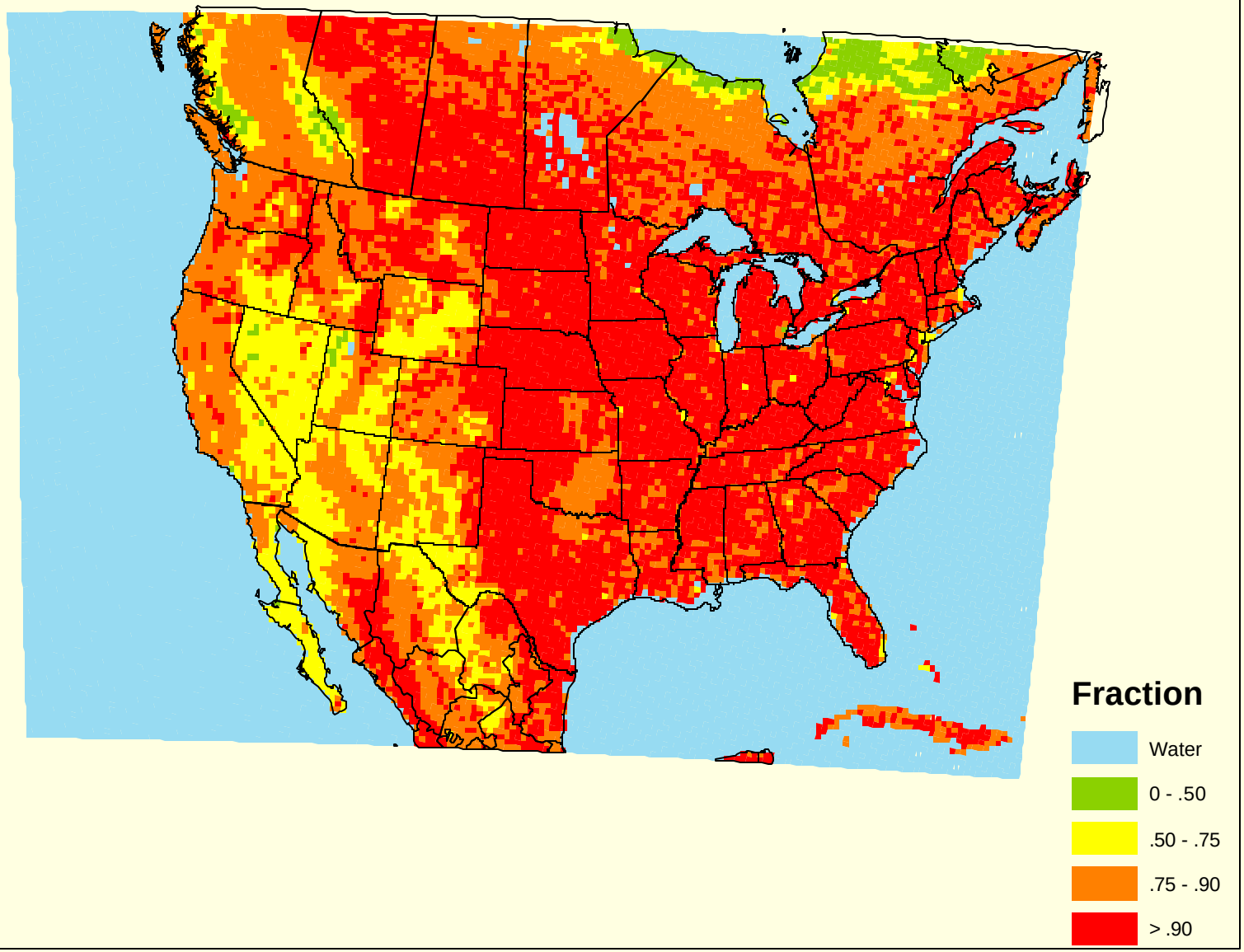
Available Information on Vegetation, Structures

- **For each grid (1 km resolution), We know…**
  - Vegetation fraction
  - Land use
- **For each major Vegetative species, We know…**
  - Leaf area index, Land “footprint”
  - Typical height
- **What don’t we know?**
  - Micro environment surrounding the sources
    e.g., proximity of vegetation, buildings

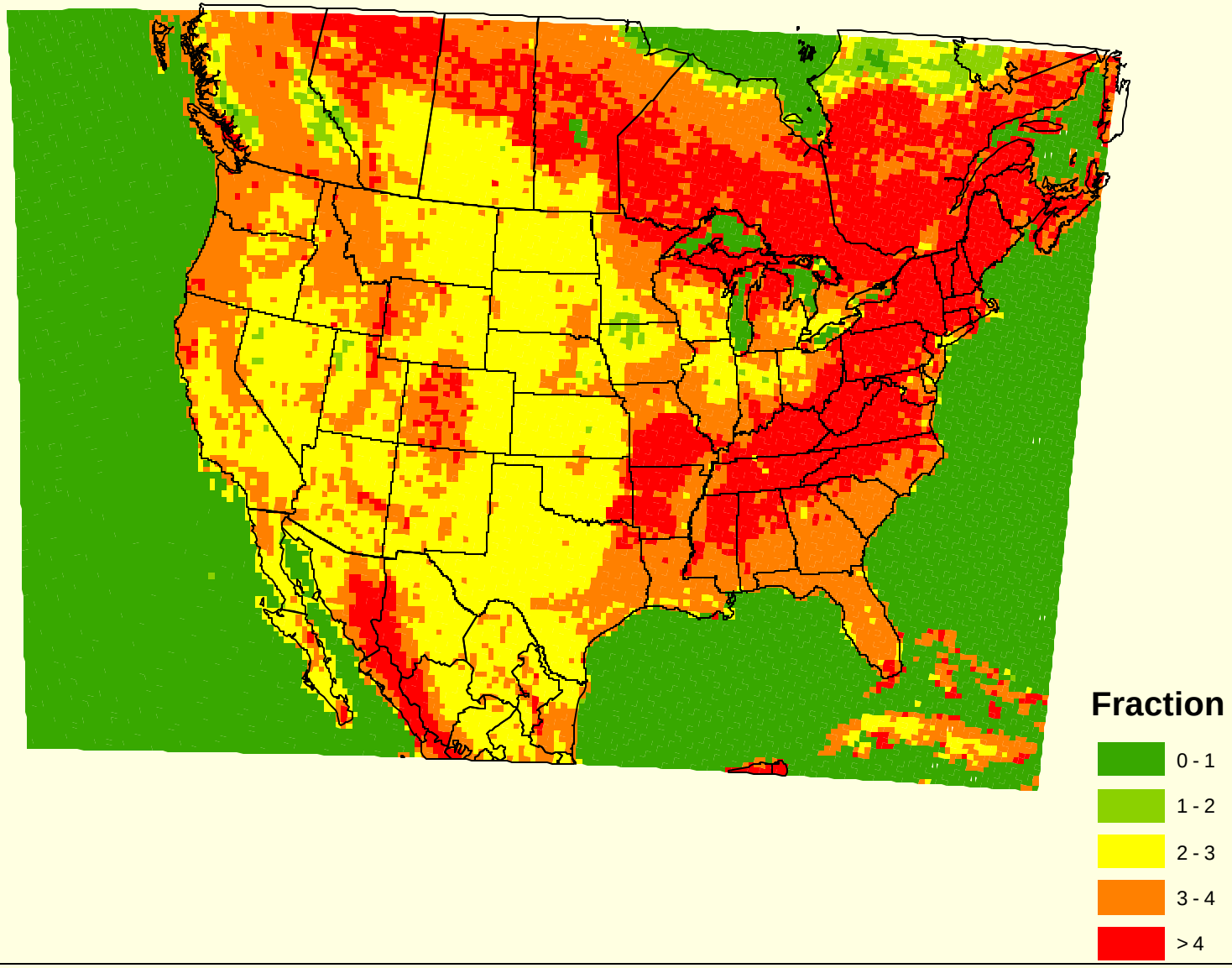
Fine Particle Removal Enhanced Near Source
… An Interim Approach

- **Sources of Information:**
  - Work by Slinn, Gillette, Watson, Countess, Cowherd, Idaho DEQ & others
  - Available info on vegetation type & fraction, leaf area index, land use, surface roughness
- **Formulate & Apply Interim Estimate of Transport Fraction**
  - Estimate particle removal enhanced by vegetation, surface roughness
  - Apply this to county level datasets.
- **Ongoing & Future:**
  - Incorporate into emission processor algorithms, with better spatial & computational refinement
  - **Encourage further research efforts to further understand and improve these removal processes (DRI, WESTAR, WRAP, Idaho DEQ)**

Vegetation Fraction



Leaf Area Index



Fine Particle Removal Enhanced Near Source

Links to More Information

- BELD Dataset
  - http://www.epa.gov/asmdnerl/images/beld3_web.gif
- DRI Report
  - http://www.epa.gov/ttn/chief/efdocs/fugitivedust.pdf
- Western Governors Panel Report
  - http://www.wrapair.org/ (See WRAP REPORTS – Fugitive Dust Expert Panel Workshop Reports)
- MRI Report
  - Draft Report on Task 1, Activity Databases for PM2.5 Fugitive Dust Inventories Contract 68-D-01-002 WA 1-05

Fugitive Dust Update

Questions?

PM2.5 Carbon Update

Thompson G. Pace

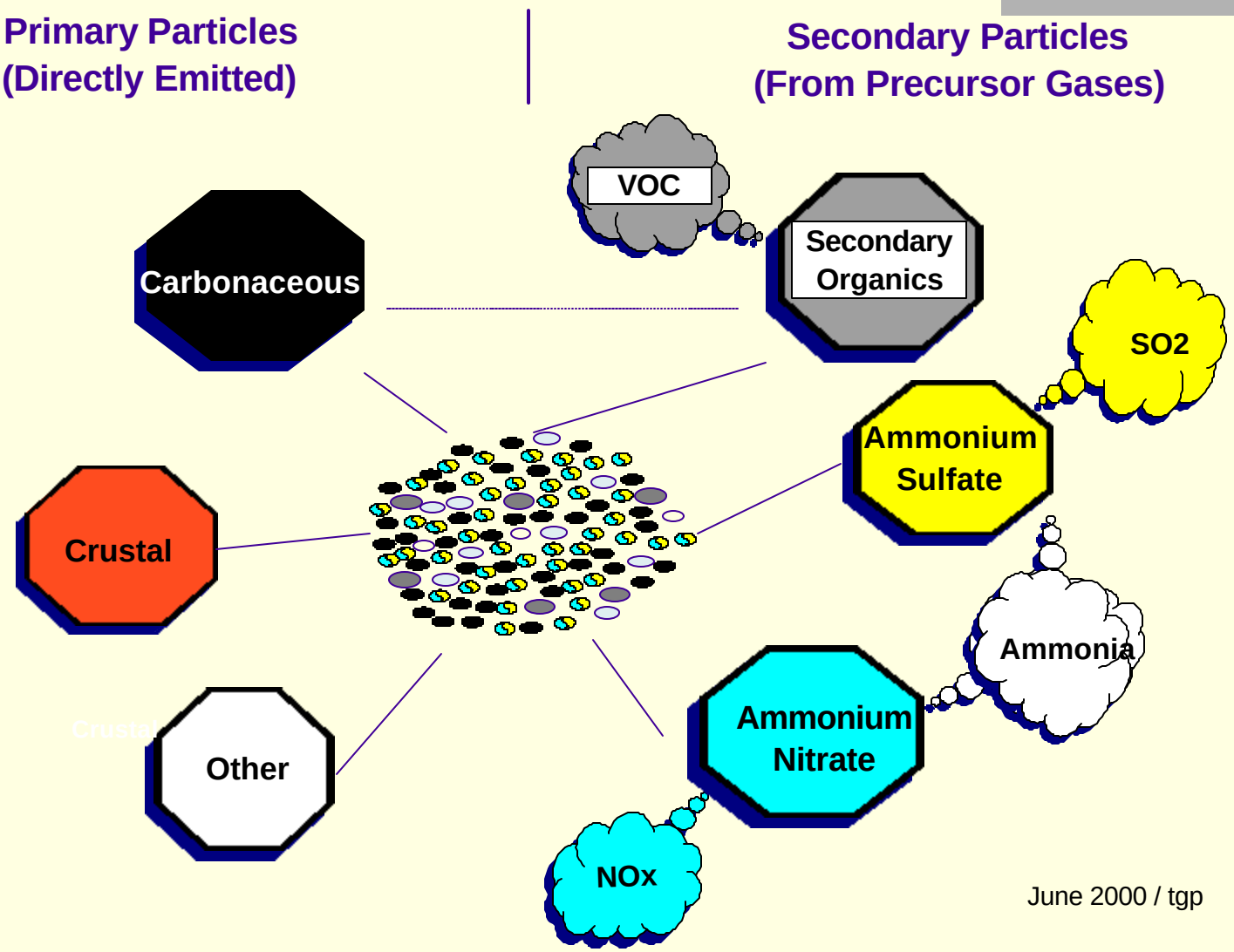
USEPA

US EPA EI Conference

Atlanta GA

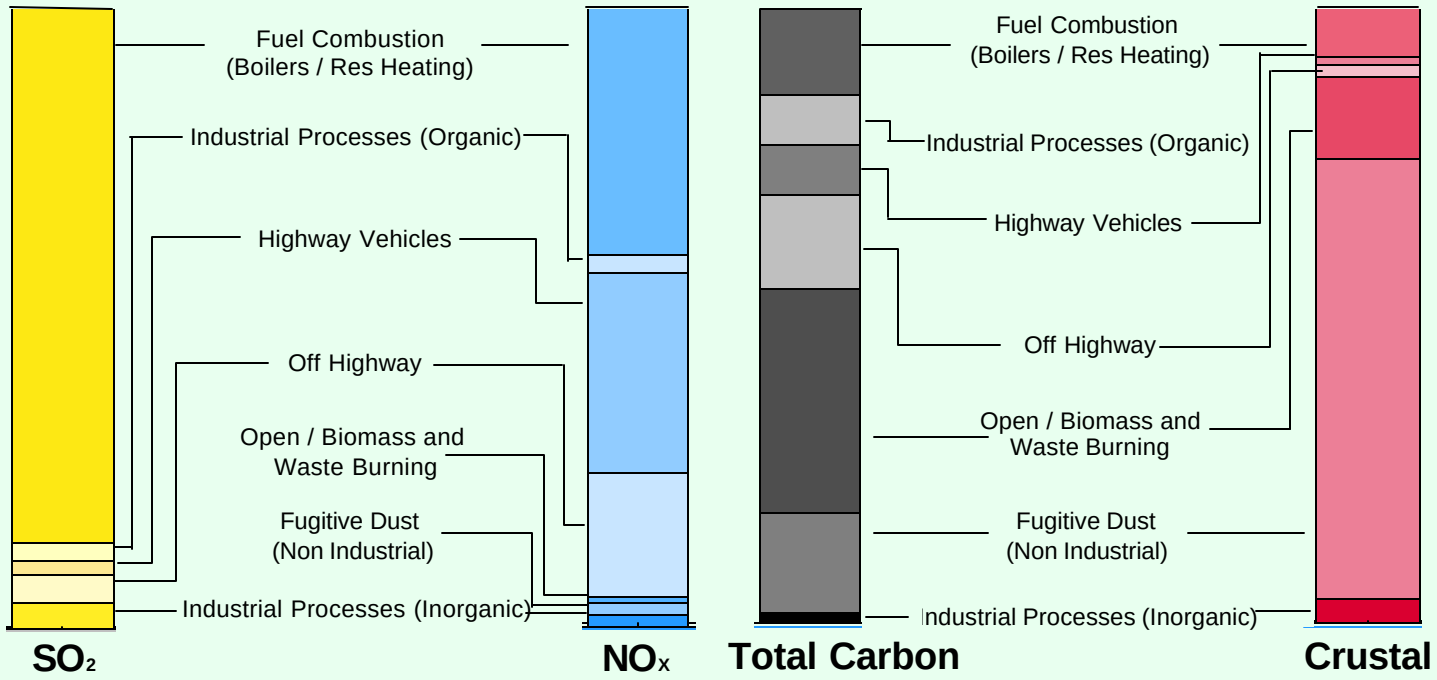
April 15-19, 2002

PM 2.5 In Ambient Air - A Complex Mixture

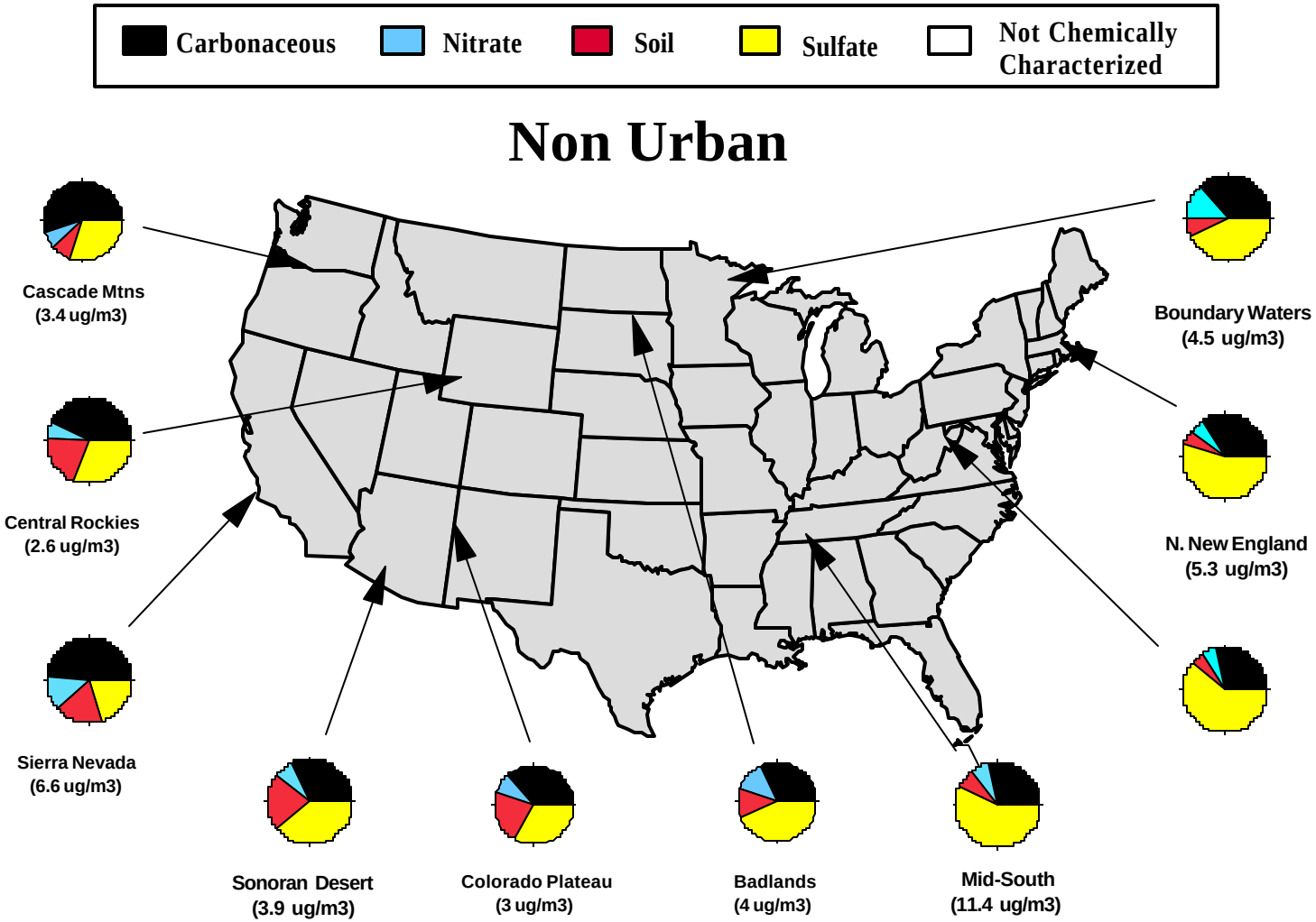


June 2000 / tgp

PM2.5 National Emissions Summary

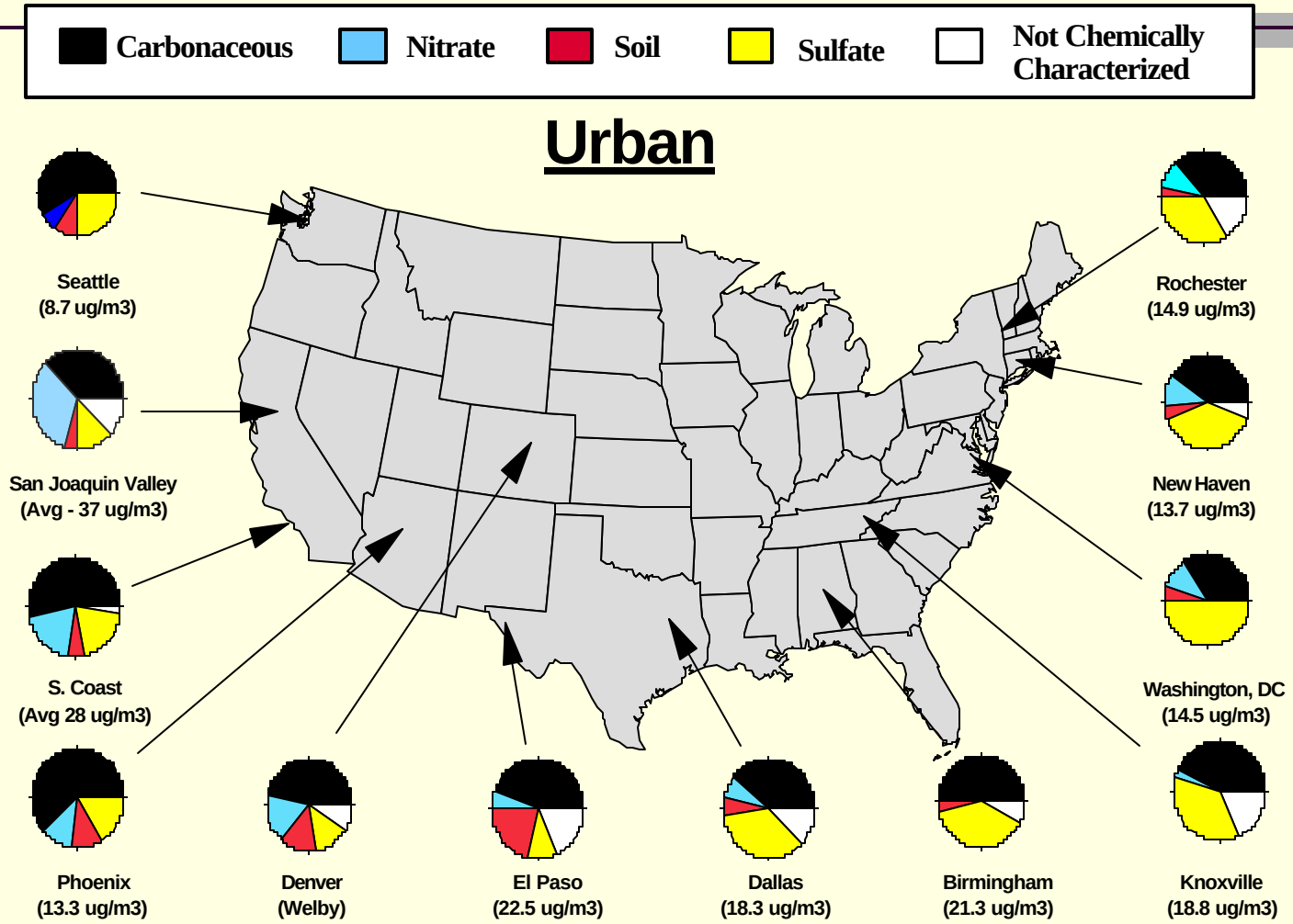


PM2.5 Ambient Composition

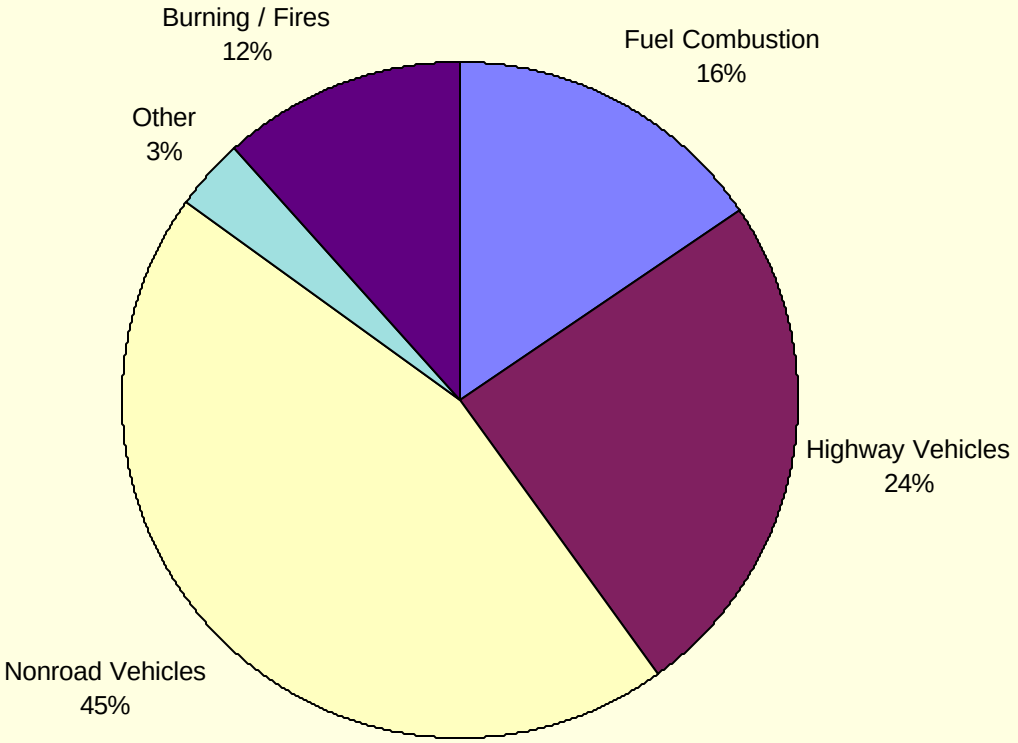


Note: PM-2.5 mass concentrations are determined using at least 1 year of monitoring at each location using a variety of sampling methods. They should not be used to determine compliance with the PM-2.5 NAAQS.

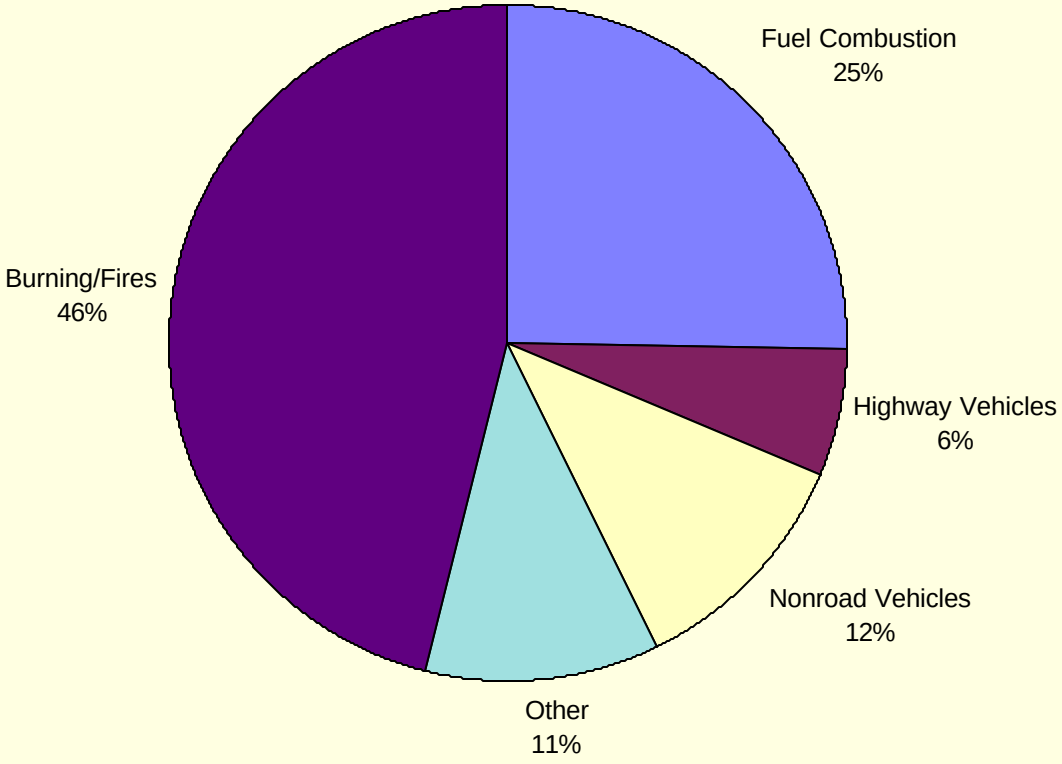
PM2.5 Ambient Composition



1996 HDD Rulemaking Inventory
PM-2.5 Speciated Elemental Carbon
[570,000 Annual Tons]



1996 HDD Rulemaking Inventory
PM-2.5 Speciated Organic Carbon
[920,000 Annual Tons]



Area Source Combustion - General

- All PM_{10} and $PM_{2.5}$ emission estimates in the 1999 NEI for the following Area sources are assumed to be PM10- FIL and PM25-FIL:
  - Wildfires
  - Managed Burning
  - Open Burning

- Residential Wood Stoves & Fireplaces are based on measurements of PM10-PRI and PM25-PRI

Wildfire & Managed Burning

Wildfire & Managed Burning
Emissions Estimates in the '99 NEI

- **SCCs**
  - **Wildfires: 2810001000**
  - **Managed Burning: 2810015000**
- **Pollutants**
  - **PM_{10}, $PM_{2.5}$, NO_x, CO, VOC, SO_2, 30 HAPS**
- **Emission Factors**
- **Regional Fuel Loading Factors**
- **Activity Data**
- **Emissions Calculations**

Wildfire & Managed Burning
Emissions Estimates in the '99 NEI (Cont'd)

Wildfire Activity Data Sources

(No. of Acres Burned/Year):

- **State-Level Activity**
  - **US Forest Service (USFS)**
  - **National Park Service (NPS)**
  - **Bureau of Land Management (BLM)**
  - **US Fish & Wildlife Service (USFWS)**
  - **State/Private Burners (obtained from USFS)**
- **Regional-Level Activity**
  - **Bureau of Indian Affairs (BIA)**

Wildfire & Managed Burning
Emissions Estimates in the '99 NEI (Cont'd)

Managed Burning Activity Data Sources

(No. of Acres Burned/Year):

- **State-Level Activity**
  - **NPS, BLM, USFWS, BIA**
- **Regional-Level Activity**
  - **USFS**
  - **State/Private Burners [from National Interagency Fire Center (NIFC)]**

Wildfire & Managed Burning

Allocation to State & County-level

- NIFC regions mapped to USFS regions and summed
- Regional USFS and NIFC activity summed and apportioned to States using BELD2 land cover type acreage
- Activity summed for each State
- State-level activity allocated to counties using BELD2 land cover type acreage

Wildfire & Managed Burning

How can the NEI for Wildfires be Improved?

Options for Obtaining the Inputs for Wildfire Emissions Inventories

Parameter	û û û û		Increasing level of detail and accuracy		û û û û	
Area burned	DOI and FS summary reports		Federal and state incident databases	Federal and state incident databases with auditing and quality assurance	Satellite data with auditing and quality assurance	Ground-truthing with land surveys, aerial surveys, etc.
Vegetative cover	Regional defaults	Estimates from existing inventories		Satellite data	Survey land managers	Ground-truthing with land surveys, aerial surveys, etc.
Fuel loading and characteristics	General estimate	Land manager determination of NFDRS fuel classes	Land manager determination of fuel type, with emission model defaults	Fuel characteristics classification system		
Fuel consumption	Regional defaults		Fuel consumption models with dry fuel assumption	Fuel consumption models with crown adjustment		Models with input from land managers and crown adjustment
Emission factors	General defaults	Regional defaults	Separate factors for flaming and smoldering	Emission models or correlation with CO or CE	Emission models with input from land managers	Vegetation-specific emission data
Temporal distribution of emissions	Default seasonal and/or hourly profiles	Allocation using actual seasonal fire frequencies		Fire-specific emission calculations		Fire-specific hourly modelin

Wildfire & Managed Burning

How can the NEI for Managed Burning be Improved?

Options for Obtaining the Inputs for Prescribed Fire Emissions Inventories

Parameter	û û û û		Increasing level of detail and accuracy		û û û û	
Area burned	Previous inventory estimates	State incident databases	State incident databases with auditing and quality assurance	Survey land managers for different ownership categories	Satellite data with auditing and quality assurance	Ground-truthing with land surveys, aerial surveys, etc.
Vegetative cover	Regional defaults	Estimates from existing inventories		Satellite data	Survey land managers	Ground-truthing with land surveys, aerial surveys, etc.
Fuel loading and characteristics	General estimate	Land manager determination of NFDRS fuel classes	Land manager determination of fuel type, with emission model defaults	Fuel characteristics classification system	Photo-series correlation	Transect measurements
Fuel consumption	Regional defaults		Vegetation-specific defaults	Fuel consumption models with default inputs		Models with input from land managers
Emission factors	General defaults	Regional defaults	Separate factors for flaming and smoldering	Emission models or correlation with CO or CE	Emission models with input from land managers	Vegetation-specific emission data
Impact of mitigation measures	Default emission factors for activity fuels	Account for activity fuels in fuel consumption modeling		Account for impacts of fuel moisture		Situation-specific emission data
Temporal distribution of emissions	Default seasonal and/or hourly profiles	Allocation using actual seasonal fire frequencies		Fire-specific emission calculations		Fire-specific hourly modeling

Wildfire & Managed Burning

What Federal Activities are Occurring ?

- **Fire EI "Data-gathering Process" is evolving**
  - **MOU between EPA & Burn Agencies should help coordinate efforts & clarify Roles / Responsibilities**
- **Investigate the role of remote sensing & national databases:**
  - **Occurrence of fire event, area burned**
  - **Vegetative type**
  - **Develop, refine national & regional models & databases to estimate pre-burn fuel loading**
  - **Refine, expand use of fuel consumption models**
  - **Develop guidance on estimating impact of mitigation measures on emissions**
- **Exchange information among air quality experts in:**
  - **fire emissions, fire management, & air quality management.**

Wildfire & Managed Burning

What can RPO's, States & Tribes focus on ?

- **Improving activity data for larger-sized fires.**
  - **Area burned -- wild & prescribed fires**
  - **Vegetative Type**
  - **Fuel Loading**
  - **Fuel Consumption**
  - **Impact of Mitigation Measures**
  - **Temporal Distribution of Emissions**
- **Develop expertise in fire emissions, fire management**
- **Develop contacts, rapport with the various burners in your jurisdiction.**

Open Burning

Open Burning

What sources are included?

SCCs:

- 2610030000 - Residential Municipal Solid Waste (MSW) Burning
  - Pollutants: PM_{10}, $PM_{2.5}$, CO, NO_x, VOC, SO_2, 32 HAPs
- 2610000100 - Residential Leaf Burning
- 2610000400 - Residential Brush Burning
- 2610000500 - Land Clearing Debris Burning
  - Pollutants: PM_{10}, $PM_{2.5}$, CO, VOC, 6 HAPs

Open Burning

How can States Improve the NEI Emissions for Residential MSW Burning?

- EPA has developed an EIIP section on Open Burning
  - EIIP Volume III, Ch. 16
- Obtain State or local estimates of per-capita waste generation
- Use State or local estimates for amount or percentage of MSW burned
- Specification of counties with burning bans
- Sources
  - *Solid Waste Agency*
  - *Air Agency*
  - *Health Department*
  - *Solid Waste Management Organization*
  - *Local Survey*
- Open Burning Project for MANE-VU may provide improvements to the open burning inventory for these States in the near future

Open Burning

How can States Improve the NEI Emissions for Yard Waste Burning?

- EPA has developed an EIIP section on Open Burning
  - EIIP Volume III, Ch. 16
- Obtain State or local estimates of quantities generated and/or burned
  Sources: Solid Waste Management Agency or Local Survey
- Determine locally which specific counties have burning bans, or yard waste pick-up/landfill, or composting programs
  Sources: Air Agency, Solid Waste Management Agency
- Obtain State or local estimates of the months when yard wastes are burned
  Sources: Solid Waste Management Agency or Local Survey)
- Open Burning Project for MANE-VU may provide improvements to the open burning inventory for these States in the near future

Open Burning

How can States Improve the NEI Emissions for Land Clearing Debris Burning?

- EPA has developed an EIIP section on Open Burning
  - EIIP Volume III, Ch. 16
- See fugitive dust construction categories for suggestions for improving estimates of the acres cleared.
- Identify specific counties with burning bans, and specification of counties where wastes are burned.

  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

- S/L/T agencies should provide comments on methodology to Roy Huntley (EPA/EFIG) 919-541-1060

Residential Wood Combustion

Residential Wood Combustion

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

- Until 1999 NEI (Version 1.5), the NET/NEI included emissions from all woodstoves and fireplaces under SCC 210408001 (fireplaces without inserts)
- For 1999 NEI (Versions 1.5 & 2.0), RWC estimates based on revised methodology
- For the draft 1999 NEI (Version 2.0), EPA incorporated S/L/T SCCs and emissions and removed EPA emission estimates for SCC 210408001
  - See area source documentation for draft 1999 NEI for details (ftp://ftp.epa.gov/EmisInventory/draftnei99ver2/criteria/documentation/)

Residential Wood Combustion

How are RWC Emissions Estimated in the '99 NEI?

- **SCCs**
  - **FIREPLACES**
    - 2104008001 Without Inserts
    - 2104008002 With Inserts; Non-EPA Certified
    - 2104008003 With Inserts; Non-Catalytic, EPA Certified
    - 2104008004 With Inserts; Catalytic, EPA Certified
  - **WOODSTOVES**
    - 2104008010 Non-EPA Certified
    - 2104008030 Catalytic, EPA Certified
    - 2104008050 Non-Catalytic, EPA Certified

Residential Wood Combustion

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

- **Pollutants**
  - **PM10-PRI, PM25-PRI, NO_x, CO, VOC, SO_x**
  - **HAPs (number of pollutants)**

Fireplaces	**Woodstoves**
2104008001 (2)	2104008010 (25)
2104008002 (25)	2104008030 (25)
2104008003 (28)	2104008050 (28)
2104008004 (25)	

Residential Wood Combustion

How Can You Improve the NEI for Your Area?

- EPA Encourages S/L/T agencies use their own data
- EIIP document for RWC
  (http://www.epa.gov/ttn/chief/eiip/pm25inventory/areasource.htm)
  - Preferred Method: Residential Wood Survey
    - Obtain locally representative information on the amount of wood fuel use specifically for woodstoves & fireplaces (with and without inserts)
    - This will require a local survey, or activity data generated by State & local governments
    - Reduces uncertainties in estimates associated with allocating national activity to counties
  - Alternative Method: Census Bureau and EIA Data Method
    - Use if resources are limited or emphasis is on preparing summer season inventory

Residential Wood Combustion

How Can You Improve the NEI for Your Area?

Obtain info on specific stove types in your area:

- AP-42 has Specific PM10-PRI & CO Emission Factors for:
  - Pre-Phase I = Not certified to 1988 NSPS
  - Phase I = Certified to 1988 NSPS
  - Phase II = Certified to 1990 NSPS
  - Pellet Stoves (certified & exempt); Masonry Heaters (exempt)

Estimate rule effectiveness / rule penetration in your area:

- Incorporate effects of S/L/T rules and level of compliance
- NEI methodology does not account for S/L/T rules

Residential Wood Combustion

How Can You Improve on the NEI Methodology for Your Area?

- NEI Category Addition
  - EPA is working on methodology to incorporate wax-based sawdust fire logs into activity estimates for fireplaces without inserts

- S/L/T agencies should provide comments on methodology to Roy Huntley (EPA/EFIG) 919-541-1060

Other Carbon Issues

- Measurement issues: EC - OC "Split"
- Secondary Organic Particles
- Emission factors for EC & OC
  - Very limited testing
  - Estimates needed for Haze Modeling
  - Burn Temperature & fire phase affect EC / OC "Split"
    - Hotter fires… more EC
- Current EI developed in SMOKE w/ set of ~ 60 factor
  - Each SCC "assigned" to one of the factors

Special Thanks

- E. H. Pechan & Assoc. for Preparation of Slides on Open Burning, RWC & ASEM
  - Randy Strait
  - Kirsten Theising
  - Glen McDonald (ASEM Presentation)
- Sally Dombrowski, Mary Taborn & David Misenheimer of EFIG for their tireless efforts

That’s All !

Questions ?