Emission Inventory Needs and Enhancements Planned for the US

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Topics to be Covered

- **What is the EI & Why do we Need it ?**
  - **What the NEI is (& What it isn't)**
  - **What is Needed (and Why) ?**
  - **What are the Important Sources**
  - **How is the NEI Developed ?**
- **Inventory Issues & Update**
- **Process-based Emissions Models**
- **Ongoing Issues in the NEI**

What's Included in the US National Emission Inventory (NEI) ?

- **PM10, PM2.5, SO2, NOx, Ammonia, VOC, CO & HAPS.**
  - Point sources (over 70,000 sources, 0.5M emission points)
    - County, Latitude, and Longitude.
    - Units / process emission points within each source.
    - Release parameters – stack height, etc.
    - Control equipment type and efficiency, ideally.
  - Area & Mobile Sources by County (> 3000 Counties)
    - 400 categories of Highway & Non road Mobile.
    - 300+ categories of Area sources.
- **Annual emissions, but possibly shorter periods also.**
- **Other data fields**
- **Documentation.**
  - Process description code (SCC); business type code (SIC).

Notes: 1) More detail is usually available in State / Local / Tribal & RPO databases;
2) Spatial & temporal allocations & speciation done in emissions processor

Related Information Usually Found in the Emissions Processor… Not In the EI

Related Information Found in Emission Processors

- PM2.5, VOC speciation profiles.
  - Standard practice for PM: Organic carbon, Elem. carbon, sulfate, nitrate, crustal; PMC from PM10 & PM2.5
  - Special Needs for PM: Elements, ions, specific organics.
- Spatial, Temporal allocation factors.
- "Transport fraction" for fugitive dust. (Ammonia ??).

Status of Emission Processors

- SMOKE ~ full toxics support, updating QA, adding FD transport
- OpEM ~ under development by LADCO
- MOVES ~ under development by OTAQ (Fall 2005)
- EMS-2003 ~ LADCO just released V3

Why is an Emission Inventory Needed?

- Air quality model development & testing.
- Preliminary control strategy explorations for PM and Regional Haze.
- Emission rule adoption – federal or state/local.
- SIP boundaries & attainment demonstrations.
- Tracking trends & attainment progress.
- Source permitting, Compliance monitoring.
- Community risk assessment.
- Public information requests.

Geographic Needs ~ All of North America

Important PM2.5 Source Categories in the NEI

DIRECT EMISSIONS

Combustion [a, b]

- **Open Burning (all types)**
- **Non-Road & On-Road Mobile**
- **Residential Wood Burning**
- **Wildfires**
- Power Gen
- Boilers (Oil, Gas, Coal)
- Boilers (Wood)

Crustal / Metals [b]

- **Fugitive Dust**
- Mineral Prod Ind
- Ferrous Metals

PRECURSOR EMISSIONS

SO2 [c]

- **Power Gen (Coal)**
- **Boilers (Coal)**
- Power Gen (Oil)
- Boilers (Oil)
- Industrial Processes

NOx

- **On-Road Mobile (Gas, Diesel)**
- **Power Gen (Coal)**
- **Non-Road Mobile (Diesel)**
- **Boilers (Gas, Coal)**
- Residential (Gas, Oil)
- Industrial Processes

NH3

- **On-Road Mobile**
- **Animal Husbandry**
- **Fertilizer Application**
- Wastewater Treatment
- Boilers

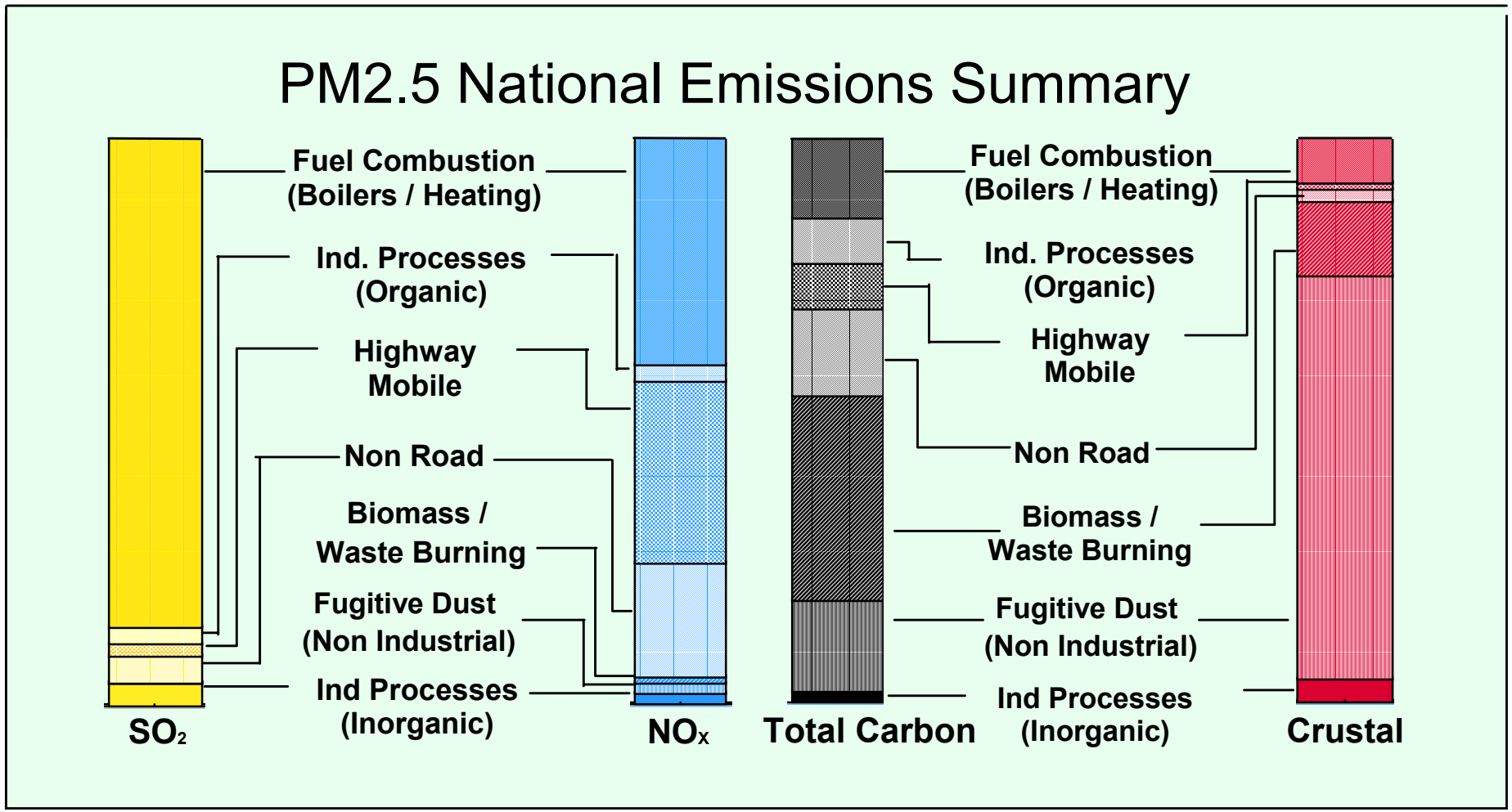
VOC [d]

- **Biogenics**
- **Solvent use**
- **On-Road (Gas)**
- Storage and Transport
- Residential Wood
- Petrochemical Industry
- Waste Disposal

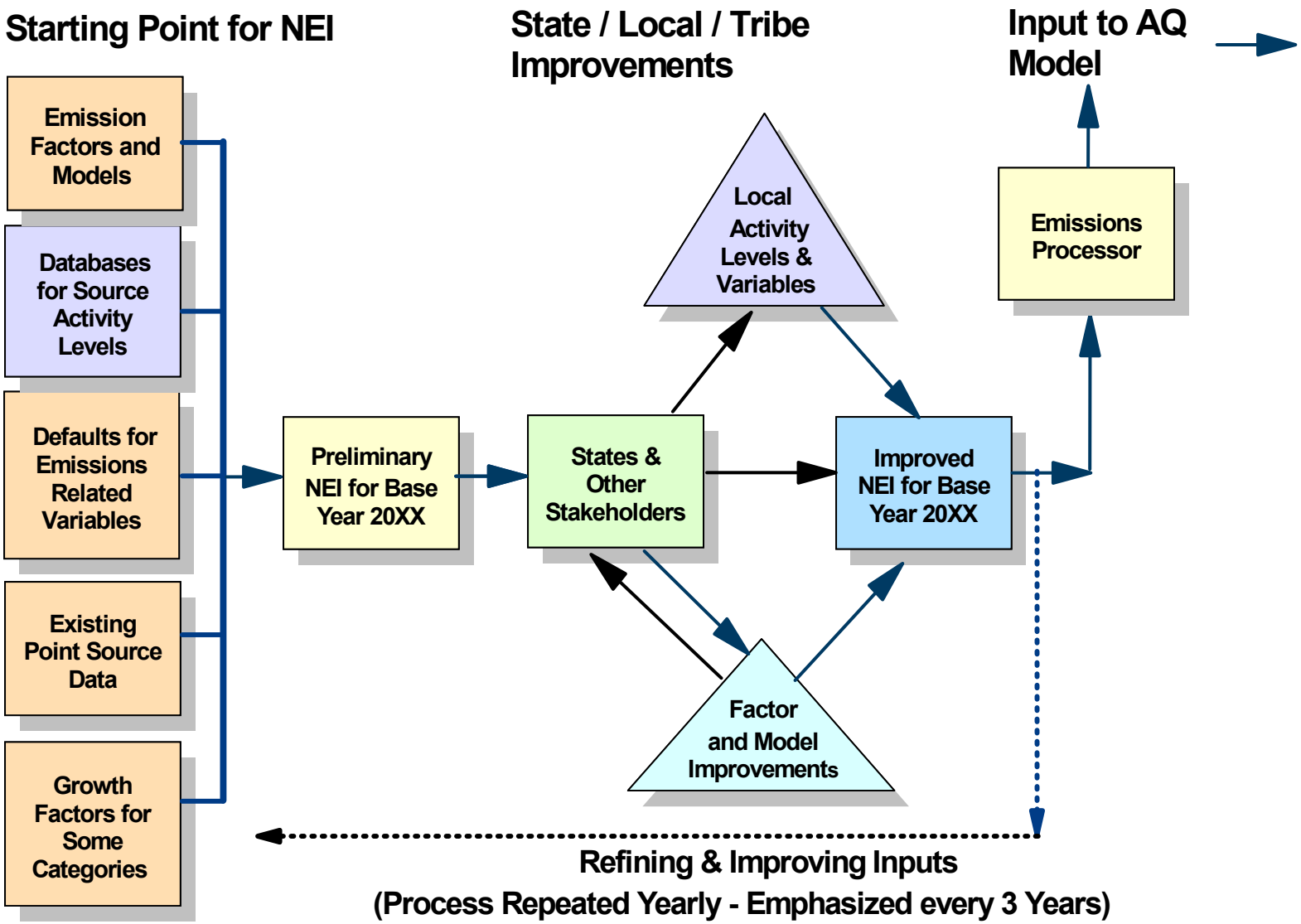
a Includes primary organic particles, elemental carbon and condensible organic particles; also some flyash
b Impact of carbonaceous emissions on ambient PM 5 to 10 times more than crustal emissions impact
c Includes SO_2, and SO_3 and H_2SO_4 condensible inorganics
d Contributes to formation of secondary organic aerosols

NOTE: Categories in **BOLD** are most important nationally. Their relative importance varies among and between urban and rural areas.

Sources of Direct PM2.5 (after Speciation)



NEI Development ~ Cooperative, Iterative



The Emission Inventory:
New Requirements, New Faces

- **New Consolidated Emissions Reporting Rule (CERR).**
  - 2001 – large point sources.
  - 2002 -- all sources, all pollutants.
  - States should have changed source reporting requirements to match.
- **5 Regional Planning Organizations (RPO's)** are investing heavily in inventory development, QA, and improvement.

The Emission Inventory:
New Tools, New Procedures

- **Tools & Methods Work**
  - PM Condensibles, QA/QC Tool
  - Emissions Processor Improvements
    - Temporal & spatial profiles improvements
    - Speciation profile improvements “PM2.5 in progress”
    - SMOKE now handles HAPs, interfaces w/ Mobile 6

- **Procedural Changes for 1999 / 2002 NEI’s**.
  - ’02 ~ 1st NEI to get Scientific peer review
  - Transparency & reproducability ~ Meet OMB’s IQ Guidelines
  - NIF Reporting Format
  - HAPS / Criteria Merger ~ “in progress”

Inventory Issues & Update … Point Sources

For sources >100 tons per year (lower in some states)

Almost always self-report to state / local / tribes

Estimated by continuous stack monitors (SO2 and NOx), emission factors, or single tests

- ’99 / ’02 Improvements
  - Quality Assurance., Chemical naming standards ~ EPA Data Standards
  - Emission history table ~ tracks facility-level changes
- Future ~ Complete Merger of HAPs / Criteria

Inventory Issues & Update … Area Sources

Estimated by state / local / tribal agency or by EPA.

- *Over 300 possible categories.*

Mixed, evolving suite of methods & data sources.

- *Methods and coverage inconsistent across agencies*
- *Methods evolve from one version to another.*
- *Issue – Double counting with point sources.*

- Recent methods improvements
  - Open Burning, Fertilizer, Construction, Wood Burning
  - Near Source Removal of Fugitive Dust (Transport Fraction).
    - (We are investigating NH4 surface interactions.)

Inventory Issues & Update … Highway Mobile

Estimated by state/local/tribal agency, or by EPA. VMT is…

- *By county, By type of road, maybe by individual roadway*
- *By type of vehicle*

Emission factor model – MOBILE5, MOBILE6, EMFAC

Many possible levels of fine tuning, so estimates may differ by organization

- Current NEI Issue – Transferring estimation inputs to allow consistent projections, scenarios, etc.

Inventory Issues & Update … Nonroad Mobile

NONROAD 2002 model from EPA.

- *Construction equipment, lawn and garden, recreational vehicles, etc.*

Planes, locomotives, and commercial marine.

- *Various methods and data bases for local estimates.*
- *EPA estimates national emissions and allocates to counties based on activity surrogates.*
- *Military base emissions are a continuing problem.*

- Current NEI Issue – Transferring estimation inputs to allow consistent projections, scenarios, etc.

Inventory Issues & Update … Biogenic Sources

Hourly Biogenic *emission estimates needed for air quality modeling.*

- *BELD3 data on vegetation coverage.*
- *BEIS3 emissions model.*
- *Meteorology data/model, e.g. MM5.*

Annual inventory estimates are useful for general information.

- *EPA has annual estimates for 1996, will create new county totals for 2002 by running every day.*

- V3.11 accounts for seasonality of fertilizer NO release & short term fluctuations due to rainfall.

Inventory Issues & Update … Data Exchange & Management

Separate data systems in each jurisdiction.

- *Volume of data is huge.*
- *Many chances for oversights, errors, and miscommunication.*

- EPA has defined a common exchange format – "**NIF**" -- for getting data from states and sharing our data with others
- QA, accuracy, transparency, access, query tools, and timely corrections will be continuing challenges.

Process-based Emissions Models

The National Emissions Inventory *is NOT currently linked to real time conditions (nor process variables) that may affect emissions magnitude.*

Process-based Emissions Models *can provide this link and enable potentially great improvements in the quality of the inventory and chemical transport model estimates.*

Process-based Emissions Models

- Space- & Time- Sensitive Emissions due to…
  - e.g., wind, temperature, RH, vegetation types, soil type & moisture
- Linkages: MM5, GIS coverages, Emission algorithms
- Currently ~ BEIS3, MOBILE6
- PbEM Needs
  - Fugitive Dust (wind, unpaved roads, construction, tilling, removal)
  - Ammonia (fertilizer application, animal husbandry, removal)
  - Wildland Fires (fuels, fuel consumption, plume rise)
  - Residential Wood Burning
  - Evaporative Loss
  - Others ?
- Examples: Wildland Fire & Fugitive Dust

Wildland Fire Emissions Module

(under development)

- **Modular input to Emission Models (e.g., SMOKE, OpEM) to interface with the CMAQ modeling system.**
- **User Inputs:** Fire locations, duration, size
- **Model Components**
  - Fuel loading default: NFDRS / FCC map
  - Fuel Moisture: Calculates using MM5 met data
  - Fuel Consumption: CONSUME2.1 / FOFEM
  - Emissions, Heat Release & Plume Rise: EPM & Briggs (modified)
- **Outputs:** Gridded hourly emissions, plume characteristics
- **Integrate, Test & Release Module (late 2004 earliest – w/ funding)**

Fugitive Dust Emissions Module

(under development)

- **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 (mid 2004 earliest – w/ funding)**

Other Inventory Issues

- **Transient, Cyclic & Atypical Operation**
- **Speciation, Diurnal & Seasonal Profiles**
- **Uncertainty**
  - **Varies Among Pollutants & Source Types**
  - ***NARSTO*** ~ contains *qualitative* assessment
  - **Range of Certainty**
    - **SO2** (best) … **open sources** (least)
  - **Reducing Model / Inventory-induced Uncertainty**
    - **Speciated Rollback**
  - **Receptor Models**
    - **Independent tool to assess source contribution biases & guide EI improvements**