Emissions Inventories: What Has Been Done; Issues, Strengths and Weaknesses; Next Steps

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May 19, 2005

3rd Particulate Matter/Regional Haze/Ozone Modeling Workshop

Emissions Inventories: What Has Been Done; Issues, Strengths and Weaknesses; Next Steps

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Presentation Outline

- Inventory issues related to ozone/PM2.5/RH modeling and what has been done so far (RPOs, multi-state organizations)
  - Organic carbon inventories in urban areas
  - Ammonia inventories
  - How to use CEM data
  - How to use mobile data, how to use/represent diesel vehicle data
  - Speciation profiles
  - Fire
  - Primary PM / Fugitive dust
  - Canadian/Mexican inventories
  - Projection inventories
  - Other
    - Residential Wood Combustion, Open Burning
    - Oil/Gas Production/Distribution emissions
    - How to Tag Emission Sources

Presentation Outline

- Outstanding issues/weaknesses/further work
- Wish list: Emission inventory community's messages to modelers and EPA…
- What modelers ask of us?

What has been done so far

Organic Carbon Inventories in Urban Areas

- LADCO/MRPO did monitoring studies and model sensitivity with OC and EC (shows impact).
- No specific inventories available
- There is a disconnect between VOC emissions and chemical transport. Chemical transport does not create significant amount of PM organics.
- CENRAP future work: Plans to define carbon sources

What has been done so far

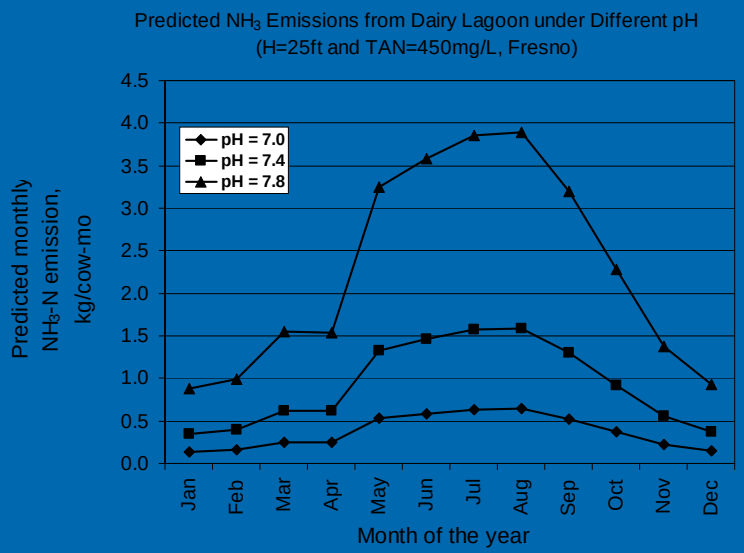
Agricultural Ammonia Inventories

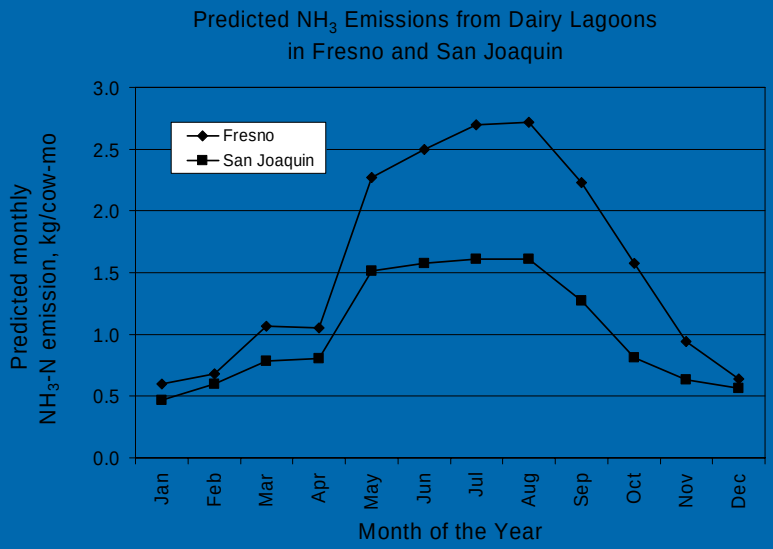
- CMU work (completed)
  - Ag sources: easy to run and modify
  - Includes updated animal populations
  - Monthly estimates of agriculture emissions by SCC
  - Integrated EPA's mass balance scheme and MMTs
- EPA work (near completion)
  - Mass balance equations for animal husbandry
  - Based on annual animal populations, MMTs, and corresponding emission factors
  - County-level annual emissions per animal type
  - New "Gilliland profiles" created based on 2001 modeling platform results (higher summer and lower winter emissions). Impact on modeling will be tested before release.
- CONCEPT (underway) – (see next slide)
  - Process based ammonia model

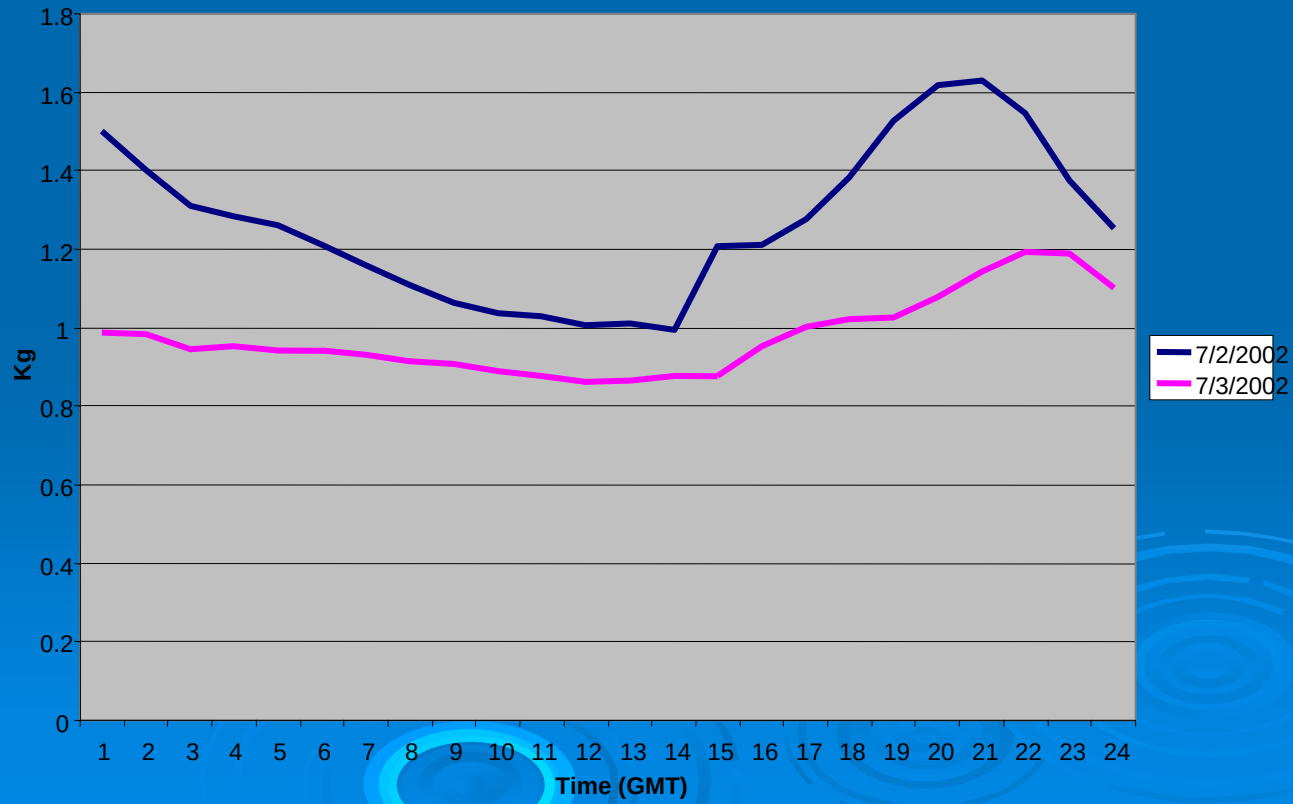
What has been done so far

CONCEPT's NH3 Model

- NAS Study asks for Process Based Model
- Tracks Nitrogen in Feed, Animals, and Waste.
- Uses Hour Specific Met (temp, wind sp, solar radiation) to effect housing conditions.
- Many inputs: Crude Protein in Feed, Ventilation rates, Animal Age.
- Problems: Complex science results in very slow model, Needs some re-coding.


Predicted NH_3 Emissions from Dairy Lagoon under Different pH
(H=25ft and TAN=450mg/L, Fresno)
Predicted monthly NH_3-N emission, kg/cow-mo
pH = 7.0
pH = 7.4
pH = 7.8
Month of the year


Predicted NH_3 Emissions from Dairy Lagoons
in Fresno and San Joaquin
Predicted monthly NH_3-N emission, kg/cow-mo
Fresno
San Joaquin
Month of the Year


Kg
Time (GMT)
7/2/2002
7/3/2002

What has been done so far

Agricultural Ammonia Inventories

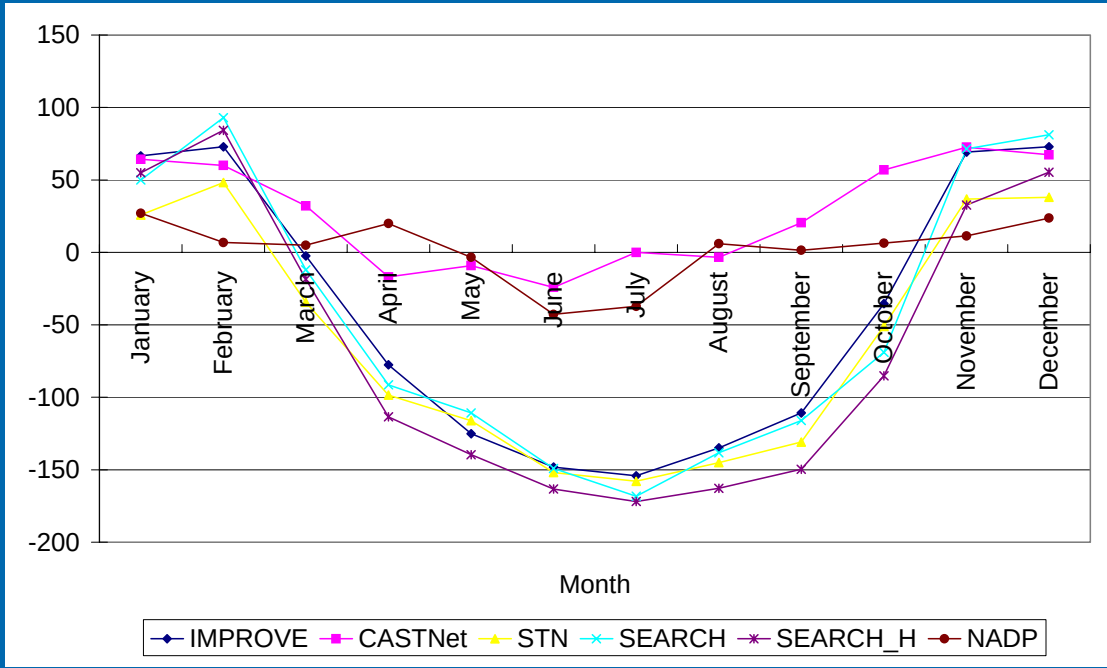
- Comparison of methods? Currently CMU and EPA models are very similar. MRPO uses Pandor's temporalization instead of Gilliland profile

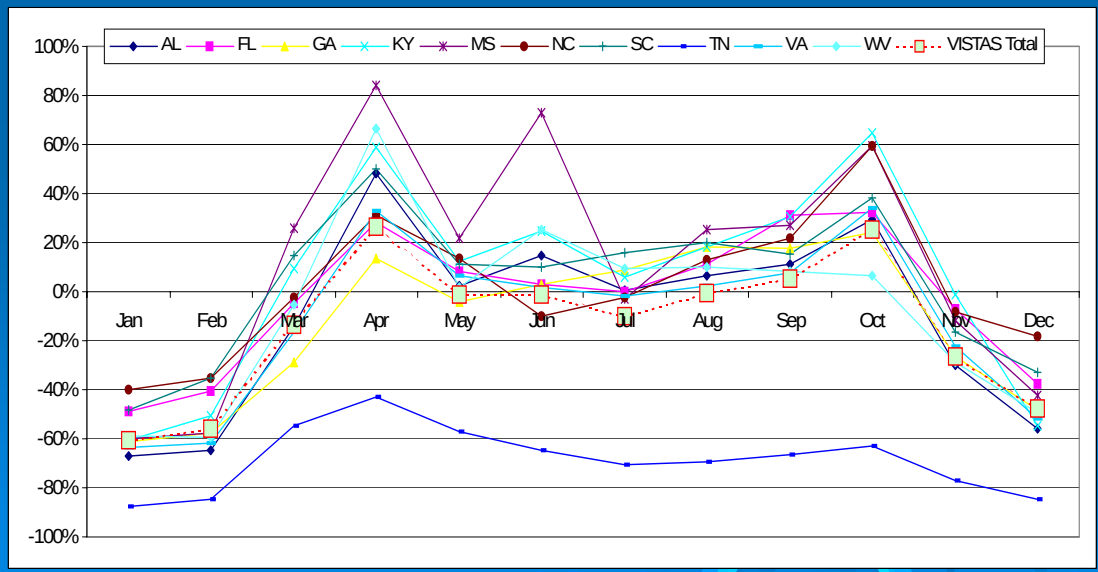
- WRAP Modeling Center 2005 task - NH3 model evaluation and recommendations
  - Compare the 4 dominant NH3 EI models: area source AP-42 method data, CMU, ENVIRON Land Use, LADCO (if/when available, use defaults) - 36-km model grid cell will be the basis of the comparisons
  - Aggregate the grid cells into relevant spatial units such as states, counties, and interesting regions (Central Valley, CA, east-west Colorado, Idaho agricultural lands, etc). Specific analyses to focus on within these areas include:
    - Differences in temporal variability: diurnal, monthly, seasonal, annual;
    - Spatial gradients and comparison of the land use categories used by the different models;
    - Relative magnitudes of the different categories to the total NH3 in each analysis region;
    - Relative magnitudes of the different models in each analysis region;
    - Case studies within the domain will focus on specific areas of high NH3 activity such as the Central Valley, CA, ID agricultural lands, and east vs. west Colorado.

What has been done so far

Other Work on Ammonia Inventories

- Individual RPO ammonia inventory improvement efforts
  - WRAP Land Use work (completed) – see: http://pah.cert.ucr.edu/aqm/308/emissions_reports04.shtml
    - 5 source categories – domestic, fertilizers, livestock, soils, wild animals
    - Uses MM5 met to drive emissions
    - Easy to change emissions estimates with updated land use data
  - VISTAS: Application of new CMU temporal adjustments appear to reduce NH3 inventory when needed [next slide]
    - Improvement to AQ model nitrate model performance
  - MANE-VU: Industrial refrigeration, composting, cement kilns, wastewater treatment plants
  - MRPO interested in learning if there is any on-road ammonia work done





VISTAS Nitrate Performance Improvement

←**NO3 Fractional Bias** Initial 2002 CMAQ Base Case Simulation

Winter Overestimation

Summer Underestimation

← **Changes in Ammonia Emissions** between Initial and Revised 2002 CMAQ Base Case Simulations

What has been done so far

How to use CEM Data

- VISTAS: developed unit level temporal profiles based on CEM data (next slides…)
- MANE-VU/NESCAUM work (next slides…)
- MANE-VU/OTC/NJ work (adjustments following VISTAS work)
- MRPO: using only part of facility specific data
- EPA work (next slides)

Can not use CEM data in IPM!

What has been done so far

How to use CEM Data—EPA work

- Testing impact of including 2001 CEM data nationally vs default temporal profiles. July and Jan2001.

- Assuming impact is to improve model performance, will move to use the CEM data in 2002 modeling.

- Working to improve matching between 2002 NEI and CEM datasets (OAQPS/CAMD collaboration). The CEM-based ORIS/Boiler IDs will be included in the 2002 NEI.

- Working to (perhaps) develop a new approach for future-year temporal allocation based on IPM information (more detailed than season-specific, winter/summer). Preliminary work includes improving how SMOKE uses CEM data to provide methods for:
  - SMOKE computing hrly emissions of VOC & PM2.5 from EGUs based on hrly heat input data in CEM.
  - Approach for using same (or averaged) future-year temporal profile based on CEM, if desired.

Currently can not use CEM data in IPM!

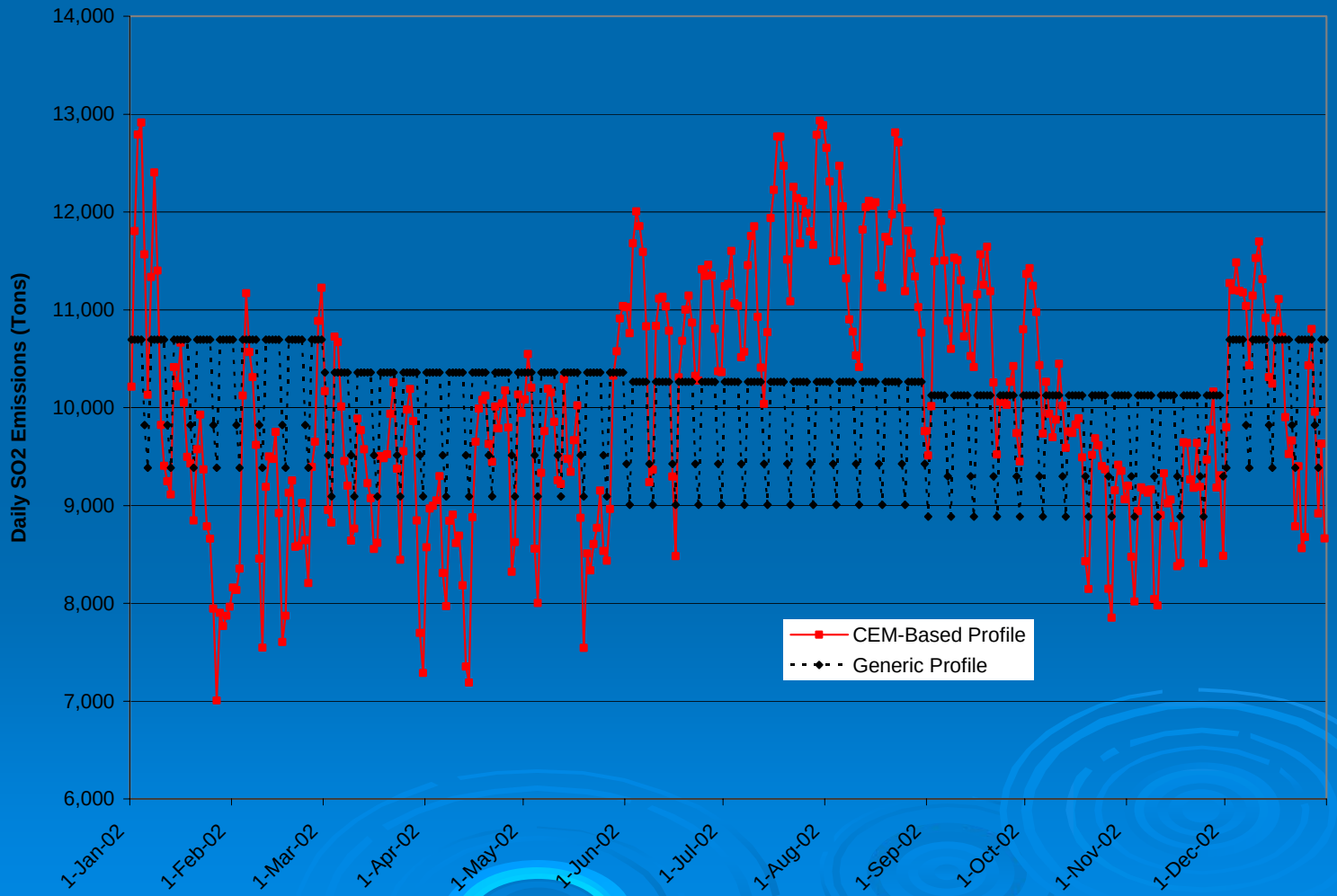
VISTAS CEM Data Analysis

- Application of CEM-based temporal profiles to annual emission totals in the VISTAS domain exhibit the uniqueness of individual sources and their operating characteristics

- This hourly distribution of emissions greatly enhanced the inputs provided to the air quality model and improved model performance in more than one season and sub episode

- Historical CEM data also used to develop load curves for reference base case and future year EGU emissions [RRF calculations]

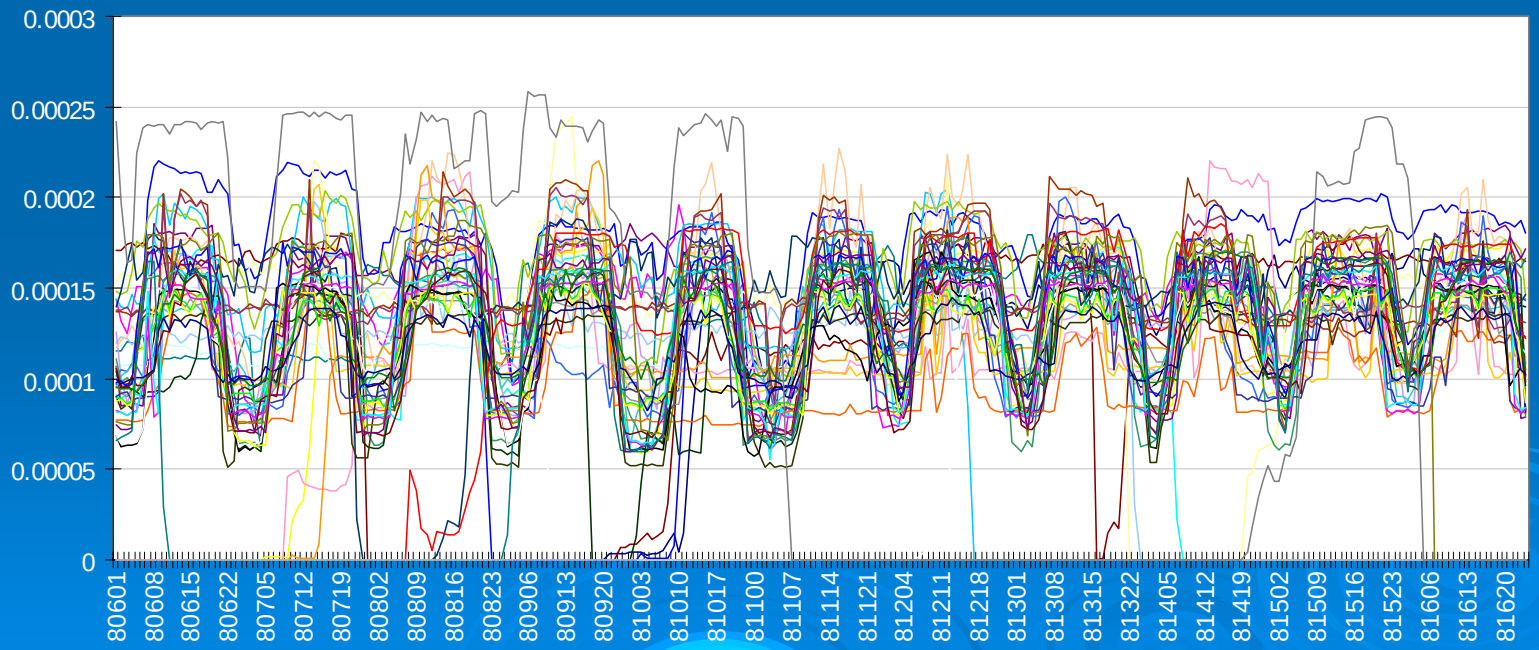
VISTAS EGU SO2 Emissions for 2002 Base Year Modeling



MANE-VU/NESCAUM CEM Data Analysis

- Specific application for August 2002 episode for specific large facilities

- Direct use of CEM data for 48 large units for special impact analysis (SO_2 and NO_x)
- Develop CEM-based hourly emissions using hourly heat input data (CO, VOC, PM_{10}, $PM_{2.5}$, and NH_3)
- Can represent specific conditions for specific sources



Hourly fraction of heat input from CEM data (X-axis: date/time in MDDHH, Y-Axis: hourly fraction of heat input, dimensionless)

What has been done so far

Mobile Sources

- MRPO integrating link-based model into CONCEPT (underway)
  - HDD/LDG ratios by day/hr makes difference in large urban areas.
- Running Mobile 6 with SMOKE (MANE-VU, VISTAS, WRAP, CENRAP)
  - WRAP M6 EI report for WRAP region for 2002, 08, 13, and 18
  - Nonroad, planes, trains, in- and near-port shipping emissions for same yrs
  - Gridded commercial marine vessel shipping lane emissions – covering 25 to 300 km off west coast of NA (Corbett method)
- NMIM (underway) runs Mobile 6 and Nonroad model, includes VMT database to calculate emissions
- EPA running sensitivity analyses to assess impact on CMAQ performance of running with a SMOKE/MOBILE6 approach instead of a monthly-averaged emissions approach.
  - Expected results this summer.
  - This will include analysis of multiple levels of temporal aggregation to balance SMOKE processing speed with model performance improvements for ozone and PM.

What has been done so far

Speciation Profiles

- EPA (SPECIATE)
  - New SPECIATE expected in July with new cross-references andVOC-to-TOG information.
  - New profiles for VOC and PM2.5
  - This tool will allow users to prepare speciation profiles for CB-IV, SAPRC-99, or user-defined profiles including support of CMAQ for toxics.
  - CB-IV+ may be included.
  - Expect tool to be completed by October.

- MRPO
  - Replaced 7 out of 8 profiles (covering 95% mass) for PM
  - Using region specific profiles for on-road VOC (based on fuel mix)
  - Separating crustal PM and other PM

What has been done so far

Fire Inventory

- National Wildfire Emissions Inventory:
  - Available in July 2005
  - Daily/ hourly point source fire information in SMOKE ready format for entire country
- MRPO Fire Inventories (point based, day specific, wild, prescribed, ag, etc.)
- VISTAS Fire Inventories (agricultural, prescribed, land clearing and wildfire)
  - Modeling files generated using more specific raw data
  - Includes acres, dates, and locations of fire activity
  - Generated elevated fire file for sources with appropriate data elements
  - Applied revised plume rise algorithm based on DAYSMOKE [Southern High-Resolution Modeling Consortium; Athens, GA]
- CENRAP (ag burning)
- WRAP Fire Inventories (wild, prescribed, ag, etc.)
  - for report and actual 2002 WRAP region fire emissions data **http://wrapair.org/forums/fejf/tasks/FEJFtask7PhaseII.html**

What has been done so far

Residential Wood Combustion

- MANE-VU 2002 RWC inventory completed
  - Based on EIIP recommendation, conducted a regional survey on residential wood combustion activity and developed a RWC inventory for Mid-Atlantic and Northeastern states
  - Developed annual inventory with specific temporal profiles for indoor and outdoor wood burning equipment.

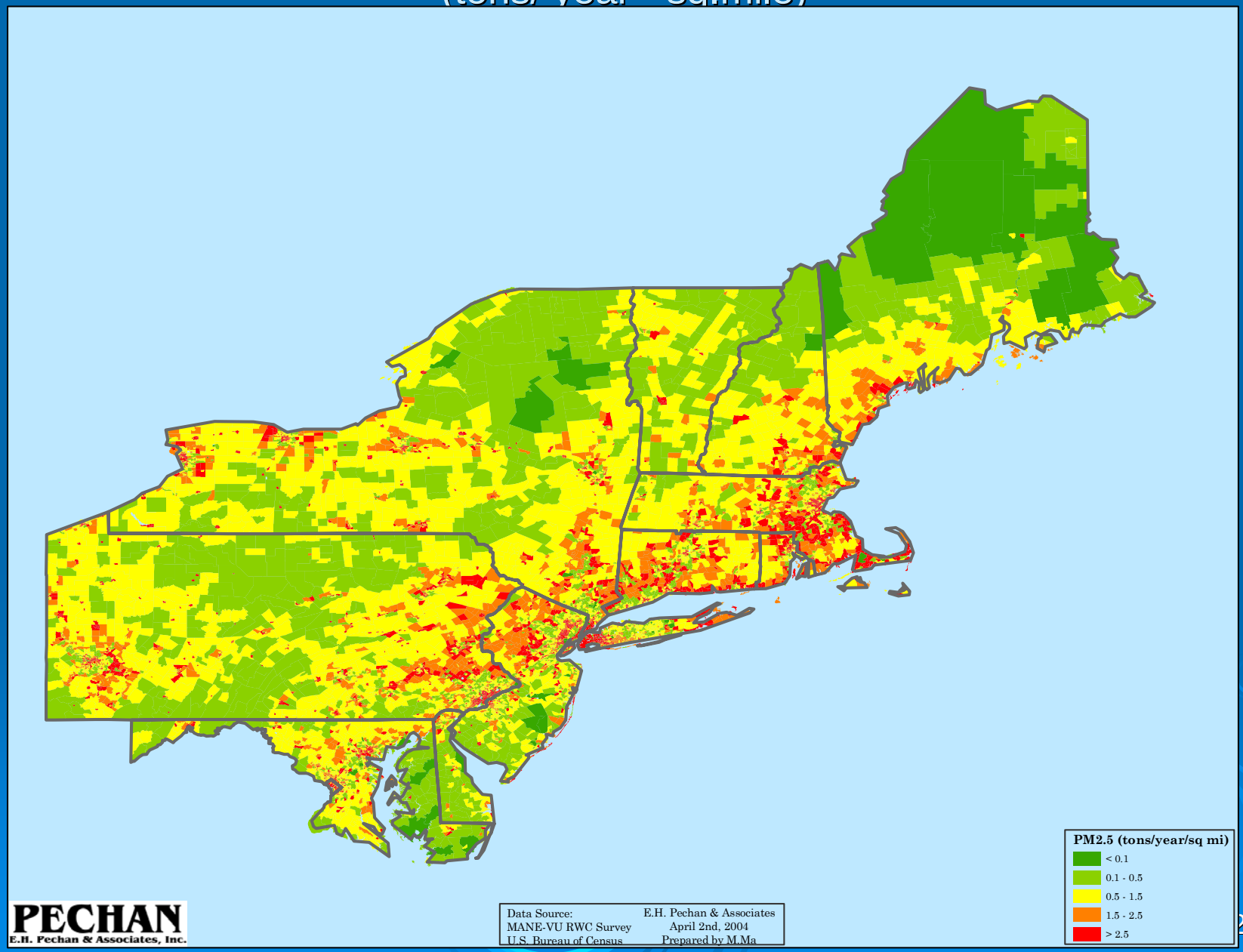
- EPA: working on an improved dataset for fireplaces and woodstoves future-year projection.
  - Data expected to be available this summer.
  - Also working on an improved set of monthly temporal profiles that will reflect a new approach, temporal "throughput" information from the 2002 NEI, RPO profiles if any are available, and climate zone considerations.

What has been done so far

Open Burning

- MANE-VU 2002 Open Burning inventory completed
  - Survey for residential municipal solid waste burning, leaf and brush burning, and municipal yard waste burning
  - Developed annual inventory with temporal allocation profiles (weekly and weekday/weekend) for indoor and outdoor wood burning equipment. Also compiled rule effectiveness and rule penetration numbers.

MANE-VU RWC $PM_{2.5}$ Emission Density Plot for Indoor Equipment (tons/ year - sq.mile)



Differences between the MANE-VU and NEI Estimates in RWC inventory

- MANE-VU $PM_{2.5}$ inventory = 145,693 tons
  - Includes pellet stoves and furnace/boilers
  - Factor to convert wood consumption (cords) to tons = 1.8 tons/cord (few responses of softwood burning)
  - Bottom up inventory from census tract level
  - Allocates more emissions to rural areas

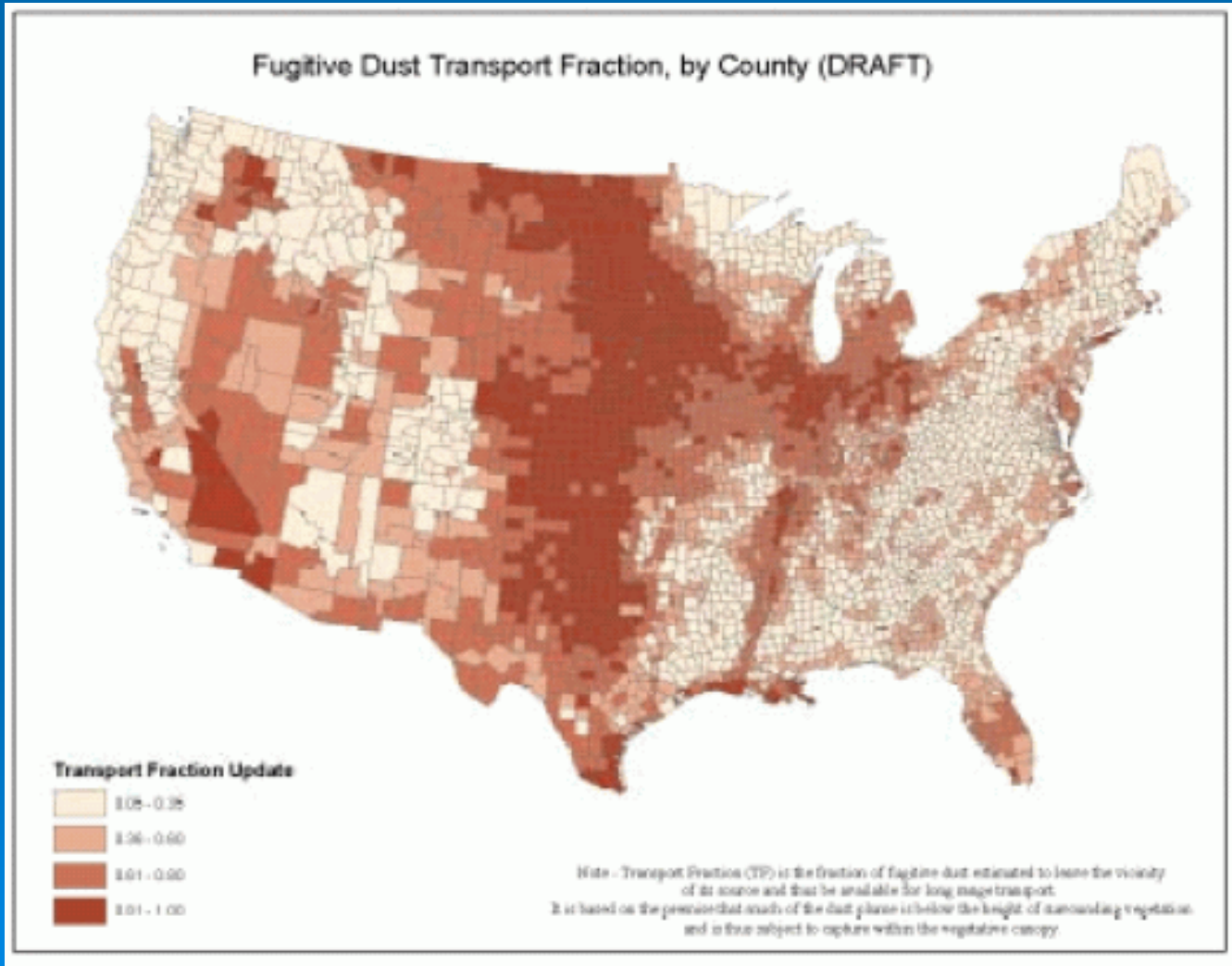
- $PM_{2.5}$ NEI for MANE-VU region = 77,393 tons
  - Does not include pellet stoves or furnace/boilers
  - Factor used to convert volume to mass = 1.163 tons/cord
  - National stats allocated to regions, then to counties
  - Allocates more emissions to urban areas

What has been done so far

Fugitive Dust

- EPA work: EPA developed county level transport fractions based on land use data (next slide)
- WRAP developing transport fraction for west based on land use data (Environ Windblown Dust Model for WRAP)
  - 2 phase, 3-year project to develop method
  - Dust generated by MM5 met
  - Easy to change emissions estimates with updated land use data
  - http://wrapair.org/forums/dejf/documents/WRAPRMC-RevDraft_WBDust_4-15-05.pdf
  - Includes air quality model performance evaluation
  - Can be applied to any or all of the RPO modeling domain
  - Can apply transport fractions by land use [not county]
- Need to keep track of who applied transport fractions and how during emissions calculations
  - MANE-VU – did not apply TF
  - MRPO – applied based on forest cover data 90-97.5%
  - VISTAS – applied TFs in modeling inventory
  - CENRAP ?
  - WRAP – applied in SMOKE to non-WRAP region

EPA calculated transport fractions by County



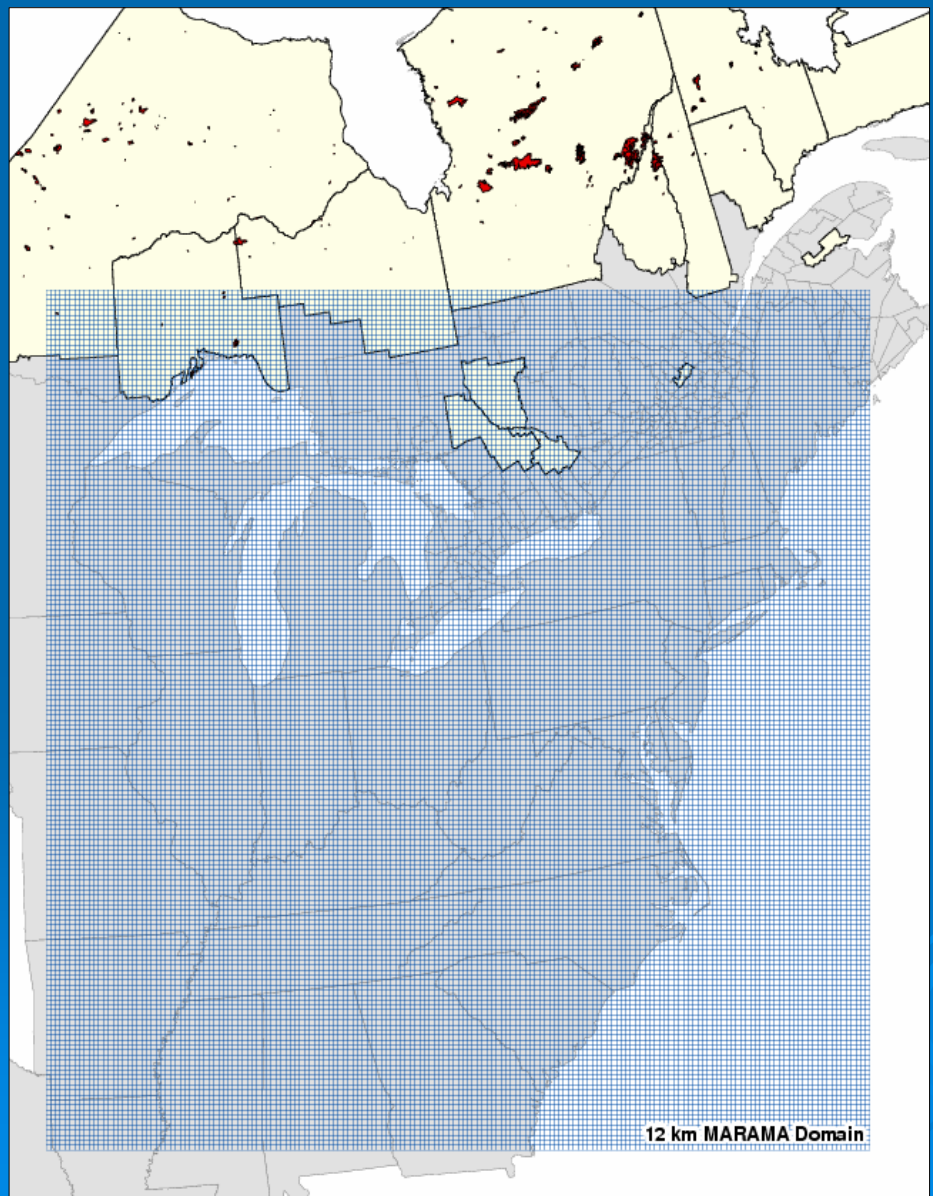
What has been done so far

Canadian/Mexican Emissions

- MANE-VU: Eastern Canadian Fire Inventory
  - Wildfire and Prescribed fires
  - Most large fires in 2002 occurred outside of the Eastern 12 km domain (nest slide)
  - Point source daily and hourly fire emissions
    - Had to make certain assumptions due to lack of EC recommendations on emissions factors and consumption factors
- EPA: Environment Canada (2002)
  - Planning to develop public point source emissions inventory files for 2002. No estimate available of when the 2002 data will be available.
  - Canada 2000 area, nonroad and onroad available on EPA website.
  - Canada 2002 point (not suitable directly for modeling) data available on Canada website.

Awaiting updated, using currently available Canadian/Mexican emissions

Canadian Fire Activity in 2002



What has been done so far

EGU Projections

- First round: VISTAS and MRPO IPM runs
  - Regional improvement application to EPA assumptions for CAIR
  - Updates to input data, State regulations, expected new generation
  - Development of CEM-based temporal profiles for hourly distribution of seasonal emissions
- Eastern (MRPO, CENRAP, MANE-VU & VISTAS) RPO IPM runs
  - VISTAS/MRPO funded work: 2008, 09, 12, 15, 18, 20, 2026, OTB, OTW, BOTW
  - Each RPO updated NEEDS input data for IPM and developed crosswalk to link IPM input data to RPO inventories
  - Stakeholder review of assumptions and NEEDS
  - RPOs recommended specific global assumptions
  - IPM runs begin May 2005
  - Results available: June 2005
  - Post-processing step to re-format data into model ready files: June/July. A tool is developed by PECHAN for MRPO.
- MANE-VU/OTC Sponsored IPM runs
  - Additional sensitivity and control strategy runs beginning in June
  - Other eastern RPOs will be able to provide input to the MANE-VU runs

What has been done so far

EGU Projections

- WRAP
  - Not using IPM
  - **See Road Map at: http://wrapair.org/forums/ssjf/documents/eictts/docs/SSJF%20Projections_Roadmap_Mar14.pdf**

- RGGI (Regional Greenhouse Gas Initiative)
  - Northeastern states initiative (some Mid-Atlantic states as observers) with stakeholder involvement
  - Purpose: To evaluate impacts of implementing a CO2 cap on the electric power sector in the Northeast and Mid-Atlantic region
  - Developed detailed assumptions for use in IPM

What has been done so far

Non-EGU Projections

- MRPO and MANE-VU:
  - Identifying source categories that are not well represented with EGAS and NONROAD projections, state/stakeholder review
  - Using EGAS and NONROAD with most up to date versions for remaining source categories
- VISTAS:
  - Growth and control factors originally based on EPA CAIR data improved with input from State/stakeholder groups
- CENRAP?

- **WRAP – See Road Map at: http://wrapair.org/forums/ssjf/documents/eictts/docs/SSJF%20Projections_Roadmap_Mar14.pdf**

What has been done so far—Other

Source Tagging Emission Sources for Contribution Assessment

- MANE-VU/NESCAUM -

- Developed for mercury and sulfate contribution assessment in Northeast U.S.
- Develop inventory pre-processing software and updated SMOKE to generate tagged, (REMSAD) model-ready emissions
- Compare against CMAQ to ensure performance
- Tagging possible by FIPS and by SCC (or both)
- RPO 2002 EI is tagged for 5 different regions (MANE-VU/MW-RPO/VISTAS/CENRAP/CANADA) and 3 different source sectors (EGUs/Non-EGU points/non-points)

What has been done so far—Other

- Spatial allocation (EPA):
  - New datasets being developed that include changes to counties in Colorado and Virginia in 2002.
  - Timeline uncertain.

- New tool to run MIMS Spatial Allocator (EPA): to reproduce EPA spatial surrogates for any grid being developed by October.

- Official SMOKE release expect in September.
  - Default installation being updated to include mercury modeling data/approaches used in the Clean Air Mercury Rule.

- Possible improvements in projections and ancillary data (EPA) for major criteria industries: pulp, paper, and paperboard mills, cement manufacturing, and refineries.

- Oil/Gas Production/Distribution emissions (WRAP): no refining, focus on coalbed methane

CENRAP REFINE 2002
Completion Date: 7/31/05

- Revise SCC for Arkansas;
- Provide missing Ammonia for some area source categories for Arkansas and for locomotive and marine for Texas;
- Update Area Sources in Select TX Counties;
- Update nonroad oil and gas equipment in TX;
- Update EI from Missouri;
- Data issues that arise from modeling runs (to be determined).
- Update EGU in KS (double count issue);
- Update TRI sources in KS (double count issue);
- EGU issues; incorporating data from IPM runs;
- 2002 Inter-RPO Wildfire Emissions/Emission Factors (if available)
- Mobile Sources and Agricultural Fugitive Dust
- Ammonia
- Planned Burning
- MMS – Gulf of Mexico Sources

CENRAP EI
Issues, weaknesses

- Biogenics in general but the fertilizer and livestock, in particular. Jointly they are around 80% of the ammonia inventory for Cenrap. Fertilizer factors vary significantly.
-
- Wildfire data is missing in CENRAP. Anticipated Federal data but the effort will not be finalized on time.
-
- Mexico fire data. The spring Ag fires cause an significant haze issue.
-
- Future inventory - projected VMT for large portion of the area not available. Areas under Ozone SIP tend to have it but others with potential significant growth do not.

Outstanding issues, weaknesses, further work

What source categories are very uncertain or believed to be incorrect?

- In terms of overall flux and impact on modeling
  - Mobile
  - Livestock emissions near urban areas (e.g. Ohio)
  - Non-road (recreational marine)
- In terms of % uncertainty associated with specific source categories
  - Residential Wood Combustion emissions
  - Commercial Marine Vessels
  - Ammonia from cement plants
- EPA comparison of NEI to RPO inventories (top 10 sources)

Wishlist

- Near-source deposition should be dealt with w/ photochemical models, not by emissions modeling
- Source apportionment/receptor models do not give answers transferable to make improvements in inventories
- Emission factor development by EPA
- Guidelines and harmonization of dead-lines
- Streamlined process on how to make better use of NEI efforts for modeling purposes—making inventories and EI staff "modeling-friendly"
- Communication and compatibility among emissions processors
- Support of inter-RPO data warehouse (funding and usage)
- Process of developing modeling inventories for the next round