US EPA Perspectives on Regulatory Modeling: Current Practice and Future Directions

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Overview

- Introduce U.S. Air Quality Management (AQM) System
- Central Role of Science in US AQM especially Air Quality Modeling
- Through the Eyes of EPA's Air Quality Modeling Group (AQMG)
- Current Practices with Examples
- New Challenges
  - New National Ambient Air Quality Standards
  - Stress on Model Skill at Multiple Scales for AQM purposes
  - Capabilities to support Health Research and Assessments
  - Multi-pollutant Air Quality Management
- Collaboration Anyone?

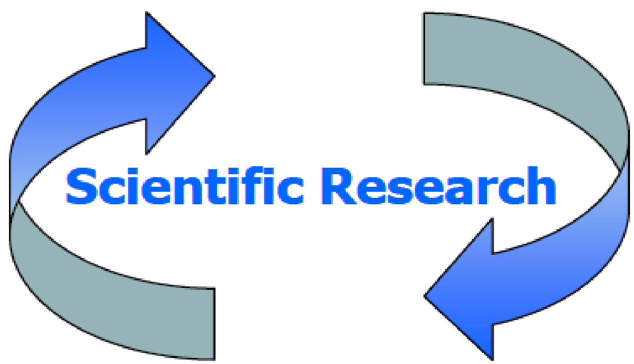
Evolution of EPA's Air Quality Management System

Establish Goals

NAAQS
Visibility Goal
PSD increments
Acid Rain SO_x Cap

Determine Emissions Reductions

Monitoring
Inventories
Analysis & Modeling
PAMS Network
Photochemical Grid Modeling



Develop Programs to Achieve

SIPs, Local & Tribal Plans
Legislative Mobile Reductions
Federal Fuel Additive Rules
NSPS
NESHAP (Risk)
Subpart D in Nonattainment Areas
- RACT and New Source Review
- Reasonable Progress
- Mobile I/M

Utility NSPS % Reduction
Federal Acid Rain Program
Federal MACT Plus Risk
Tier2, Toxics Mobile Standards
O3/PM Area Classfication
Requirements: VOC, NOx RACT, Federal CTG, I/M, 3%/yr Progress, New source offsets,
O_3 Transport Commission

Implement and Enforce Strategies

Sources comply
Permits
Enforcement
NSR Permits
Title V permit programs

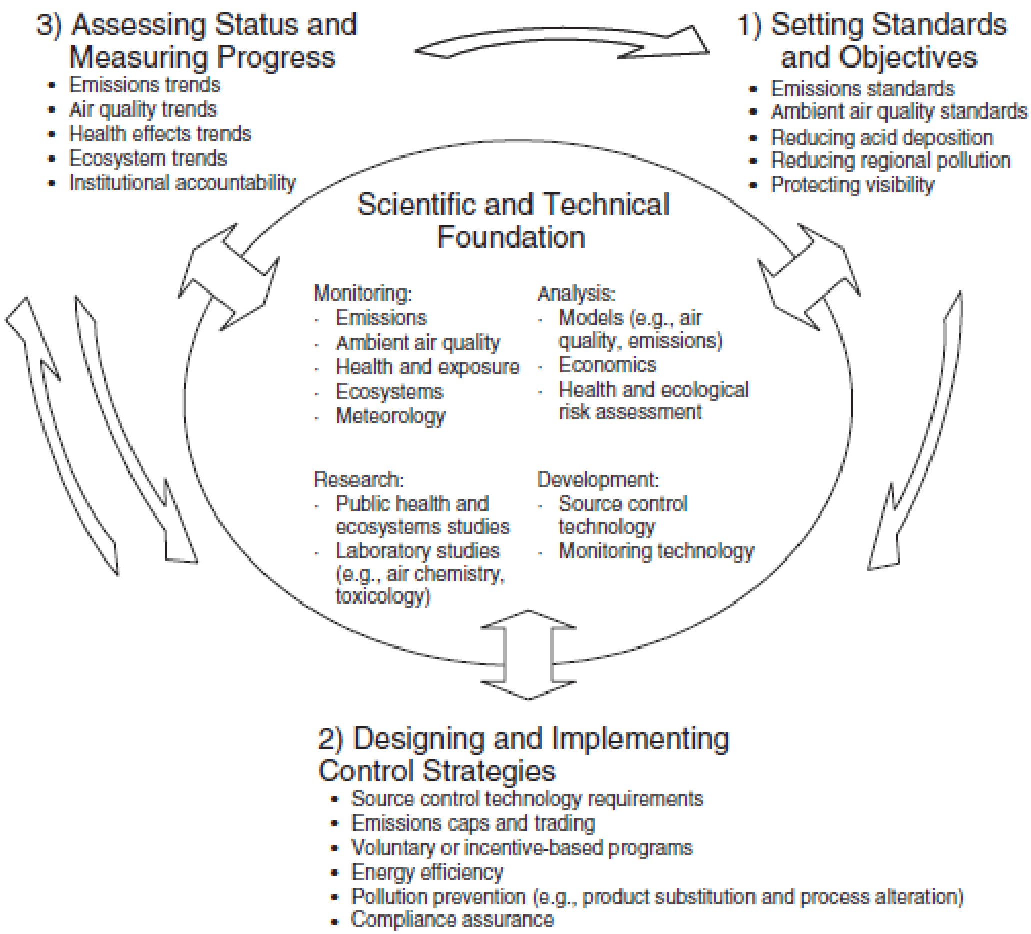
Track and Evaluate Results

Attain 3-5 years
Attain 3, 5-10 years
Attain, 5-10 (+2) years or 3, 6, 9, 15-17, 20 years (O_3)
Rule Effectiveness
CEMs
Tools:
- Monitoring (air quality, visibility, deposition, emissions)
- Receptor modeling

1970 Clean Air Act Amendments
1977 Clean Air Act Amendments
1990 Clean Air Act Amendments

Source: Bachmann, *JAWMA*, 2007

Scientific Foundation of U.S. AQM System



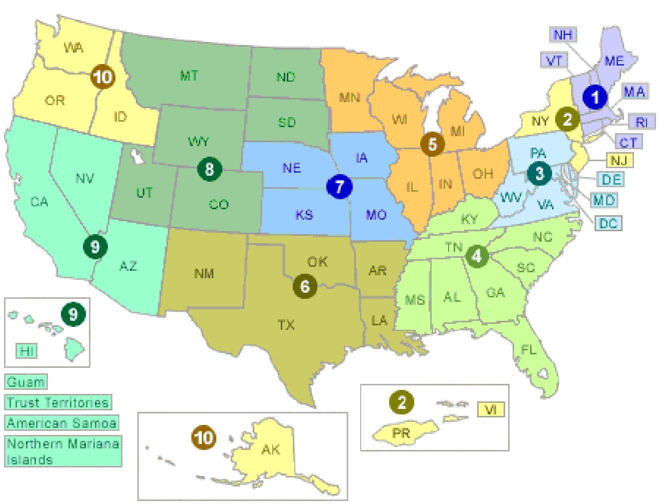
SOURCE: NRC (2004)

Basic Facts about U.S. National Ambient Air Quality Standards (NAAQS)

- The Clean Air Act directs U.S. EPA to identify and set two types of national standards for pollutants with adverse public health and environmental effects.
  - Primary standards protect public health with an adequate margin of safety, including the health of at-risk populations such as asthmatics, children, and older adults.
  - Secondary standards protect public welfare from adverse effects, including visibility impairment and known or anticipated effects on the environment (e.g., vegetation, soils, water, and wildlife).
- The Clean Air Act also requires EPA to review each standard and the science upon which that are based at least once every 5 years.
- US EPA established NAAQS for six criteria pollutants:
  - Ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, lead, and particulate matter (both PM10 and PM2.5)
- Air quality modeling is focus and key for NAAQS implementation
  - Federal rules (mobile sources, inter-state transport)
  - State Implementation Plans (SIPs)
  - Permit programs

Roles & Responsibilities under U.S. AQM System

- The EPA, other Federal agencies, and the 300+ State, local and tribal air quality agencies have worked since the enactment of the Clean Air Act to develop an effective partnership to achieve reductions in emissions of air pollutants nationwide.
- The EPA's Office of Air and Radiation (OAR) is responsible for administering the Clean Air Act and develops national programs, policies, and regulations for controlling air pollution and radiation exposure (http://www.epa.gov/aboutepa/oar.html)
- The EPA's Office of Research and Development (ORD) is the principal scientific and research arm of the Environmental Protection Agency (http://www.epa.gov/aboutepa/ord.html)
- EPA has ten Regional offices, each of which is responsible for the execution of the Agency's programs within several states and territories.



- EPA OAR = Conduct modeling in support of Federal rules and issue guidance to State/local/tribal agencies and stakeholders to promote national consistency & equity across programs
- EPA ORD = Atmospheric research and model development
- EPA Regional Offices = Reviewing authority
- State/local/tribal agencies = Conduct modeling for State Implementation Plans (SIPs) & issue permits
- Sources = Conduct modeling for permits

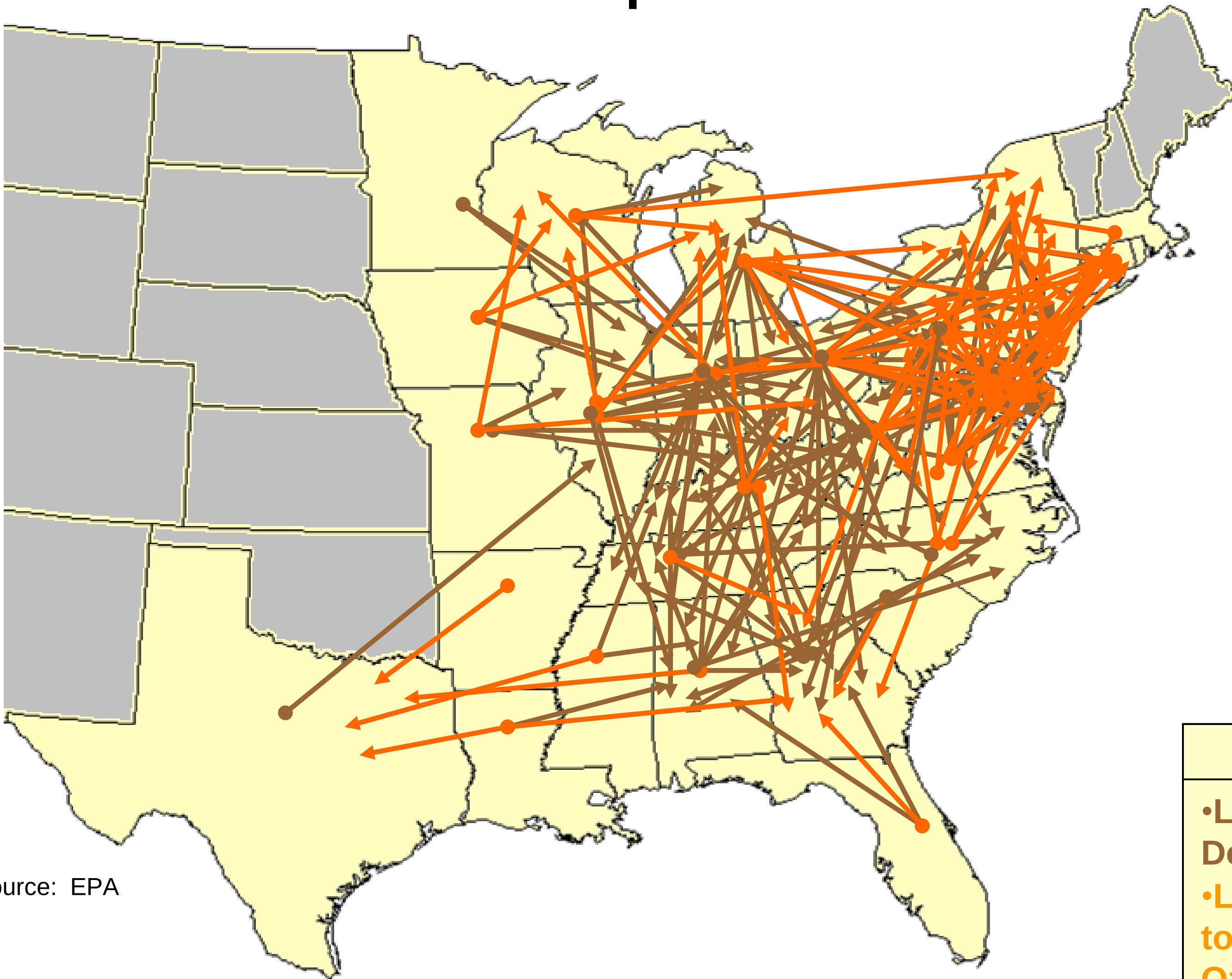
EPA/OAR's Air Quality Modeling Group

- Conducts air quality modeling for Agency regulatory and policy assessments
  - e.g., NOx SIP Call, Heavy Duty Diesel, Nonroad Rule, Clear Skies, CAIR, CAMR, NAAQS Regulatory Impact Analyses
- Provides guidance for the use of air quality models for SIP demonstrations and NSR/PSD permitting
  - O_3/PM/RH Modeling Guidance
  - *Guideline on Air Quality Models* (aka Appendix W)
- Partners and coordinates w/ others (e.g, ORD, NOAA, scientific community, etc) on model evaluations and development efforts

AQMG Activities

- Regulatory/Policy Modeling
  - Clean Air Interstate Rule (CAIR)—photochemical modeling serves as legal basis for rule
  - Regulatory Impact Analysis (RIAs)—modeling assesses ‘illustrative’ implementation scenarios and provides inputs to benefits analysis
- SIP Modeling Support to EPA ROs and State/local agencies
  - Updates to integrated O3/PM/RH SIP Modeling Guidance
  - Technical support and review of SIP modeling demos
- NSR/PSD Permit Modeling
  - Annual workshops and Modeling Conferences
  - AERMOD/CALPUFF Updates and Implementation
  - Model Clearinghouse, clarification memos, and R/S/L technical support
- Coordination with ORD
  - Multi-pollutant modeling platform
  - CMAS Center and CMAQ performance evaluations
  - AERMIC

Interstate Transport Problem Is Complex



- Upwind/downwind issues are not neat
- Demonstrations need to show individual source contributions
- Emissions and meteorology change over time

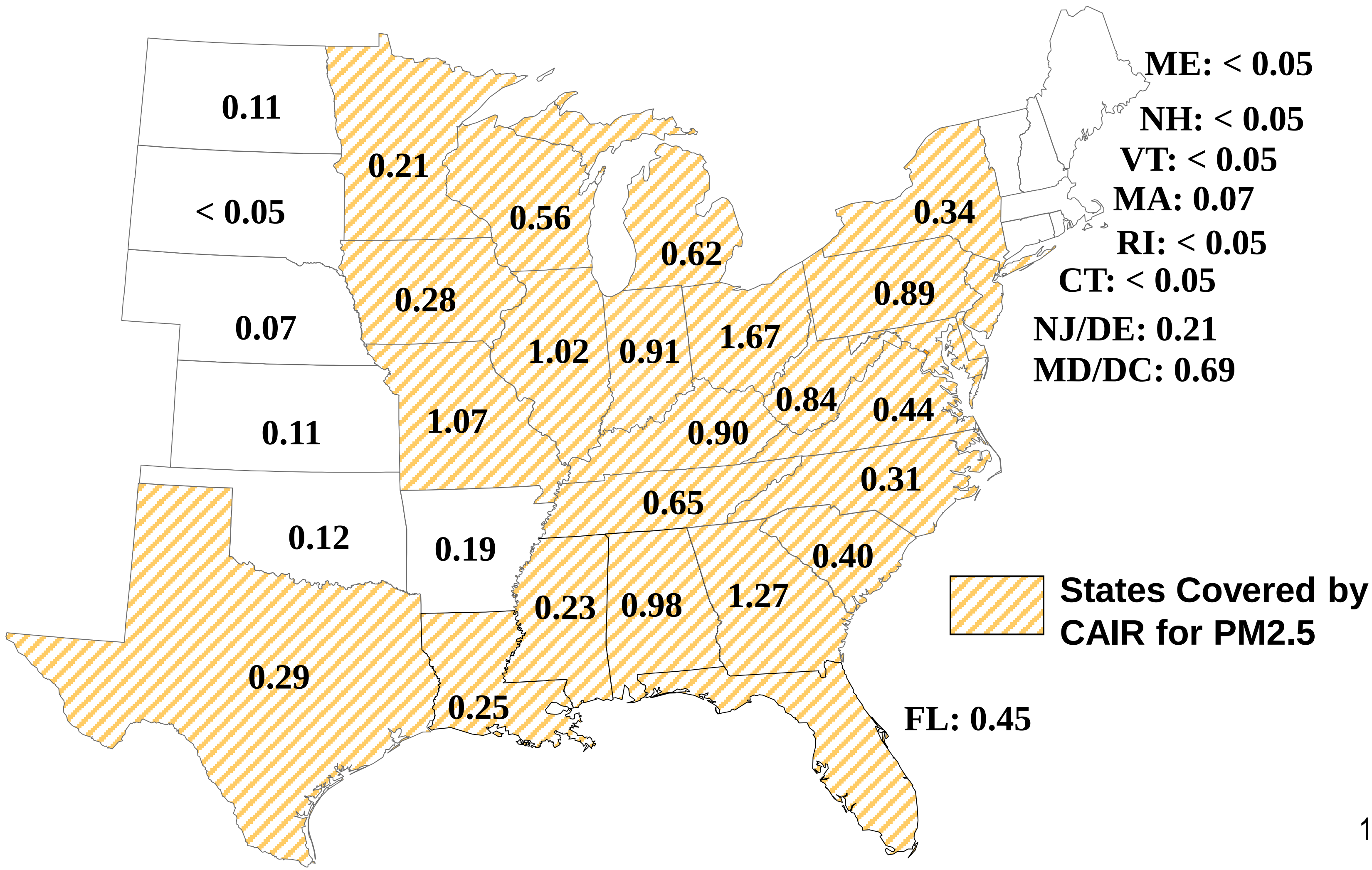
Key to Arrows

- **Linkage of Upwind to Downwind for $PM_{2.5}$**
- **Linkage of Upwind to Downwind for Ozone**

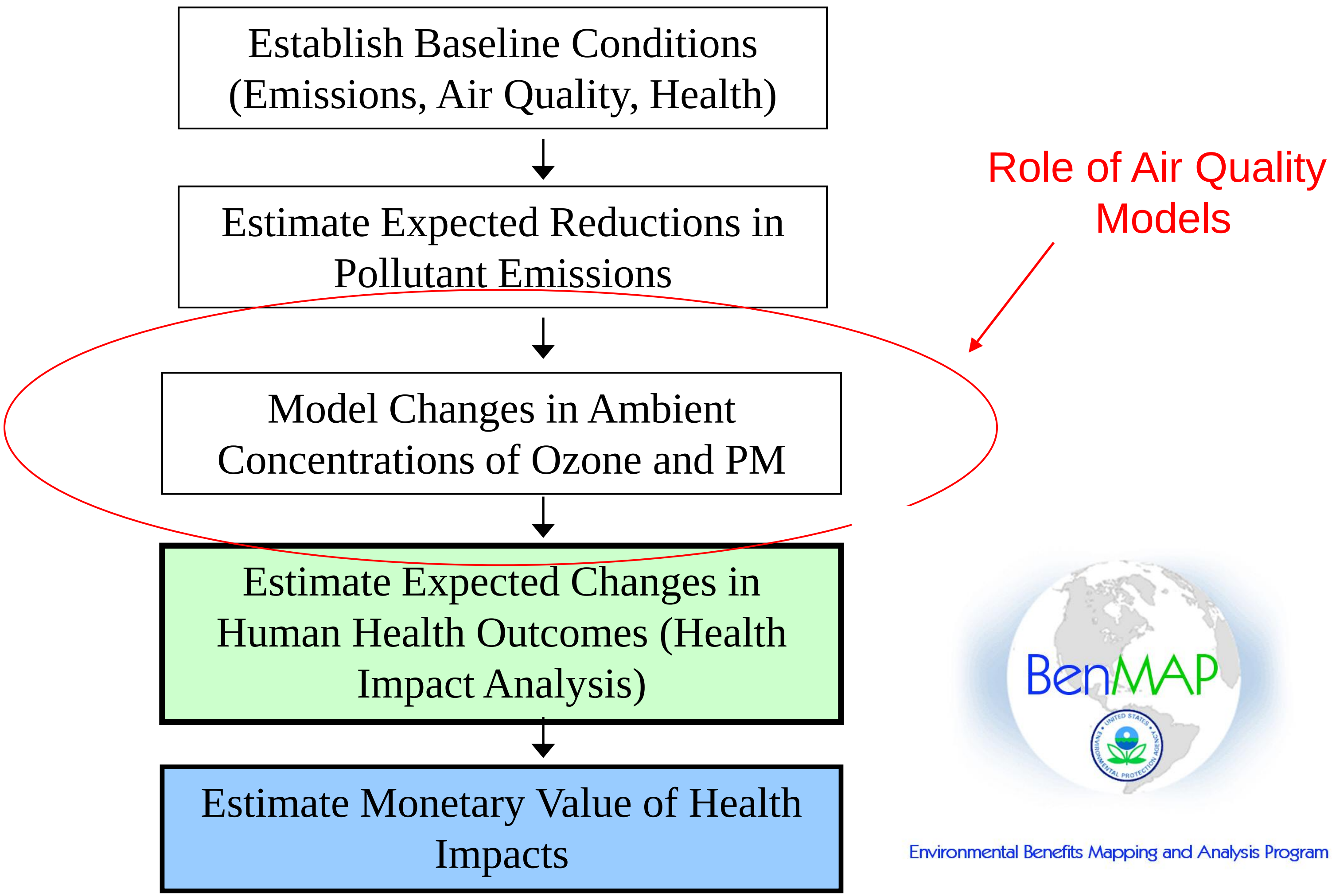
Source: EPA

CAIR Region 2010 Major Upwind-to-Downwind Linkages for $PM_{2.5}$ and Ozone

Maximum Contribution (ug/m^3) to PM2.5 Nonattainment in Other States
- Based on CAIR State-by-State Contribution Modeling -



Regulatory Impact Analysis: Elements of a Benefits Analysis



BenMAP

Environmental Benefits Mapping and Analysis Program

http://www.benmap-model.org/

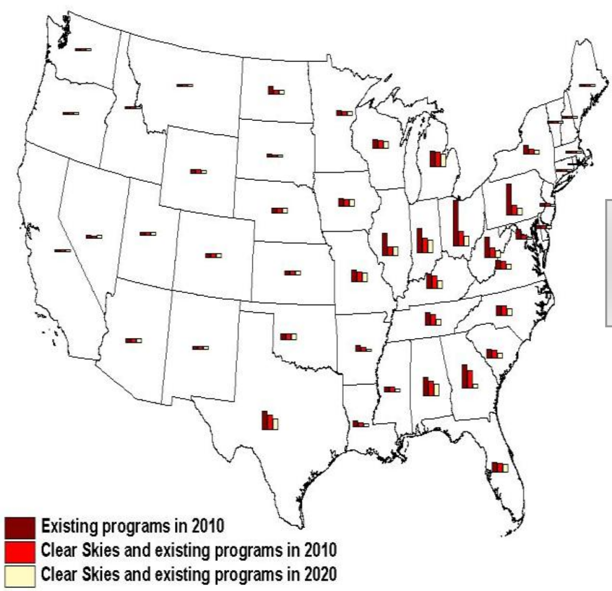
Role of Air Quality Models in Benefits Assessment

Emissions, Costs, and Other Impacts (IPM)

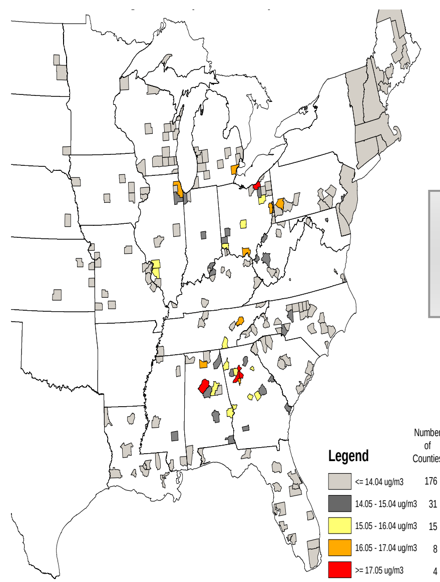
Air Quality Projections (CMAQ & CAMx)

Public Health and Environmental Benefits (BenMAP)

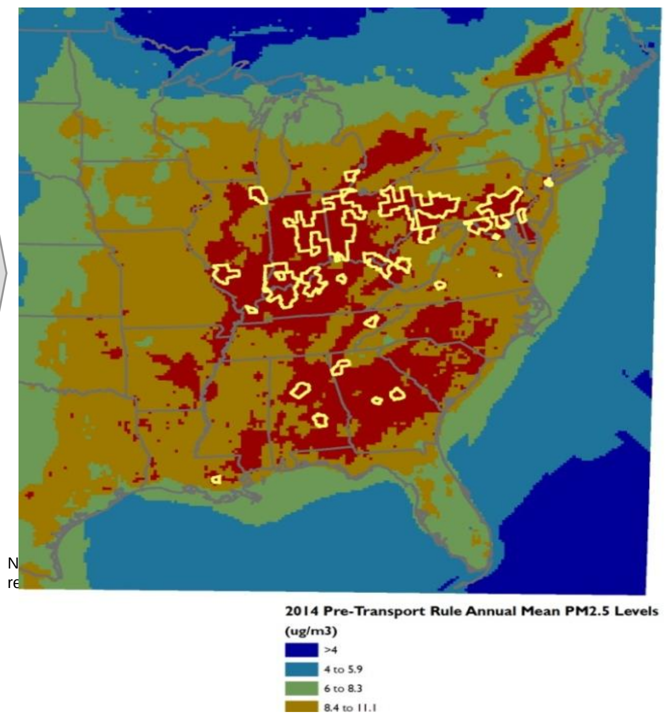
Power Sector Emissions of Sulfur Dioxide



Remaining Nonattainment Areas



PM2.5 Health Impacts



For EPA Regulatory Impact Analysis (RIAs) reports, please refer to:
http://www.epa.gov/ttnecas1/ria.html
2008 O3 NAAQS and 2006 PM NAAQS in particular

Ozone/PM2.5/Regional Haze Modeling Guidance

- "Guidance on the use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze"
  - Original draft- January 2001
  - Draft final- September 2006
  - Final version- April 2007

  http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf
- Unlike permit modeling, there is no "preferred model"
  - Models should meet Appendix W requirements for "alternative models"
- Models should be (same language as Appendix W):
  - Peer reviewed
  - Demonstrated to be applicable to the problem being addressed
  - Adequate data bases should be available to run the model
  - Model should be shown to have performed adequately in the past
  - Source code must be available at no cost (or for reasonable cost)
- Vast majority of States/RPOs have used either CMAQ or CAMx for ozone, PM2.5, and regional haze
  - Use of AERMOD for local primary PM2.5 issues (local area analysis)

"Relative Use" of Air Quality Models

- We use model estimates in a "relative" sense
  - Premise: models are better at predicting relative changes in concentrations than absolute concentrations
- Relative Response Factors (RRF) are calculated by taking the ratio of the model's future to current predictions of ozone or PM2.5 species
  - RRFs are calculated for ozone and for each component of PM2.5 and regional haze
  - Therefore, Future DV = Current DV times RRF
- Projected ozone and PM2.5 concentrations are, thereby, "tied" to ambient measurements that provides a more robust and scientifically credible future projection of air quality.
- Model Attainment Test Software has been developed to apply modeled tests
  - Performs ozone, PM2.5, and regional haze tests
  - Interpolates ambient data (where necessary) for ozone and PM2.5 tests
  - Creates "gradient adjusted" fused spatial fields using ambient data and model output for unmonitored area analysis

http://www.epa.gov/scram001/modelingapps_mats.htm

Guideline on Air Quality Models

- EPA's *Guideline on Air Quality Models* (also published as Appendix W of 40 CFR Part 51) was originally published in April 1978 to provide consistency and equity in the use of modeling within the U.S. air quality management system.
  - Most recent update was as part of 2005 AERMOD promulgation, available at: http://www.epa.gov/ttn/scram/guidance_permit.htm

- Addresses use of dispersion models for use in determining compliance with National Ambient Air Quality Standards (NAAQS), and other regulatory requirements such as New Source Review (NSR) and Prevention of Significant Deterioration (PSD) regulations.

- These guidelines are periodically revised to ensure that new model developments or expanded regulatory requirements are incorporated.

A Brief History of AERMOD

- Developed by AMS/EPA Regulatory Model Improvement Committee (AERMIC)
- Proposed as replacement for ISCST3 April 2000
- EPRI-sponsored PRIME downwash algorithms incorporated in AERMOD in 2001
- Promulgated December 9, 2005 as preferred model for near-field applications (< 50km) in EPA's *Guideline on Air Quality Models*, Appendix W to 40 CFR Part 51
- One-year "grandfather" period expired December 9, 2006
- The AERMOD Modeling System consists of:
  - AERMOD dispersion model—an advanced steady-state plume dispersion model
  - AERMET meteorological processor
  - AERMAP terrain processor
  - Non-regulatory tools in AERSURFACE and soon to be released AERSCREEN
- Evaluated on total of 17 Field Study Databases
  - 10 without Building Downwash, 7 with Downwash
  - 13 with Flat or Rolling Terrain, 4 with Complex Terrain
- AERMOD model last updated Oct. 19, 2009, version dated 09292—expect new release on SCRAM later in June 2010

AERMOD Implementation Issues

- EPA anticipated a number of implementation issues associated with promulgation of AERMOD as the preferred Guideline model
- **AERMOD Implementation Workgroup** (AIWG), consisting of Regional/State/Local modelers, initially formed in April 2005
- Issued final report in April 2006, including **57** issues prioritized and grouped; developed "**AERMOD Implementation Guide**"
- New AIWG formed early 2007 as "standing group" to advise OAQPS regarding AERMOD implementation issues
- New AERMIC committee also recently formed to provide scientific/technical support to OAQPS regarding AERMOD, held first meeting of new AERMIC committee in late March 2008

CALPUFF Modeling System

- To address needs for modeling Class I areas, EPA, National Park Service, Fish and Wildlife Service, and Forest Service formed the Interagency Workgroup on Air Quality Models (IWAQM) in 1990's.
  - In 1998, EPA published IWAQM Phase 2 report recommending CALPUFF for regulatory LRT model applications. Phase 2 report provided recommended settings for CALPUFF model control options (http://www.epa.gov/ttn/scram/7thconf/calpuff/phase2.pdf)
- In 2003, EPA promulgated the CALPUFF modeling system as its "preferred" model for Long Range Transport (LRT) model applications. IWAQM Phase 2 report becomes de-facto "recommendations for regulatory use" for regulatory CALPUFF applications.
  - May be considered as alternative model on case-by-case basis for near-field applications involving 'complex winds' subject to approval (AERMOD is preferred model for near-field reg apps)
- In 2005, EPA Regional Haze program recommends CALPUFF for single source visibility assessments. Application of CALPUFF for hundreds of sources highlights need to update IWAQM Phase 2 recommendations.
- In June 2007, EPA updated Regulatory Approved Version
  - CALPUFF version 5.8, level 070623
  - CALMET version 5.8, level 070623
  - CALPOST version 5.6394, level 070622

IWAQM Phase 3

- In 2008-2009, IWAQM reconvenes to update Phase 2 guidance and begin examining options for Phase 3. Goals include:
  - Develop evaluation databases and statistical evaluation framework
  - Reassess model performance to update guidance
  - Examine additional model platforms for Phase 3 process.
- In Summer 2009, EPA releases draft document "Reassessment of the Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report: Revisions to Phase 2 Recommendations" available at:
  http://www.epa.gov/ttn/scram/guidance/reports/Draft_IWAQM_Reassessment_052709.pdf
  - CALPUFF modeling system continued to evolve so IWAQM guidance no longer reflected current state of world
  - Followed by Clarification memo on EPA-FLM recommended settings for CALMET to facilitate more direct use of prognostic data in CALPUFF
    http://www.epa.gov/ttn/scram/CALMET%20CLARIFICATION.pdf
- IWAQM Phase 3 initiated with EPA and FLMs (2009) – evaluation of possible model platforms for development/adaptation for single source, full photochemistry model applications
  - "The final Phase (3) will consider the long-term, optimum modeling needs" –IWAQM Work Plan, May 1992
  - Drafting MOU for signatures by EPA and FLM Senior Management
  - Establish and implement process for review and identification of candidate models that address needs for impacts on AQRVs, PSD increments, and NAAQS at multiple scales

9th Modeling Conference

- EPA hosted this conference in RTP, NC on October 9-10, 2008 http://www.epa.gov/ttn/scram/9thmodconfpres.htm with detailed agenda included the following:
- Appendix W Refresher
- Non-Guideline Applications
  - National Air Toxics Assessment
  - Risk and Exposure Assessments
  - National Environmental Protection Act (NEPA)
- Use of Gridded MET in Dispersion Models
- Current Guideline Models
  - AERMOD
  - CALPUFF
- Review of Current and Available Model Evaluation Methods
- Review of New and Emerging Models/Techniques for Future Consideration
  - Long range transport modeling (particle, puff, etc.)
  - Single-Source Modeling for O3, PM2.5, and Visibility

Research & Application Roles: ORD/NERL & OAQPS

NERL | NERL | NERL/OAQPS | OAQPS

Atmospheric Chemistry Data & Models → CMAQ Model Development & Testing → Base Year Model Evaluation → Future Baseline & Control Case Applications

R&D → Testing & Evaluation → Applications/ Reg Assessment

AERMIC | AERMIC/NERL/OAQPS | OAQPS

Research Data & Algorithms → AERMOD Model Development & Testing → Performance Evaluation & Consequence Analysis → Model Applications & Guidance

AERMIC: Then and Now

- AMS/EPA Regulatory Model Improvement Committee initially formed in 1991; charged to develop replacement for ISCST based on state-of-the-science; AERMOD promulgated Dec. 2006
- New AERMIC committee first met in RTP on March 25-27, 2008
  - Membership of “new” AERMIC committee:
    - Roger Brode, OAQPS, Co-chair
    - Jeff Weil, CIRES-NCAR, Co-chair
    - Akula Venkatram, UC-Riverside
    - Al Cimorelli, EPA Region 3
    - Bret Anderson, EPA Region 7
    - Vlad Isakov, EPA/ORD/AMAD
    - Steve Perry, EPA/ORD/AMAD
- Formally meet 3 to 4 times per year with report outs at R/S/L workshop and pursuing coordinated research plan

EPA Administrator & OAR AA Priorities

Administrator Jackson

Action on Climate

Improve Air Quality

Working for Environmental Justice (EJ)

OAR AA Gina McCarthy

- Communicating Climate Science
- Federal Rules

- **Strengthen NAAQS**
- **Federal Rules**
- **International Clean Air Efforts**

- **Multi-pollutant Planning**
- Air Monitoring
- School Air Toxics

All of these demands stress and challenge our air quality modeling system and its current capabilities . . .

New Challenges

- All roads lead to and through new NAAQS
  - More stringent standards
  - Shorter averaging times including 1 hour stds for NO2 and SO2
  - Pursuit of modeling to support risk & exposure analysis
  - Renewed emphasis on near-field, source attribution, int'l tranport
- Stresses and challenges to air quality modeling
  - Permit modeling for PM2.5 & support new short-term NAAQS
  - Integration across multiple scales
  - Space and time predictions to support health and exposure research and assessments
  - "One-atmosphere" approach to inform multi-pollutant air quality planning

Ongoing National Ambient Air Standard Quality Reviews

	Lead	NO_2 Primary	SO_2 Primary	Ozone	CO	PM	NO_2/SO_2 Secondary
Proposal	New schedule being developed	Jun 26, 2009	Nov 16, 2009	Jan 6, 2010	Oct 28, 2010	Nov 2010	July 12, 2011
Final	Oct 15, 2008	Jan 22, 2010	Jun 2, 2010	Aug 31, 2010	May 13, 2011	July 2011	Mar 20, 2012

NOTE:

Underlined dates indicate court-ordered or settlement agreement deadlines.

National Ambient Air Quality Standards

Pollutant	Primary Standard(s)	Secondary Standard(s)	Date of Last Review
Ozone	0.075 ppm (8 hour)	Same as primary	2008
PM2.5	15 µg/m3 (annual) 35 µg/m3 (24 hour)	Same as primary	2006
PM10	150 µg/m^3 (24 hour)	Same as primary	2006
Lead	0.15 µg/m^3 (3 month)	Same as primary	2008
NO2	100 ppb (1 hour)	Same as primary	2010
CO	9 ppm (8 hour) 35 ppm (1 hour)	None, no evidence of adverse welfare effects	1994
SO2	0.03 ppm (annual) 0.14 (24 hour)	0.5 ppm (3-hour)	1996

NAAQS Status

- O3 NAAQS
  - On September 16, 2009, EPA announced that it is reconsidering the current levels of the ozone primary and secondary standards.
  - EPA expected to issue final rule by August, 31 2010
- NO2 NAAQS
  - On January 22, 2010, EPA strengthened the health-based National Ambient Air Quality for nitrogen dioxide (NO2) by setting a new 1-hour NO2 standard at the level of 100 parts per billion (ppb) (~190 µg/m3)
  - EPA established a new form for the 1-hour NO2 standard as the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour average concentrations.
  - EPA is considering the need for changes to the secondary standard under a separate review.
- SO2 NAAQS
  - On November 16, 2009, EPA proposed to strengthen the NAAQS for sulfur dioxide (SO2) by revising the primary SO2 standard, designed to protect public health, to a level of between 50 and 100 parts per billion (ppb) measured over 1- hour (~130 to 260 µg/m3)
  - EPA will issue a final rule by June 2, 2010.
  - EPA is considering the need for changes to the secondary standard under a separate review.

Upcoming Modeling Guidance for NO2 NAAQS

- EPA's current regulatory permit model, AERMOD will be used for modeling compliance with the NO_2 1-hr NAAQS, with additional guidance and tools to be provided to facilitate its use
- Provide clarification memo on how Appendix W's 3-tiered screening level procedures, involving the conversion of NOx to NO2, apply to new hourly standard
  - Tier I – Total Conversion of NO to NO2 (most conservative—100% conversion)
  - Tier II – Ambient Ratio Method (ARM) default of 0.75 likely too high for estimating hourly NO2 conversion.
    - Requires source oriented NO2 and NOx monitoring to develop a more site specific and representative hourly NO2 to NOx conversion ratio
    - Data unavailable in many cases to derive representative ratio
  - Tier III: Several alternative methods currently implemented in AERMOD model
    - Ozone Limiting Method (OLM) – limits amount of NO2 conversion by available ambient ozone
    - Plume Molar Volume Ratio Method (PVMRM) – limits conversion of NO2 by amount of ambient ozone that is able to mix into the NOx plume on an hourly basis

$PM_{2.5}$ Permit Modeling Guidance: Status

- Differences in nature of PM2.5 from other criteria pollutants and the form of the daily NAAQS standard means that standard modeling practices may not be appropriate
- Recognizing this and associated technical difficulties, PSD modeling for PM2.5 should be viewed as screening-level analysis similar to Appendix W approach for NO2 (Section 5.2.4)
- EPA recently issued draft conformity guidance for modeling the local air quality impacts of certain transportation projects on the PM2.5 and PM10 NAAQS.

  http://www.epa.gov/oms/stateresources/transconf/policy/420f10036.htm
- Issue PM2.5 permit modeling guidance
  - Compile experiences and recommendations into draft guidance by Fall 2010
  - Host workshop to discuss and gain public input on draft guidance
  - Issue “final” PM2.5 permit modeling guidance by end of year or early 2011

Range of Dispersion Model Applications Growing

- **Increasing demands to serve multiple purposes in our AQM system including . . .**
  - **Demonstrate Compliance with air quality regulations (NSR/NAAQS, PSD, etc.) for Regulatory Permitting**
  - **Estimate human exposures to criteria and air toxic pollutants for Exposure and Risk Assessments**
  - **Design Ambient Monitoring programs**
  - **Design/evaluate Air Pollution Control strategies**
  - **Provide estimates of Near-field Concentration Gradients to supplement photo-chemical grid model (CMAQ/CAMx) results to support Local Area Analyses for SIP demonstrations and urban area studies**

Requirements of Operational Regulatory Dispersion Models vs. ER Models

- Regulatory models need to predict the peak of the concentration distribution, unpaired in time and space, for comparison to AQ standards
- Emergency response models and models used for risk and exposure assessments require skill at predicting concentration distributions paired in time and space
  - Exposure modeling research requires finely resolved inputs of ambient concentrations (e.g., hourly/census block).
  - Near-roadway, source apportionment and other “hotspot” research requires characterization of pollutant dispersion at fine gradients
  - Evolving health research is creating new demand for finely resolved pollutant data ranging from sub-grid (e.g., 1 km CMAQ runs) to neighborhood/address-level scales
- Growing need for integrated exposure and risk-based approaches to health and environmental impact assessments places higher demands on dispersion model skill that will be difficult to meet

Improving our atmospheric models is critical for successful exposure/risk studies

- Need continued emphasis on improving our atmospheric models through support of our basic research & development
- Rigorous testing and evaluation are critical for necessary improvement in model inputs and science, e.g.,
  - Challenges with meteorology at fine scales
  - Complex urban environments
  - Improvements in local scale emissions inventories
  - Need more resolved local emissions
  - Modeling science to improve chemistry and physical processes at fine scales
- Better understanding and characterization of model uncertainty/variability at fine scales
- Need evaluation/comparison of techniques across applications

Why Use Prognostic Met Data?

- Meteorological data are key inputs to air quality models such as AERMOD and CALPUFF
- Recognize existing limitations and issues with current inputs such as NWS met data for AERMOD
  - Representativeness issues of observations for source locations
  - Upper air data sparsely located, especially in mountainous areas
  - Significant gaps in calms and variable winds
- Onsite meteorological data collection is expensive and time consuming
- However, these problems may be alleviated by using outputs from prognostic gridded meteorological models
  - Gridded meteorological models routinely generate datasets that could be beneficial for use in dispersion models
  - Gridded met data already used for regulatory modeling with CALMET/CALPUFF for long range transport applications

Concept Isn't New: IWAQM Phase 2

"Ultimately the desire is to use all of the meteorological fields generated by the primitive equation model as direct input to the air quality model(s) chosen by IWAQM. The IWAQM recommends an interim approach using these meteorological fields to generate "soundings" every 80 km and then using these as input to the various meteorological drivers of the chose air quality models."

-IWAQM Work Plan

May 1992

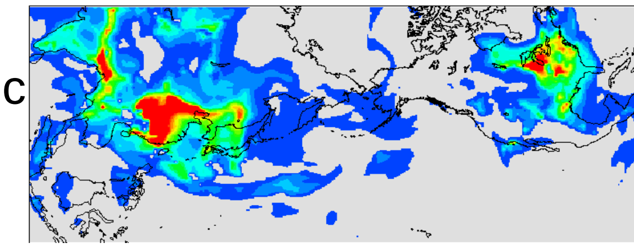
Use of Gridded MET: Activities & Plans

- MM5-AERMOD Tool
  - Evaluating use of MM5 data in AERMOD: used in Detroit MP study
  - Still in development and testing but potentially used in next National Air Toxics Assessment (NATA)
- Mesoscale Model InterFace (MMIF) version 1.0
  - Collaborative effort between EPA and FLMs to develop tool to deliver data directly to CALPUFF
    - Tool development, evaluation, documentation
    - EPA will need to develop guidance for R/S/L
    - Likely used in upcoming Alaska OCS permits along with model clearinghouse
- Provided details at 9th Modeling Conference and AWMA Specialty Conference but must complete ongoing development work with guidance before use in regulatory modeling

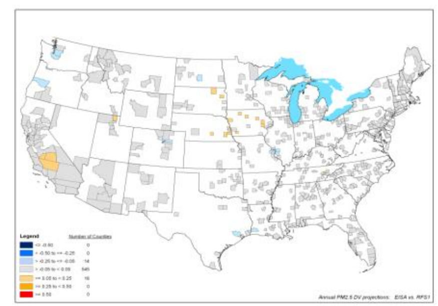
CMAQ as Core for EPA's Multi-Scale Modeling Efforts

Community
MULTI-SCALE
Air Quality
Model

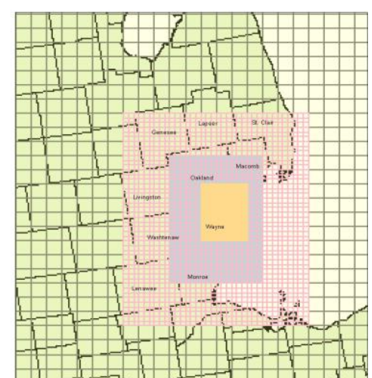
Hemispheric



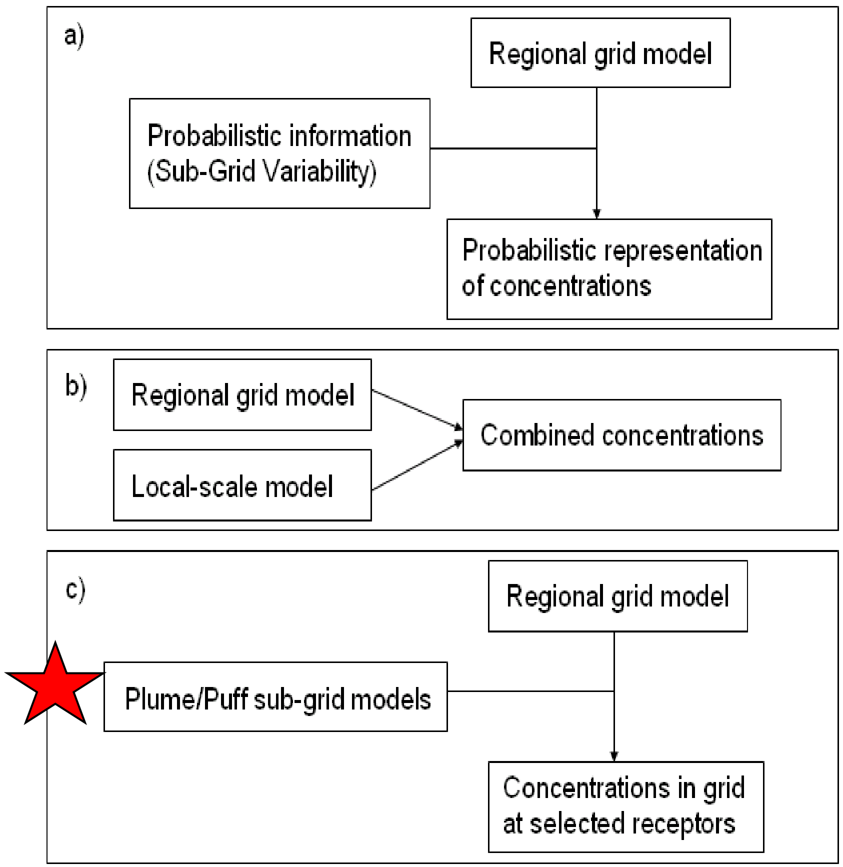
Nat'l/Regional

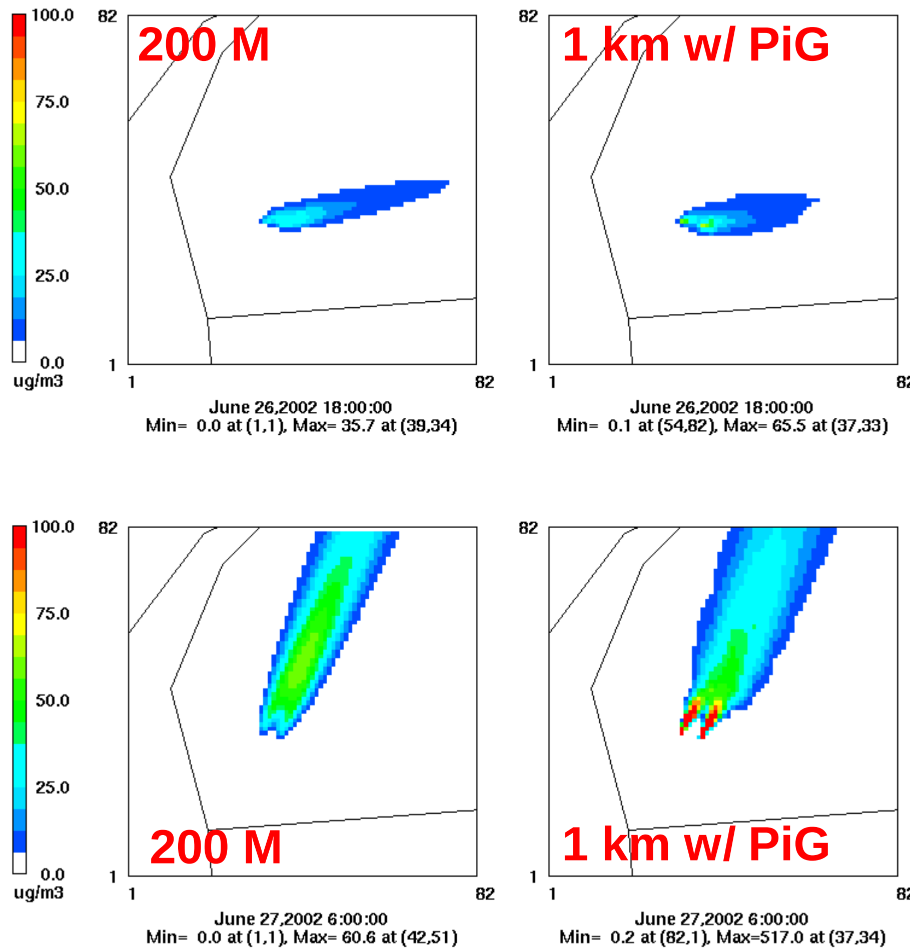


Urban



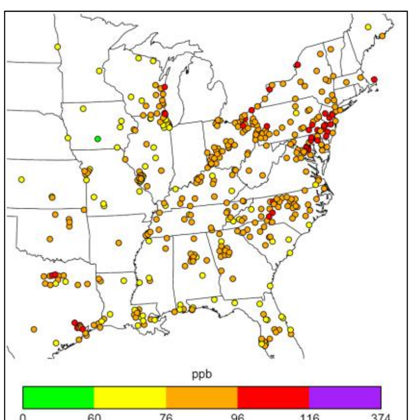
Approaches to Sub-grid Treatment: Spatial plot graphics from Illinois Environmental Protection Agency





Improve Spatial Prediction with Combined Air Quality Data

- Issue: Cannot monitor at all locations, but want to know pollution everywhere
  - Typical Solution: use kriging to interpolate air monitoring data, but
    - Monitoring data is spatially sparse, some areas have no monitors
    - Use of classical kriging techniques may introduce arbitrarily large prediction errors in these areas
- New Solution: Consider Combined Observation-Prediction Approaches
  - Better air quality input for modeling linkages to public health data
  - More accurate delineation of pollution non-attainment areas
- What Does the Combined Approach Provide ?
  - Draw on strengths of each data source in more fully characterizing air quality



Observed Concentrations

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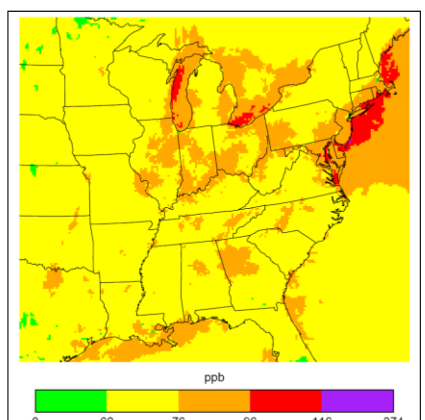

Photochemical Model Estimates

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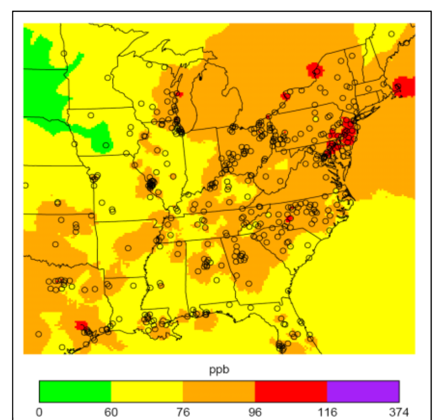
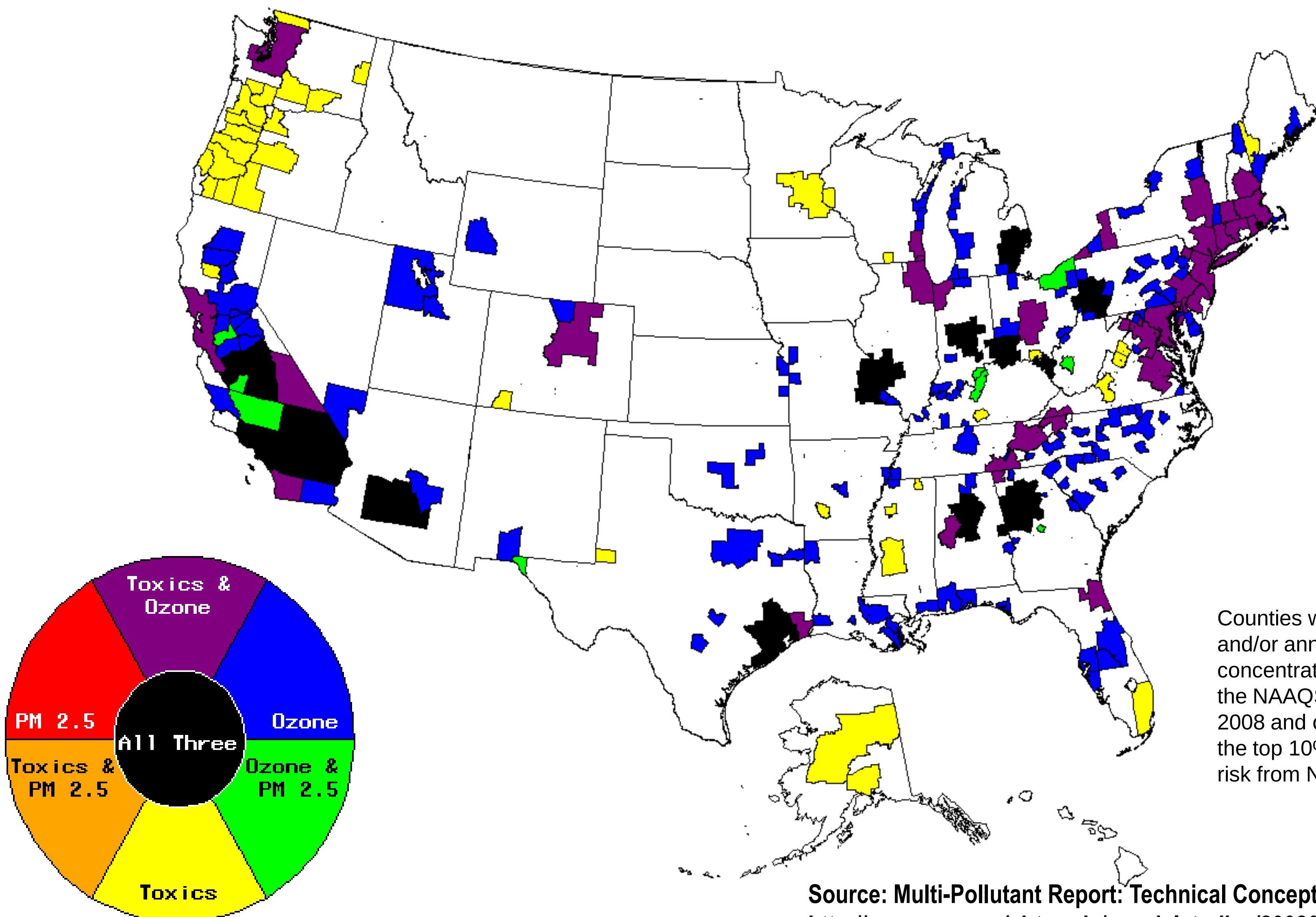


Statistical Air Quality Predictions

Nature of Multi-pollutant Air Quality Problems in US

Many urban areas have O3, PM, <u>and</u> air toxics problems.



Counties with ozone and/or annual PM2.5 concentrations above the NAAQS for 2006-2008 and counties in the top 10% of modeled risk from NATA 2002

Source: Multi-Pollutant Report: Technical Concepts & Examples
http://www.epa.gov/airtrends/specialstudies/20080702_multipoll.pdf

One-Atmosphere Approach

Mobile Sources

Cars, trucks, planes, boats, etc.

Industrial Sources

Power plants, refineries/ chemical plants, etc.

Area Sources

Residential, farming commercial, biogenic, etc.

Chemistry

Meteorology

- Ozone
- PM
- Acid Rain
- Visibility
- Air Toxics
- Atmospheric Deposition
- Climate Change

Background on EPA work

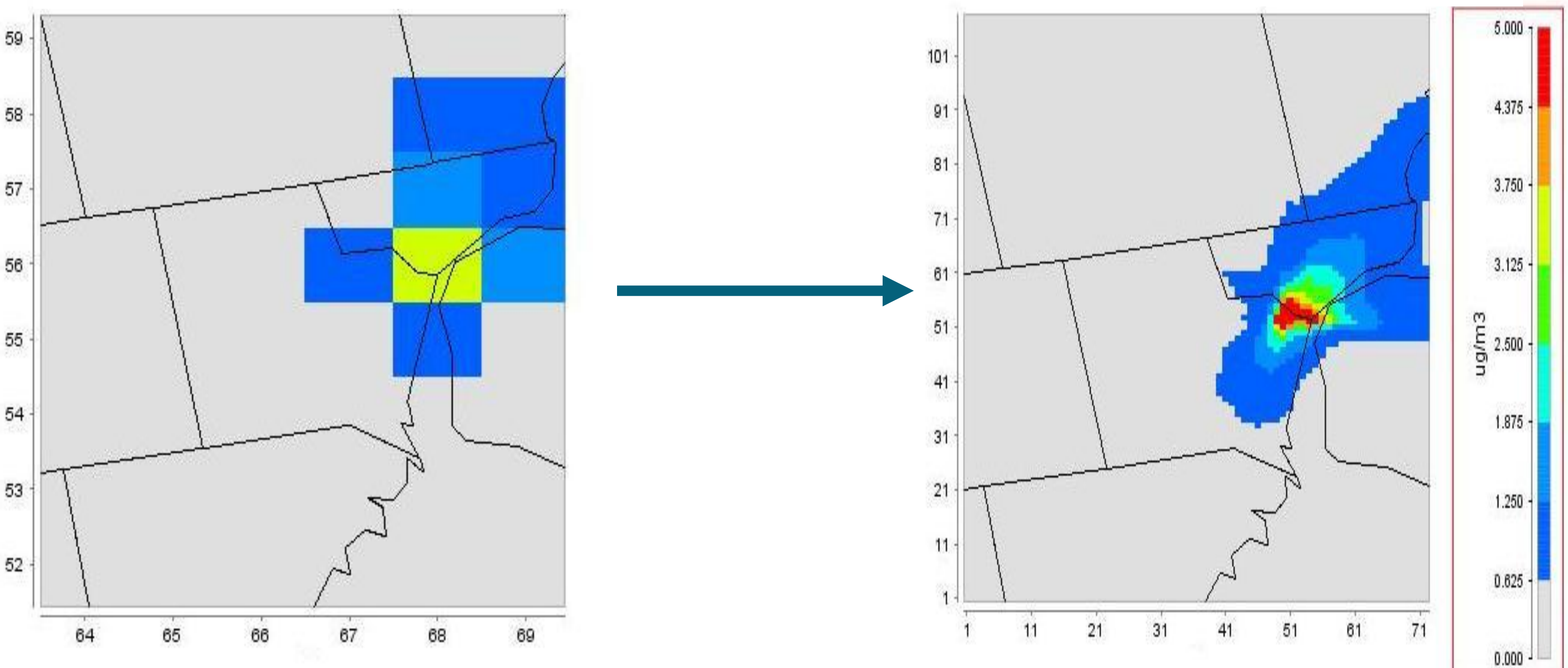
- Detroit multipollutant & multiscale assessment
  - Photochemical model/AERMOD hybrid approach too resource intensive
  - Found that 4 and 1 km modeling useful for matching up to available health endpoint data
  - Fine scale emissions input to model very important to capture primary and secondarily formed pollution
  - Sub-grid plume treatment and sub-grid receptors useful for characterizing near-field improvements in air quality for controls at large point sources
- Fused surfaces integrating observations and model estimates
  - Efforts like CDC-PHASE provide air quality characterizations for some purposes but not detailed health studies or integrated modeling studies (i.e., linking models)

Detroit Multi-pollutant Pilot Project: What We Learned

Higher resolution modeling allows us to combine more detailed knowledge of urban air quality with local health data. This provides states with information they need to make informed decisions about multi-pollutant, risk-based control strategies.

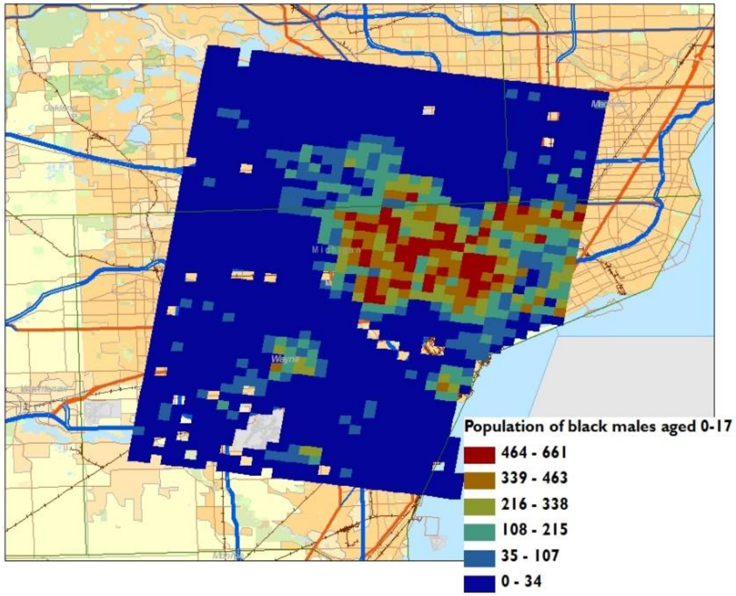
Lower resolution (12 km)

Higher resolution (1 km)

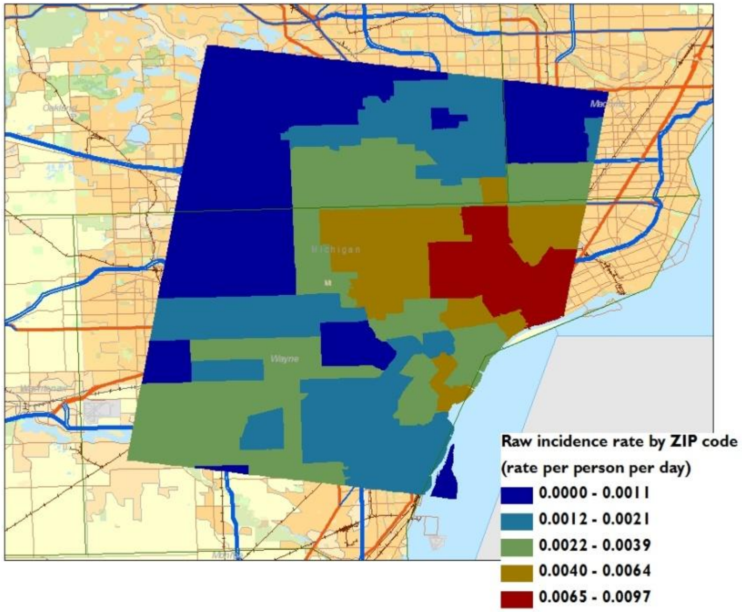


Local air quality, demographic and health data can be used to inform decisions on multi-pollutant, risk-based emissions control strategies and maximize city-level health benefits. Provides health benefits to vulnerable and susceptible populations.

African-American males aged 0-17

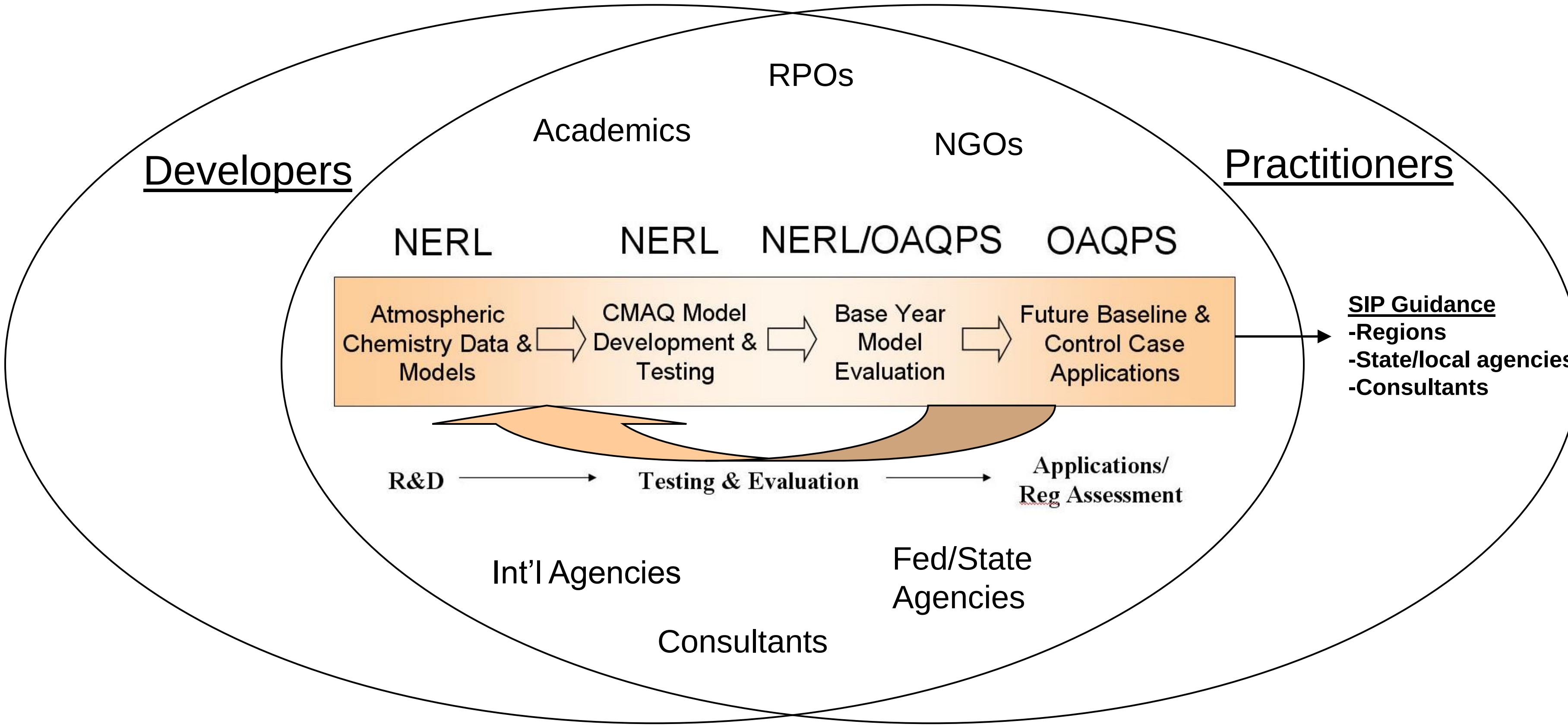


Hospitalization rates for asthma among children



		Status Quo	Multipollutant, Risk-based Approach
Total Benefits (M 2006$)		**$1,127**	**$2,385**
Change in pop-weighted $PM_{2.5}$ Exposure (ug/m^3)	*Regional*	*0.16*	*0.1666*
	Local	*0.2703*	*0.7211*
Change in pop-weighted O_3 Exposure (ppb)	*Regional*	*0.0005*	*0.0006*
	Local	*0.0318*	*0.0583*
Total Costs (M 2006$)		**$56**	**$66**
Cost per $\mu g/m^3$ $PM_{2.5}$ reduced		*$0.50*	*$0.32*
Cost per ppb O_3 reduced		*$2.6*	*$0.58*
Net Benefits (M 2006$)		**$1,071**	**$2,319**
Benefit-Cost Ratio		**20.1**	**36.1**

Broaden Model Development, Evaluation, Application Paradigm



Engage entire community to learn from model evaluation and applications to identify performance issues and direct model development efforts to improve models in policy-relevant areas through independent and collaborative efforts

Avenues for Collaboration

- Conferences such as HARMO and AWMA Specialty Conferences on dispersion models
- LRTAP/HTAP meetings and interactions
- Special projects
  - Air Quality Model Evaluation Int'l Initiative (AQMEII)
  - Model inter-comparisons stress need for new field study databases
- Work together and better engage with public health community
  - For example, special session at CMAS conference this Fall on "Air Quality Science: An Essential Ingredient for Air Pollution Health Studies"

  http://www.cmascenter.org/conference/2010/call_for_papers.cfm?temp_id=99999
- 10th Modeling Conference
  - EPA expects to host in Fall 2011 in EPA facility in Research Triangle Park, NC
  - New NAAQS and other regulatory needs will likely require some detailed discussions on modeling capabilities to meet these challenges
  - Likely ask for community input on potential revisions to regulatory model(s) and App W updates