Environmental Benefits Mapping and Analysis Program

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Air Benefits and Cost Group

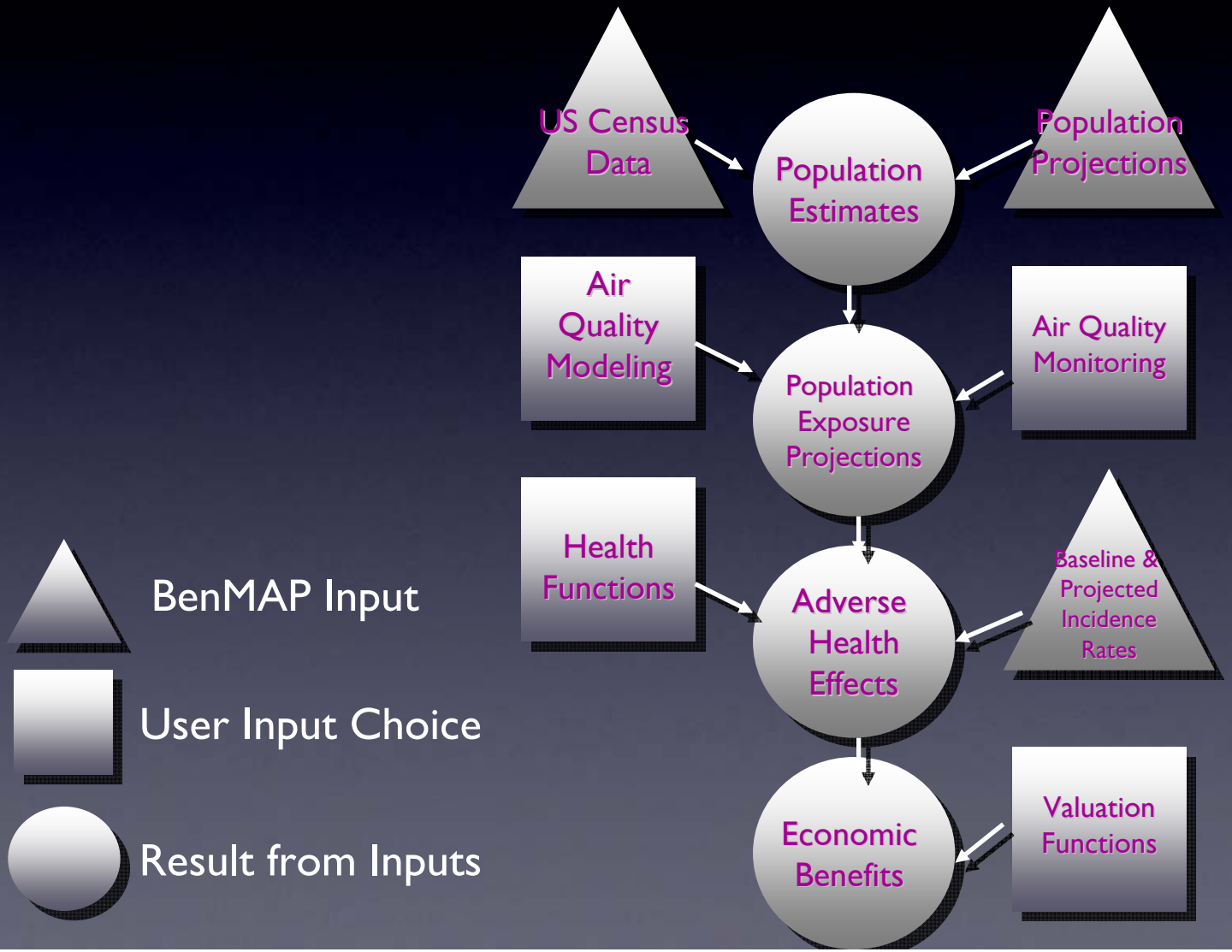
Overview

- What kinds of questions can BenMAP answer?
- What is the scientific foundation underlying the model?
- How do we use BenMAP to estimate human health benefits of improvements in air quality?
- How do we estimate full attainment benefits?
- On what projects has BenMAP been used?
- Next steps for BenMAP development

What Kinds of Questions Can BenMAP Answer?

- What are the benefits of modeled or monitored changes in ambient $PM_{2.5}$, PM_{10} and Ozone?
- What would the benefits be of a hypothetical reduction in $PM_{2.5,}$ PM_{10} and Ozone?
  - "What if Ozone levels were reduced by 20 percent in Texas?" or
  - "What is the impact of just attaining a 50 ug/m3 daily $PM_{2.5}$ standard?"
- What are the benefits of a modeled or hypothetical change in $PM_{2.5}$, PM_{10} and Ozone in South Korea?

The Data BenMAP Uses to Perform a Benefits Analysis



BenMAP Data Libraries

- Incidence rates
  - A variety of incidence rate data covering numerous health effects
- Affected populations
  - 2000 Census data and projections to 2025 for 250 age/sex/race population subgroups
- Estimated pollutant effect coefficients
  - Hundreds of concentration-response functions from the epidemiology literature
- Estimated/modeled changes in ambient air pollution
  - BenMAP can estimate population level exposures based on modeled or monitored air quality, or a combination of both
- Estimated values for avoided health effects
  - Hundreds of health effect-specific values

Key Features of BenMAP

- User-friendly experience
  - Driven by windows-based graphical user interface
  - Enables users to perform a standardized or highly customized analysis
  - Results (exposure, incidence, and valuation) available in a variety of formats including ASCII, .dbf, and shape files
- Comprehensiveness
  - Model includes a substantial population, health and air quality databases
  - Model incorporates an integrated GIS mapping, query, and statistics tool
- Flexibility
  - Users can add their own population, air quality, and health databases

Peer Review of BenMAP

- BenMAP was peer-reviewed in Spring 2004.
  - The peer-review report is available on the BenMAP website and is included with all distributed CD-ROMs.
  - EPA's peer-review guidance was followed to ensure an independent, expert review.
- Peer review overall was very supportive of BenMAP model
  - Reviewers provided several comments we have now addressed

Analytical Transparency

- BenMAP designed for public use and public scrutiny
- Published a detailed User's Guide with extensive appendices documenting model algorithms and data sources
- With each run, the user can generate an "audit trail" listing details of the run for QA and comparison with other analyses
- Consistent with Data Quality Guidelines, this "audit trail" can and should be shared with reviewers

What Health Effects Does EPA Quantify?

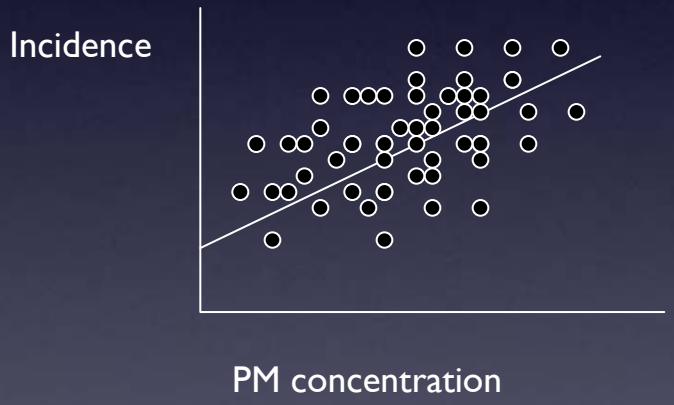
	Particulate Matter	Ozone
Current		
Mortality	✓	✓
Chronic bronchitis	✓	
Nonfatal heart attacks	✓	
Hospital admissions	✓	✓
Asthma ER visits	✓	✓
Acute respiratory symptoms	✓	✓
Asthma attacks	✓	✓
Work loss days	✓	
Worker productivity		✓
School absence rates		✓

Scientific Foundation for EPA Air Benefits Analyses

- We apply a "benefits transfer" technique
  - The science and art of adapting primary research from similar contexts to obtain the most accurate measurements of benefits
  - Benefits analysis approach supported by NAS (2002)
- BenMAP includes health impact and valuation functions from peer-reviewed sources
- BenMAP peer reviewed in 2004

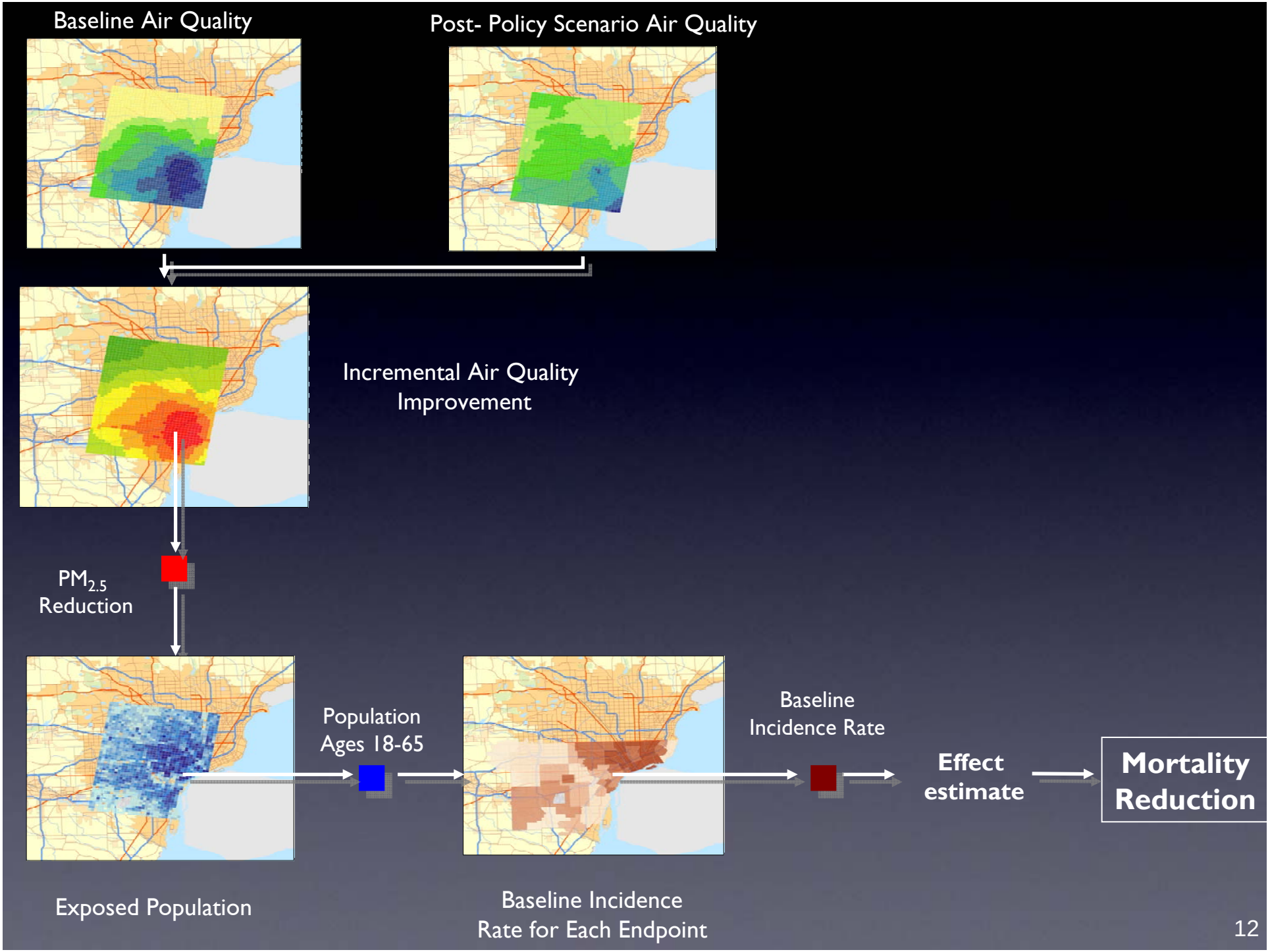
Scientific Foundation for BenMAP: Derivation of Health Impact Functions

Quantitative relationship between PM exposure and incidence of health effect



Estimated change in incidence calculated with the following variables:

- f (change in ambient PM levels, the PM effect estimate)
- Baseline incidence rate
- The population exposed


Baseline Air Quality
Post- Policy Scenario Air Quality
Incremental Air Quality Improvement
$PM_{2.5}$ Reduction
Population Ages 18-65
Baseline Incidence Rate
Effect estimate
Mortality Reduction
Exposed Population
Baseline Incidence Rate for Each Endpoint

Scientific Foundation for BenMAP: Valuing Health Outcomes

- Cost of Illness (COI)
  - Medical expenses for treatment of illness
  - Captures the money savings to society of reducing a health effect
  - Ignores the value of reduced pain and suffering
- Willingness To Pay (WTP)
  - Lost wages, avoided pain and suffering, loss of satisfaction, loss of leisure time, etc.
  - Measures the complete value of avoiding a health outcome
- Quality adjusted life years (QALY) – measured in terms of "healthy" life year equivalents rather than dollars

Scientific Foundation for BenMAP: Valuing Health Outcomes

- Example: Value of a *statistical* life saved
  - 1 $\mu g/m^3$ reduction in pollutant concentration produces decrease in mortality risk of 1/10,000
    - For every 10,000 individuals, one individual would be expected to die in the absence of the reduction in PM concentrations
  - WTP for this 1/10,000 decrease in mortality risk is $500
  - Value of a *statistical* life is 10,000 x $500 = $5 million
- Mortality benefits have accounted for about 90% of the total benefits of $PM_{2.5}$ air rules

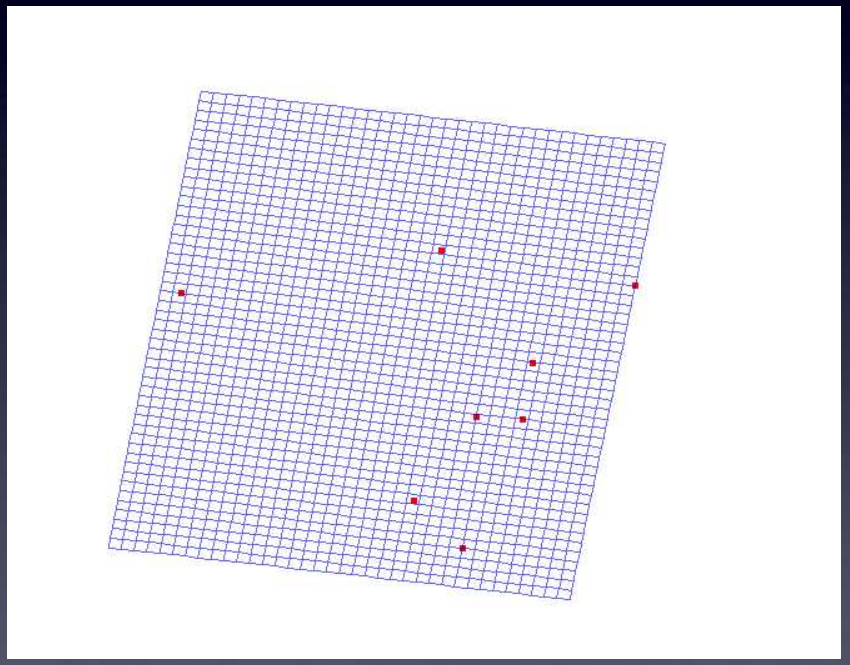
Estimating Full Attainment Benefits

- Analytical challenges
  - Single modeled scenario for 0.070 ppm alternative will not simulate attainment in all areas for all standard alternatives
  - Must estimate benefits of full attainment with each standard alternative

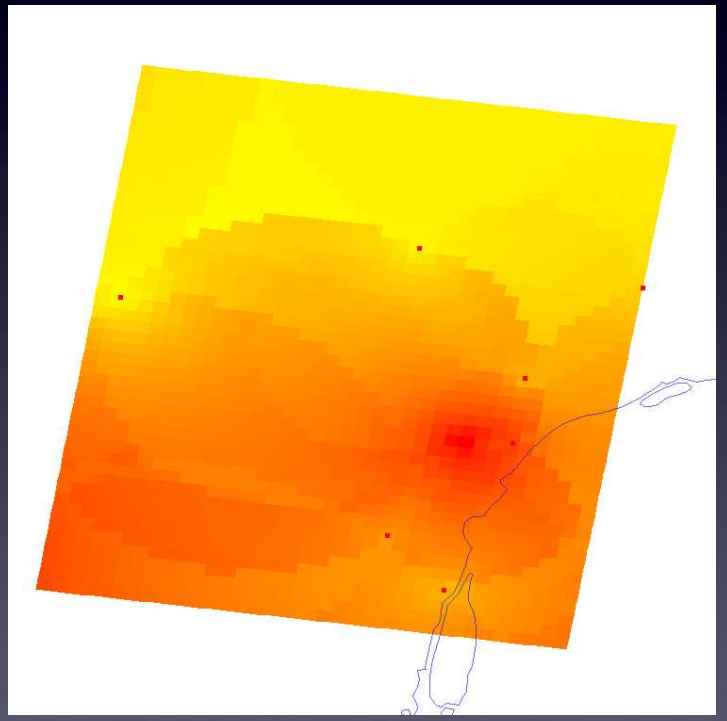
Estimating Full Attainment Benefits

- Brief Review of Proposal Methodology
  - 0.070 ppm and 0.065 ppm attainment: roll back ozone monitors
  - 0.079 ppm and 0.075 ppm attainment: interpolate benefits

Monitor Rollback



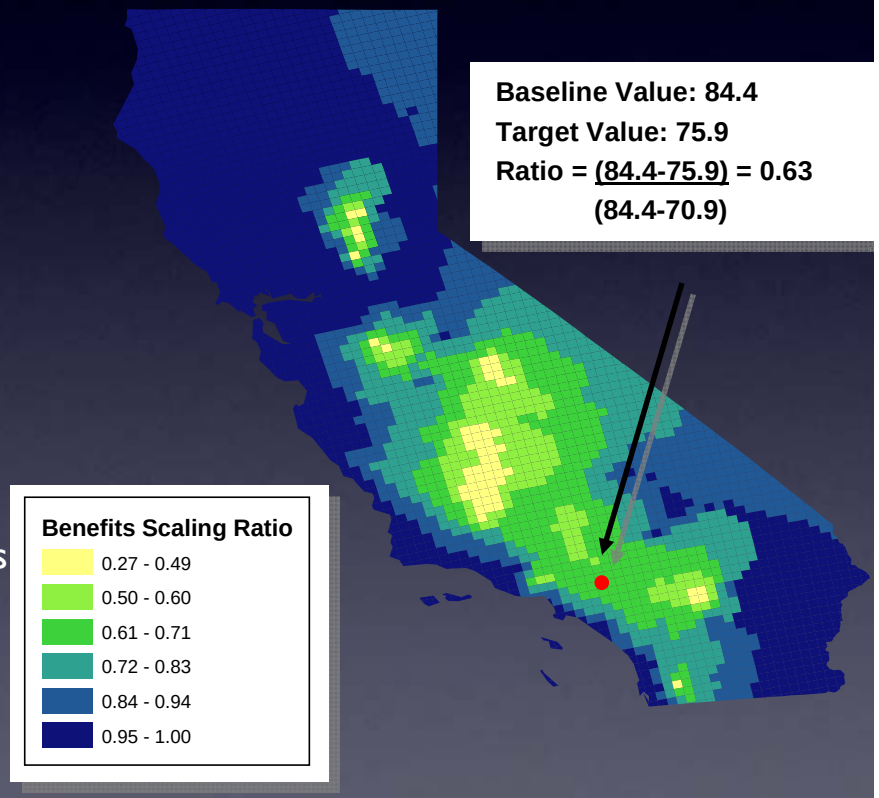
First "roll back" monitors so that they just attain the standard alternative. Import the monitors to BenMAP as point data



Next, perform VNA interpolation in BenMAP to create a spatial surface. This new surface represents the full attainment of the standard alternative

Example Interpolation Technique

- 0.075 ppm benefits derived through interpolation technique
- Process:
  - Use existing benefits estimate of attaining 0.070 incremental to 0.084
  - Identify any monitor projected to not attain 0.075 ppm in baseline
  - For that monitor, calculate a scaling ratio
  - Perform spatial interpolation of scaling ratios in BenMAP to create grid-level scaling ratios
  - Multiply grid-level incidence and valuation estimates by grid-level scaling ratio



Estimating Full Attainment Benefits

- Planned methodology for final RIA
  - 0.070 ppm and 0.065 ppm attainment: exploring the use of the sensitivity runs as basis of extrapolation
  - 0.079 ppm and 0.075 ppm attainment: use a modified version of the interpolation technique
    - Constrain the interpolation to those counties that would have emission controls applied to meet 0.079 ppm and 0.075 ppm

Use of BenMAP in EPA Analyses

- Past Projects:
  - Non-Road Diesel Rule
  - Clean Air Interstate Rule
  - $PM_{2.5}$ NAAQS
  - Small Spark Ignition Rule
  - Locomotive and Marine Diesel Rule
  - Ozone NAAQS
- Upcoming Projects:
  - SO_2 NAAQS
  - NOx NAAQS

Other BenMAP Projects

- FAA aircraft analysis
- Oregon woodstove analysis
- New York City Department of Health borough-level analysis
- Georgia Department of Natural Resources SIP planning
- Philadelphia diesel $PM_{2.5}$ benefits analysis

BenMAP International Projects

- China: Benefits analysis of EGU control strategy. Chinese analyst recently visited RTP for training.
- South Korea: Health benefits of Seoul air quality management plan
- Latin America: Benefits of air quality improvements in Mexico City, Saõ Paulo, Santiago
- India: Benefits analysis in Mumbai

Future Directions for BenMAP

Enhancement

Improving cost of illness estimates and the baseline incidence and prevalence data for BenMAP and the NAAQS risk assessments

Improving one-step analysis feature

- Diesel PM Analysis Tool
- Distributional Analysis Tool
- Visibility Benefits

Community Modeling Analysis and Support

Incorporate ability to model air toxics benefits