Science-Based Policies for Particulate Matter Air Quality Management in California

Particulate Pollution in the San Joaquin Valley: Translating Science into Policy

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About Us

- Planning and Technical Support Division
  - Air Quality Data Branch – Karen Magliano, Chief
    - Meteorology, gas-phase, and particulate matter (PM) data quality assurance; statistical analyses; corroborative analyses; PM\textsubscript{2.5} SIP development; ……
  - Modeling and Meteorology Branch – John DaMassa, Chief
    - Prognostic meteorology modeling, emissions inventory development, 3-D grid-based photochemical modeling of ozone and PM, model improvements, corroborative analyses, field program support, ……
Introduction

- California has the most severe PM$_{2.5}$ air quality problem in the nation
- Areas must meet federal PM$_{2.5}$ air quality standards between 2015 (annual) and 2019 (24-hour)
- Advanced modeling and data analyses methods are critical to the design of effective control programs
PM2.5 Nonattainment Areas

- Two areas violate federal annual standard – plans submitted in 2007/8
- Seven areas violate revised 24-hr standard – plans are due in 2012
Weight-of-Evidence Approach

- U.S. EPA now requires an integrated assessment of technical information in attainment demonstrations
- Weight-of-evidence approach includes (but not limited to):
  - Conceptual model
  - Grid-based photochemical modeling
  - Receptor/other modeling
  - Air quality and emission trends
Field Studies Provide Technical Foundation

- California Regional PM Air Quality Study (CRPAQS)
- South Coast MATES program
- CalNex
Key Questions Addressed by Field Studies

- What is the spatial and temporal variability of PM and where is public exposure the greatest?

- What meteorological conditions are most conducive to PM formation? What is the role of transport?

- Which chemical constituents are the largest contributors? What are the sources?

- What are the most effective precursors to control?
Nature of the PM$_{2.5}$ Problem

San Joaquin Valley Air Basin
National PM2.5 Annual Average
(2006)

South Coast Air Basin
National PM2.5 Annual Average
(2006)

PM$_{2.5}$ (µg/m$^3$)
- Less than 15.1
- 15.1 - 17.0
- 17.1 - 19.0
- 19.1 - 21.0
- 21.1 - 23.0
PM$_{2.5}$ Chemical Speciation

**2004-2006 Average Composition Fresno**
- OC: 41%
- AmmNitrates: 37%
- AmmSulfate: 11%
- Geological Elements: 4%
- EC: 5%

**2003-2005 Average Composition Rubidoux**
- OC: 29%
- AmmNitrates: 44%
- AmmSulfate: 15%
- Geological Elements: 5%
- EC: 2%

Case Study

Residential Wood Burning Controls
Wintertime Organic Carbon Distribution

Chow et. al. 2005
Diurnal Profiles for Carbon

Chow et. al. 2006
Daily Woodsmoke Markers at Fresno

Gorin et. al. 2005
Individual Particle Analysis at Fresno

Qin et al. 2006
Woodsmoke Regulations

- San Joaquin Valley adopted a regulation addressing residential wood burning in 2003. Elements include:
  - Mandatory curtailment program
  - Restrictions on new construction
  - Restrictions on sale of woodstoves
- Regulation was further amended in 2008
- Similar regulations adopted in Sacramento and San Francisco Bay Area
Fresno: Pre-Rule and Post-Rule Violation Days

Lighthall et al., 2008
Case Study

$\text{NO}_x$ vs. Ammonia Controls
Wintertime Nitrate Distribution

Chow et al., 2005
Hourly concentrations of NO, O₃, and Nitrate at 90 m on Angiola Tower

McCarthy et al., 2004
Ambient Indicator Species Ratios

Angiola Monitoring Site

McCarthy et al., 2005
Grid-Based Modeling Precursor Sensitivity Analysis

![Graph showing percentage reduction in nitrate over time.]

- 50% NOx Reduction
- 50% Ammonia Reduction
Recent ARB NOx Regulations

- Construction equipment
- Private truck fleets
- Ships and harbor craft
- Locomotives
- Smog Check enhancements
Post CRPAQS Field Studies
February 15, 2007: HSRL measurements in SJV

US EPA, NASA Langley, Univ. of Maryland, ARB, SJVAPCD
Ozone and its Precursors

June 20, 2008

Ozone and its Precursors:

- **O$_3$** (Ozone)
- **NO**
- **NO$_2$**
- **HCHO** (Formaldehyde)
- **OH**
- **HO$_2$** (Hydroperoxy radical)

June 9, 2010

Particulate Pollution Conference in SJV
CalNex – 2010: Research at the Nexus of Air Quality and Climate Change

http://www.esrl.noaa.gov/csd/calnex/

- **Where:** California and the eastern Pacific coastal region
- **When:** May - July 2010
- **How:** The focus of the NOAA Earth System Research Laboratory Chemical Sciences Division's measurement component of this project will be the NOAA WP-3D and Twin Otter Remote Sensing aircraft, the R/V *Atlantis* ship platform as well as ground sites.
- **Who:** Investigators in this project include researchers from several universities and governmental agencies.
CalNex Science Issues

Emissions Quantification - Greenhouse Gases and O\textsubscript{3} and Aerosol Precursors – improved emission inventories, particular focus on GHG, soot and sulfur emissions.

Chemical Transformation - O\textsubscript{3} and Aerosols, Day and Night, Gas-Phase and Heterogeneous – improved chemical mechanisms for air quality modeling, particular focus on organic and sulfate formation.

Transport and Mixing - Intercontinental, Inter- and Intra-state, Boundary Layer/Free Troposphere – improved understanding of how we are affected, and affect, our neighbors.

- Aerosol Properties and Radiative Effects - Regional Haze, Direct Radiative Forcing, Cloud-Aerosol Interactions, Satellite Validation – Reduced uncertainty in the role of aerosols in climate – Improved understanding of role black carbon plays in climate

- Model Development - Diagnostic Evaluation of Forecast Models, Chemical Data Assimilation, Regional Climate Models
CalNex Measurements

Long-term surface observations
Instrumented tall towers
Supersites (Bakersfield, Pasadena)
Daily ozonesonde launches
Radar wind profiler network
Mobile research platforms
  NOAA WP-3D, Twin Otter, RV Atlantis
  CIRPAS Twin Otter
  NASA King Air (CARES)
  DOE G-1 (CARES)
  USFS Cessna
Satellite observations
  TES, OMI, Sciamachy, IASI
Conclusions

- Technical analyses have been instrumental in guiding policy decisions in recent PM$_{2.5}$ planning efforts.
- These tools will become even more important as emission reductions become more difficult to identify.
- Tools will also help in assessing tradeoffs/synergies between various pollutants and greenhouse gases.