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

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

June 9 and 10, 2010

Ajith Kaduwela and Karen Magliano
California Air Resources Board

James Sweet
San Joaquin Valley Air Pollution Control District

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; $PM_{2.5}$ 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

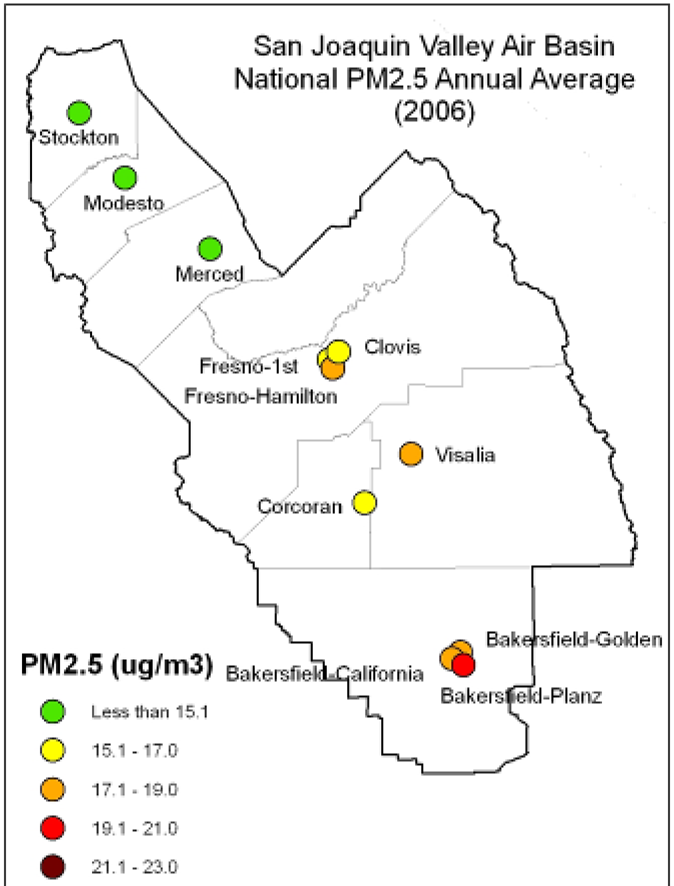
- California Regional PM Air Quality Study (CRPAQS)
- South Coast MATES program
- CalNex

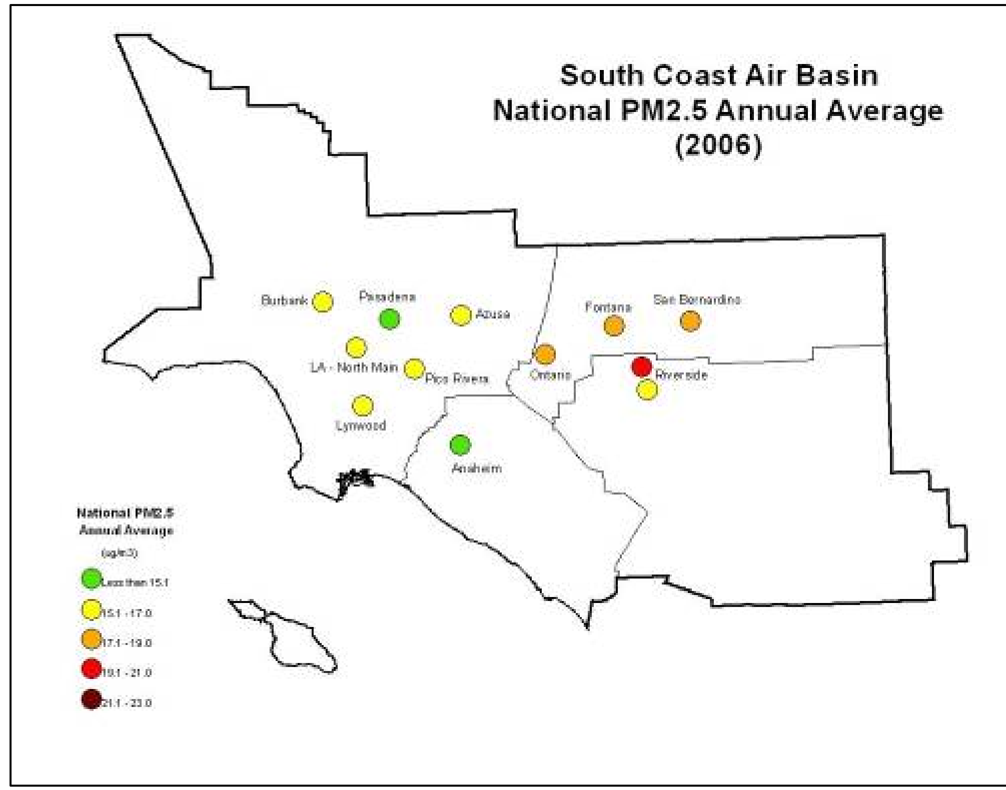



Key Questions Addressed by Field Studies

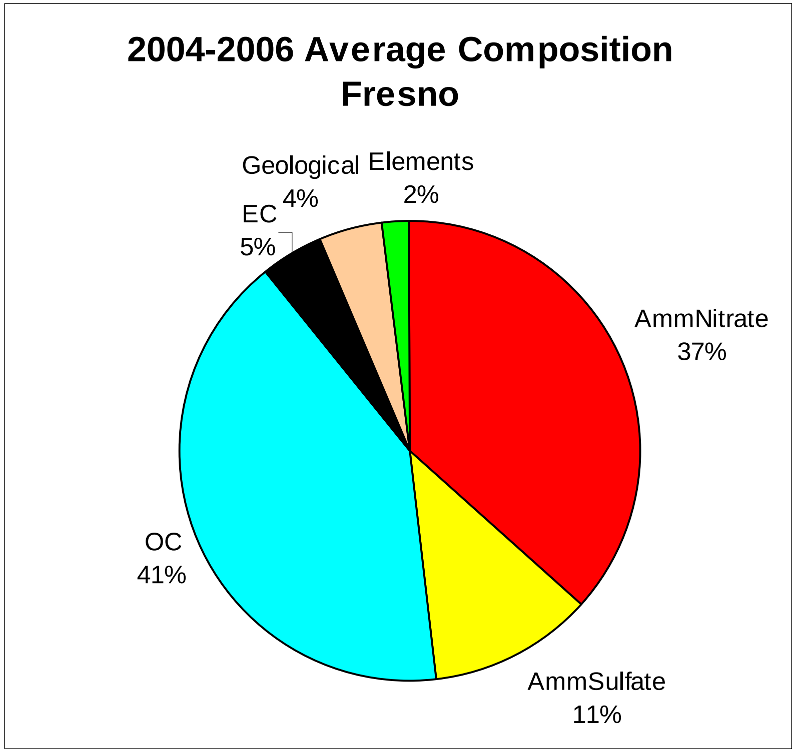
- What is the spatial and temporal variability of PM and where is public exposure the greatest?
- What meteorological conditions are most conducive to PM formation? What is the role of transport?
- Which chemical constituents are the largest contributors? What are the sources?
- What are the most effective precursors to control?

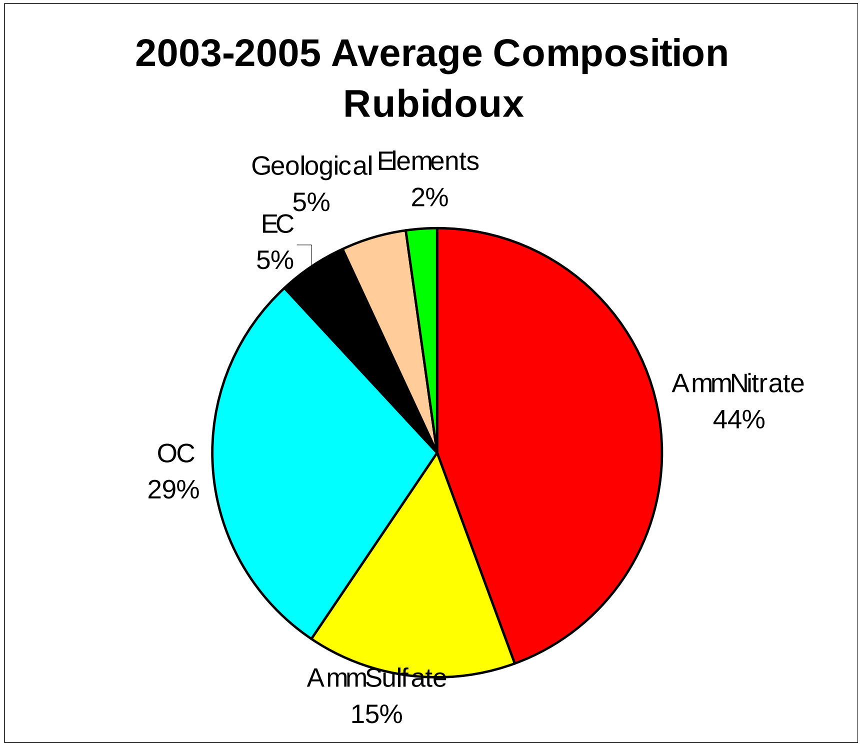
Nature of the $PM_{2.5}$ Problem





$PM_{2.5}$ Chemical Speciation

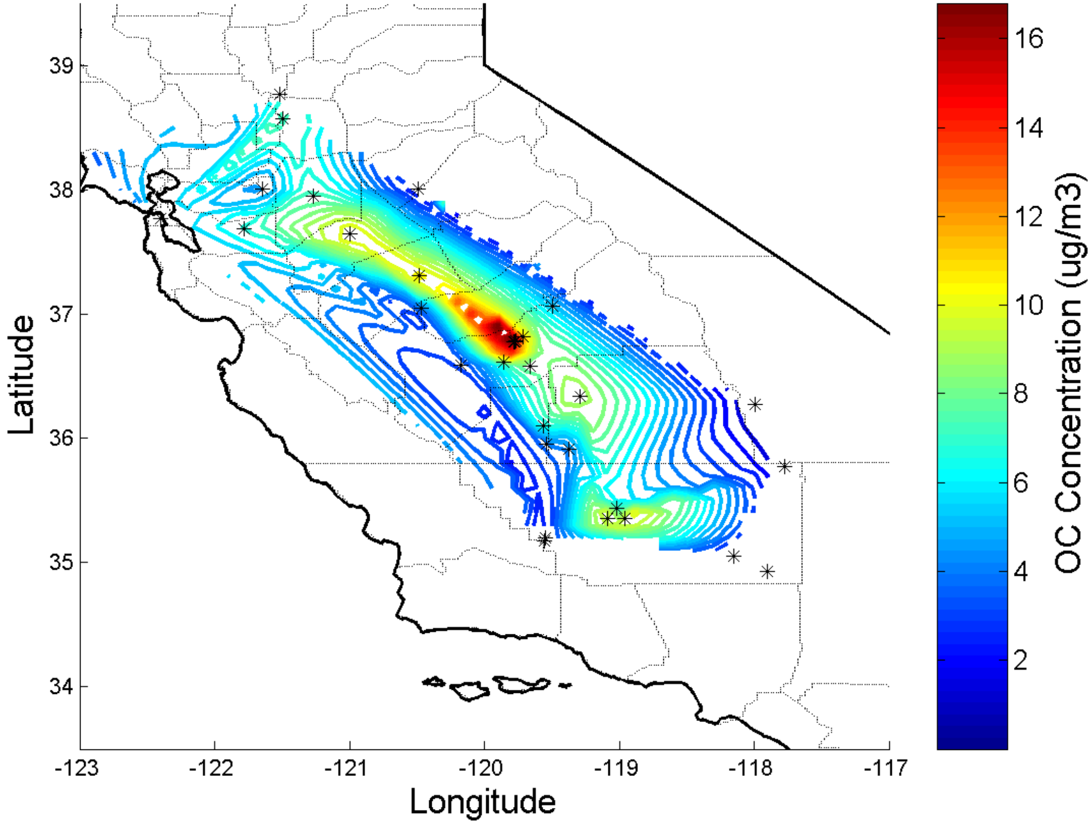




Case Study

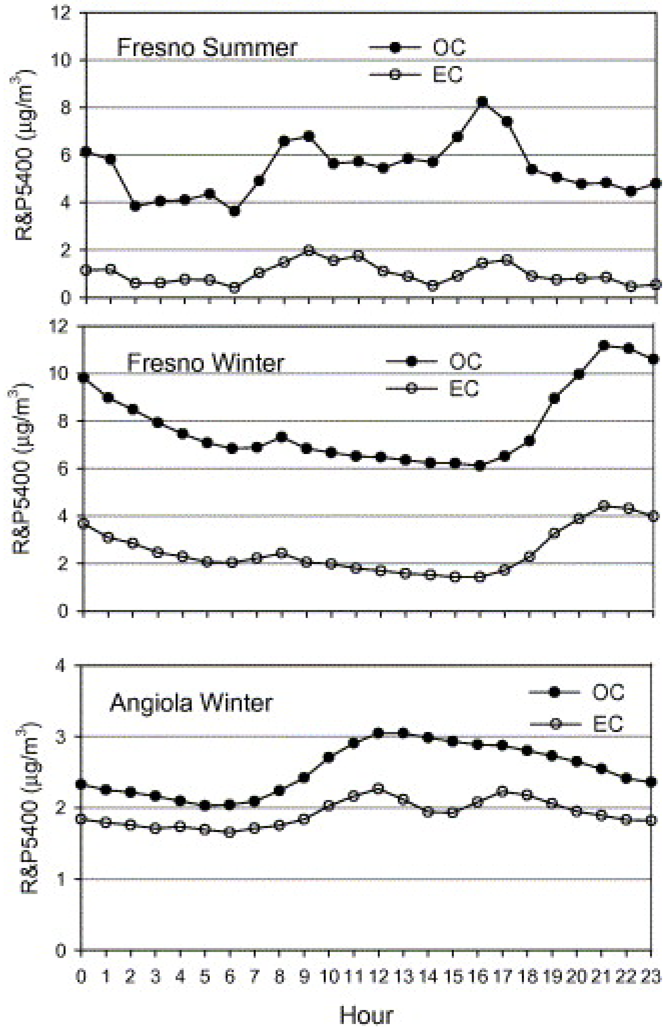
Residential Wood Burning Controls

Wintertime Organic Carbon Distribution



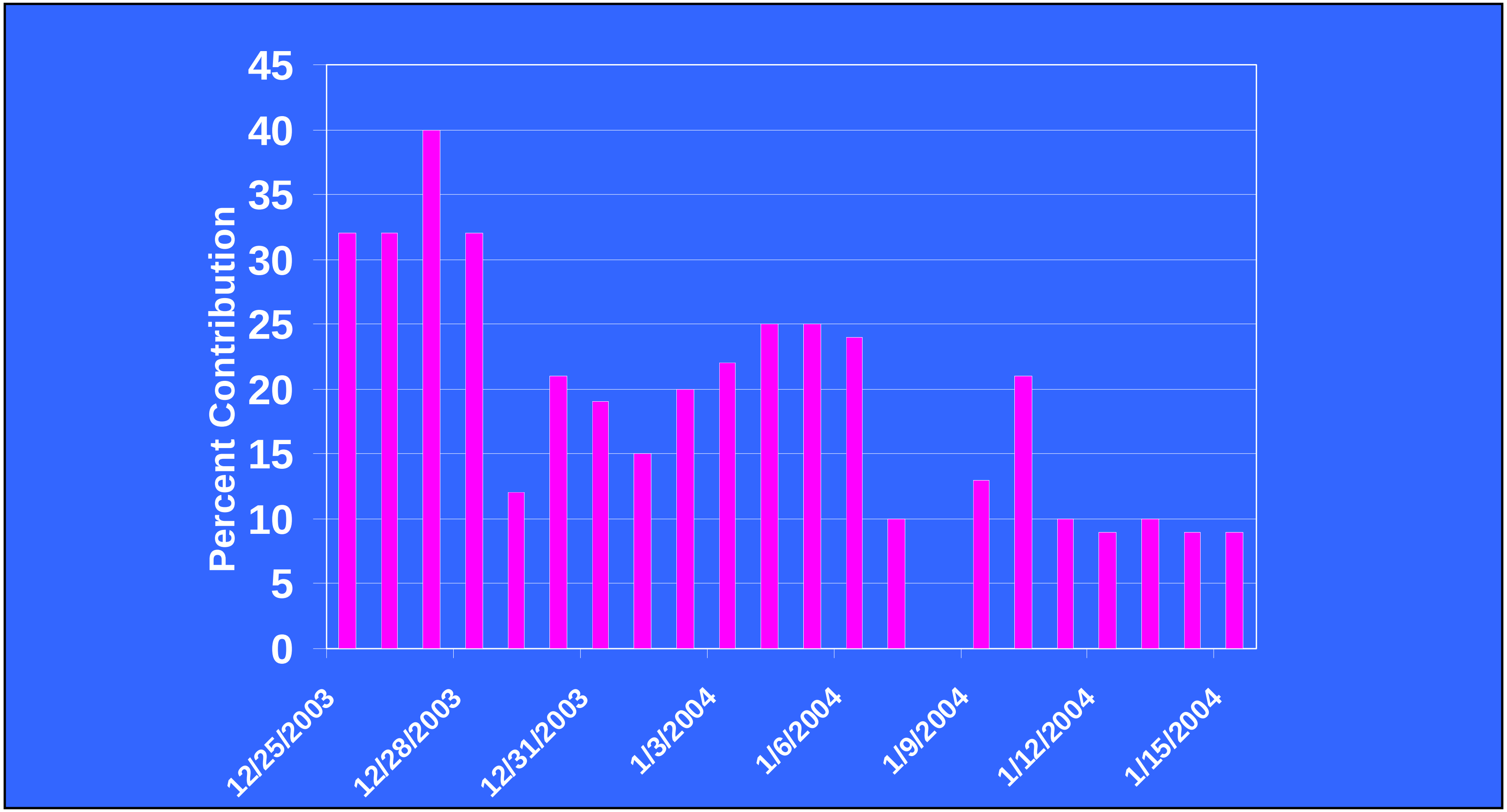
Chow et. al. 2005

Diurnal Profiles for Carbon



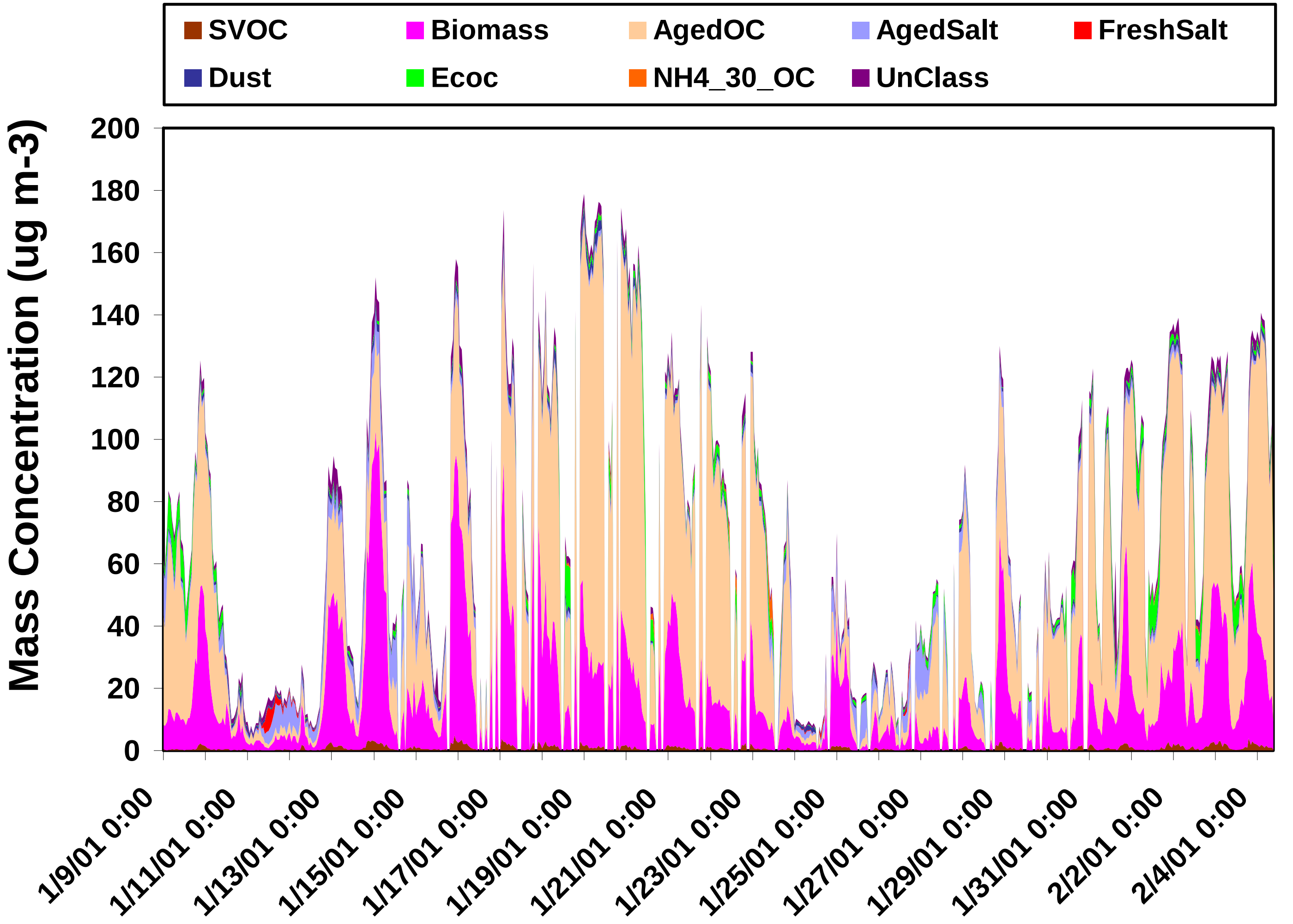
Chow et. al. 2006

Daily Woodsmoke Markers at Fresno



Gorin et. al. 2005

Individual Particle Analysis at Fresno

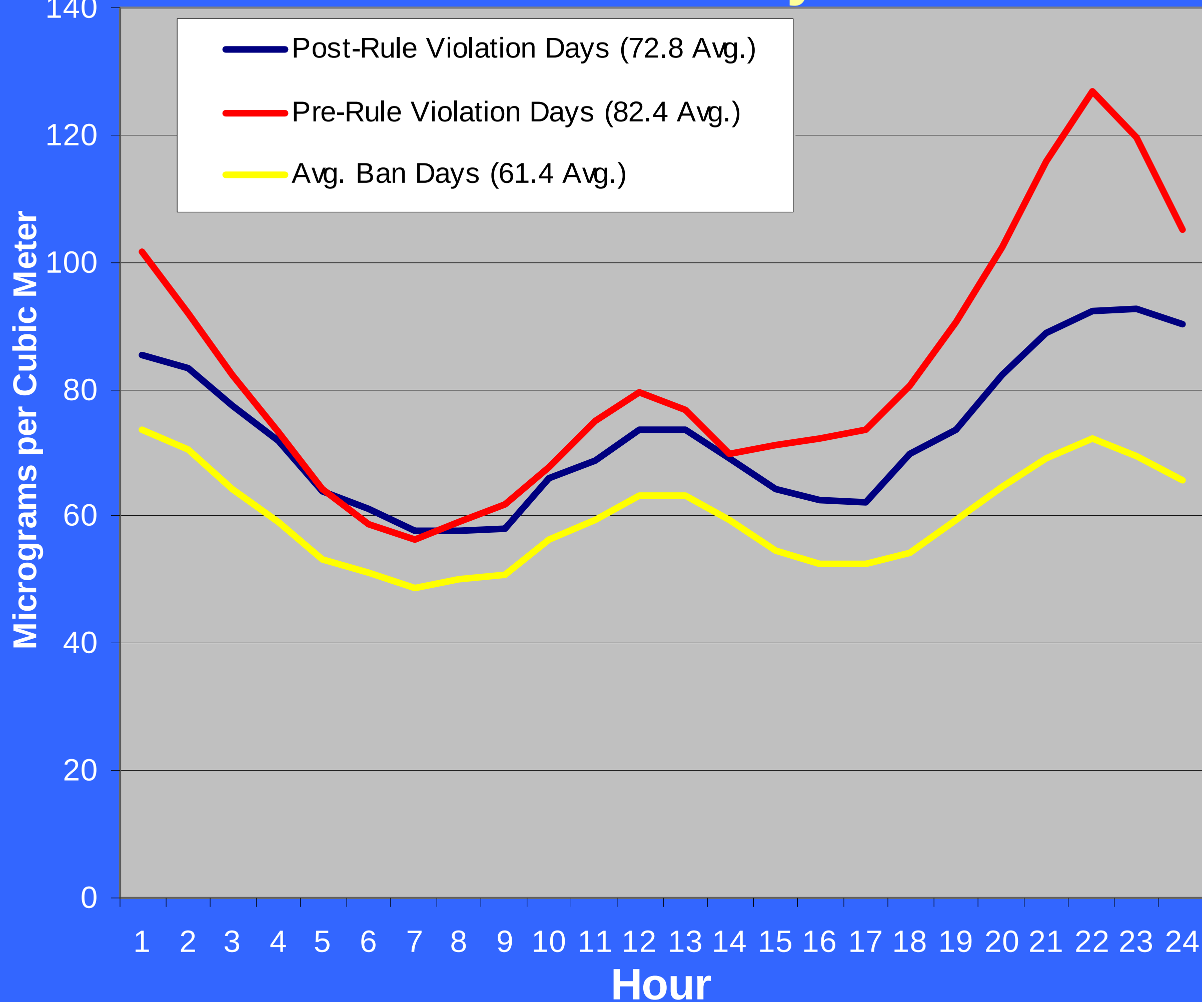


Qin et al. 2006

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

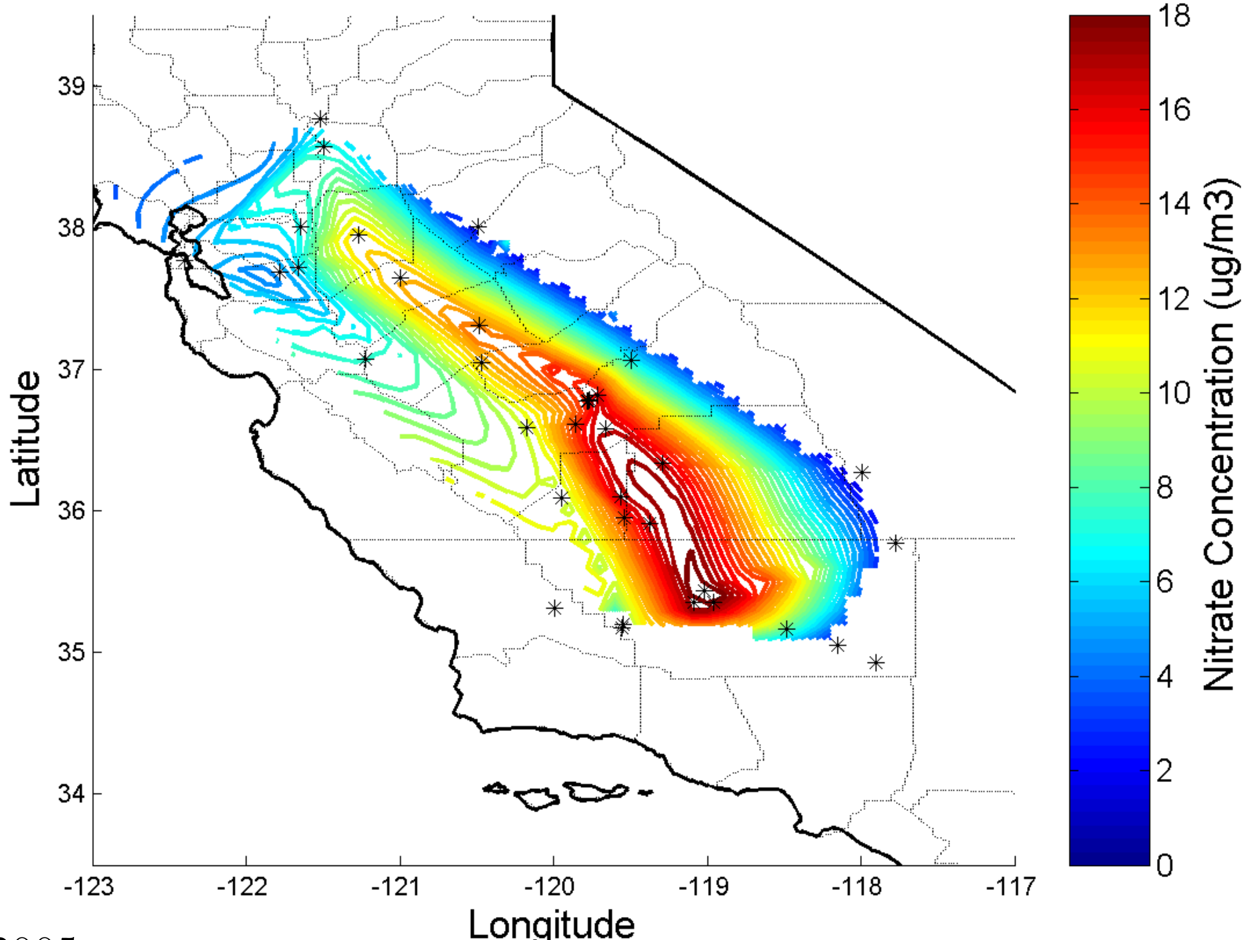


Lighthall et al., 2008

Case Study

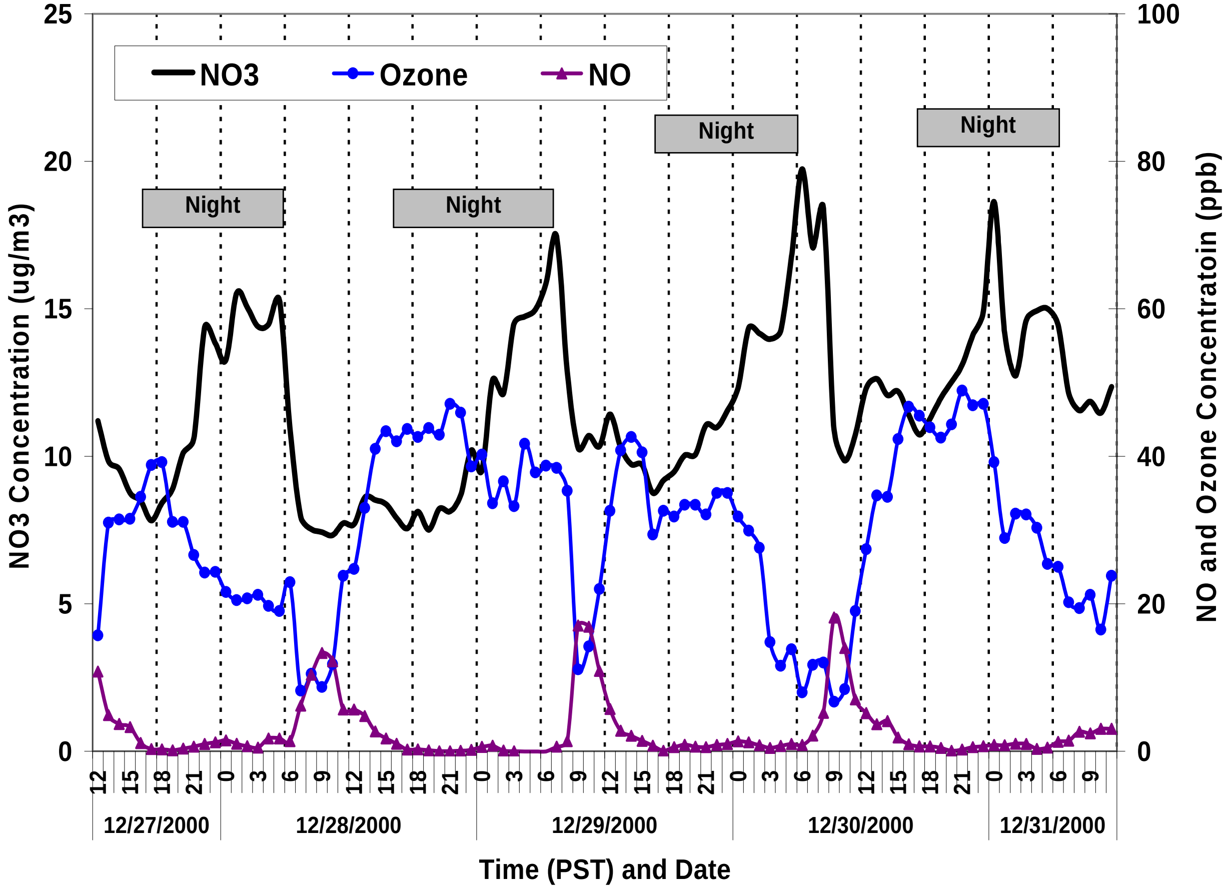
NO_x vs. Ammonia Controls

Wintertime Nitrate Distribution



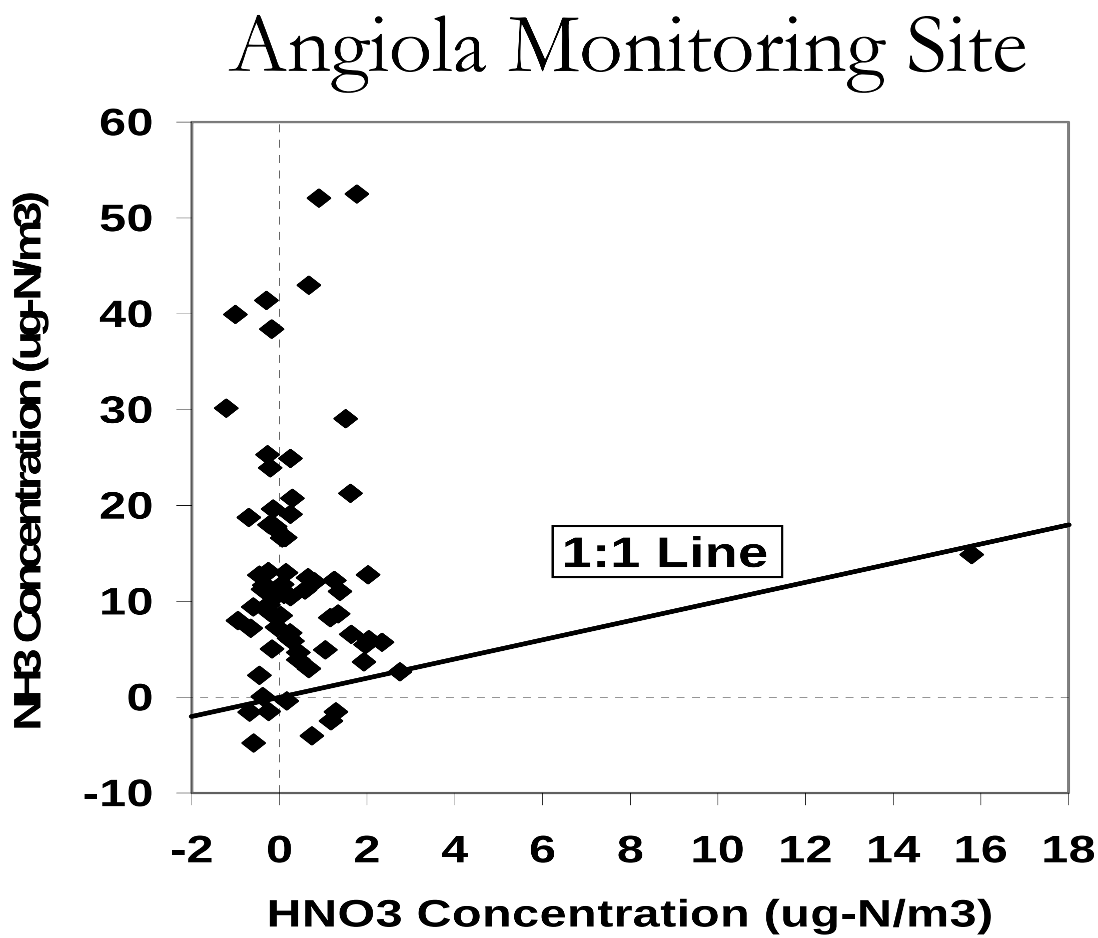
Chow et al., 2005

Hourly concentrations of NO, O_3, and Nitrate at 90 m on Angiola Tower



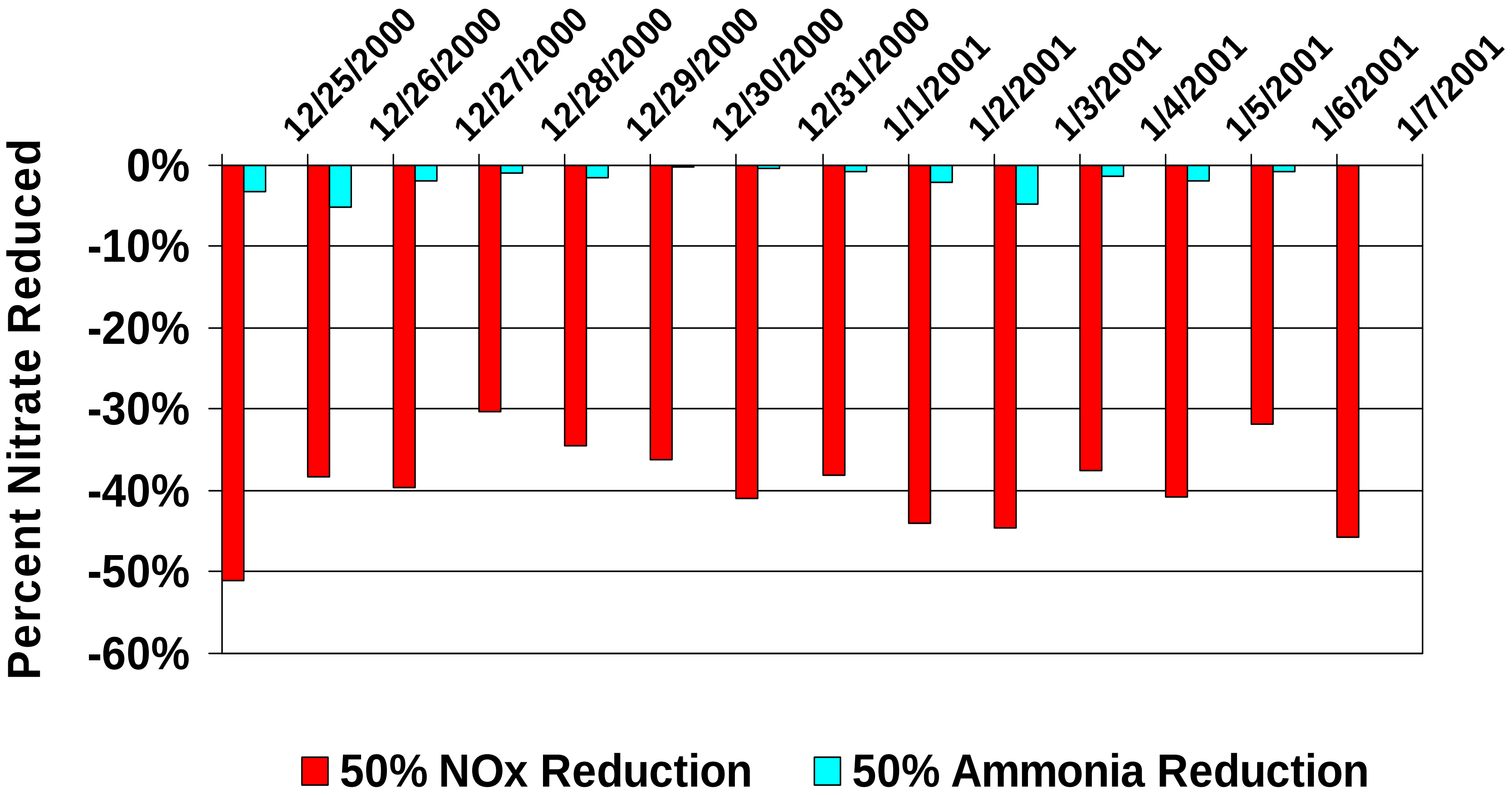
McCarthy et al., 2004

Ambient Indicator Species Ratios



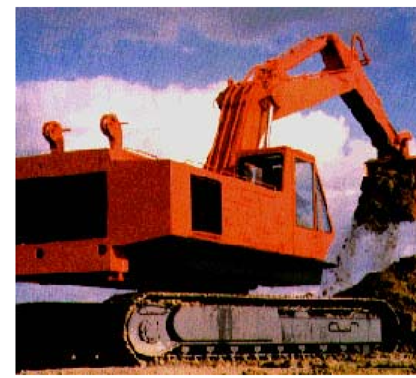
McCarthy et al., 2005

Grid-Based Modeling Precursor Sensitivity Analysis



Recent ARB NOx Regulations

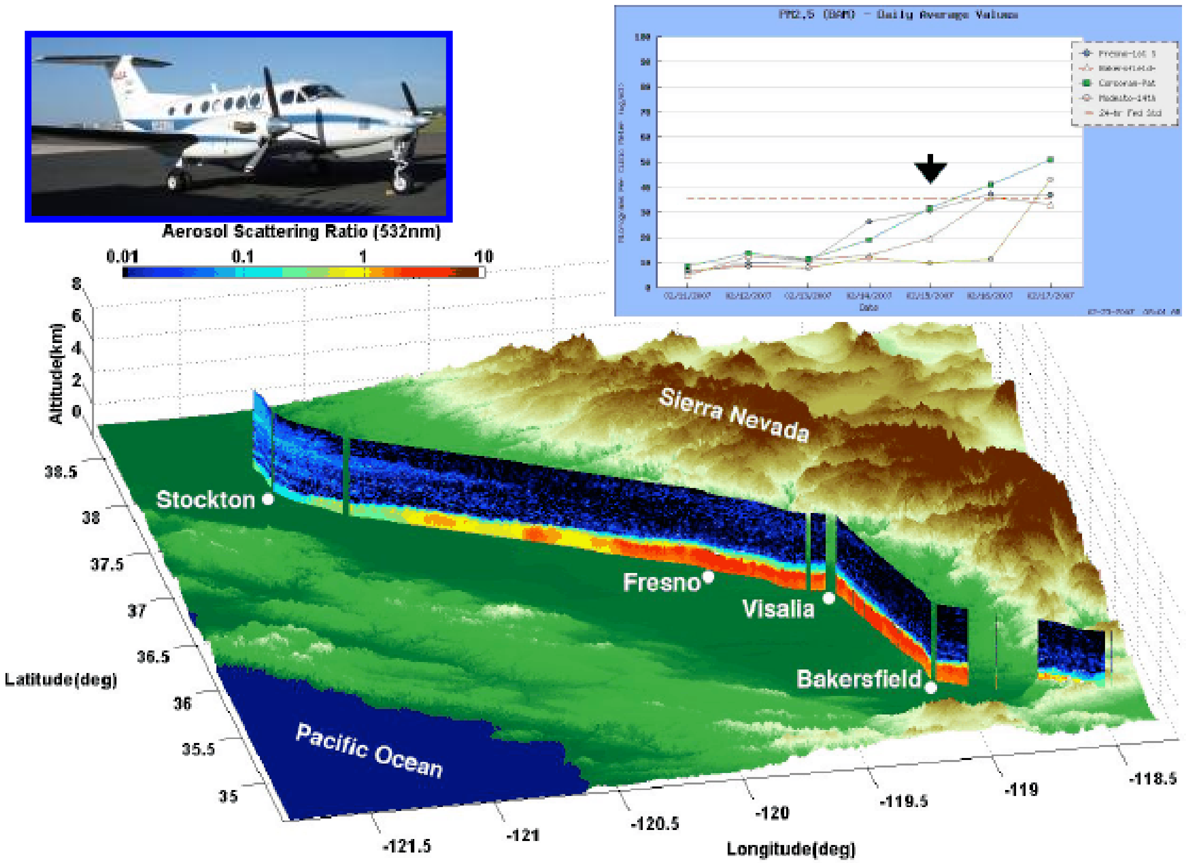
- Construction equipment
- Private truck fleets
- Ships and harbor craft
- Locomotives
- Smog Check enhancements

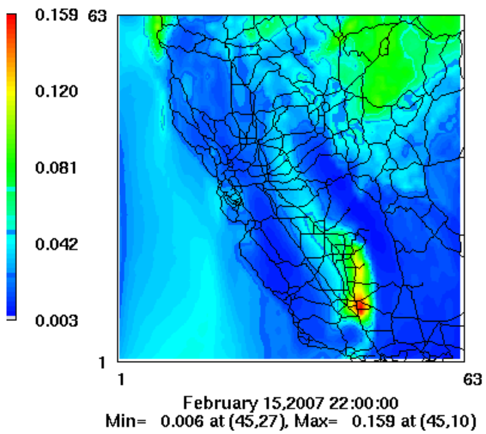

Post CRPAQS Field Studies

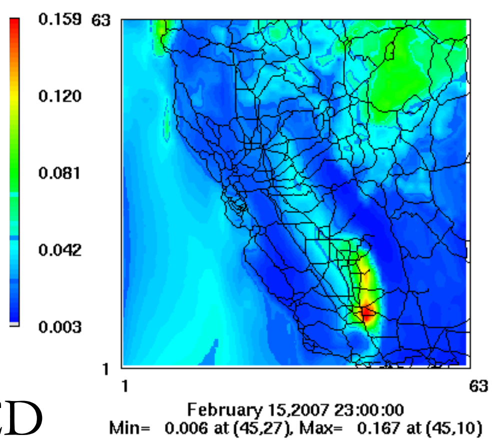
US EPA AMI

February 15, 2007: HSRL measurements in SJV



AOD





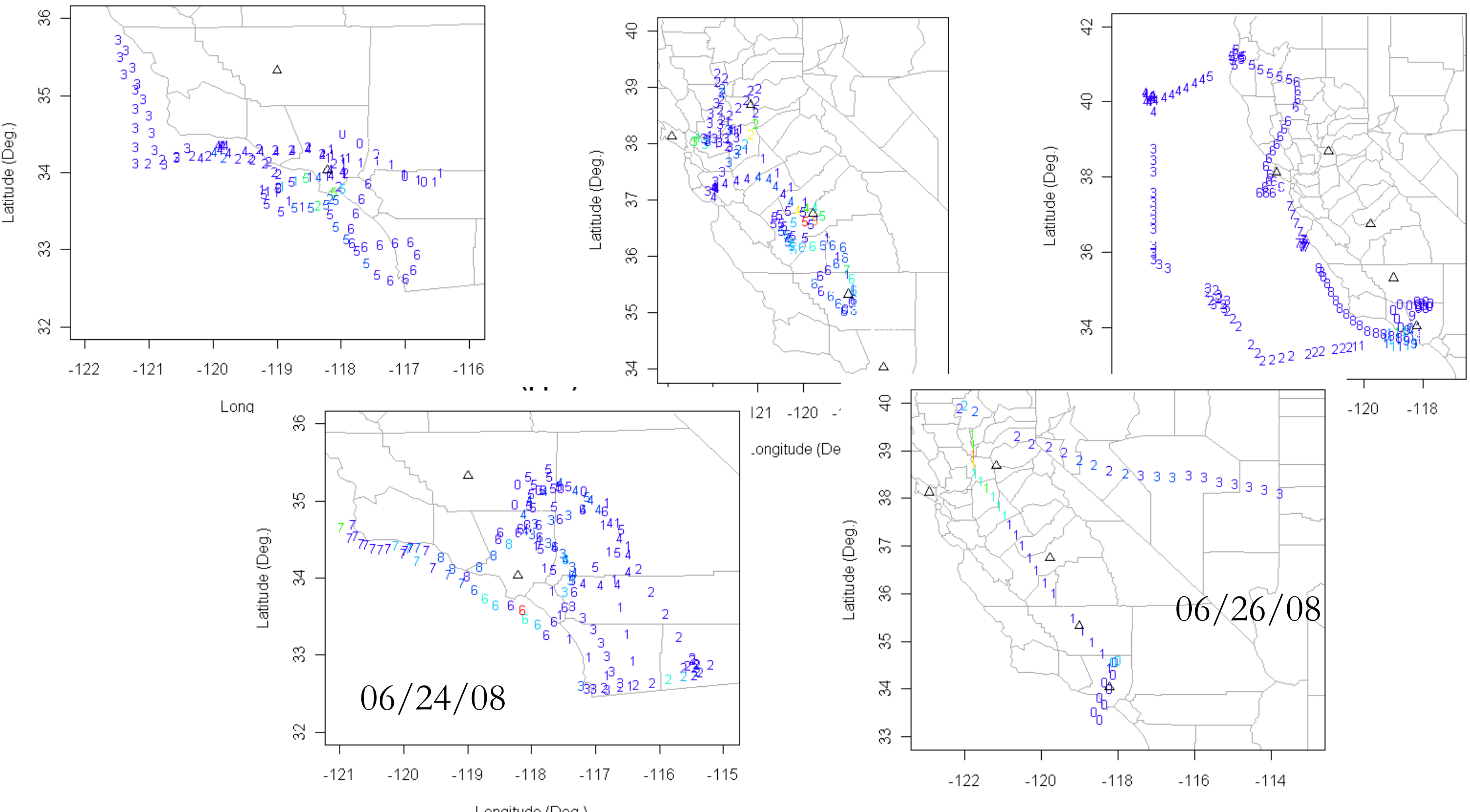
US EPA, NASA Langley, Univ. of Maryland, ARB, SJVAPCD

ARCTAS-CA DC-8 Flight Patterns

06/18/08

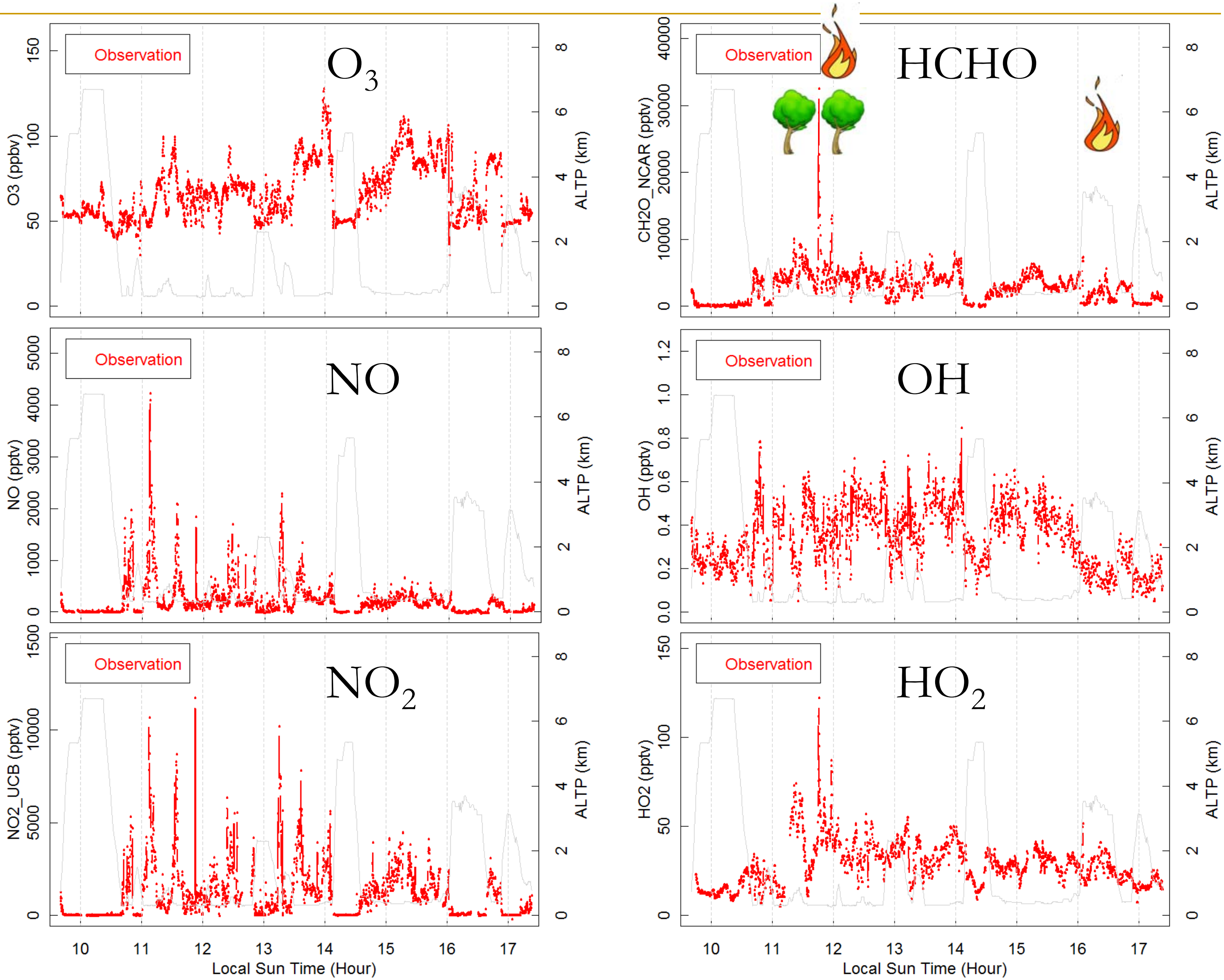
06/20/08

06/22/08



Ozone and its Precursors

June 20, 2008



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_3 and Aerosol Precursors – improved emission inventories, particular focus on GHG, soot and sulfur emissions.

Chemical Transformation - O3 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

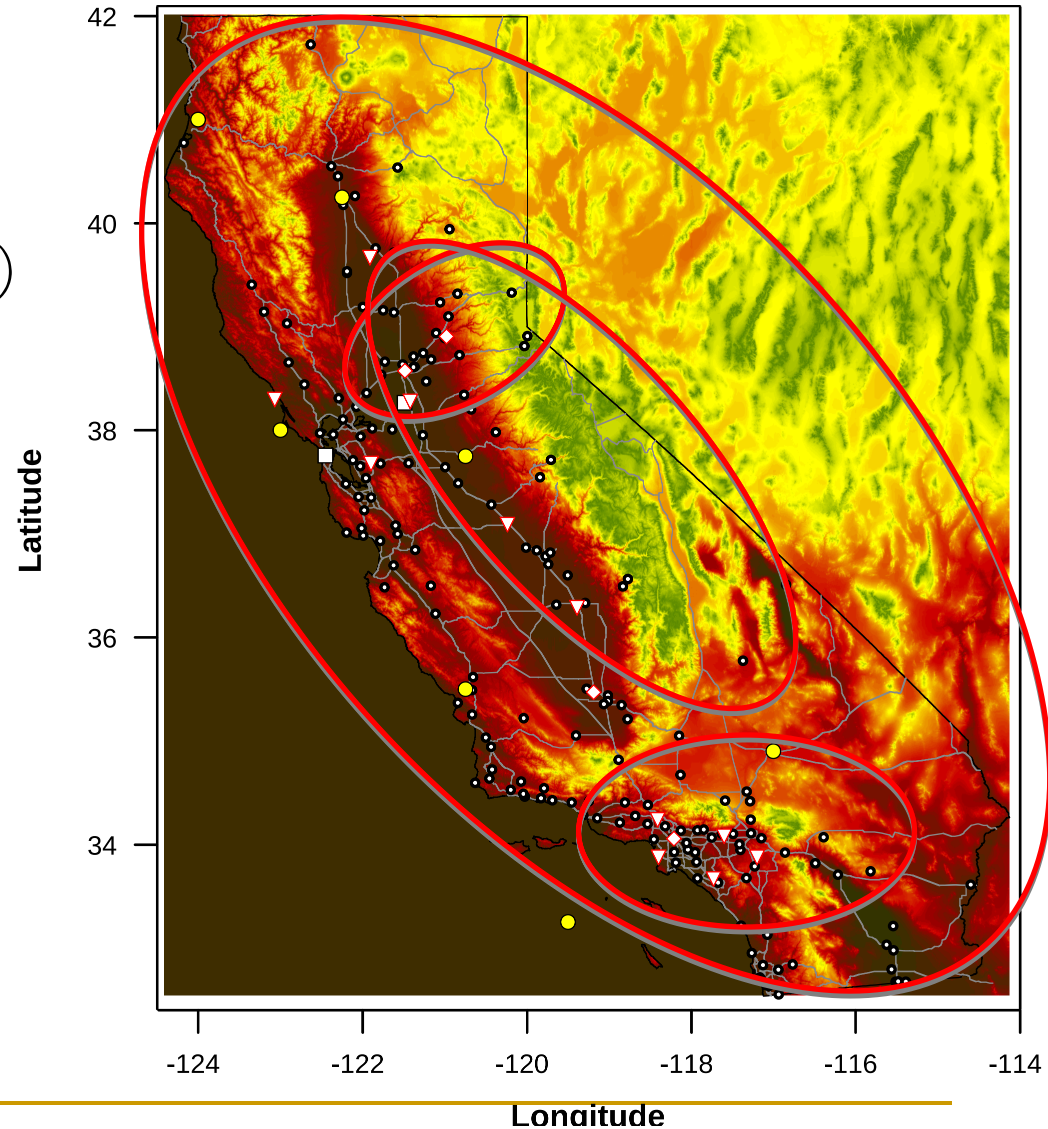
CalNex Measurements

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