The Regulatory Role of Chemical Mechanisms and Future Needs

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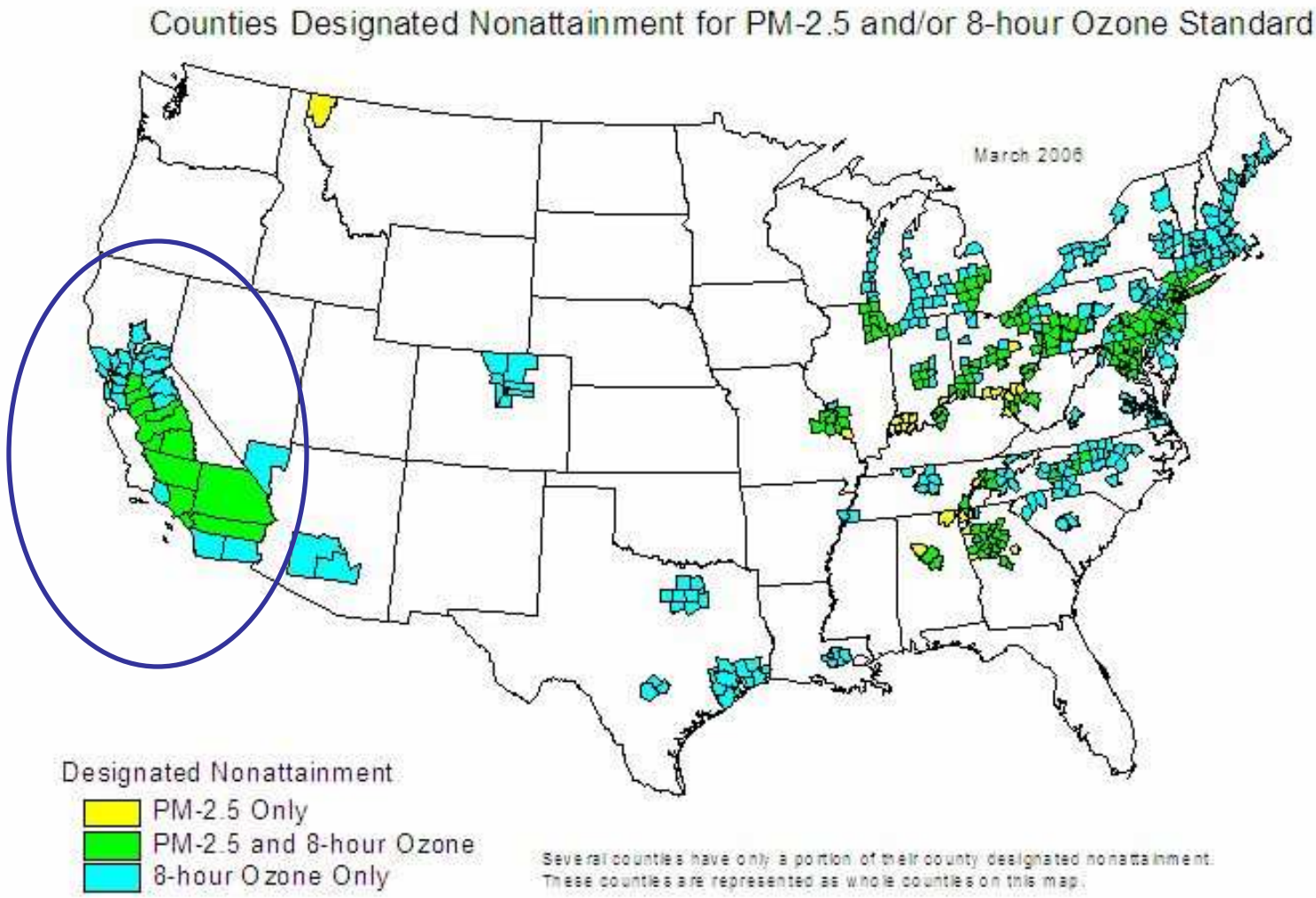
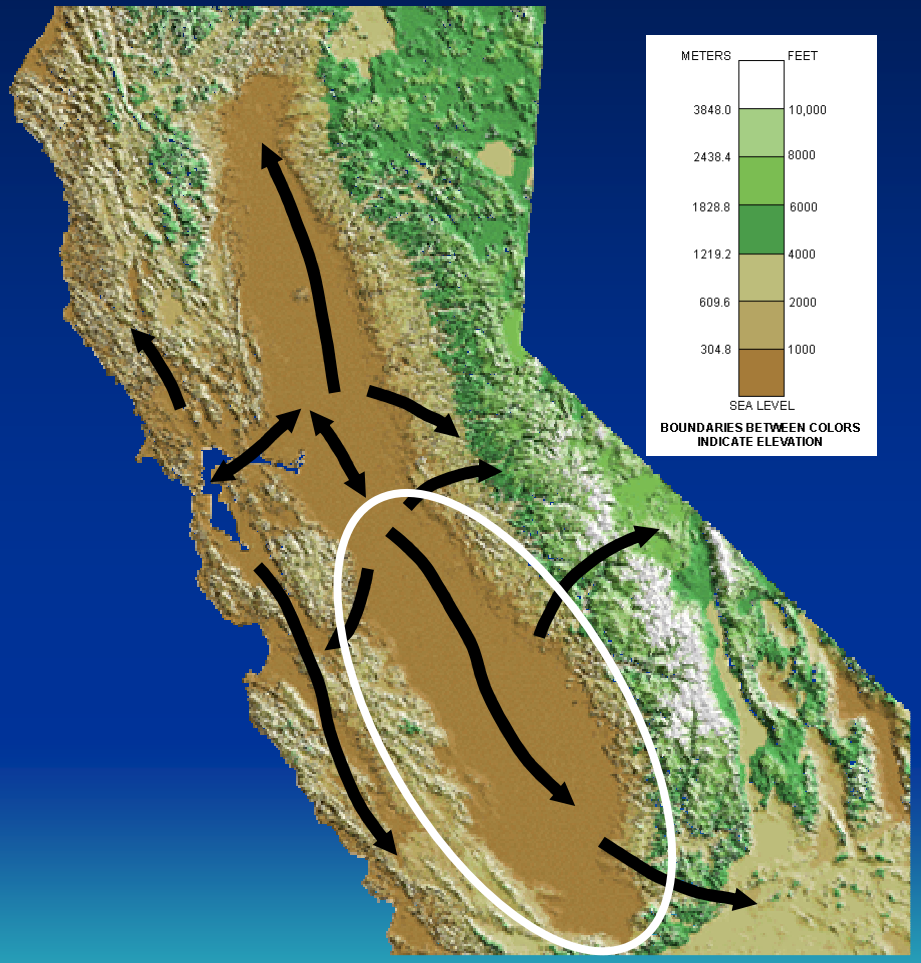

Counties Designated Nonattainment for PM-2.5 and/or 8-hour Ozone Standard
March 2006
Designated Nonattainment
PM-2.5 Only
PM-2.5 and 8-hour Ozone
8-hour Ozone Only
Several counties have only a portion of their county designated nonattainment.
These counties are represented as whole counties on this map.

The San Joaquin Valley

- One of the most productive agricultural regions in the world – Cadillac Dessert
- Major goods movement corridors
- Oil production in the southern Valley
- Air Quality: Second most polluted area in the US and second most studied area in the world
- Ozone pollution in the summer and PM pollution in the winter (but the annual PM standard is more restrictive)



Prof. John Watson, DRI

Major field studies

- 1970: Project Lo-Jet (identified summertime low-level jet and Fresno eddy)
- 1972: Aerosol Characterization Experiment (ACHEX, first TSP chemical composition and size distributions)
- 1979-1980: Inhalable Particulate Network (first long-term $PM_{2.5}$ and PM_{15} mass and elemental measurements in Bay Area, Five Points)
- 1978: Central California Aerosol and Meteorological Study (seasonal TSP elemental composition, seasonal transport patterns)
- 1979-1982: Westside Operators (first TSP sulfate and nitrate compositions in western Kern County)
- 1984: Southern SJV ozone study (first major characterization of O_3 and meteorology in Kern County)
- 1986-1988: California Source Characterization Study (quantified chemical composition of source emissions)
- 1988-89: Valley Air Quality Study (first spatially diverse, chemical characterized, annual and 24-hour $PM_{2.5}$ and PM_{10} seasonal)
- Summer 1990: San Joaquin Valley Air Quality Study/Atmospheric Utilities Signatures Predictions and Experiments (SJVAQS/AUSPEX, first central California regional study of O_3 and $PM_{2.5}$) – Also known as SARMAP (SJVAQS/AUSPEX Regional Modeling Adaptation Project)
- Winter 1995: CRPAQS Pilot Study (IMS95, first sub-regional winter study)
- **December 1999 to February 2001: CRPAQS and CCOS (first year-long, regional-scale effort)**
- December 1999 to present: Fresno Supersite (first multi-year experiment with advanced monitoring technology)

Key Policy Questions

- Where are the locations of greatest public exposure to air pollution?
- How much progress has been made with existing air pollution control programs?
- What additional emission reductions are needed to meet the State and National Ambient Air Quality Standards?
- What is the relative importance of the different emission sources?

Key Policy Questions (Cont.)

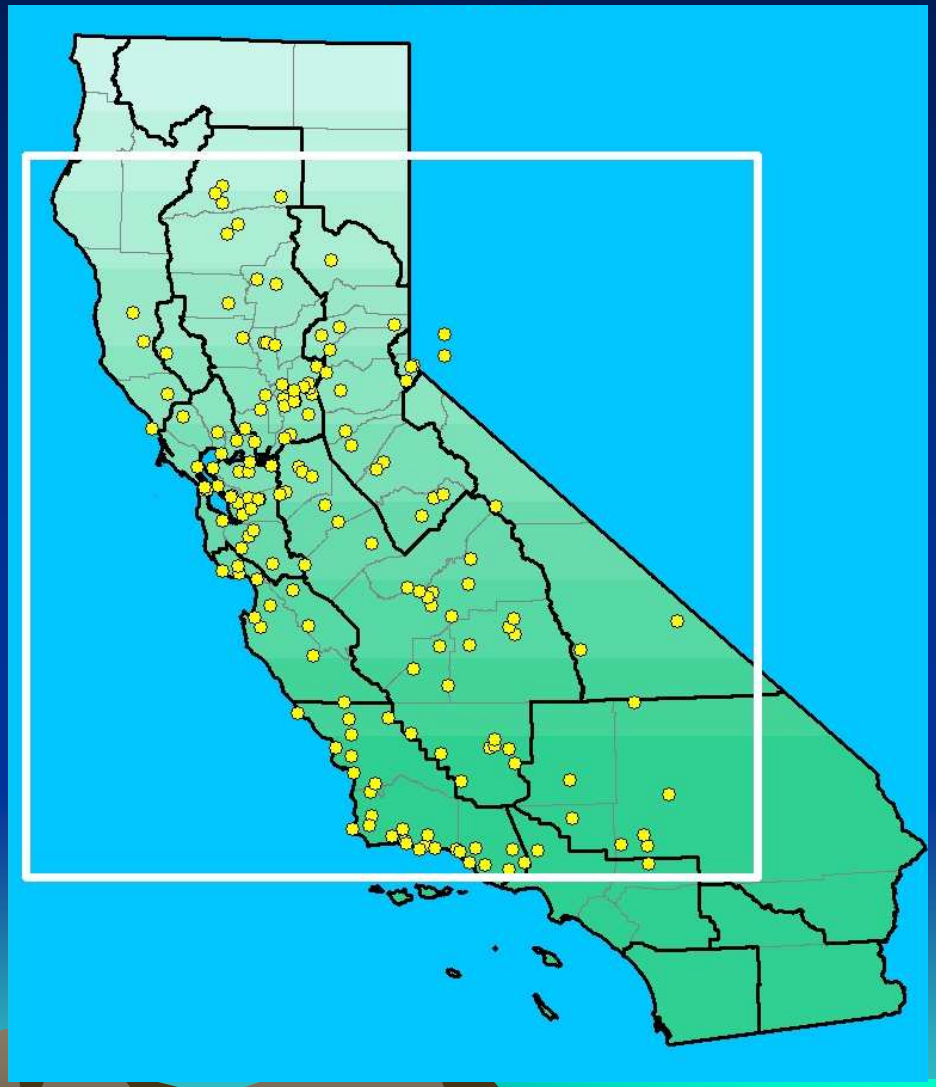
- What is the relative importance of emission reductions in reactive organic gases (ROG), oxides of nitrogen (NO_x), and ammonia (NH_3)?
- What is the importance of pollutant transport between and within air basins?
- Can we meet the initial 8-hour ozone (O_3), $PM_{2.5}$, and Regional Haze attainment dates? If not, what are the earliest feasible dates?

Central California Air Quality Studies (CCAQS) - 2000

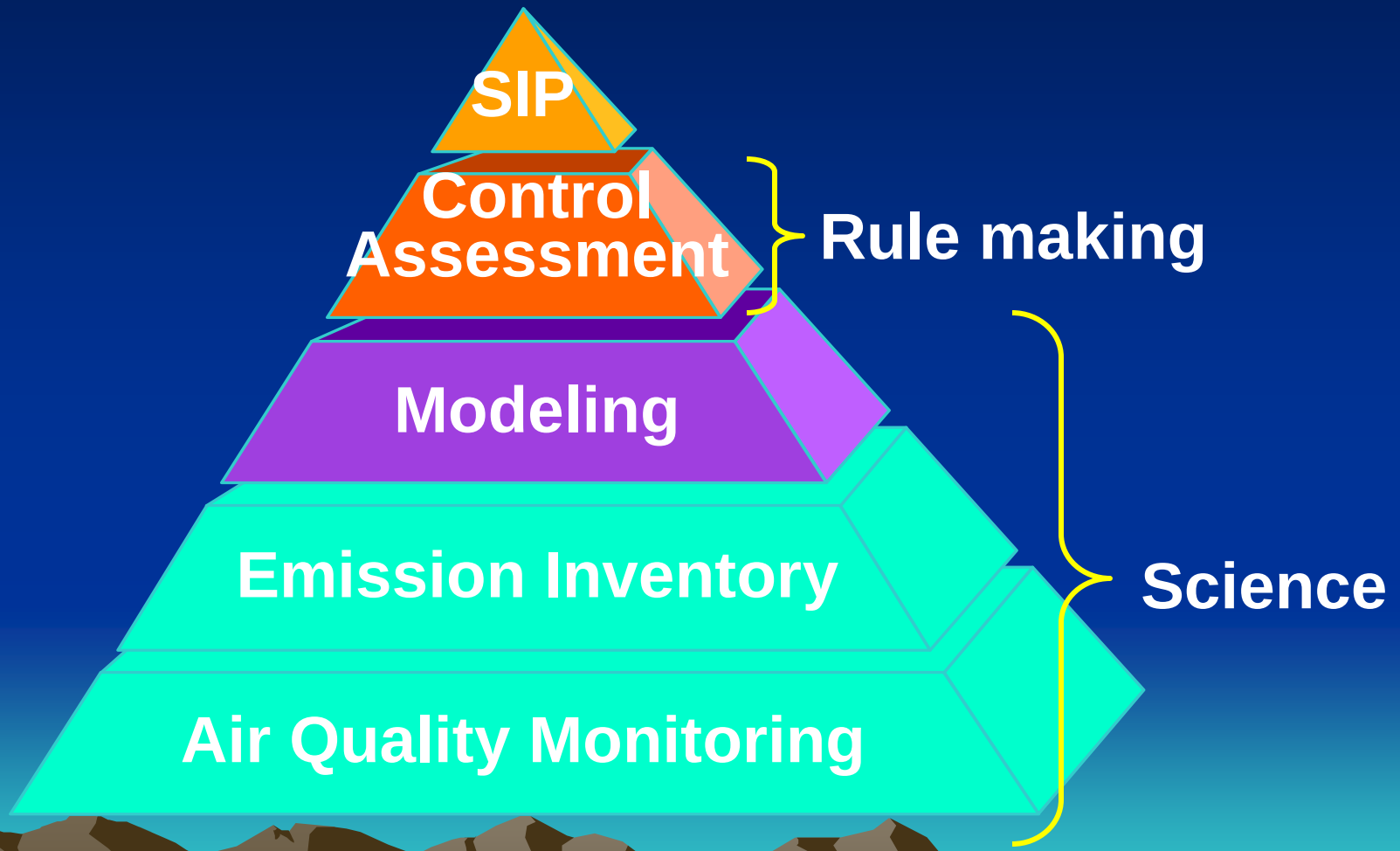
- California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS)
  - Builds on a pilot study in 1995-96 (IMS-95)
  - Provides the scientific basis for PM_{10}, $PM_{2.5}$, and Regional Haze State Implementation plans (SIPs)
  - 14 months
  - ~US$28 million
- Central California Ozone Study (CCOS)
  - Builds on a 1990 ozone study (SARMAP)
  - Provides the scientific basis for 1-hour and 8-hour ozone SIPs
  - 4 months in the summer
  - ~US$18 million
- Major goals of CCAQS are:
  - Further develop conceptual models of air pollution in central California
  - Obtain data for model development and validation (for the refinement of emission control strategies)
- www.arb.ca.gov/ccaqs/ and A&WMA Measurements Conference in 2007

Air Quality Monitoring Stations

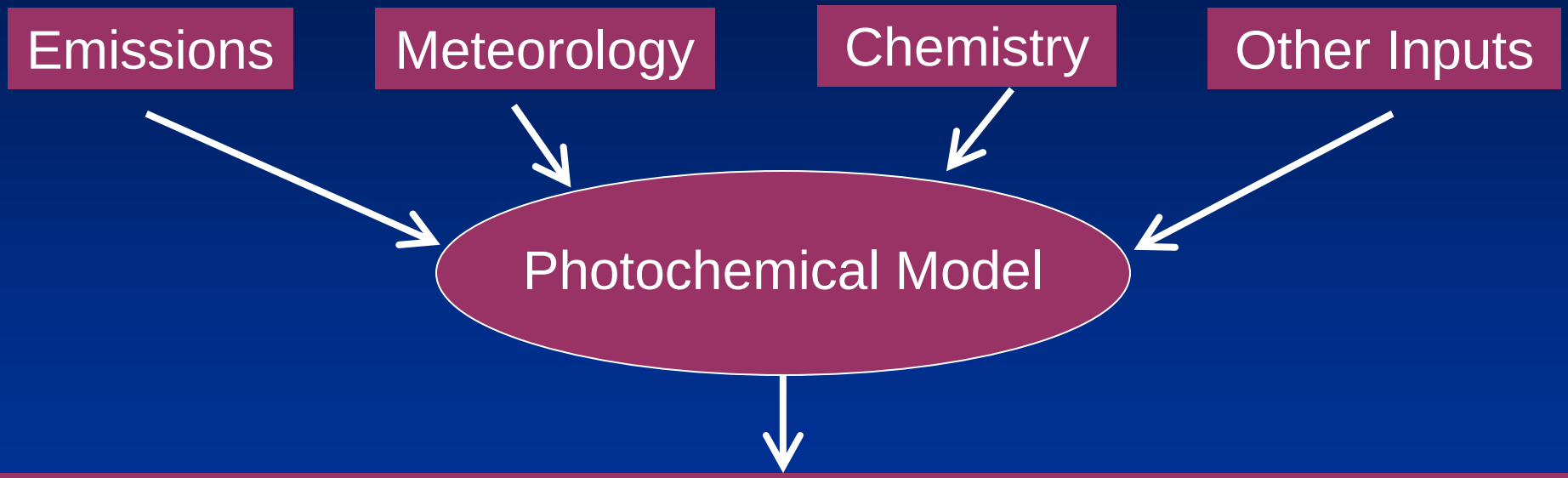
- Criteria and toxics monitoring
  - Compliance (routine)
  - Supplemental
  - Research
- Similar network for meteorological monitoring



Process for Developing SIPs



Photochemical modeling



Models are mathematical representations of our best knowledge about atmospheric processes

Chasing the Peak

- Regulatory Modeling emphasis is on peak pollution concentrations
  - But longer averaging times make low concentrations important
    - Intra-day dynamics important
  - Changes in day-to-day peak concentrations may mostly be due to meteorological variations than those of emissions
    - Inter-day dynamics important

Beyond the Episode

- Regulatory standards are based on multi-year averages, but modeling is done for shorter durations
  - Need “100s of model runs” for control strategy assessments
  - The number of runs depends on
    - Efficiency of chemical mechanism solvers
    - Level of mechanism condensation
  - Chemical mechanisms should be able to accommodate seasonal changes

Things to Think About

- Transition from Urban to Regional
  - Chemical mechanisms that can handle a wide range of pollutant concentrations, emissions scenarios, and meteorological conditions
- The “One Atmosphere”
  - Inter-pollutant interactions are important
    - Control of one criteria pollutant should not be at the detriment of another
  - Focus shift from ozone to ozone and particulate matter
- Global Climate Change
  - Ability of the chemical mechanisms to “follow” the meteorology is important

The N_2O_5 Issue

- N_2O_5 is responsible for night-time nitrate formation
- N_2O_5 has indirect implications for other pollutants
- Night-time formation of nitrate is important in Central California
- Three areas of interest for N_2O_5
  - Laboratory measurements
  - Field measurements
  - Computational methodology
- We are contemplating a comprehensive review of all three areas above, with a California focus, before we proceed further with N_2O_5 research

Specific Questions – Short Term

- From your viewpoint, what are the most pressing short-term needs (i.e. current applications) for improving chemical mechanisms? Please consider any of the following, or other areas that you think are important:
  - Research needs
  - Implementation issues
  - Methods to better address policy needs
  - Improving confidence in model predictions

Specific Questions – Long Term

- What are the most important areas for longer-term improvement (i.e. significantly improving future applications)?
- What should government and industry (local, national, and global) be doing to make sure we have appropriate chemical mechanisms? Are we on the right path? How do we make sure we continue to make progress and motivate new faculty and students?

Further Considerations

- Publication of conference proceedings as a regular issue of the Atmospheric Environment?
- This conference as a regular event?
- Next Step: A conference with emphasis on mechanisms for secondary particulate Matter modeling?
- A Chemical Kinetics Database (in collaboration with combustion researchers)?

Thank you for your attention!

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