CalNex 2010 Science Questions

The following science questions guided the field research of CalNex 2010. The questions were thought to be feasibly addressable in the context of the proposed study and were intended to be: 1) sufficiently general to cover the scientific issues of immediate policy interest, and 2) sufficiently specific to provide the needed technical focus for the researchers. These science questions fell into three broad categories.

Emissions

Climate change problems originate from society's increased emissions of radiative forcing agents (CO_2, CH_4, N_2O, halocarbons, black carbon, aerosols) while air quality problems persist due to emissions of air pollutants (e.g., NO_2, SO_2, CO, air toxics, PM2.5) and of precursors (e.g., VOC, NOx) to them and other pollutants (e.g., O_3). Our understanding of these emissions on both regional and global scales is limited.

A. How can we improve the emissions inventory for greenhouse gases, ozone and aerosol precursors including emissions from soil, ships, and other non-industrial or transportation related processes? What measurements can help validate the use of satellite data for biogenic VOC and NOx emission inventories?

B. What emissions (natural and anthropogenic) and processes lead to sulfate formation over California coastal waters and in urbanized coastal areas? What is the contribution from ship emissions? How does Southern California compare and contrast with the San Francisco Bay Area?

C. What sources and processes contribute to atmospheric mercury concentrations in California?

Chemical Transformation and Climate Processes

Critical uncertainties remain in our understanding of: 1) the chemical and physical processes in the atmosphere that transform or remove primary emissions, and 2) how aerosols in the atmosphere affect radiation fluxes.

D. How important are chemical processes occurring at night in determining transport and / or loss of nitrogen oxides, reactive VOC and ozone? Do regional models in California adequately represent these processes and their effect on air quality?

E. What are the sources and physical mechanisms that contribute to high ozone concentrations aloft that have been observed in Central and Southern California?

F. Are there significant differences between Central Valley and South Coast Air Basin precursors or ozone formation chemistry? Will meteorological and/or precursor differences between the Central Valley and the South Coast Air Basin lead to different chemical transformation processes and different responses to emissions reductions? What is the importance of natural emissions to the ozone formation

process? Are there regional differences in the formation rates and efficiency for particulate matter as well?

G. **What are the impacts of aerosols in California on radiative forcing and cloud formation?** What are the most important precursors and formation processes for secondary organic aerosol? What is the role of aqueous phase processes in atmospheric transformations?

Transport, Modeling, and Meteorology

Climate change and air quality issues have both global and regional scale aspects that interact through atmospheric transport. Critical uncertainties remain in our understanding of these interactions.

H. **What are proper oceanic boundary conditions** for coastal and regional atmospheric chemistry modeling? Are there variations in oceanic boundary conditions in northern and central California versus the southern part of the state? What physical and chemical changes occur as a parcel of air moves from off-shore, through the shore zone, and inland?

I. **How can we better characterize and model air flow** over coastal waters and the complex terrain of California? For example: what factors influence air flow in the southern San Joaquin Valley, particularly with respect to flow between the San Joaquin Valley and South Coast Air Basin versus recirculation north along the Sierra Nevada and Coastal ranges?

J. **Do significant deficiencies exist in the representation of chemistry and meteorology in research and operational models** and can model performance be improved through the collection of additional measurements? What physical and chemical processes are not characterized adequately by current models? Is there an optimum grid resolution to capture all of the relevant physical and chemical processes that occur?

K. **What are the important transport corridors for key chemical species** and under what conditions is that transport important?

L. **What are the relative roles of regional (North American) sources and long-range transport (from East Asia) on aerosol forcing over California?**