State of California
AIR RESOURCES BOARD

Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 510
Sacramento, California 95814
(916) 445-0753

January 31, 2014
9:00 a.m.

ADVANCE AGENDA

I. Approval of Minutes of Previous Meeting:

October 18, 2013 meeting

II. Discussion of a New Research Project:

1) "Characterizing the Climate Impacts of Brown Carbon," $452,500, University of California, San Diego, Proposal No. 2768-277

Black carbon (BC, the dark soot produced from combustion) absorbs light and gives off heat, and is now recognized as a significant contributor to global warming. Light absorbing organic carbon (OC) that is not black, called brown carbon (BrC), was recently discovered to also be a potentially large contributor to global warming. The combustion sources that contribute to BrC in the atmosphere are not well characterized, and recent studies suggest that there may be multiple pathways for its formation. To help characterize and differentiate sources of BrC from BC, the proposed research will apply advanced instrumentation that will provide unprecedented chemical and optical characterization of BrC sources and investigate its formation pathways. These measurements will be used to separate and characterize BrC, and quantify its importance in regional and global modeling climate forcing. This project will improve our understanding of the fundamental processes that govern BrC formation and its evolution in the atmosphere, and help us determine the potential climate benefits of mitigating emission sources of BrC in California.

III. Discussion of a Request for Proposals (RFPs):

1) "Evaluation of the Impacts of Emissions Averaging and Flexibility Programs for all Tier 4 Final Off-Road Diesel Engines," $300,000, RFP No. 14-301

IV. Discussion of Draft Final Reports:

1) "Behavioral Responses to Real-Time Individual Energy Usage Information: A Large Scale Experiment," University of California, Los Angeles, $322,003, Contract No. 10-332

Reductions in energy usage in the residential sector are needed in order for California to meet its greenhouse gas (GHG) reduction goal. This project investigated how real time appliance level energy usage information provided through advanced metering technology can induce conservation behavior. This research leveraged a large asset of advanced residential energy monitoring technology deployed in 120 apartments in Los Angeles. The residents were given feedback to optimize motivations to reduce energy use. The message formats varied to identify best practices and optimal messaging. The researchers compared the effectiveness of messages based on the environmental or health benefits associated with conservation to more conventional messages focused on the pecuniary savings associated with conservation. The results show that health based messages, which communicate the public health externalities of electricity production, outperform monetary savings information as a driver of behavioral change in the home. Participants who received messages emphasizing air pollution and health impacts associated with energy use reduced their consumption by 6 percent over the experimental period as compared to the control group. Health messaging was particularly effective on families with children, who achieved up to 19.8 percent savings. No significant conservation was found for participants who received messages informing them about monetary savings. These results advance our knowledge of effective non-price incentives for energy conservation and provide tools for California to meet its climate goals.

2) "Behavior Strategies to Bridge the Gap Between Potential and Actual Savings in Commercial Buildings," University of California, Davis, $134,981, Contract No. 09-327

Building operations will play a major role in cost-effectively achieving energy use and emissions reductions. Improving building operations also supports state goals for maintaining healthy indoor environments, a green economy and a clean energy workforce. This project focused on how building operators approach energy use and conservation in their work, viewing the building as a social system. It drew on interviews, a workshop, surveys, and case studies, learning from operators, other facilities staff, researchers, policymakers, and occupants. The researchers found two clusters of obstacles to lowered energy use. First, while building operators have the technical means to reduce energy use, social, organizational, and technical constraints limit ability and motivation. These include low status, customer service demands, poor feedback on occupant environment, little energy data, and shortcomings of Building Management Systems. A second cluster of obstacles rests on the fact that current combinations of buildings, management, and expectations leave many occupants dissatisfied. These results suggest that targeting building operators to implement energy reduction strategies is ideal if the following issues are addressed: 1) increasing visibility and status of building operators; 2) improving ability to see energy; and 3) better integration of the indoor environment with energy efficiency.

3) "Location Specific Systemic Health Effects of Ambient Particulate Matter," University of California, Davis, $285,866, Contract No. 10-302

Ambient PM (particulate matter), especially that which is less than 2.5 microns in diameter (PM2.5), is a significant public health concern due to its strong correlation with adverse health impacts related to exacerbation of both pulmonary and cardiovascular disease. Although the observed association has been relatively consistent, some of the the biological mechanisms through which inhaled particulate matter could influence systemic and cardiovascular health endpoints remain unclear. While regulation of PM levels is done on the basis of mass concentration within specific size ranges, there is much interest in the relative contribution of specific PM components and sources to PM induced health effects. Classes of PM constituents thought to contribute to PM toxicity include transition metals, polycyclic aromatic hydrocarbons (PAH), and biologic material such as endotoxin. Most studies to date have focused on PM2.5 from urban areas. The extent to which known differences in PM2.5 chemical composition influences health effects in rural as compared to urban areas is largely unknown. This study compared production of mediators of blood clotting and lung and systemic inflammation in mice exposed to PM2.5 from urban and rural sites near Sacramento. It also investigated the roles of transition metals, PAH, and endotoxin in inducing the observed effects. Lung inflammation was assessed by histopathology and measurement of markers of inflammation in lung tissue samples. Systemic markers of platelet activation and inflammation were measured in the blood. The results suggest that urban PM2.5 has greater toxicity than rural PM2.5, possibly related to PAH content, that metals do not play a significant role in mediating inflammatory effects, and that endotoxin contributes to inflammatory effects related to exposure to both urban and rural PM2.5.

4) "Peripheral Blood Gene Expression in Subjects with Coronary Artery Disease and Exposure to Particulate Air Pollutant Components and Size Fractions," University of California, Irvine, $274,931, Contract No. 09-341

Cardiovascular disease outcomes have been associated with exposure to particulate matter (PM) air pollution in many epidemiological studies. Experimental studies have revealed potential mechanisms for these effects, which involve increases in oxidative stress and inflammation, coagulation, and changes in vascular function. Exposure studies have also examined changes in the expression of genes in key biological pathways linked to these potential mechanisms. The current study evaluated gene expression with air pollution exposure in an elderly cohort consisting of 43 subjects with coronary artery disease living in retirement communities in the South Coast Air Basin. The subjects were part of the Cardiovascular Health and Air Pollution Study (CHAPS). The exposure assessment of this study included hourly measurements of indoor and outdoor pollutant gases and daily size-specific particle mass and chemical composition. Source apportionment results in the retirement communities showed that mobile sources were the major contributors to indoor as well as outdoor particulate matter at all sites. This is important because the elderly subjects in this study spent most of their time indoors. For the analysis of gene expression, 35 genes were selected based on biological function and also on relevance to pathways involved in air pollution effects. Results of the analysis showed an association between the exposure to traffic-related air pollutants and the expression of seven genes linked to pathways that are involved in oxidative stress response, detoxification, inflammation, and platelet activation (coagulation). This study

provides additional information on the impacts of traffic pollution in the elderly with cardiovascular disease.

5) "Using Remote Sensing to Quantify Albedo of Roofs in California's Seven Largest Cities," Lawrence Berkeley National Laboratory, $250,000, Contract No. 10-321

Cool roofs reflect a fraction of incident sunlight that would otherwise be absorbed and heat commercial buildings and residences. The reflection of incident light also counteracts some of the greenhouse effects from absorbed radiation. Of critical importance for the prediction of benefits from a large scale cool roof (and cool pavement) climate change mitigation policy is the understanding of current reflectances (albedos) of major urban centers in California, such as Los Angeles, Long Beach, San Diego, Bakersfield, Sacramento, San Francisco, and San Jose. In this project, the investigators used multi-band aerial imagery, ground-truth field work, and statistical/spatial simulations to determine reflectances for these major urban centers. They also found, by using a limited simulation, some potential in using cool roofs for climate change mitigation, as well as for avoiding heat island effects in Bakersfield. Results from this work include both a database of roof reflectances for major urban centers and a method to generate reflectance data from aerial imaging, which is useful for creating similar albedo databases for other urban centers.

6) "Understanding Primary Organic Aerosol Volatility at Atmospherically Realistic Concentrations for the SIP Analysis," University of California, Davis, $309,769, Contract No. 10-313

Emissions tests have determined that primary organic aerosols (POA) generated from combustion sources behave like a series of semi-volatile compounds when the particulate phase concentrations range between 100 – 10,000 µg/m3. More recent models fit to measurements of POA emitted from gasoline powered vehicles predict that POA is semi-volatile and will largely evaporate given sufficient time in the atmosphere. These conclusions are not supported by measurements of oxygenated organic species (carbonyls) emitted by gasoline vehicles. Hence, a follow-up study was needed to reconcile these differences. The objective of this project was to identify the dominant partitioning mechanism for POA emitted from gasoline- and diesel-powered vehicles at atmospherically realistic concentrations in the range from 5 to 30 µg/m3. The results indicate that vehicles emit appreciable amounts of POA from fuel combustion that has very low volatility that can be characterized as effectively non-volatile under typical atmospheric conditions. The POA emitted during the cold-start portion of the driving cycle appears to have greater volatility than POA emitted during other phases of the driving cycle. These findings will have broad application within regional air quality models used to evaluate the efficiency of emissions control programs on Particulate Matter (PM).

7) "Three-Dimensional Measurements of Aerosol Mixing State during CalNex Using Aircraft Aerosol Time-Of-Flight Mass Spectrometry," University of California, San Diego, $400,000, Contract No. 09-333

Aerosol properties have been characterized extensively using ground-based measurements in California. However, these measurements may not fully capture the spatial variations of aerosol properties both regionally and vertically, which are critically important as the aerosol climate effects are affected by the location of particles in the

atmosphere. As part of the CalNex 2010 field campaign, an aerosol time-of-flight mass spectrometer (ATOFMS) was used to measure single particle aerosol chemical speciation and mixing state onboard the Twin Otter aircraft and the R/V Atlantis research ship. The extensive regional coverage provided by CalNex 2010 and some other aircraft campaigns allowed for unique and unprecedented insights into the variation of particle chemistry and sources in California. The results show that the majority of ambient carbonaceous particles in California were internally mixed and heavily influenced by secondary species that were most prevalent in the particular region. In general, there were significant spatial and temporal variations in aerosol properties and mixing states in the Ports of Los Angeles / Long Beach, the South Coast Air Bain, and Northern California. The data provided important information to improve our understanding of the climate effects of aerosols in California.

8) "Extended Analysis of the CARES Aerosol Chemistry Data to Characterize Sources and Processes of Organic Aerosol in the Sacramento Valley of California," University of California, Davis, $155,000, Contract No. 10-305

Particles less than 2.5 microns in diameter have serious adverse impacts on human health and play an important role in climate forcing, visibility degradation and deposition to ecosystems and crops. Although a significant fraction of these submicron aerosols are comprised of OA - typically 30 to 80 percent of the mass fraction - the sources and composition of this OA in California are highly uncertain. This project investigated the composition, sources, and processes of submicrometer particles in northern California by means of integrated analyses of measurements that were taken during the CARES in the Sacramento and western Sierra Foothills area in 2010. Measurements from a high resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS), which provides size-resolved chemical composition of aerosols in real time, formed a critical element in the study. Results from the analyses include: the growth of new particles was driven primarily by condensation of oxygenated organic species; bulk composition of the ultrafine mode organics during new particle events was similar to SOA observed in transported urban plumes; and new particle events over Sacramento and Sierra Nevada regions are promoted by the interaction between biogenic emissions and urban plumes. The data and analysis results from this work help constrain SOA formation mechanisms and indicate aerosol processes that are not currently treated in models.

9) "AMAX-DOASTrace Gas Column Observations from Research Aircraft Over California," University of Colorado, Denver, $549,999, Contract No. 09-317

Assessments of atmospheric chemical models and emissions inventories are based largely on measurements from ARB's monitoring network, which are confined to a limited number of surface stations. To overcome these spatial restrictions, a University of Colorado Multi-Axis Differential Optical Absorption Spectrometer (CU AMAX-DOAS) was deployed on the National Oceanic and Atmospheric Administration (NOAA) Optical Remote Sensing Twin Otter research aircraft as part of the CalNex field campaign over California in the summer of 2010. Comprehensive observation maps were made for horizontal and vertical distributions of the pollutants nitrogen dioxide (NO_2), formaldehyde (HCHO), and glyoxal (CHOCHO) over much of the SoCAB, SJV, and Northern California (Bay Area to Sierra foothills). Based on these measurements, extensive comparisons and analyses were carried out and include: comparisons with ground based and satellite (NASA OMI) measurements, weekend/weekday studies of ozone in SoCAB,

quantification of NO_X emissions and O_X production regions and rates, comparisons with NO_X emissions inventories, and studies of constraints imposed by HCHO and CHOCHO on oxidative capacity in models. Measurement products from this project will be used to improve air quality models for photochemical production of ozone and aerosols, and thus improve ARB's abilities to strategically target mitigation efforts for air quality and climate change.

10) "Synthesis of Policy Relevant Findings from the CalNex 2010 Field Study," National Oceanic and Atmospheric Administration, $252,378, Contract No. 10-326

Ozone and PM2.5 air quality in the South Coast Air Basin (SoCAB) and San Joaquin Valley Air Basin (SJVAB) continue to be among the worst in the nation, with slower than desired rates of improvement. A major field study (Research at the Nexus of Air Quality and Climate Change, aka CalNex 2010) was conducted in the early summer of 2010 to investigate the factors contributing to the poor air quality and the strategic relationships between the air quality and climate change emission control programs. ARB contracted with NOAA to prepare a report synthesizing the primary results and findings coming out of the CalNex study. Some of the more significant findings coming out of CalNex that have regulatory or policy implications include the following:

1) SOA and background O_3 comprise a significant portion of ambient PM2.5 and O_3 concentrations and may impact the focus and amount of emission reductions needed to attain ambient air quality standards.
2) California's focus on reducing NO_X emissions has reduced both ozone and PM concentrations.
3) Improvements are still needed in the current emissions inventory (e.g., unidentified VOC source in the San Joaquin Valley, methane and N_2O underestimated).
4) Improvements are still needed in air quality forecasting and modeling.
5) Biogenic emissions combine with anthropogenic emissions in the SJVAB to create significant amounts of SOA, even during the night.
6) Not all emission control efforts will be "win-win" from both air quality and climate change perspectives.

11) "Calibrating, Validating, and Implementing Process Models for California Agriculture Greenhouse Gas Emissions," University of New Hampshire, $249,688, Contract No. 10-309

Agricultural soils are an important source of GHGs that are responsible for global warming. Because production of GHGs such as nitrous oxide (N_2O) and methane (CH_4) in soil is driven by microbial activities, the emission fluxes of these gases, being affected by numerous environmental factors, are extremely variable both spatially and temporally. The current California inventory of N_2O from agricultural soils is developed using default emission factors derived from global averages. An alternative approach, recommended by the Intergovernmental Panel for Climate Change (IPCC) and adopted by the U.S. Environmental Protection Agency, is to use process-based modeling which accounts for environmental and management variables. This project developed a California-specific process-based DeCompoistion DeNitrification (DNDC) modeling tool that incorporates California soil, crop, and management practice information for estimating N_2O emissions from California agricultural soils. It was estimated that, based on the modeling package, California agricultural soils contributed 3.50 metric million tonne CO_2 equivalent (MMT

CO_2E) of N_2O emissions which is lower, but within the uncertainty range of the current N_2O inventory. The modeling tool along with its associated database provided ARB the capability of producing detailed N_2O maps based on prevalent agricultural land use and management practices, and can be used to develop future N_2O inventory from agricultural soils for mitigation efforts.

12) "Modeling Optimal Transition Pathways to a Low Carbon Fuel Economy in California," University of California, Davis, $278,356, Contract No. 09-346

Achieving the 2050 target of greenhouse gas (GHG) emissions at 80 percent below the 1990 levels requires extensive modification of the California energy sources and uses. This project developed a model that analyzes the many issues and controversial policy scenarios that would have to be addressed before the 2050 or interim GHG emission reduction targets can be met. The project developed a model called CA-TIMES. The model is a flexible bottom-up energy cost optimization model for California. Its flexibility lies in its ability to use technology specification and many other options by the modeler in a scenario format. To demonstrate the model, the contractor specified several scenarios. Two of the main scenarios reveal the need for significant investment in California's energy system, especially in the clean electricity production, because of major shifts in transportation and residential fuel use.