

**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 20, 2011
9:00 a.m.**

ADVANCE AGENDA

Interagency Agreements

1. "Risk of Pediatric Asthma Morbidity from Multi-Pollutant Exposures," University of California, Irvine, \$285,000, Proposal No. 2717-270

One of the Air Resources Board's (ARB) goals is the protection of sensitive populations, such as children, from air pollution impacts. Numerous studies have shown a link between particulate matter (PM) exposure and asthma morbidity outcomes in children. While these studies have contributed to our understanding of the health impacts of particle exposure in children, several issues regarding the biologically active components of PM remain to be addressed. For example, there is limited information on the health effects of two important classes of particles in California, primary organic aerosols (POA) directly emitted from combustion sources; and secondary organic aerosols (SOA), which are largely photochemically-produced. Moreover, these classes of organic aerosols have different spatial and temporal variability and they are minimally correlated with each other in southern California (Delfino et al 2009b, 2010a, 2010b). The proposed study aims to analyze the possible relationship between asthma morbidity using hospital data for 7,954 children with asthma, and both regional and local exposures to PM including POA and SOA. This will be studied using PM predictions (size-resolved mass, speciation and source apportionment) generated by regional air quality models. PM will be estimated for three particle sizes, including ultrafine (UFP), PM_{2.5}, and PM₁₀, along with estimates of the contributions of specific sources of PM (e.g. diesel, gasoline and wood smoke). Other air pollutants such as ozone (O₃), nitrogen oxides (NO₂ and NO_x) and carbon monoxide (CO) will also be estimated. The study will evaluate whether temporal and spatial variations of PM_{2.5} sources and species affect the association between PM_{2.5} mass concentrations and emergency department visits and hospital admissions for asthma. It will also evaluate the association between air pollution susceptibility, including asthma recurrence and socioeconomic status and demographic factors. The present study will leverage the daily POA and SOA exposure data from the University of California, Davis/California Institute of Technology (UCD/CIT) Source Oriented

Chemical Transport Model. The proposed study is expected to provide new information on the association of asthma morbidity with multiple local and regional air pollutants and general particle composition. Findings will be relevant to efforts by ARB to control PM_{2.5} by assessing the importance of sources and components that are related to health outcomes.

2. "Near Freeway Spatial Gradients in Particulate Biological Activity," University of California, Los Angeles, \$340,632, Proposal No. 2723-270

The objective of this project is to investigate seasonal and spatial variations in the biological activity and chemical composition of particulate matter (PM) samples. Samples of both fine and coarse PM will be collected upwind and at five locations downwind of the I-5 freeway during the summer and winter. The samples will initially be analyzed for chemical composition and chemical reactivity. Subsequently, biological activity will be assessed in a cultured cell model. The main goal of this project is to test the hypothesis that there are spatial gradients in PM composition, chemical reactivity, and biological activity that correlate with distance from the freeway. The results from this project have the potential to influence regulations by providing information on both the spatial gradient of on-road emissions in the vicinity of a major highway, and the extent to which particle composition and biological activity change with distance from a roadway.

3. "Residential Energy Use and GHG Emissions Impacts of Compact Land Use Types," University of California, Berkeley, \$100,000, Proposal No. 2719-270

Approximately 20 percent of California's household greenhouse gas (GHG) emissions are related to heating and cooling needs, which are partly a function of house size and orientation, and are therefore strongly tied to land use planning decisions. The few academic studies that have examined residential energy use as a function of urban form indicate that residents living in high density urban centers emit 20 to 50 percent fewer GHG from heating and electricity usage than residents of low density suburbs. These studies have relied upon data sets created by national energy agencies, rather than more disaggregated state- or local-scale data that more accurately reflects local climatic conditions in California. The objective of this research is to 1) investigate the relationship between land use planning factors and residential energy use in California's various climate zones; and 2) develop a spreadsheet modeling tool that analyzes residential energy use as a function of land use planning factors. Expected results will assist cities and counties with calculating GHG reductions of land use policies to encourage more compact development. Findings will support achievement of ARB's Green Building Strategy and will also be useful to quantify statewide GHG emission reductions to meet the goals of Assembly Bill (AB) 32 and Executive S-3-05.

4. "The Cool California Carbon Challenge: a Pilot Intra- and Inter-Community Carbon Footprint Reduction Competition," University of California, Berkeley, \$300,261, Proposal No. 2718-270

The AB 32 Scoping Plan indicates a need for voluntary reductions of residential GHG emissions if California is going to reduce carbon emissions to 1990 levels by the year 2020. However, motivating behavioral change can be difficult: improved access to information does not generally suffice to motivate individuals and communities to adopt energy-saving behaviors, even when these behaviors are in the actors' economic best interests. Strategies that have demonstrated some success in motivating environmentally benign behaviors include competitions coupled with other approaches such as goal-setting, modeling of normative behaviors, feedback, rewards, and providing tailored information. The goal of this project is to develop, monitor, and evaluate a carbon footprint reduction program for California households and communities that is based on ARB's CoolCalifornia.org website and toolkit and that leverages a variety of proven strategies to motivate behavioral change. The competition will be piloted in three California communities over a twelve month period, and persistence of results will be investigated six months after the competition ends. Results of this work will include a prototype competition model to foster voluntary emissions reductions through community-level competitions, assessment of the competition's effectiveness in fostering residential carbon footprint reductions in three communities, identification of factors associated with reductions (or lack thereof) in household carbon footprints, and persistence of the competition's impact. These results will support the State's efforts to curb residential GHG emissions using CoolCalifornia.org resources.

5. "Zero Pollution Lawn and Garden Equipment," University of California, Davis, \$375,896, Proposal No. 2722-270

The lawn and garden equipment sector is a significant pollution source in California. The non-riding lawnmower is representative of this sector. The vast majority of heavy users such as professional landscapers only use combustion-based lawnmowers and equipment due to the increased mobility they provide. Electric lawnmowers are effective for some homeowners but even the most advanced battery technology is not capable of providing a reasonable solution for professional landscape crews and the bulk of small combustion engine users. This project will research lawn and garden equipment, the technical requirements in this sector and will investigate the potential pathway for reducing emissions through fuel cell application. The fuel cell's hydrogen supply will be generated from a proprietary sodium silicide system engineered by SiGNa Chemistry. As a proof of concept, a demonstration prototype lawnmower unit will be built and tested to demonstrate the feasibility of these technologies, which will allow ARB to consider reduced emission limits for lawn and garden equipment sold in California.

Standard Agreements

6. "Evaluation of Pollutant Emissions from Portable Air Cleaners," Lawrence Berkeley National Laboratory, \$400,000, Proposal No. 2721-270

Portable air cleaners using new technologies can generate primary and secondary emissions such as formaldehyde, fine and ultrafine particles, and highly reactive chemical species, including hydroxyl radicals, which may lead to poor indoor air quality and associated health effects for consumers. In this study, principal investigators (PI) will measure pollutant emissions from new technology air cleaners in a test chamber under realistic indoor operating conditions and assess the implications of those emissions for indoor air quality and health. The PIs will test six air cleaner models, with a focus on those using photocatalytic oxidation (PCO). The proposed research will help ARB determine whether there are any indoor air quality or health concerns that need to be addressed and help consumers make informed decisions when purchasing and using these devices. In addition, this research may prompt the development of appropriate engineering controls to reduce the emissions of these pollutants.

7. "Developing Databases to Estimate California-Specific Climate Forcing Benefits of Cool Roofs," Lawrence Berkeley National Laboratory, \$250,000, Proposal No. 2720-270

"Cool" roofs and pavements can reflect a significant amount of sunlight, reduce cooling load, decrease the urban heat island effect, and save energy. In addition to energy savings, increases in surface reflectivity or albedo also produce an indirect climate benefit by creating a negative radiative forcing proportional to the amount of additional sunlight reflected back through the atmosphere to space. Research at Lawrence Berkeley National Laboratory (LBNL) to quantify the direct energy saving benefits of cool roofs and pavements is currently funded by the California Energy Commission (CEC) and ARB. This project is intended to improve efforts to quantify the indirect benefits of "cool" roofs due to increased albedo. This project will develop California specific information on roofing stocks and the associated albedos, which is necessary for improved estimates of the climate benefits of increasing urban albedo through the widespread application of "cool" roofs and pavements. Using satellite retrieval and other available data resources, the Principal Investigator (PI) will assemble maps of solar reflectance (albedo) for seven major urban areas in California (Los Angeles, San Diego, San Jose, San Francisco, Fresno, Long Beach and Sacramento). The databases generated by this proposal will be an important part of any future modeling effort to improve estimates of carbon dioxide (CO₂) equivalent climate forcing benefits of a program to increase urban albedo in California. This project is a necessary first step toward estimating the total climate benefits (direct energy savings + indirect albedo benefits) of cool communities.

Draft Final Reports

8. "A Spatial Synoptic Classification Approach to Projected Heat Vulnerability in California Under Future Climate Change Scenarios," Kent State, \$191,553, Contract No. 07-304

Executive Order S-3-05, signed by Governor Schwarzenegger on June 1, 2005, called for the California Environmental Protection Agency to prepare biennial science reports on the potential impact of global warming on certain sectors of the California economy. ARB was assigned to lead the analyses of public health impacts of climate change. The first report under this executive order was released in 2006, and included an analysis of the risk of heat-related mortality in five of the most populous areas of California. This analysis was performed by Sheridan, Hayhoe, and Kalkstein, the same investigators that served as contractors for the project described in this draft final report. This project extended and improved the previous methodologies and expanded the analysis to nine California urban areas.

The objectives were to estimate changes in the number of oppressive air mass events (those types most associated with heat-related mortality) over the coming century under higher and lower climate change scenarios; to translate these changes into potential impacts on mortality rates in California, by urban center and age group; and to assess the expected adaptation potential of the population in each urban area.

The study estimated heat-related mortality across California's nine largest metropolitan areas through 2100 both with and without acclimatization, and estimates of the number of actual heat warnings that would be called under the same circumstances by an operational Heat Watch Warning System (HWWS). Products also included an assessment of the adaptation potential that might be achieved through implementing HWWS in additional cities beyond San Francisco and San Jose.

The results suggest that climate change will lead to increased heat wave frequency and duration over the remainder of this century, as well as increased heat-related mortality. Projected increases of each of these factors is influenced by the climate change model used for the analysis, the greenhouse gas emissions scenario employed, and the assumptions about population growth and demographics.

9. "Fine-Scale Spatial and Temporal Variability of Particle Number Concentrations within Communities and in the Vicinity of Freeway Sound Walls," University of Southern California, \$461,334, Contract No. 05-317

Ultrafine particles (UFPs; <0.1 micron in diameter), which comprise the vast majority of particles in the air, contribute very little to the overall particulate matter (PM) mass upon which ambient air quality standards have been established. Recent studies indicate a potential link between particle number concentrations (PNC) and health

impacts. In addition to primary, or direct, UFP emissions (mainly associated with the combustion of fossil fuels), secondary formation from gaseous pollutants in the atmosphere also creates UFPs. To investigate the spatial and temporal variability of UFPs, minute by minute particle number measurements were made in three study phases covering a source region (Harbor Communities), a receptor region (Riverside area), and locales downwind of freeway sound walls. The results confirm the fine-scale variability in PNCs from direct sources but also indicate a significant contribution of secondary particle formation to PNCs in regions downwind of urban areas. The rate of decline in PNCs near freeways and the difference with and without sound walls also has implications for urban planners and investigators of air pollution health effects.

10. "Development of the UCB-L Particle Monitor for Future California Applications in Environmental Justice," University of California, Berkeley, \$213,088, Contract No. 06-321

As the public becomes more knowledgeable about air pollution and its effect on health, local community-based air pollution monitoring projects have become more important. Community members and groups want to protect themselves from localized exposures to high concentrations of particulates, and to understand whether they are being exposed requires high quality, low cost, simple to use instruments. Ambient aerosol monitoring commonly requires either expensive or difficult to use instrumentation with lab backup that is impractical for individuals to use. This study modified a low cost, simple, accurate optical commercial particle counter, the Dylos™, and evaluated its use as an ambient fine particulate monitor. The preliminary name of the prototype device is the Berkeley Aerosol Information Recording System (BAIRS). Based on lab and ambient air testing against standard monitoring equipment, it performed well with a detection limit of less than $1 \mu\text{g}/\text{m}^3$ and resolution better than $1 \mu\text{g}/\text{m}^3$. It is also robust, and able to measure concentrations up to $1.0 \text{ mg}/\text{m}^3$. The project funding ended before development of multiple field-capable devices could be built and deployed, which should be the next step in evaluation for use by non-technical community groups.

11. "Analysis of Satellite Measurements to Improve California's Model for O_3 and PM," University of California, Berkeley, \$350,724, Contract No. 06-328

Air basin modeling generally focuses on brief episodes with high air pollutant concentrations that exceed air quality standards ("design days"). This focus, in turn, narrows development of spatially and temporally detailed emission inventories to short duration high pollution periods in only a few air basins. This situation limits refined emissions inventories for nitrogen oxide (NO_x), volatile organic compound (VOC), and particle precursors to locations where violations of state standards are most frequent - possibly at the expense of accurate predictive capabilities in regions that are not now in violation but might become so in the near future. This project tested the utility of satellite measurements of total column nitrogen dioxide (NO_2) to map NO_x emissions at scales useful for regional and urban air quality modeling. Although the "raw" satellite data have poor spatial resolution (tens of km per pixel), satellite drift, cloud cover, and other sources of variation, composite mapping can

provide higher resolution than is inherent in individual measurements. The analysis of satellite NO₂ data confirms that trends observed from space are extremely accurate — inter-annual variations as small 1-2 percent is evident in the time series studied. Experience in this project also showed that interpretation of the satellite record requires attention to both the spatial resolution of the primary observations and the model used to interpret those observations. The spatial coverage of the satellite observations from the National Aeronautics and Space Administration's (NASA) Ozone Mapping Instrument (OMI) on the Aura satellite varies over a 16-day sequence and long-term averages can be constructed that have higher resolution than the original observations. This spatial pattern is sensitive to emissions, meteorology, and chemistry and is one of the most informative tests available of the accuracy of the NO_x components in current air quality models. The report describes application and evaluation of the satellite observations with attention to trends in major air districts in California and with an eye to new strategies for integrating satellite observations into the air quality management system.

12. "Deployment of a Novel Aerosol Mobility/Mass Spectrometer for Quantitative Chemical Analysis of Organic Aerosols from Mobile Sources," University of Southern California, \$245,338, Contract No. 06-330

A major challenge to the further understanding of the composition and sources of ambient aerosols is the development of an instrument to conduct *in-situ* quantitative measurements of organic compounds. To help address this need, this recently completed project directed efforts towards the construction, testing and field deployment of a novel instrument that combines particle size classification with compound specific measurements - chemical ionization mobility/mass spectrometry (CIMMS). Because of significant uncertainties involved in the construction and testing of such an instrument, the project was split into two phases and RSC approval was required before Phase 2 could be started. Even with this foresight, the project ran into several substantial setbacks; the stop work order for all contracts in the summer of 2009, equipment construction and procurement issues, and the departure of a graduate student. These ultimately curtailed the possible testing and field studies that could be conducted in the allotted time, despite the best efforts of the principal investigator (PI). As it stands, the final report documents progress made in the construction/testing of CIMMS and presents results from several laboratory and field measurements. While these mark important steps in the development of this instrument, the project fell short of completing all planned tasks.

13. "Indoor Environmental Quality and HVAC Survey of Small and Medium Size Commercial Buildings," University of California, Davis, \$1,060,000, Contract No. 06-311

Heating, ventilation, and air conditioners (HVAC) constitute the largest fraction of energy use for many commercial buildings. Small and medium commercial buildings (SMCB), buildings with total floor area between 1,000 and 50,000 square feet, make up 96 percent of commercial buildings in the United States; however, actual measurements in California of HVAC and indoor air quality parameters in SMCB

have been lacking. The overall objective of this field study was to characterize all aspects of HVAC in SMCB and its impacts on, and relationships with, indoor air quality (IAQ). The study involved field inspection of HVAC equipment at 37 SMCB (3 repeated for seasonal analysis), as well as measurements of volatile organic compounds (VOC), particulate matter (PM_{2.5} and PM₁₀), air exchange rates, carbon monoxide (CO), carbon dioxide (CO₂), and other parameters of concern to ventilation and IAQ. Among the many significant results, the investigators found that healthcare establishments, fitness gyms, offices, hair salons, and retail stores provided less outdoor air ventilation than required by state regulations, filtration was often poor, and that the majority of the buildings had formaldehyde concentrations above the 8-hour reference exposure level (7 ppb). The study identified a number of areas where the operation and maintenance of HVAC equipment and actions associated with indoor sources could be improved. The results from this project will be very valuable to the California Energy Commission (CEC) and ARB as they seek to improve the energy efficiency of SMCB while maintaining good IAQ.

14. "Developing a California Inventory for Ozone Depleting Substances and Hydrofluorocarbon Foam Banks and Emissions from Foams," Caleb Management Services, Ltd., \$349,758, Contract No. 07-312

Insulating foam, including those used in building insulation and refrigerator-freezers, contain high-global warming potential GHGs that are primarily released at the time of building demolition or appliance recycling at its end-of-life. The central proposition behind this research project is that it could make environmental sense from a climate policy perspective to mitigate emissions by either reducing current reliance on high-global warming potential (GWP) blowing agents and/or by separating and diverting GHG-containing foams out of the waste stream to be processed in ways that reduce GHG emissions. Investigators surveyed 302 entities encompassing the entire insulating foam lifecycle from production, distribution, use, and end-of-life recycling or disposal of waste foam. The survey results were used to determine existing foam inventories (banks), current emissions, estimated emissions through 2020, and to summarize potential GHG emissions reduction scenarios for the foam sector. Current 2010 annual GHG emissions from foam are estimated at 5.7 million metric tons of carbon dioxide equivalents (MMTCO₂E), which is expected to increase to 7.8 MMTCO₂E annually by 2020. There is technical potential to reduce 25-35 percent of the GHG emissions from the foam sector by 2020, equating to 2.0 – 2.8 MMTCO₂E annual reductions in 2020. Reductions could be achieved through a phase-out of the use of high-GWP foam blowing agents, building foam recovery and destruction, and appliance foam recovery and destruction.

15. "Development of a California Geospatial Intermodal Freight Transport Model with Cargo Flow Analysis," University of Delaware, \$199,937, Contract No. 07-314

California represents a major international gateway for goods movement in North America. Along with an anticipated increase in overall goods movement, intermodal freight transport, where goods are moved along a combination of highways, railways, and waterways, is expected to increase correspondingly. Policymakers and planners must develop operational and infrastructure improvement strategies to

increase the efficiency of freight movement, reduce the demand for transportation fuels, and mitigate the environmental impacts associated with intermodal freight transport. This project developed a California-specific intermodal freight transport model to describe the movement of goods generated by California's ports and through highway, rail, and waterway systems and the configured model with California-specific data was then used in a case study to examine the possible benefit of shifting freight transportation from trucks to rail. The case study estimated the carbon dioxide (CO₂) emissions to be approximately 2.9 million metric tons (MMT) attributable to the container traffic of the three major West Coast ports (Los Angeles-Long Beach, Oakland, and Seattle) under a least-travel-time scenario (which comprises mostly trucks). A total reduction of approximately 1.7 MMT of CO₂ would be expected through a nationwide modal shift from trucks to railways for West Coast ports generated goods movement; within the state of California, this reduction is nearly 0.5 MMT of CO₂. Overall, this research demonstrated how the model, configured with California-specific data, can be used to improve understanding and decision-making associated with intermodal freight transport in California.

16. "Potential Design, Implementation, and Benefits of a Feebate Program for New Passenger Vehicles in California," University of California, Davis, \$796,641, Contract No. 08-312

A feebate regulation combining a one-time rebate program for new low-emitting vehicles with a one-time fee for new high-emitting vehicles could contribute significantly to the reductions from the transportation sector necessary to achieve California's climate change goals. Researchers from the University of California, Davis, Berkeley and Irvine conducted a comprehensive study on the implementation and design options for a feebate program based on quantitative modeling of manufacturer and consumer response, past experiences of similar programs, expert interviews, consumer focus groups, and a statewide household survey. They found that feebate policies could be used in California to achieve additional reductions in GHGs beyond those projected from emission standards alone and at a net *negative* social cost (savings). Different feebate program configurations could lead to greater reductions, but require tradeoffs in consumer welfare and manufacturer equity. In a California-only program, reductions result mostly from a shift in consumer purchasing patterns rather than improvements in vehicle technology; a national program that covers the entire vehicle market would promote significantly greater levels of vehicle redesign. Stakeholder sentiment towards this type of policy was mixed, with auto dealers, focus group participants, and some automakers largely opposed, while survey respondents and other automakers were more receptive. This study demonstrates that with careful design, a feebate program could be a viable, non-regressive policy to achieve some additional GHG reductions from the light-duty vehicle sector. However, the impact in California would be greater under a nationwide program compared to a state or regional one.