CALIFORNIA AIR RESOURCES BOARD

Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 510, 5th Floor
Sacramento, California 95814
(916) 445-0753

January 11, 2019
9:00 a.m.

ADVANCE AGENDA

I. Approval of Minutes of Previous Meeting:

October 4, 2018 meeting

II. Discussion of Responses to a Request for Proposals:

1. "Off-Road Diesel Low-Emission Demo for Nitrogen Oxide (NO_X), Particulate Matter and Toxics," $500,000, RFP No. 18RD006

    - Southwest Research Institute $499,990
    - West Virginia University $489,379
    - University of California, Riverside $500,000

    Because of the continued dominance of diesel engines for off-road applications, and the continuous improvement of emission control for on-road engines and vehicles, off-road diesel engines will become an increasingly larger fraction of air pollutant emissions from the transportation sector. Off-road diesel engines newer than 2014 model year with output over 56 kW (75 horsepower [hp]) must meet the stringent Tier 4 final emission standards of 0.40 g/kW-hr for nitrogen oxides (NO_X) and 0.02 g/kW-hr for particulate matter (PM). To meet those emission standards, most Tier 4 off-road diesel engines with power ratings in the range of 56 to 560 kW (75 to 750 hp) employ either a combined diesel particulate filter (DPF) and selective catalytic reduction (SCR) system or an SCR-only configuration. This project will measure the emission rates of a suite of criteria and non-criteria pollutants from two off-road diesel engines with different aftertreatment configurations. One engine will be Tier 4 certified and equipped with a combined DPF and SCR system, and the other engine will be Tier 4-certified as well but equipped with an SCR-only system (i.e., no DPF). The project will also explore the optimal engine and aftertreatment configurations for future laboratory demonstration of low NO_X off road diesel engines.

III. Discussion of Draft Final Reports:

1. "Effects of Ultrafine PM Exposure in an Animal Model of Neurodegenerative Disease," University of California, Los Angeles, $497,821, Contract No. 14-315

   Exposure to ambient particulate matter (PM) is known to be associated with increased cardiopulmonary morbidity and mortality; much less is known about impacts of PM exposure on the brain. The objectives of this study were to determine whether long-term exposure to ultrafine particulate matter (UFPM) from Irvine, California is associated with the following: neurodegenerative processes in a mouse model of Parkinson's disease (PD); accelerated progression of innate immune responses in the brain; and cognitive or behavioral deficits. Transgenic (PD model) and wild-type (control) animals were exposed to ultrafine concentrated ambient particles (CAPs) or filtered air for 22 weeks, followed by assessment of motor and cognitive behaviors. Chemical assays were then used to analyze the animals' post-mortem brains. Results showed significant adverse effects in a test of fine motor coordination and balance, both in transgenic and control animals, in response to CAPs exposure. However, no differences were seen between mouse strains or exposure treatments for three other behavior/cognition assays. There was a trend toward elevated pro-inflammatory marker IL-6 in the hippocampal brain region in CAPs-exposed animals (both strains), although the difference was not significant. No differences between mouse strains or treatments were seen for brain levels of the anti-inflammatory marker HO-1 or for the neurotransmitters dopamine or norepinephrine. These findings can be used to inform future studies of potential health impacts of PM exposures.

2. "Greenhouse Gas Measurements at Walnut Grove Tower," University of California, Davis, $200,000, Contract No. 15-302

   California has committed to an ambitious plan to reduce GHG emissions to 1990 levels by 2020 with the passage of Assembly Bill 32 (AB 32). This has led to efforts to measure, quantify, and mitigate emissions of a variety of key GHGs, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Over the past decade, a variety of studies have estimated GHG emissions in different regions of California using measurements from satellites, aircrafts, and ground towers. This study continued high-accuracy multi-species measurements of CO_2, CH_4, and other selected GHGs and tracers at a ground-based monitoring tower near Walnut Grove, California (WGC), a premier research monitoring site with the longest running measurement of terrestrial influences in the state. The multi-year GHG concentration measurements conducted under the project were combined with previous measurements at the site to track GHG trends over the past decade (2007-2017). Results include hourly resolved time-series measurements of primary GHG species (CO_2, CH_4, N_2O) and Carbon Monoxide (CO) at 91 and 483 m above ground level, and flask measurements every other day for the above species, the radiocarbon isotope, $^{14}CO_2$, several important industrially produced GHGs, and other volatile organic compounds (VOCs) that might be used as tracers for anthropogenic activities. Using the flask measurements, this project found that temporal trends in the primary GHG species are broadly similar to the global background levels observed at Mauna Loa. More specifically, the relative trends for CO_2, and N_2O at WGC were consistent with the global background trends, whereas CH_4 trends grew more slowly at WGC, and CO declined more rapidly compared to Mauna Loa. For the high-GWP GHGs,

both SF6 and HFC-134a increased over the last decade at the WGC site, while CFC-11 and Halon-1211 decreased over the same period, similar to the global background. The resulting decadal record provides information on GHG concentrations for central California that can be used to estimate regional emissions when combined with other information in an inverse model context.

3. “Improved Understanding of the Magnitude of Trans-Pacific Long Range Transported Ozone Aloft at California's Coast,” San Jose State University Research Foundation, $281,699, Contract No. 15RD007

   Although surface concentrations of ozone (O_3) have greatly decreased over most of California over the past several decades in response to air quality control efforts, O_3 concentrations in the SJV have decreased at a slower rate, preventing attainment of National Ambient Air Quality Standards (NAAQS). The unique trough-like topography, diverse emission sources, and high summer temperatures place extreme demands on the design of control strategies to reduce ozone concentrations in this region. These efforts are further complicated by significant tropospheric background concentrations from upwind anthropogenic precursors, long range transport, and stratospheric intrusion events. The goal of this project was to collect upper air ozone data at a California coastal site to 1) better characterize the incoming baseline concentrations of ozone aloft, and 2) to support air quality modeling for the State Implementation Plan (SIP). The project measured vertical profiles of ozone concentrations on a near daily basis for three months, from late spring to summer of 2016. This characterization of aloft ozone will benefit the CARB as well as the atmospheric scientific community and provide a baseline for California’s ozone air quality, which is critically needed for the design of effective SIPs to attain the current and future NAAQSs for ozone.

4. “Designing Light-Duty Vehicle Incentives for Low-and Moderate-Income Households,” University of California, Los Angeles, $482,608, Contract No. 15RD011

   This study assessed using purchase incentives to promote the retirement of functional, high-emitting vehicles and increase adoption of advanced clean vehicles by low- and moderate-income California households. Additionally, this study examined the vehicle holdings, vehicle purchase decision-making and financing, travel patterns, and barriers to vehicle access by households in the target population. A statewide, representative survey forms the basis of this study. The survey included a vehicle choice experiment of 1,604 low- and moderate-income households. Results show that offering vehicle rebates significantly increases the adoption of conventional hybrid vehicles, plug-in hybrid electric vehicles (PHEVs), and battery electric vehicles (BEVs), with purchase rebates of $2,500, $5,000, and $9,500 increasing the purchase rates by approximately 20 percent, 40 percent, and 60-80 percent respectively across vehicle types compared to no rebate. In contrast, offering guaranteed loans had a small and uneven effect on the propensity to purchase these vehicles. Results indicate that low- and moderate-income Californians value their vehicles, as they have the same number of vehicles as the statewide average, which is two vehicles per household. Furthermore, these households spent almost $14,000 to acquire their last vehicle, which is over half of their yearly income.

5. “Investigative Modeling of PM2.5 Episodes in the San Joaquin Valley Air Basin during Recent Years,” University of California, Davis, $199,234, Contract No. 15-301

   The decreased severity of air pollution events in California over the last 15 years has benefited human health, yet also presented new challenges for air quality modeling. Chemical transport models (CTM) used in SIP development have not been able to completely adapt to the changing emissions and meteorological conditions. One of the results from this is that, compared with events 10-15 years ago, CTMs under predict peak nitrate concentrations in the San Joaquin Valley (SJV) by a much larger amount. To address this and other model shortcomings, this project addressed potential causes for under predictions in nitrate concentrations and, where possible, developed best available solutions. This work was carried out in two phases. An initial phase investigated possible modeling biases in both reactive nitrogen emissions and meteorological fields through various comparisons with measurements. Based on the results of this work, phase 2 investigated corrections to biases in emissions of nitrate precursors, corrections to biases in meteorological fields, optimization of nitrate production conditions, and refinements to the spatial resolution for nitrate formation. Using a revised CTM based on these findings, the Principal Investigator (PI) simulated several historical and current air pollution episodes and compared these with measurements from 2010 CalNex, 2013 DISCOVER-AQ, and CARB ground sites in 2015. In addition to improvements in descriptions of the meteorological fields, the PI proposed increases in nitrogen oxides (NO_X) emissions, primarily from candidate soil emissions. Further work is needed to fully test this hypothesis and better understand the seasonal and agricultural impacts on this possible NO_X source. Overall, the optimized CTM still has difficulties in the description of boundary layer dynamics and associated processes that recent work suggests is important in particulate nitrate formation in the SJV.

6. “Lidar Profiling of Ozone in the San Joaquin Valley,” National Oceanic and Atmospheric Administration, $99,611, Contract No. 15RD012

   Ground-level ozone (O_3) is harmful to human health and the environment, and is regulated under the Clean Air Act (CAA). The San Joaquin Valley (SJV) is classified as an extreme O_3 non-attainment area for the 8-hour O_3 National Ambient Air Quality Standard (NAAQS). Although studies have shown that local and regional photochemical production is the dominant source of the high ground-level O_3 in the SJV, it has been determined that O_3-rich lower stratospheric air can sometimes descend and entrain transported Asian pollution and biomass burning plumes to the surface. To evaluate the impact of long-range transport, stratospheric intrusion, and biomass burning on ground-level O_3 in the SJV, this project conducted measurements of O_3 and particulate backscatter profiles above the SJV using the Tunable Optical Profiler for Aerosols and oZone (TOPAZ) mobile lidar. The measurements were conducted as part of the 2016 CABOTS coordinated by CARB, which aimed to investigate the influence of O_3 transported aloft on ground-level O_3 in the SJV. This effort also coincided with additional in-situ data collected by researchers from the University of California at Davis (UCD), Scientific Aviation, and NASA Ames Research Center. Furthermore, the TOPAZ data was paired with NOAA ESRL Global Systems Division (GSD) RAP-Chem and FLEXPART models to further evaluate the impact of transported O_3 in the SJV. The resulting data revealed elevated O_3 layers between 4 and 6 km above the SJV, consistent with biomass burning, transport from Asia, and descent from the lower stratosphere. However, most of these layers passed over the

Sierra Nevada since the boundary layers in the SJV were too shallow to capture the O_3 transported aloft during the measurement campaign. A few descending events were captured that decreased ground-level O_3 due to displacement of more polluted surface air. Longer, more continuous measurements are necessary to investigate the frequency of impacts on an annual basis especially when the photochemical production of O_3 at the surface is less prominent. Analysis of the data during a wildfire event (Soberanes Fire near Big Sur) suggested that ground-level O_3 increased in the central SJV by 10-20 parts-per-billion by volume (ppbv) or more each day during the first two weeks after the fire started, including the highest O_3 days in 2016. The emissions from this fire may be responsible for the 10 percent increase in the number of exceedance days in the SJV in 2016.

7. "Characterizing the Climate Impacts of Brown Carbon," University of California, San Diego, $502,500, Contract No. 13-330

   Black carbon (BC) absorbs light and gives off heat, and is now recognized as a significant contributor to global warming. More recently, "brown carbon" (BrC—light-absorbing organic carbon) has also attracted interest as a possible cause of climate change. Previous global model simulations suggest that the strongly absorbing BrC could contribute up to +0.25 watt per square meter (W/m^2) or about 19 percent of the absorption by anthropogenic aerosols. Through a multi-institution collaboration, this study identified and characterized the contribution of BrC to climate forcing in California. Areas with significant residential burning in the San Joaquin Valley (Fresno) and with photochemical aerosol formation in the South Coast Air Basin (Fontana) were investigated to characterize their different mixes of emission sources and seasonality. The quantitative analysis of these results separated and characterized BrC, providing important quantification of emissions-specific particle absorption properties for modeling climate forcing. The regional climate modeling result indicates that top of atmosphere radiative forcing increased by ~0.28 watt per square meter (W/m^2) due to BrC absorption. The results, averaged over one year (2014-2015), of the global-through-regional nested simulations indicate that absorption by BrC in aerosol particles and clouds increased domain-averaged near-surface air temperatures by ~0.018 degree Kelvin (K), whereas absorption by organic matter (OM) plus BC increased it by ~0.17 K, suggesting a warming by BC of ~0.15 K. Overall, climate impacts from BC emitted from fossil fuel sources are predicted to dominate over the effects of BrC. The results of this project provide valuable insights regarding 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.

8. "Heavy-Duty On-Road Vehicle Inspection and Maintenance Program," University of California, Riverside, $500,000, Contract No. 15RD022

   Despite substantial reductions in NO_X and diesel PM emissions from heavy-duty vehicles (HDVs), they are still significant contributors to statewide and regional emissions of these pollutants. Because of their long service life, it is important that HDVs remain in emissions compliance throughout their entire lifetimes, and an HDV inspection and maintenance (I/M) program could be a way to ensure their compliance. A contract was awarded to the University of California, Riverside to evaluate and assess alternatives for a more comprehensive HD I/M program that could be implemented in California. This pilot study recruited 47 vehicles with 51 repairs at two

commercial repair facilities, and measured emissions before and after repair. Vehicles were recruited for measurements when the check engine light was on indicating that the engine control module (ECM) had identified a repair or maintenance need. Substantial reductions in NO_X emissions (75 percent at 30 mph and 46 percent at 50 mph) and PM opacity (43 percent) were observed for the fleet after successful repairs. Successful repairs of the 27 vehicles with the Diagnostics Message 1 (DM1) Malfunction Indicator Light (MIL) on, meaning that the vehicles had emissions-related malfunctions, resulted in even greater NO_X emissions reductions. Analysis of more extensive two-year repair records indicated that 26 percent of the 2010+ vehicles had their check engine light on when they arrived at a repair facility for maintenance and/or repair, and 16 percent of the 2010+ vehicles had the DM1 MIL on. The average repair costs per vehicle were $1,803 for vehicles with check engine lights on and $2,037 for vehicles with the DM1 MIL on. Based on a review of the potential methods, the researchers propose that a revised HD I/M program incorporate both OBD and tailpipe methods, in a manner that is cost effective and provides cross confirmation between the different methods.

IV. Other Business:

1. Update on the 2019/2020 Research Plan