# 12th CRC MOBILE SOURCE AIR TOXICS WORKSHOP

## Summary Report

Past, Present, and Future of Mobile Source Air Toxics

California Air Resources Board
4001 Iowa Avenue, Riverside, California 92507

February 10-11, 2026

**Co-Sponsored by:**

California Air Resources Board

South Coast Air Quality Management District

**WORKSHOP ORGANIZERS**

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**Workshop Overview**

The 12th Coordinating Research Council (CRC) Mobile Source Air Toxics (MSAT) Workshop, held on February 10-11, 2026, at the California Air Resources Board Southern California Headquarters in Riverside, California, brought together over 130 attendees to discuss the past, present, and future of mobile source air toxics. The workshop featured 32 presentations from regulatory, research, and industry experts, focusing on the sources, emissions, and health impacts of MSATs, as well as strategies for reducing MSAT exposure.

The workshop featured two plenary talks that explored the shifting transportation landscapes, highlighting the success of historical air quality policies and the growing importance of emerging pollutants, including non-tailpipe emissions and the health effects of wildfires and volatile chemical products.

The technical sessions provided a comprehensive look at various facets of mobile source air toxics, including MSAT emission sources and their impacts on air quality and public health exposures. The emission topics ranged from the emission profiles of heavy-duty vehicles to the secondary aerosol formation potential of renewable fuels. Researchers presented data on the environmental and health implications of lithium-ion battery thermal runaway, the development of high-resolution hybrid modeling to characterize exposure in disadvantaged communities, and studies quantifying the impact of freight movement on air pollution. The sessions also emphasized the importance and utility of using advanced monitoring and modeling techniques—such as mobile laboratory sampling and the Community Multiscale Air Quality (CMAQ) model—to improve the precision of emission inventories and effectively validate regulatory interventions.

The second day of the workshop focused on health and exposure impacts of MSATs, as well as regulatory policies and programs. Presenters discussed the link between traffic-related air pollution and adverse health outcomes, including neurodegenerative diseases and cardiovascular conditions. Research from the Health Effects Institute and various university teams underscored the importance of distinguishing between particle mass and number concentrations, with findings highlighting the need for additional and continued actions to protect the vulnerable populations. Additionally, the workshop highlighted the efficacy of pragmatic interventions, such as HEPA filtration, in reducing blood pressure and improving cognitive function among individuals living near major highways, while also showcasing community-led efforts to monitor and reduce pollution burdens in overburdened areas.

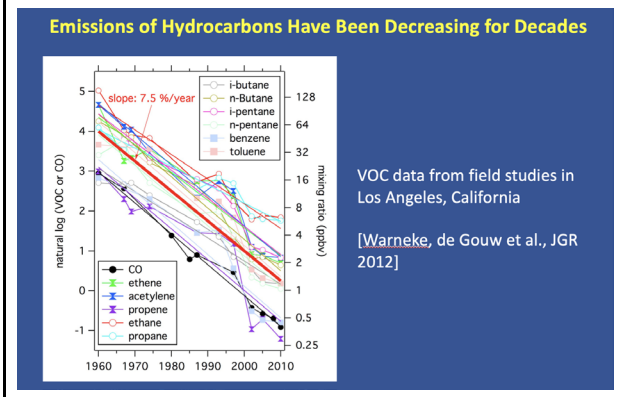
Following the workshop, the attendees were surveyed to receive workshop feedback. Results from 16 survey respondents indicated a high level of satisfaction with the technical quality and duration of the event. Attendees praised the organized structure, which successfully categorized the complex topic of mobile air toxics into five distinct perspectives. Overall, the event was well-

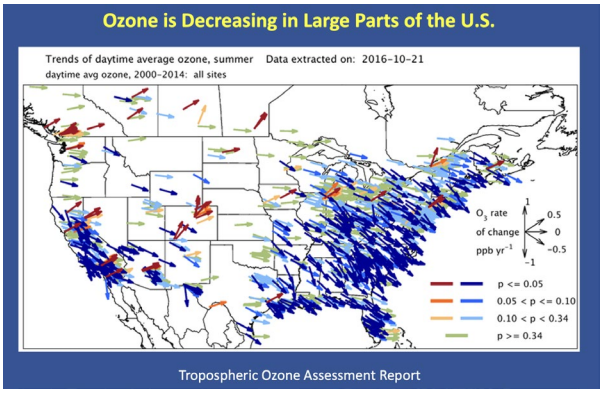
regarded for its depth and organization, with participants expressing strong interest in continued discussions on future findings from initiatives like the Multiple Air Toxics Exposure Study (MATES) VI and the potential for panel discussions to identify actionable next steps.

## Plenary Talks

1) **Air Toxics in Urban Air: Past, Present and Future** - Joost de Gouw (University of Colorado, Boulder)

In the first plenary presentation titled *Air Toxics in Urban Air: Past, Present and Future,* Dr. Joost de Gouw examined the trajectory of urban air quality, and the emerging challenges that now define the field. The project's motivation centered on the observation that while motor vehicle emissions have declined steadily over the past few decades, the landscape of urban air pollution is shifting. The presentation highlighted the significant success of the Clean Air Act, noting that emissions of most air toxics from motor vehicles have been decreasing for several decades, leading to a dramatic improvement in urban air quality. Emissions of hydrocarbons have decreased over the past decades, and emissions of nitrogen oxides are also changing rapidly, while ozone and haziness are also decreasing in large parts of the U.S.




However, Dr. de Gouw argued that further progress is becoming increasingly challenging, and that regulatory efforts must now contend with new complexities. He identified several factors that are complicating air quality management, including shifting chemical regimes involving nitrogen oxide (NOx) and volatile organic compounds (VOC), the growing influence of climate change on evaporative and biogenic emissions, and the rising relative importance of emission sources such as volatile chemical products (VCPs), wildfires, and oil and gas production, which have all become relatively more significant than traditional tailpipe sources.

The presentation highlighted that VCPs (such as cleaners, care products, inks, glues, etc.) have become the dominant sources of VOCs, and also have importance for ozone formation, including

results from a modeling study using data from the CalNex campaigns that showed that VCP emissions lead to 14 ppbv additional O3 (8-hour average).

Wildfires also pose a unique challenge. The U.S. is frequently impacted by wildfire smoke (May-Sep), and on smoke days, ozone is 7.8 ppbv higher in urban air. He noted that during the Marshall fire in 2011, 1084 buildings burned and 149 were damaged, but many unburnt homes were also exposed to heavy smoke during the fire. His research showed that many VOCs were enhanced indoors and decreased gradually. Activated Carbon filters were very effective at reducing indoor VOCs.

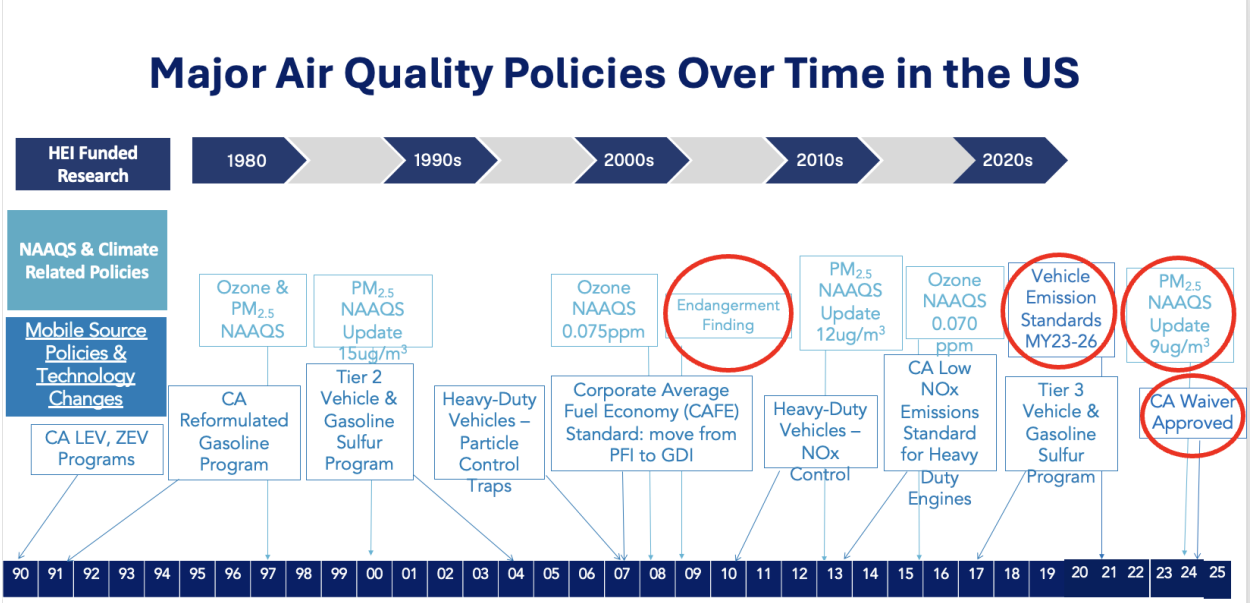
Mapping out inequalities in VOC exposure in Denver, the presentation noted that although large air pollution sources such as oil and gas and agriculture are outside of the city, Denver still has significant air pollution inequalities, where residential areas have higher VOCs than the US-36 corridor. Dr. de Gouw's research also observed that a small woodshop had the highest VOCs of all, and posed the question whether emissions from small businesses were overlooked in inventories.

The presentation emphasized that while historical policies have been effective, future air quality management must adapt to a changing landscape where new, non-traditional sources of pollution present significant challenges to public health and equity. The presentation concluded by suggesting that addressing these emerging pollutants requires a departure from legacy models to account for these modern, more variable sources of pollution.

The presentation also outlined that the scientific community's approach to these issues has evolved alongside technological advancements in measurement capabilities. Dr. de Gouw detailed how sophisticated monitoring tools, such as mobile laboratories, have allowed researchers to map air toxics with greater precision, revealing sharp spatial gradients within urban centers that were previously difficult to capture. These detailed measurements have not only improved our understanding of atmospheric chemistry, but have also been critical for understanding exposure disparities, as they illustrate that the burden of air toxics is not distributed evenly.

2) **Mobile Source Air Toxics in Transition: Scientific Insights for a Changing Transportation Landscape** – Elena Craft (Health Effects Institute)

In the second plenary session titled *Mobile Source Air Toxics in Transition: Science Informing Policy in a Changing Transportation Landscape*, Dr. Elena Craft provided a comprehensive overview of the health effects of MSATs in this rapidly evolving context, integrating insights from the HEI's strategic priorities and cutting-edge research.




Slide adapted from HEI study "Environmental and Health Benefits of Mobile Source and Electricity Generating Unit Policies to Reduce Particulate Pollution," principal investigators: Stefanie Ebelt, Emory University and David Rich, University of Rochester

The presentation explored the role of science in shaping air quality policy, the efficacy of historical regulations, and the emerging priorities in environmental health research. A significant focus of the presentation was "accountability research"—a methodology used to track whether policies intended to improve air quality actually achieve their goals and provide measurable health benefits. The presentation highlighted several landmark U.S. policies, including those governing gasoline sulfur, heavy-duty engine standards, and emission programs for electricity generating units (EGUs). The presentation noted the difficulty of isolating individual policy effects due to overlapping implementation timelines, but confirms that collective efforts have successfully reduced emissions. Accountability studies presented in the talk demonstrated the tangible successes of these policies. For instance, research led by the University of Michigan found that replacing older diesel school buses yielded significant educational benefits. This data was subsequently used by the US EPA in congressional reports to advocate for expedited bus replacement programs. Another study by the University of California, Los Angeles regarding California's goods movement corridors demonstrated that nitrogen dioxide (NO2) exposure decreased faster in identified corridors compared to control areas. Furthermore, this was associated with improved health outcomes for Medicaid enrollees, providing critical evidence to support regulatory actions by CARB.

Dr. Craft also presented insights from HEI's National Particle Component Toxicity (NPACT) initiative, which asks whether there are components or sources of the PM mixture that are of greater public health concern than others. The review panel concluded that there is currently no compelling evidence to suggest that targeting specific components or sources would be more

effective than the current regulatory approach of targeting total PM2.5 mass. This conclusion is supported by the US EPA and the World Health Organization, both of which have noted that insufficient data exist to create guidelines for specific PM types, such as ultrafine particles or black carbon. A significant finding in recent HEI research is that mortality associations exist even at PM2.5 levels below current US and EU regulatory standards. Large-scale cohort studies—involving 7 million Canadians, 68 million older Americans on Medicare, and 28 million Europeans—suggest that tightening air quality standards could yield greater public health benefits than previously anticipated. HEI studies have also highlighted that transportation contributes significantly to ambient PM2.5, with roughly 7.6% of the ambient PM2.5 contributed by on-road transportation globally, and the sector is identified as the largest PM2.5 source in the U.S.

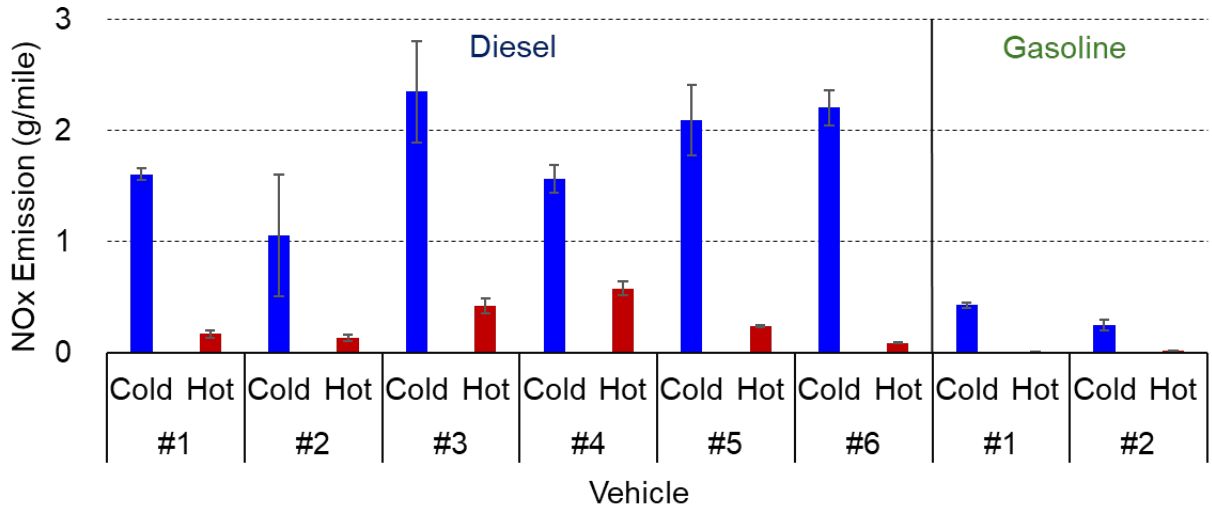
The presentation outlined several shifting priorities for the research agenda, including exploring the links between air pollution to neurodevelopmental outcomes (e.g., autism, ADHD) and neurodegenerative diseases (e.g., dementia), focus on the effects of wildfires, non-tailpipe emissions (such as brake and tire wear), and the role of the indoor environment, and the impact of air pollution on global deaths in low- and middle-income countries as compared other contributors (such as noncommunicable diseases). Looking ahead, Dr. Craft highlighted the HEI research agenda for the next few years to leverage artificial intelligence for environmental health research, despite the significant challenges in methodology. She also highlighted that future research will prioritize understanding biological mechanisms of damage, the impact of socioeconomic factors, and the health effects of a shifting transportation landscape as electrification and fleet turnover continue to progress. The findings underscored a clear trajectory: while historical policy successes have been significant, the evolving understanding of low-level exposure and neurological health risks necessitates continued, rigorous, and science-based action.

**Session 1 - Sources and Emissions of MSATs (Session Chairs: Sang-Mi Lee (AQMD) and Justine Geidosch (EPA))**

1) Comparison of Mobile Source Air Toxics from Class 4–6 Diesel and Gasoline Trucks on a Heavy-Duty Chassis Dynamometer - Kwangsam Na (CARB)

The study aimed to address a significant data gap in the transportation sector regarding heavy-duty (HD) gasoline vehicles. While numerous studies had previously characterized emissions from light-duty gasoline and diesel vehicles, limited research existed for Class 4–6 heavy-duty gasoline trucks, making it difficult to fully understand their emission characteristics. By measuring and comparing air toxics and key regulated emissions, CARB sought to characterize emission profiles by fuel type and provide updated, empirical data to improve and refine emission inventories.

The researchers evaluated a total of eight vehicles, consisting of six diesel-powered trucks and two gasoline-powered trucks. These vehicles were tested on a heavy-duty chassis dynamometer using a constant volume sampler. The study analyzed distinct emission control strategies, noting that diesel trucks utilized systems including cooled exhaust gas recirculation, selective catalyst reduction, diesel oxidation catalysts, and diesel particulate filters, whereas gasoline trucks were equipped with a three-way catalyst but lacked particulate filters.




The findings revealed that gasoline trucks provided a notable benefit in lowering NOx emissions compared to diesel trucks during transient operation, although this advantage narrowed significantly during steady-state, high-speed operation. Conversely, gasoline trucks were less effective at reducing carbon monoxide (CO), total hydrocarbon (THC), particulate matter (PM), 1,3-butadiene, and major aldehyde emissions compared to diesel trucks, regardless of the driving cycle. In particular, the diesel vehicles equipped with particulate filters demonstrated lower PM emissions than the gasoline trucks. Additionally, the study found that emissions during cold-start phase were significantly higher than those during hot-start phase for both fuel types. Air toxics

from the gasoline trucks predominated during the cold-start phase but became negligible during the hot engine phase.

2) Emission factors from on-road measurements of NOx, VOCs, CO, CH4, CO2 and other species in several Southwest US cities - Steven S. Brown (NOAA)

In this presentation, researchers from the NOAA Chemical Sciences Laboratory presented results from a comprehensive investigation of on-road emission factors for NOx, VOCs, CO, CH4, and CO2, across several major Southwest U.S. cities, including the Northern Colorado Front Range, Las Vegas, Los Angeles, and Salt Lake City. The project was primarily motivated by the need to better quantify vehicle emissions, as photochemical cycling often obscured emission ratios, and critical components like HONO remained poorly defined in urban atmospheric modeling. The research team sought to build robust statistics on mobile source emissions and to evaluate the accuracy of existing emission inventories, such as the Fuel Based Inventory for Vehicle Emissions (FIVE). To achieve these goals, the team utilized a mobile laboratory equipped with specialized instrumentation, including a Nitrogen Oxide Cavity Ring-Down Spectrometer and I-ToF CIMS on the NOAA Chemical Sciences Mobile Laboratory to capture real-time measurements of vehicle exhaust plumes while driving. The study used an approach for systematic analysis of multipollutant ratios and provided a basis for comparing observational data against established emission models.

The findings revealed that direct NO2 emissions were consistent with prior on-road research, although they were notably higher than those reported in curbside measurements from Europe and Asia. When the data were compared to the FIVE inventory, the study observed that NOx emission factors were 8% to 15% higher in Los Angeles and Las Vegas, respectively. Furthermore, concentrations of aromatic hydrocarbons, such as benzene and toluene, were consistently higher than the fuel-based inventory estimates. While the analysis of HONO/NOx ratios remained preliminary, the observed values were slightly lower than the figures typically employed in current atmospheric models. The study successfully demonstrated that the mobile laboratory approach provided a vital means of validating and improving the precision of regional emission inventories. These results provide insights into on-road emission profiles and support long-term observations of pollutants emitted from motor vehicles.

## Emission Factors Relative to FIVE Inventory

Fuel Based Inventory for Vehicle Emissions (FIVE)
McDonald et al., JGR 2014

| | Los Angeles, CA | | Las Vegas, NV | |
|---|---|---|---|---|
| parameter | FIVE | mobile laboratory | FIVE | mobile laboratory |
| $EF_{NOx}$ | 3.17 | 3.41 (0.24) | 4.00 | 4.69 (0.32) |
| $EF_{benzene}$ | 0.031 | 0.066 (0.005) | 0.029 | 0.086 (0.006) |
| $EF_{toluene}$ | 0.078 | 0.210 (0.015) | 0.068 | 0.242 (0.017) |
| $CO/CO_2$, $\times 10^{-3}$, arithmetic mean | 4.4 (0.5) | 12.0 (16.8) | 4.1 (0.4) | 13.5 (27.3) |
| $CO/CO_2$, $\times 10^{-3}$, geometric mean | 4.4 (1.1) | 7.52 (2.57) | 4.1 (1.1) | 6.85 (2.94) |

[a]Uncertainties are reported as $1\sigma$ in the parentheses for the geometric mean, /*, and arithmetic mean, ± , values.

- Emission factors (EF) in g pollutant / kg fuel
- Average gasoline and diesel EF from FIVE weighted by consumption to compare to undifferentiated data frp, the mobile lab
- Agreement for CO to $CO_2$ EF
- Observations consistently higher than FIVE for benzene and toluene EF
- $NO_x$ EF 8% and 15% higher than FIVE in Los Angeles and Las Vegas, respectively

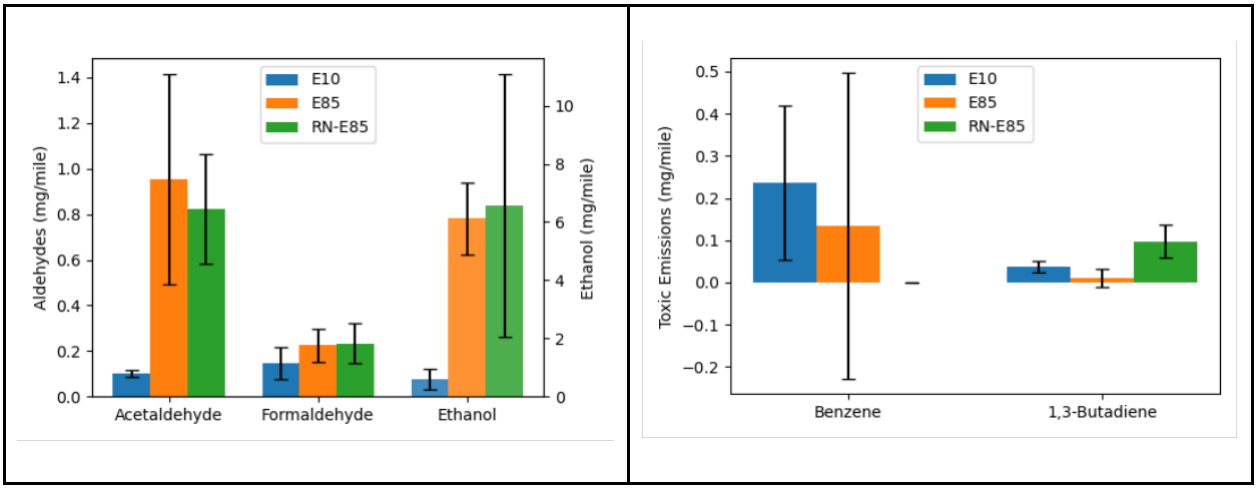
Zuraski *et al. ES&T Air* 2025

3) Mobile Source Air Toxic Emissions and Secondary Aerosol Formation from Renewable Naphtha Blends with Ethanol - Georgios Karavalakis (UCR)

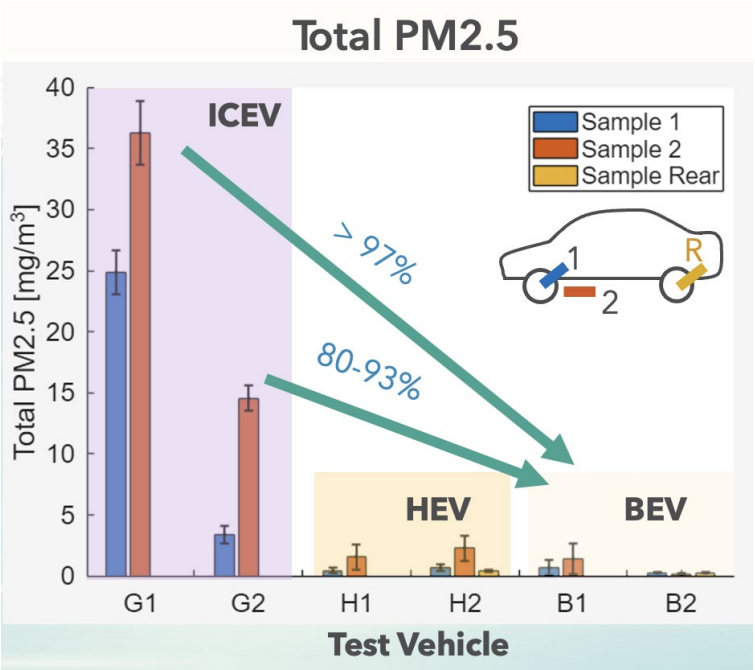
The presentation from the University of California Riverside investigated the viability of renewable naphtha (RN) as a low-carbon blendstock for high-ethanol fuels, motivated by the global necessity to reach net-zero transport emissions by 2050. As liquid fuels remain critical for the existing vehicle fleet, researchers sought to develop fully renewable gasoline substitutes, focusing on renewable naphtha because it is a co-product of renewable diesel production derived from agricultural feedstocks. The primary objective was to evaluate the performance and emission impacts of an aromatic-free, oxygen-free renewable naphtha/ethanol blend to determine if it could provide a functional alternative that reduces life-cycle greenhouse gases and criteria pollutants.

To evaluate this potential, the team utilized a 2025 Chevrolet Trax flex-fuel vehicle on a chassis dynamometer, conducting tests under the Federal Test Procedure to compare the renewable blend which consisted of 85 percent ethanol and 15 percent renewable naphtha, known as RN85, against conventional Tier 3 E10 and E85 fuels. They quantified tailpipe criteria pollutants and toxic emissions while using an oxidation flow reactor to simulate atmospheric oxidation and estimate secondary aerosol formation potential. The research findings indicated that RN85 trended lower in PM mass emissions than conventional fuels. Although solid particle number emissions were higher for RN85 than for E85, all ethanol-based fuels demonstrated a reduction of over 99 percent compared to gasoline standards. RN85 also successfully suppressed monoaromatic hydrocarbons, with benzene notably absent in the blend, although formaldehyde

and acetaldehyde emissions increased due to the ethanol content. Furthermore, the secondary aerosol formation potential was substantially lower for the renewable blends, as the reduction in aromatics limited the precursors available for particle formation. The study concluded that RN85 offered a fully renewable alternative that significantly reduced life-cycle carbon dioxide emissions by 38 to 55 percent while maintaining vehicle compatibility and lowering the overall ozone-forming potential compared to standard fuels.




4) <u>Comparison of non-exhaust particulate matter emissions between conventional and electric light duty vehicles - Okjoo Park (CARB)</u>




Researchers from the California Air Resources Board (CARB) presented a study comparing non-exhaust PM emissions from various light-duty vehicle technologies, driven by the growing environmental concern surrounding brake and tire wear as traditional tailpipe emissions decrease. The project sought to address a significant knowledge gap regarding how electric vehicle regenerative braking technologies influenced these emissions compared to conventional internal combustion vehicles. To achieve this, the team employed a Running Loss–Sealed Housing for Evaporative Determination (RL-SHED) chassis dynamometer at the CARB

facility to test six vehicles, including gasoline, hybrid, and battery-electric models, subjecting them to diverse driving cycles ranging from low-speed urban stop-and-go to aggressive high-speed conditions.

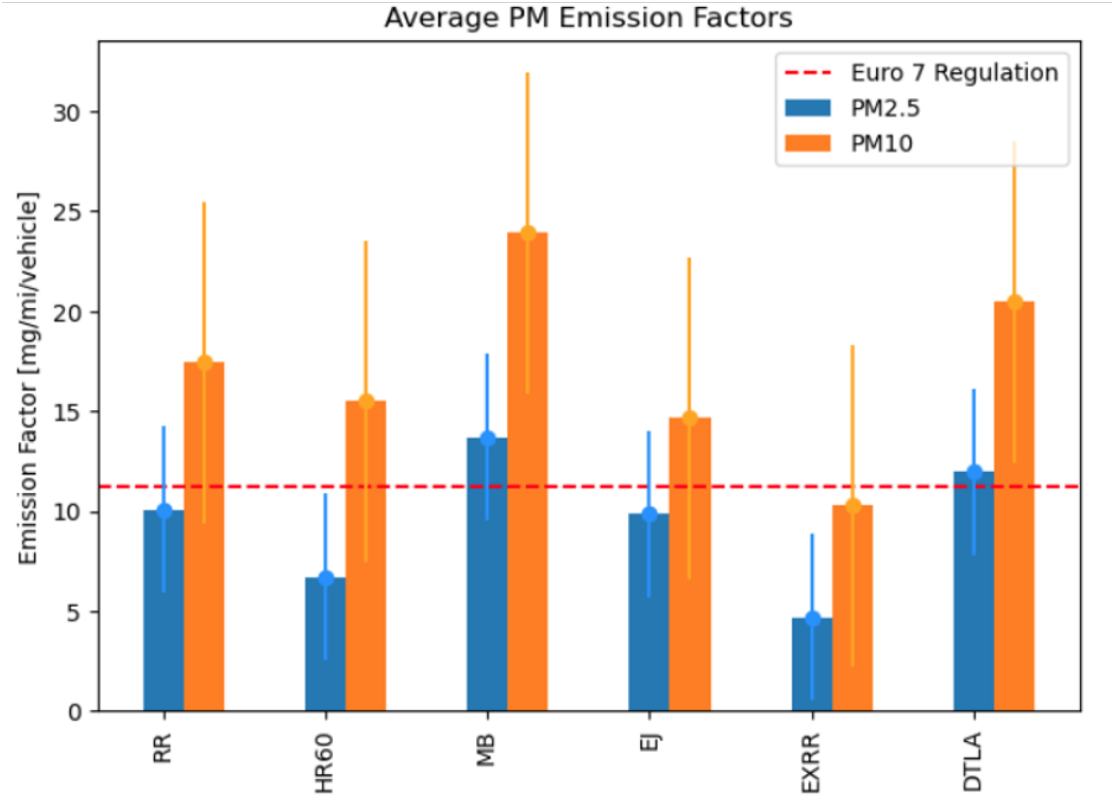
The findings indicated that battery-electric vehicles exhibited substantially lower PM emissions than conventional vehicles, despite the battery-electric vehicles having a heavier weight, with total particle mass and number concentrations reduced by more than 80 percent. Although the researchers observed that regenerative braking was applied primarily during city cycles to minimize emissions, friction brakes remained necessary during high-speed operation, which accounted for the majority of the brake-wear emissions for the electric vehicles. The study highlighted that while heavier weights are a factor for electric vehicles, the reduction in friction braking via regenerative technology significantly mitigated non-exhaust emission profiles, providing empirical evidence to support refined emission inventories.

5) Brake-Wear PM Emissions During Real-World Vehicle Testing - Georgios Karavalakis (UCR)

Researchers from the University of California, Riverside, conducted this study because non-exhaust emissions, particularly brake and tire wear, are becoming the primary source of PM as tailpipe emissions continue to decline. Because brakes account for a substantial portion of total road transport PM10, the team identified a critical need for real-world data to characterize the mass, size, and composition of these emissions across various driving cycles. To achieve this, the researchers developed an innovative, fully enclosed sampling system for a light-duty vehicle, which allowed them to isolate brake aerosol and transport it to an onboard sampling tunnel for precise analysis. PM2.5 samples were analyzed for metals and trace elements using the X-ray fluorescence (XRF) method, while particle morphology and associated composition were determined using a scanning electron microscopy (SEM) with an attached energy dispersive x-ray (EDX) system. Throughout diverse testing routes in the South Coast Air Basin—ranging from city streets to aggressive mountain driving—they employed sophisticated instrumentation, such as high-resolution impactors and dust monitors, while correlating operational parameters like brake pressure and temperature with emission spikes.

The study found that brake wear generated significant PM, with PM2.5 and PM10 emissions on several test routes exceeding established Euro 7 limits, particularly on downhill sections requiring aggressive braking. The researchers identified that particle formation occurred through two distinct processes: intense heat during braking triggered thermo-chemical reactions that produced ultra-fine particles, while direct friction between the brake pad and disc caused mechanical abrasion that generated larger particles. Chemical analysis revealed that the emitted matter was dominated by metals and trace elements such as iron, titanium, barium, and zirconium. The team concluded that driving dynamics directly dictated emission profiles, as particle number concentrations corresponded closely with braking events and aggression,

emphasizing that on-road testing is essential for accurately estimating brake-wear emission factors and informing future air quality policy.

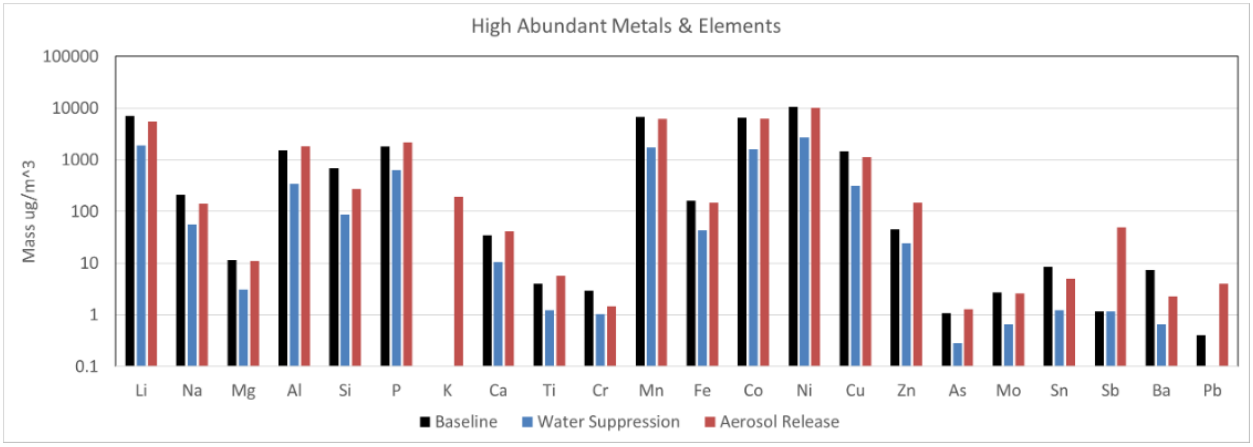



6) Lithium-ion battery thermal runaway particle emissions - Georgios Karavalakis (UCR)

This presentation from UCR reported on a study investigating the environmental and health impacts of thermal runaway in lithium-ion batteries, noting that the rapid expansion of the U.S. market for electric vehicles and stationary storage had escalated safety concerns. They explained that thermal runaway—a violent chain reaction of exothermic chemical reactions—leads to uncontrollable temperature spikes, fires, and explosions, posing severe risks because these incidents release complex, toxic mixtures of gases and PM. The team further emphasized that conventional extinguishing methods might further complicate the chemical composition of these hazardous emissions. To address these knowledge gaps, the researchers designed controlled laboratory experiments in which they induced thermal runaway in battery cells through overcharging, evaluating emissions under three scenarios: uncontrolled events, water suppression, and surfactant suppression. They utilized high-resolution instrumentation to measure particle number, size distributions, and the chemical composition of the particulates, including metals, inorganic ions, and polycyclic aromatic hydrocarbons.

The researchers found that the majority of particles generated during these fires fell within the 0.2 to 1 micrometer size range, with inorganic ion emissions dominated by acidic fluoride and

lithium resulting from electrolyte decomposition. The team identified lithium, cobalt, manganese, nickel, antimony, and copper as the dominant heavy metals present in the emissions. Furthermore, they discovered that suppression methods, particularly the use of water, significantly increased the release of carcinogenic polycyclic aromatic hydrocarbons and per- and polyfluoroalkyl substances compared to uncontrolled fires. The study highlighted that battery fires produce particles carrying a hazardous mixture of metals and carcinogens, warning that such emissions could contribute to serious health outcomes, including genotoxicity, mitochondrial dysfunction, and progressive fibrosis.



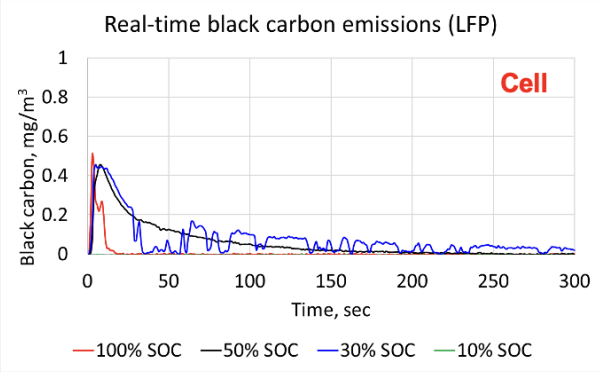

7) <u>Particulate Emissions from thermal runaway of lithium-ion batteries - Vinay Premnath (ULRI)</u>

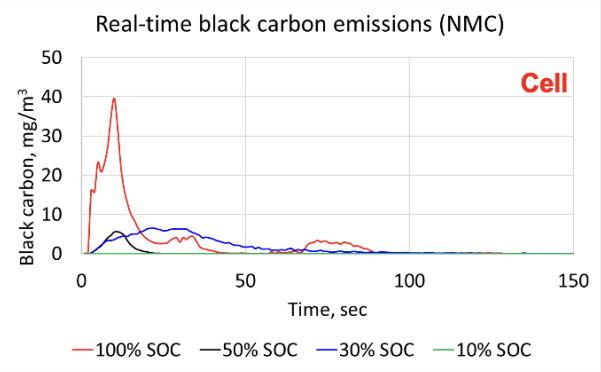
In the last presentation of Session 1, researchers from the UL Research Institutes (ULRI) discussed the rapid global adoption of lithium-ion technology in electric vehicles and e-bikes, which has increased the frequency of battery failure incidents. In such incidents, thermal runaway can cause violent, exothermic chain reactions that pose significant safety risks due to the release of toxic, flammable gases and PM, which threaten both first responders and the public. Consequently, the team identified an urgent need to characterize these hazardous emissions to inform the development of improved protective equipment, safety protocols, and regulatory frameworks. Their primary objective was to investigate PM2.5 emissions, particularly how battery chemistry—specifically Lithium Iron Phosphate (LFP) and Nickel Manganese Cobalt (NMC) —and state-of-charge influenced emission profiles, while also acknowledging the need to scale their findings from single-cell testing to multi-cell modules that represent real-world systems.

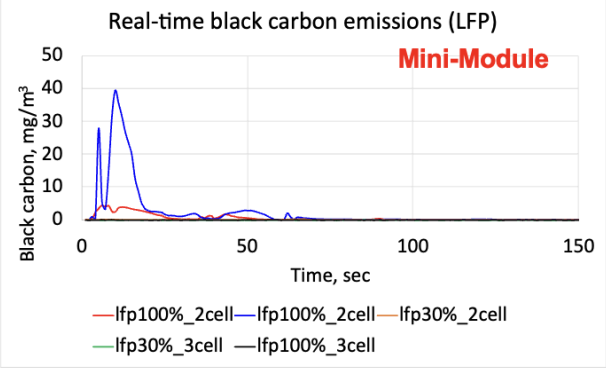
To achieve these objectives, the team conducted controlled laboratory experiments using a test chamber equipped with high-resolution sampling and analysis instrumentation, inducing thermal runaway via heater pads to ensure consistent abuse mechanisms across trials. They systematically varied the state-of-charge from 10 to 100 percent and tested configurations ranging from single cells to 3-cell modules. Their findings revealed that thermal runaway

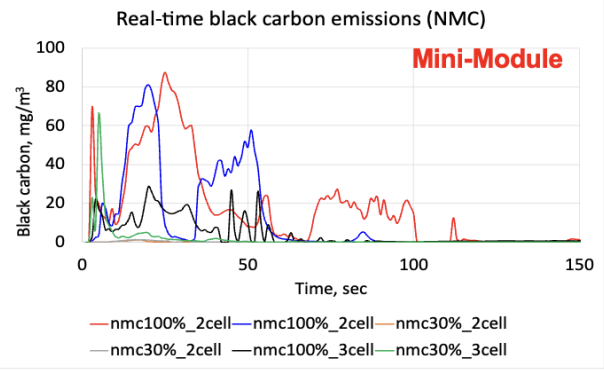
consistently resulted in massive releases of PM, with higher states-of-charge correlating with greater mass loss and higher peak temperatures. Both battery chemistries released significant quantities of BC (black carbon) and UFP (ultra-fine particles), though they observed distinct behavioral differences, with NMC cells showing more consistent fire behavior at high charge levels compared to the greater variability of LFP cells. The researchers underscored that single-cell testing was insufficient for predicting the behavior of larger battery systems, emphasizing that future research must prioritize system-level characterization to account for the variability inherent in these complex hazardous events.

# Black Carbon Emissions – Results



**Session 2 - Modeling of MSAT Emission Impacts (Session Chairs: George Karavalakis (UCR) and Sandy Winkler (Ford))**

1) Air Toxics Modeling in the South Coast Air Basin of California - Sang-Mi Lee (South Coast Air Quality Management District (AQMD))

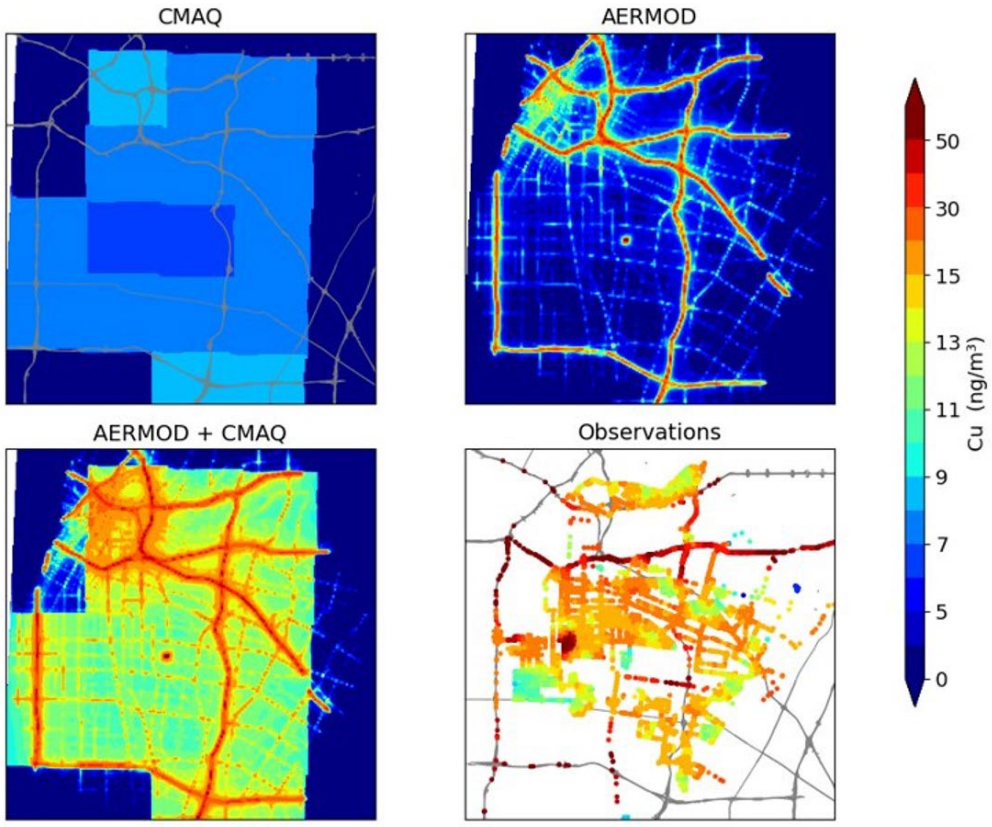
This presentation from South Coast AQMD discussed modeling results from the Multiple Air Toxics Exposure Study (MATES) series, which the agency had conducted periodically since 1986 to evaluate changes in toxic air contaminant concentrations and associated cancer risks across the South Coast Air Basin. The team detailed how the District's methodological approach has evolved over the four decades of the study. They utilized a framework that integrated extensive monitoring, emissions inventories, and health risk modeling, noting that the regional modeling software had transitioned from the early Urban Airshed Model (UAM) to the Comprehensive Air Quality Model with Extensions (CAMx) for studies conducted between 2004 and 2019, and was currently moving toward the CMAQ system for the ongoing MATES VI study. The researchers explained that they compiled comprehensive emissions data from thousands of permitted point sources, regional area sources, and both on-road and off-road mobile sources, incorporating activity data from the Southern California Association of Governments (SCAG) and emission factors from tools such as CARB's EMFAC model. To estimate health impacts, the District calculates the cancer risk for each grid cell by aggregating predicted annual average concentrations of toxic compounds and applying the California Office of Environmental Health Hazard Assessment (OEHHA) cancer risk factors.

The findings demonstrated a consistent downward trend in air toxics cancer risk across the Basin over the last three decades. The team reported that cancer potency-weighted emissions dropped by 48 percent between the MATES IV and V study periods, while population-weighted cancer risk decreased by 53 percent during the same timeframe. Diesel particulate matter (DPM) was identified as the dominant contributor to total cancer risk, consistently accounting for 50 to 83 percent of the risk across the studies, while benzene and formaldehyde emerged as the largest secondary contributors. Furthermore, the researchers observed that pollution hotspots consistently appeared near major ports, railyards, airports, and transportation corridors, particularly in environmentally disadvantaged communities. The study concluded that although modeling confirmed significant progress in reducing air toxics, the continued application of integrated monitoring and modeling tools remained essential for identifying ongoing health risks and refining future regulatory strategies.

2) High-Resolution Hybrid Modeling of Air Toxics over Disadvantaged Communities in Los Angeles - Marc Carreras Sospedra (SCAQMD)

This presentation from South Coast AQMD presented the development of a hybrid air quality modeling framework designed to characterize the spatial and temporal distribution of pollutant

concentrations and their sources at high resolution. The researchers explained that their primary motivation was to better understand local-scale exposure for residents in disadvantaged communities in Los Angeles, specifically near sites such as the Resurrection Church and Huntington Park. While regional chemical transport models, such as the CMAQ model, are effective at simulating background concentrations and transported pollutants, they lack the resolution necessary to capture near-source dispersion from roadways and industrial facilities. To bridge this gap, the team adopted a hybrid approach that integrated CMAQ with AERMOD, which provided 100-meter receptor resolution. They developed emission inputs using detailed facility reporting data and on-road activity from the Regional Transportation Plan, and they configured the model to distinguish between local and transported contributions of toxic elements.

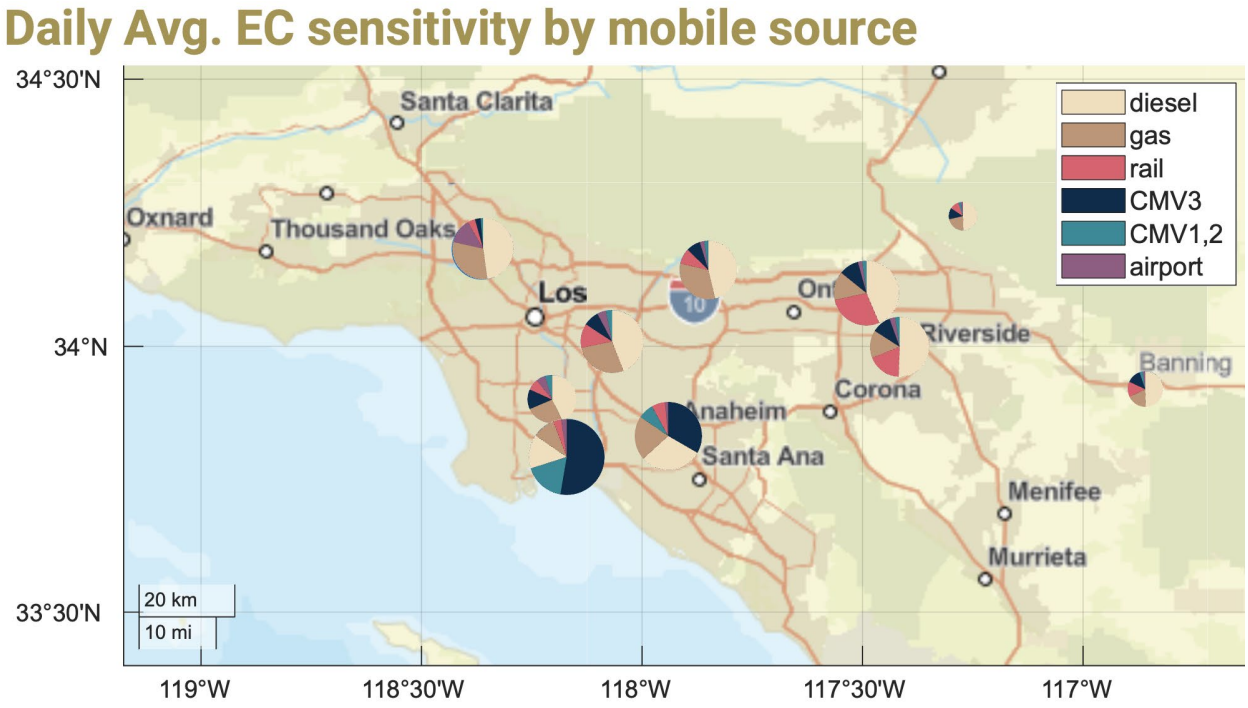



The researchers reported that the hybrid platform demonstrated improved spatial agreement with mobile and fixed-site monitoring measurements compared to regional modeling alone, particularly for vehicular tracers like barium and copper and facility-related elements such as nickel and lead. Their evaluation of diurnal variations showed that the model successfully captured the contributions of brake and tire wear as well as road dust, although they acknowledged challenges in reproducing certain localized hotspots where facility emissions data were incomplete or unreported. The study concluded that while the framework offered a

promising, spatially refined method for understanding pollutant distributions in urban environments, it was not intended to replace formal health risk assessments, which require more extensive coordination and monitoring. The researchers emphasized that the high-resolution modeling provided essential insights, demonstrating that high-emission zones and densely populated residential areas were often spatially separated, a finding they noted was critical for environmental justice analyses.

3) Application of CMAQ-DDM-3D for Modeling Mobile Source Emission Impacts on Air Toxics - Aryiana Moore (GA Tech)

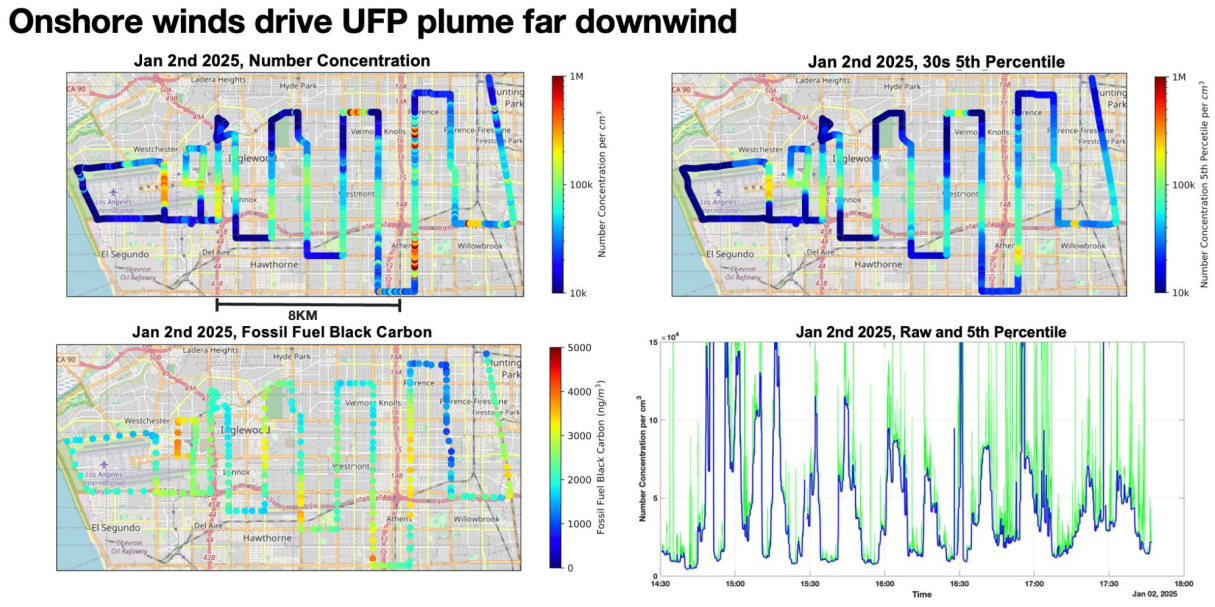
This presentation from Georgia Tech investigated the impacts of shipping vessels, rail, and diesel vehicles on PM2.5 levels in the greater Los Angeles area. They noted that despite significant emission reductions, the region continued to experience high air pollutant levels, particularly in communities with high poverty and asthma rates, where DPM was identified as a primary driver of cancer risk. The researchers aimed to quantify the contributions of specific freight-related sources to total PM2.5 levels to reduce uncertainty in source apportionment. To achieve this, they employed the decoupled direct method implemented within the CMAQ model (CMAQ-DDM-3D), which allowed them to isolate and quantify the sensitivity of pollutant concentrations to specific emission streams. They integrated this modeling with high temporal resolution PM2.5 speciation measurements from the new Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT).



The study findings indicated that diesel vehicle impacts were the most significant contributor to elemental carbon across most of the domain. Furthermore, the modeling successfully demonstrated that shipping impacts from the San Pedro Bay ports persisted throughout the region, with significant signals detected even at rural sites like Joshua Tree. The researchers concluded that the use of advanced modeling in tandem with high-resolution measurement data provided new opportunities to validate source impacts, thereby refining the understanding of mobile source contributions in the South Coast Air Basin.

4) Mobile Measurements of Ultrafine Particle Pollution Around the Los Angeles International Airport - Kyle Caulson (UCLA)

This presentation from UCLA explored the impact of ultrafine particle pollution generated by operations at the Los Angeles International Airport. They explained that ultrafine particles, which are smaller than 0.1 micrometers, posed significant health risks due to their ability to penetrate cell membranes and reach organs beyond the lungs. They noted that while aviation industry technological advancements aimed to reduce emissions per aircraft, the implementation of the Federal Aviation Administration's NextGen program had increased the density of flight operations and reduced separation standards. The team sought to determine whether these operational changes elevated pollution levels in downwind communities. The study utilized mobile measurement instruments to map ultrafine particle number concentrations and black carbon mass around the airport, and combined this monitoring data with flight activity records to differentiate between arriving and departing aircraft.

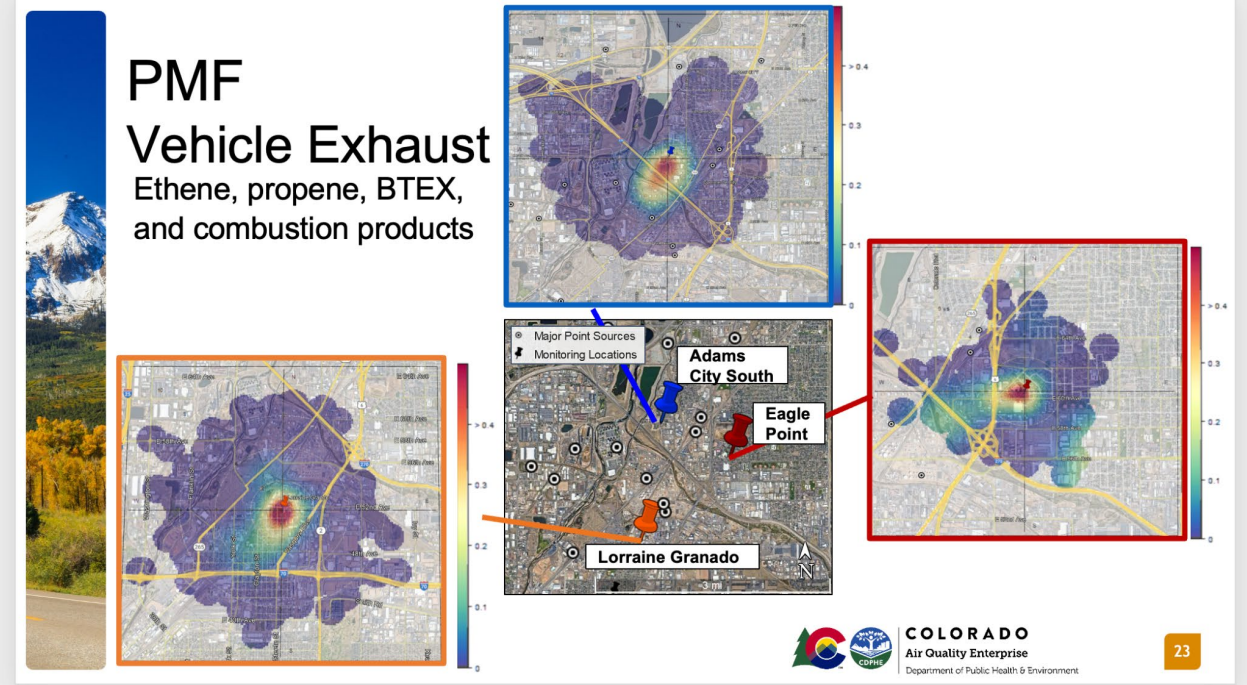



The researchers reported that there was a clear ultrafine plume extending upwards of 10 kilometers downwind of the airport and landing path, and that these concentrations ranged from

three to over ten times higher than background levels, indicating that the airport remained a substantial source of pollution for surrounding residential areas.

5) Resolving Mobile vs. Industrial Contributions: A Crosswalk Analysis of Receptor Modeling and Dispersion Modeling to Improve Source Attribution of Benzene in Commerce City / North Denver - Elizabeth Wallace (Colorado Department of Public Health and Environment (CDPHE))

This presentation from CDPHE presented research on distinguishing mobile-source and industrial-source contributions to benzene concentrations in the Commerce City and North Denver region. They reported that benzene remained a priority mobile source air toxic in the area, where major traffic corridors and industrial activity raised ongoing public health concerns. The researchers aimed to improve the accuracy of source attribution by refining the dispersion modeling framework and the Positive Matrix Factorization (PMF) receptor modeling previously applied to the region. Their approach involved updating emission inventories, utilizing representative meteorological data, and applying PMF to three speciated volatile organic compound datasets that captured both near-road and neighborhood impacts. Additionally, they performed AERMOD dispersion modeling using 2023 traffic area zone vehicle data. Through a crosswalk analysis, they reconciled emissions-based results with PMF-resolved factors to quantify mobile-source benzene.




The team found that this integrated approach increased their confidence in differentiating between mobile and industrial contributions. The study concluded that this methodology

provided a more robust basis for characterizing community exposure and supported ongoing efforts to refine risk assessments in the Commerce City and North Denver area.

6) Effects on urban air quality due to volatilisation of organic compounds from tires - Nick Molden (EA)

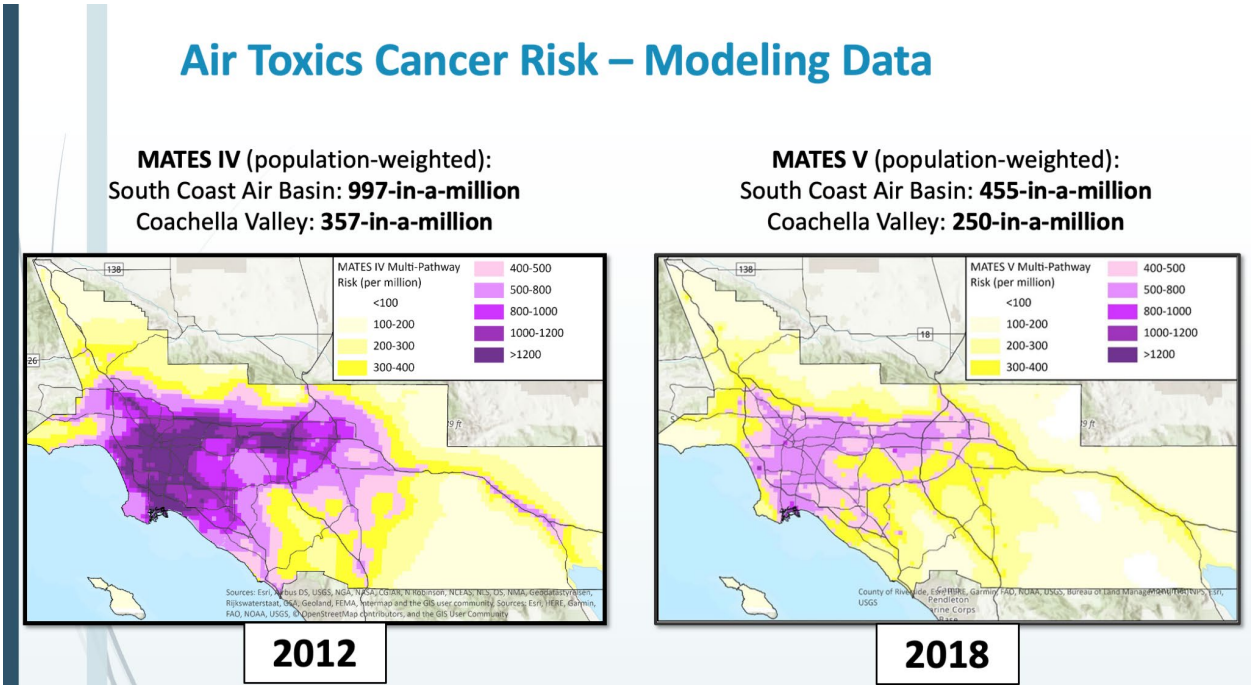
This presentation from Emissions Analytics discussed research into the often-overlooked environmental impact of tire emissions, focusing on the VOCs released during tire operation. He argued that while tires were typically viewed as sources of solid wear particles, they were essentially plastic products that released gases when heated in high-temperature environments. The study aimed to understand the scale of these emissions and model their impact on urban air quality, using Los Angeles as a case study. To achieve this, the team conducted controlled laboratory experiments using a test chamber to enclose whole tires and monitor off-gassing at various operating temperatures, ranging from average ambient levels to those found during driving conditions. They utilized advanced chromatography and mass spectrometry to identify and quantify the specific chemical species released. They then combined these emission rates with vehicle fleet size data and ozone formation potential factors in a box model.

The researchers reported that tires released hundreds of VOCs, with toluene and other aromatic compounds being particularly prominent. Their modeling indicated that tire VOC emissions represented a potentially significant and under-characterized source of secondary pollutants in urban environments, contributing to ground-level ozone and secondary organic aerosol formation. The team emphasized that tire-derived VOCs warranted further investigation as a critical factor in future air quality policy interventions.

**Session 3 - Ambient Air Quality Trends of MSATs (Session Chairs: Jason Low (AQMD) and Kate Hoag (BAAQMD))**

1) <u>The Multiple Air Toxics Exposure Study VI - Scott Epstein (AQMD)</u>

This presentation from the South Coast Air Quality Management District presented on the sixth iteration of the Multiple Air Toxics Exposure Study (MATES VI), a campaign designed to provide the public with critical information about air toxics and their associated health risks across a region encompassing 17 million residents. The researchers explained that this study served several core objectives: evaluating the progress of emission reduction efforts, providing empirical direction for future toxics control programs, and assisting in the interpretation of data from community air monitoring campaigns. The study built upon three decades of data, utilizing a combination of extensive air monitoring and chemical transport modeling to estimate cancer and chronic non-cancer risks throughout the region.

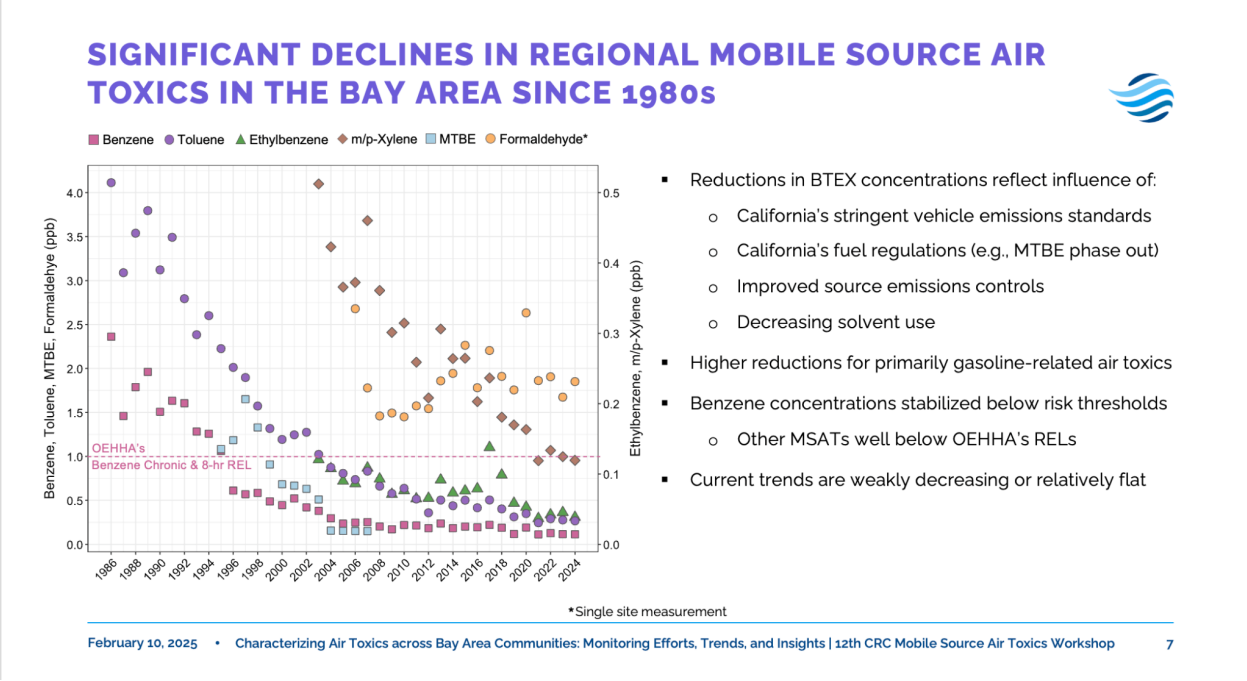



MATES VI builds on measurements and modeling results from past MATES studies. The team deployed a comprehensive monitoring network at ten locations, incorporating advanced techniques to measure roughly 100 gaseous and particulate air toxics over a one-year period to estimate risk throughout the region, while chemical transport modeling will inform risk values in unmonitored areas. Furthermore, the researchers highlighted two significant special studies embedded within the project: an analysis of the contribution of brake and tire wear to PM levels, and a quantitative assessment of ethylene oxide (EtO) spatial and temporal trends, triggered by recent EPA findings on its toxicity. The team reported that previous study data indicated a substantial decline in air toxics cancer risk over the past three decades, though they emphasized

that risks remained high, particularly in environmentally disadvantaged communities near major ports and transportation corridors. The researchers underscored that while significant progress had been made, the integrated application of monitoring and modeling remained essential for protecting public health and identifying future pollution hotspots.

2) Characterizing Air Toxics across Bay Area Communities: Monitoring efforts, Trends, and Insights - Jennifer Ofodile (BAAQMD)

This presentation from the Bay Area Air Quality Management District (BAAQMD) reported on their extensive efforts to characterize air toxics across the Bay Area, a region where public health outcomes were often driven by emissions from mobile and stationary sources, disproportionately affecting communities of color and low-income residents. The researchers explained that their goal was to improve the understanding of emission sources and their air quality impacts on overburdened communities, given the persisting cumulative impacts of historical land use practices.



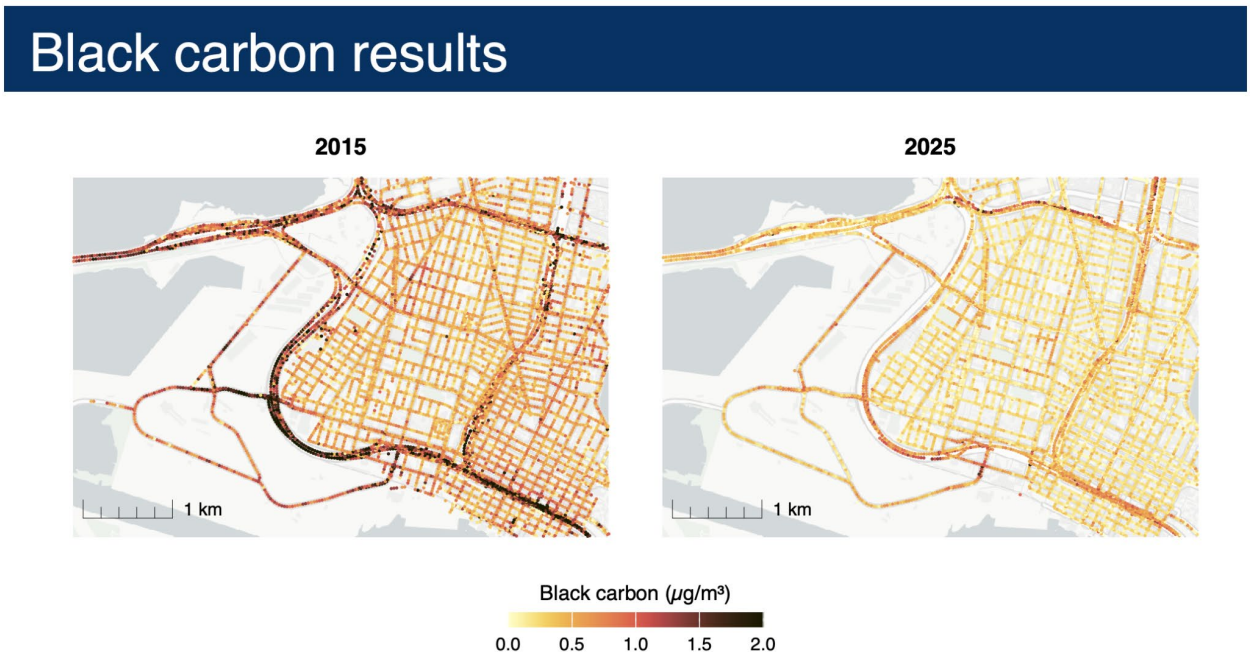

The Air District employed a multi-faceted approach, integrating data from long-term ambient air monitoring stations—which spanned near-road, urban, and rural environments—with shorter-duration projects using both mobile and stationary platforms. By analyzing spatial and temporal trends of key air toxics and source tracers, such as benzene, toluene, ethylbenzene, and xylene (BTEX), the team sought to isolate the variations in mobile source-related pollution and the contributions from local stationary sources. They reported that the synthesis of these diverse datasets provided critical insights into community-level air quality concerns, which in turn

informed future monitoring priorities and helped focus the Air District's resources on the areas where emission reduction efforts were most urgently required.

3) A Decade of Change: Air Quality in West Oakland, CA in 2015 and Today -Samuel Cliff (UCB)

This presentation from the University of California, Berkeley, presented research assessing the air quality progress in West Oakland, a community that had historically suffered a disproportionate burden of air pollution due to its proximity to a major port, freeways, and rail infrastructure. The researchers explained that a 2015 air quality campaign, which utilized Google Street View cars, had revealed persistent pollution patterns with sharp hyperlocal variability, largely associated with mobile sources and diesel combustion. Following West Oakland's designation as an Assembly Bill 617 community in 2017, the team sought to evaluate the effectiveness of regulatory changes and targeted emission reduction efforts, such as the replacement of high-polluting port vehicles and the upgrading of tugboat engines.

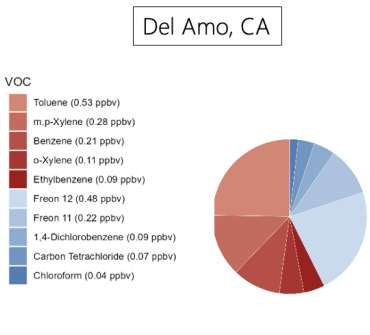
To achieve this, the researchers compared their 2015 baseline measurements with new data collected in 2025 using the UC Berkeley Mobile Air Pollution Laboratory (CalMAPLab). They reported substantial reductions in all measured pollutants, including nitrogen oxides (NO and NO2) and black carbon, and they presented additional speciated VOC measurements to identify emerging sources of concern. The findings demonstrated the measurable success of community-led regulatory interventions in improving air quality for vulnerable populations facing mobile source pollution.



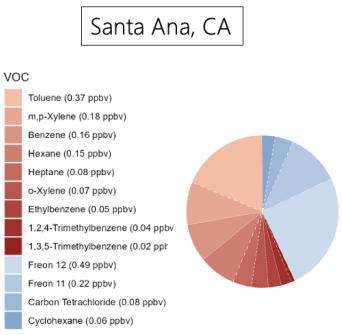
4) Air Toxics in California Communities – Evaluating the Contributions of Transportation Sources - Olivia Ryder (STI)

This presentation from researchers from Sonoma Technology and University of California, Riverside presented findings from four community-based air quality studies conducted across California between 2023 and 2026. They noted that air toxics burdens in communities are complex and vary significantly, and are primarily impacted by the emission strength, proximity, and distribution of local sources. Moreover, low-income communities were often disproportionately exposed to air pollution, yet environmental health research still predominantly emphasized PM2.5 mass rather than the specific chemical composition of toxics, which was often a better predictor of adverse health outcomes. The researchers aimed to understand the complex spatial and temporal patterns of air toxics by measuring both gas-phase and particle-phase pollutants in communities impacted by varied sources, including freeways, ports, warehouses, and industrial facilities.

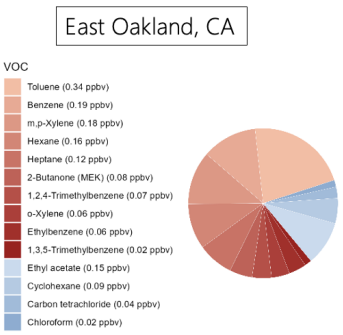
The study's approach involved a rigorous measurement program utilizing canister and passive VOC sampling and laboratory analyses, as well as filter-based metal collection. Through detailed source apportionment, the researchers sought to evaluate how both mobile and non-mobile sources contributed to the observed pollutant trends. They found that while mobile sources played a key role in driving air toxics concentrations, non-mobile sources remained critical, especially in periods when mobile source impacts were less prominent. The study highlighted that profiles of air toxics were highly heterogeneous across the state, suggesting that a one-size-fits-all approach to mitigation strategies was unlikely to be effective, particularly as transportation sectors transitioned toward cleaner fuels.




Mobile source pollutants (BTEX) comprise an estimated 57% of total VOCs measured.



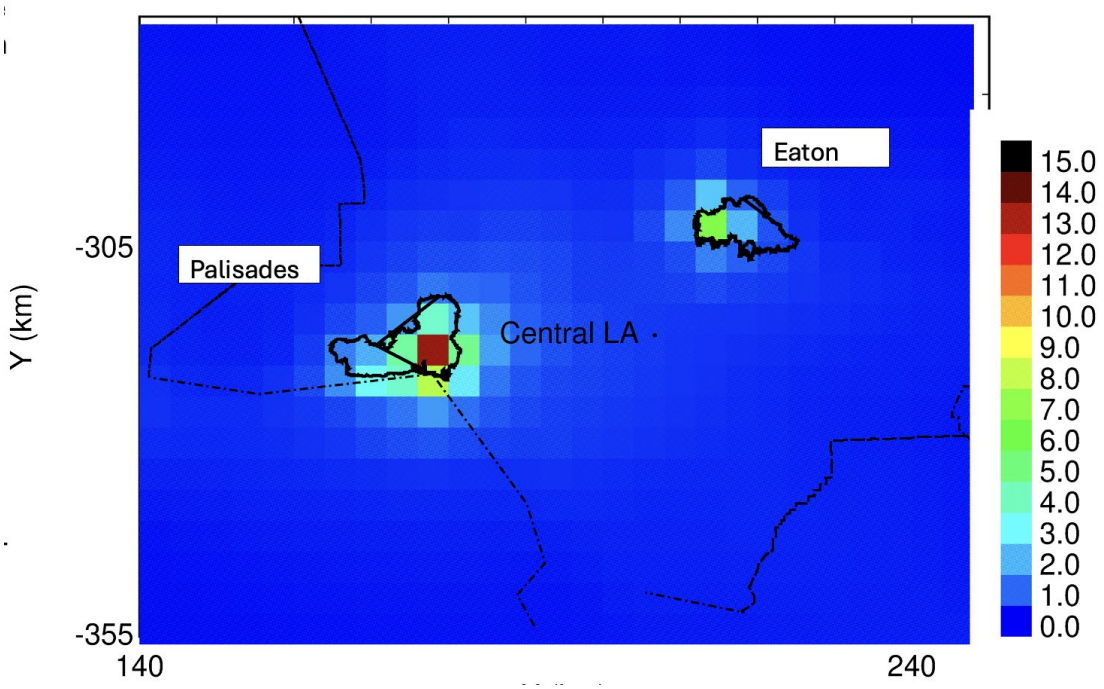

Mobile-source pollutants (BTEX, Alkanes, MEK, trimethylbenzenes) comprise an estimated 57% of total VOCs measured.




Mobile source pollutants (BTEX, Alkanes, MEK, trimethylbenzenes) comprise an estimated 81% of total VOCs measured.

5) Airborne nanoparticle metals in debris cleanup zones from Eaton and Palisades Fires - Mike Kleeman (UCD)

This presentation from researchers at the University of California, Davis, reported on the public health challenges posed by the cleanup operations following the Eaton and Palisades wildfires in January 2025, which had destroyed over 18,000 structures in Southern California. The researchers explained that the scale of the cleanup—involving the removal of millions of tons of debris from a densely populated area—created a unique air quality hazard. Their primary objective was to characterize airborne PM and nanoparticle metals generated by these operations, which occurred over a seven-month period from March to September 2025. To achieve this, the team deployed a comprehensive suite of instruments, including mobile monitoring platforms, impactors, and particle counters, to capture real-time measurements in the cleanup zones. The findings revealed the presence of nanoparticles of chrome and silver in both cleanup zones, with the highly toxic hexavalent form of chrome (Cr6+) identified as dominant.




The researchers noted that while dust mitigation measures were largely successful, even fugitive emissions from such large-scale operations could significantly impact air quality. They concluded that wildfires and their subsequent cleanup were dynamic events that required flexible, responsive monitoring strategies, as fixed-site regulatory monitors were often insufficient to capture the full scope of these localized toxic exposures.

**Session 4 - Health and Exposure Assessments (Session Chairs: Karim Hamza (Toyota) and Elena Craft (HEI))**

1) Non-exhaust particulate matter exposures and health effects: the HEI experience and what's next? - Allison P Patton (HEI)

In the session on health and exposure assessments, the first presentation from the Health Effects Institute (HEI) described findings from a recently-completed multi-city research program in North America and Europe to investigate the human health impacts of non-exhaust PM. The researchers explained that particles originating from brake, tire, and road wear now account for over half of particulate emissions from road transport. Their goal was to assess exposure and health effects, as PM from these sources had become a significant, yet under-researched, component of urban air quality, and to clarify the relative contributions of these sources.

To achieve this, the team used a combination of source apportionment, land-use regression, and randomized crossover trials to evaluate respiratory outcomes in both children and adults. They observed that emission profiles were more consistent for brake wear than for tire wear, and they found that exposure to non-exhaust particles was associated with decreased lung function and increased inflammatory markers, with potential confounders including other sources of air pollution, traffic noise, and green space. Strengths of the research included state-of-the-art exposure assessment methods, high-quality study designs, and thorough analyses that applied novel methods. The researchers noted, however, that it remained difficult to disentangle these health effects from those contributed by other local pollution sources and environmental factors like traffic noise and green space.

2) Modeling near-roadway exposures in health effects studies using a major freeway tunnel system - Keith Bein (UCD)

In the second presentation of the session, researchers from UC Davis addressed a disconnect between real-world near-roadway exposure and controlled laboratory studies. They explained that while lab studies provide control, they often fail to mimic true human exposure dynamics, such as the complexity and turbulence of near-roadway environments. To bridge this gap, the team established a novel exposure facility adjacent to the Caldecott Tunnel in California, where they could draw traffic-related air pollution (TRAP) in real-time to house and expose animal models to an unaltered mixture of emissions.

The researchers aimed to model the true human condition to investigate the onset and progression of disease. Their findings revealed that even though particulate mass concentrations at the facility often remained below regulatory standards, the chronic exposure still triggered significant neurological and cardiovascular effects. The team underscored that current federal standards failed to sufficiently protect the aging brain from the high surface area and mobility of

unregulated ultrafine particles found in traffic emissions, as these particles contribute negligible mass but significant biological activity.

3) Cardiovascular health impacts of traffic-related air pollution from different mobile sources - Chao-Yin Chen (UCD)

In the third presentation of the session, researchers at UC Davis noted that while the link between TRAP and cardiovascular consequences was well acknowledged, it remained unclear whether observed health impacts were driven by particle mass or particle number concentration, or if emissions from heavy-duty versus light-duty vehicles posed different risks. They sought to determine the extent to which these different mobile sources impacted cardiovascular health through a controlled exposure study, specifically testing whether heavy-duty vehicle (HDV) emissions posed a greater threat.

To examine these differences, the team exposed rats to real-time air from a freeway tunnel system, comparing a bore that allowed heavy-duty vehicles with one restricted to light-duty vehicles. They observed that while PM2.5 mass concentrations were similar in both environments, the heavy-duty bore had a significantly higher particle number concentration. The study found that heavy-duty vehicle emissions posed a greater cardiovascular risk and elicited stronger immune responses than light-duty vehicle emissions, which underscored the critical need for researchers to consider particle number when assessing the health impacts of air pollution.

4) A pragmatic randomized crossover trial of HEPA filtration on blood pressure, cognition, and inflammation - Doug Brugge (UCHC)

Airborne PM pollution from motor vehicles is a leading cause of cardiovascular risk, and researchers at the University of Connecticut Health Center aimed to assess the efficacy of in-home air purifiers in reducing blood pressure and improving cognitive function for adults living near major highways. They explained that since individuals spend a significant portion of their time indoors, improving indoor air quality could serve as a valuable, pragmatic intervention for susceptible populations who cannot easily relocate away from pollution sources.

The researchers conducted a double-blind, randomized crossover trial involving 156 participants, comparing one month of HEPA filtration with one month of sham filtration. Their findings showed that the intervention resulted in clinically meaningful reductions in systolic blood pressure for participants who entered the study with elevated readings, and they also observed improvements in inflammatory biomarkers for overweight participants. Furthermore, the study suggested potential benefits for cognitive function in participants over the age of 40, indicating that indoor filtration could serve as a valuable mitigation strategy for susceptible populations.

5) Component-dependent effects of traffic-related air pollution on systemic and respiratory innate immune responses - Heui Hye Park (UCD)

In the next presentation, researchers from UC Davis discussed how chronic exposure to different TRAP components affects systemic and respiratory innate immune responses in the TgF344-AD transgenic rat model of Alzheimer's disease that overexpresses human Alzheimer's disease risk genes. The study compared the combined and separate impacts of PM and gases from light-duty vehicle (LDV) and mix of light- and heavy-duty vehicle (LDV+HDV) exhausts by leveraging the Caldecott Tunnel Exposure Facility, which allowed real-world exposure to traffic emissions directly drawn from a major highway tunnel.

Subchronic TRAP exposure caused component-specific systemic inflammation in females and males. After 3 months of exposure, females exhibited a robust systemic inflammation with significantly elevated levels of pro-inflammatory cytokines across all TRAP exposures. Among all exposure groups, females exposed to PM-only from LDV+HDV exhaust had the strongest systemic inflammatory response. In contrast, not all TRAP exposures induced systemic inflammation in males. Those males exposed to Gas-only from LDV+HDV exhaust had the strongest systemic inflammatory response with elevation of both pro-inflammatory and inflammation-resolving mediators. Chronic TRAP exposure (11 months) caused source- and component-specific pulmonary inflammation and injury in males. After 14 months of exposure, compromised alveolar integrity was observed across all groups exposed to LDV+HDV exhaust. Taken together, these findings suggest that chronic exposure to ambient levels of vehicular exhaust modulates systemic and respiratory inflammatory responses in a TRAP component- and source-dependent manner.

6) The effects of chronic exposure to ambient traffic-related air pollution on Alzheimer's disease phenotypes in wildtype and genetically predisposed male and female rats - Pamela J. Lein (UCD)

In the next presentation, researchers at UC Davis investigated whether chronic exposure to ambient TRAP modified Alzheimer's disease risk and severity. They explained that while epidemiological studies consistently linked TRAP to increased Alzheimer's disease risk, preclinical data—which mostly utilized male animals exposed to high levels of isolated pollutants—remained limited regarding chronic exposure and sex-based differences. To address these gaps, they housed genetically predisposed and wildtype rats near a heavily trafficked tunnel to expose them to real-time traffic emissions for up to 14 months.

The researchers aimed to determine if chronic, low-concentration exposure accelerated disease phenotypes. Their findings revealed that chronic exposure promoted Alzheimer's disease phenotypes, including accelerated amyloid proteinopathy, phosphorylated tau accumulation, and cognitive deficits. The study concluded that current PM2.5 regulations were insufficient to

protect the aging brain, as the particles translocated to the hippocampus and interacted with genotype, sex, and age to worsen neurological outcomes.

7) Oxidative potential of brake-wear particulate matter emissions from light-duty and heavy-duty vehicles - Yuan Yao (UCLA)

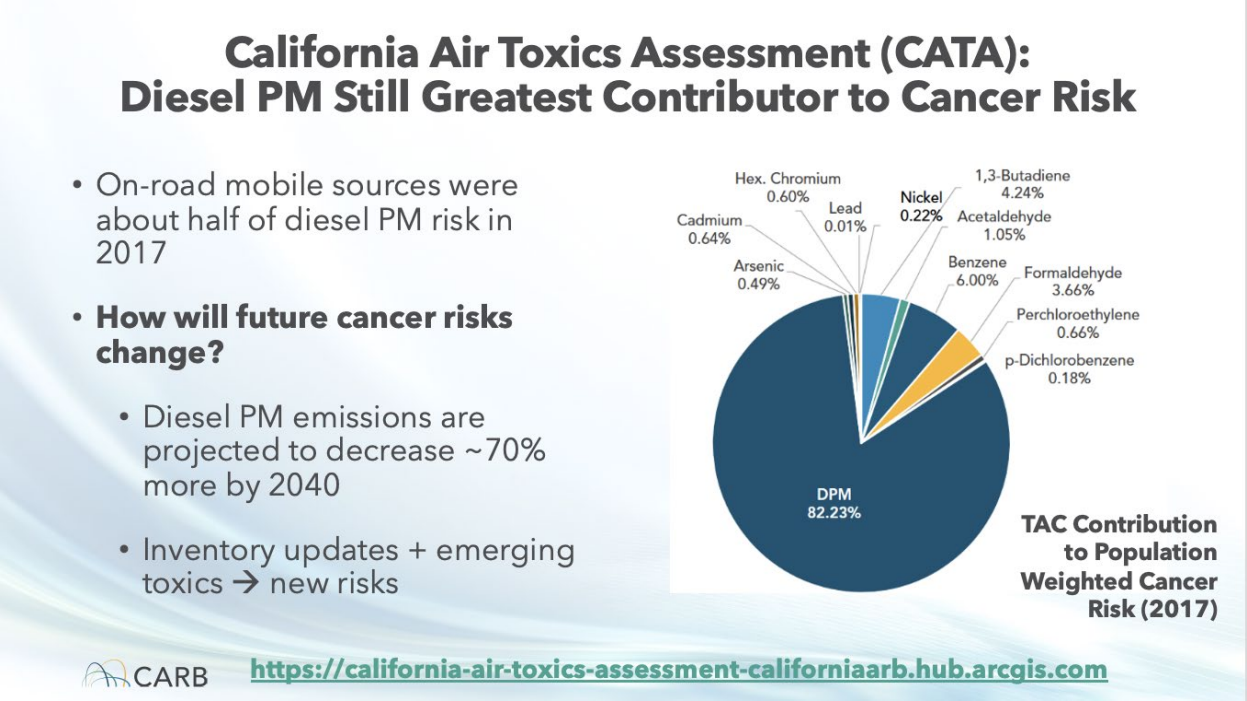
In the last presentation of the session, researchers at UCLA presented results from an investigation of the oxidative potential of brake-wear PM from light-duty and heavy-duty vehicles to better understand the toxicity of non-exhaust emissions. They explained that while brake-wear particles had become a major component of ambient air pollution, their specific health effects and toxicity profiles remained less well-understood than those of tailpipe emissions. The researchers sought to quantify this toxicity by using hydroxyl-radical formation as a metric for oxidative potential.

Through laboratory analysis of PM collected from light-duty and heavy-duty vehicles, the researchers determined that brake-wear PM2.5 exhibited higher oxidative potential than ambient PM2.5, with heavy-duty vehicles showing particularly elevated toxicity. They identified a strong link between oxidative potential and redox-active metals like copper and zinc. The team emphasized that accounting for these non-exhaust emissions was essential for accurate air-quality and health impact assessments, particularly as brake-wear PM continues to represent an increasing share of total mobile source emissions.

**Session 5 - Regulatory Programs and Accountability Studies (Session Chairs: Seungju Yoon (CARB) and Abhilash Vijayan (UCR))**

1) Sources and Emissions of Mobile Source Air Toxics: Findings from In-Use Surveillance Testing, Emissions Projections, and Emerging Opportunities - David Quiros (CARB)

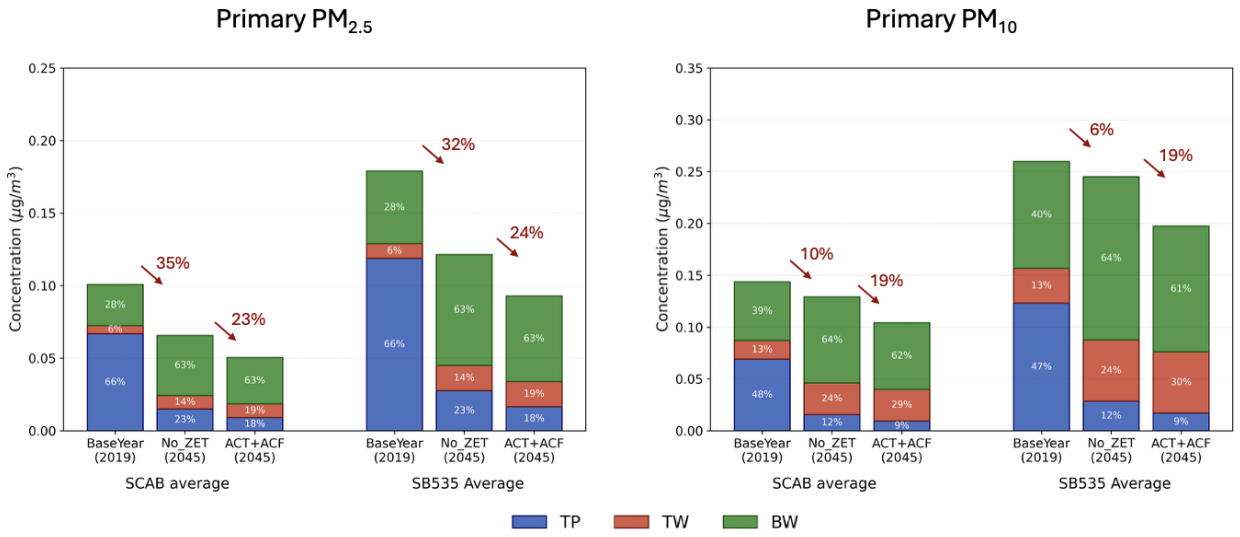
The first presentation of the session from CARB described the extensive efforts undertaken by CARB to maintain over fifteen sector-specific emissions inventory models, including EMFAC for on-road vehicles, to ensure accurate emission factors. The presentation highlighted that CARB utilizes randomized surveillance testing of in-use vehicles, vessels, and off-road equipment to capture a representative snapshot of engine performance, technology groups, and system deterioration. The primary motivation for this program was to generate reliable emissions data that could feed into photochemical air quality modeling and air toxics risk assessments, such as the California Air Toxics Assessment.




The presentation detailed how the surveillance programs periodically collected gaseous and PM samples to develop comprehensive speciation profiles, and reported that these efforts had successfully identified historical trends and future projections for mobile source air toxics across various sectors. The presentation highlighted the successful reduction of key pollutants, such as DPM, while emphasizing the ongoing need for new analytical methods to better quantify emerging air toxics of potential concern.

2) Impacts of Adopting Zero-Emission Truck Regulations on Tailpipe and Non-Tailpipe Emissions and Air Quality in Southern California, Jiachen Zhang (UCR)

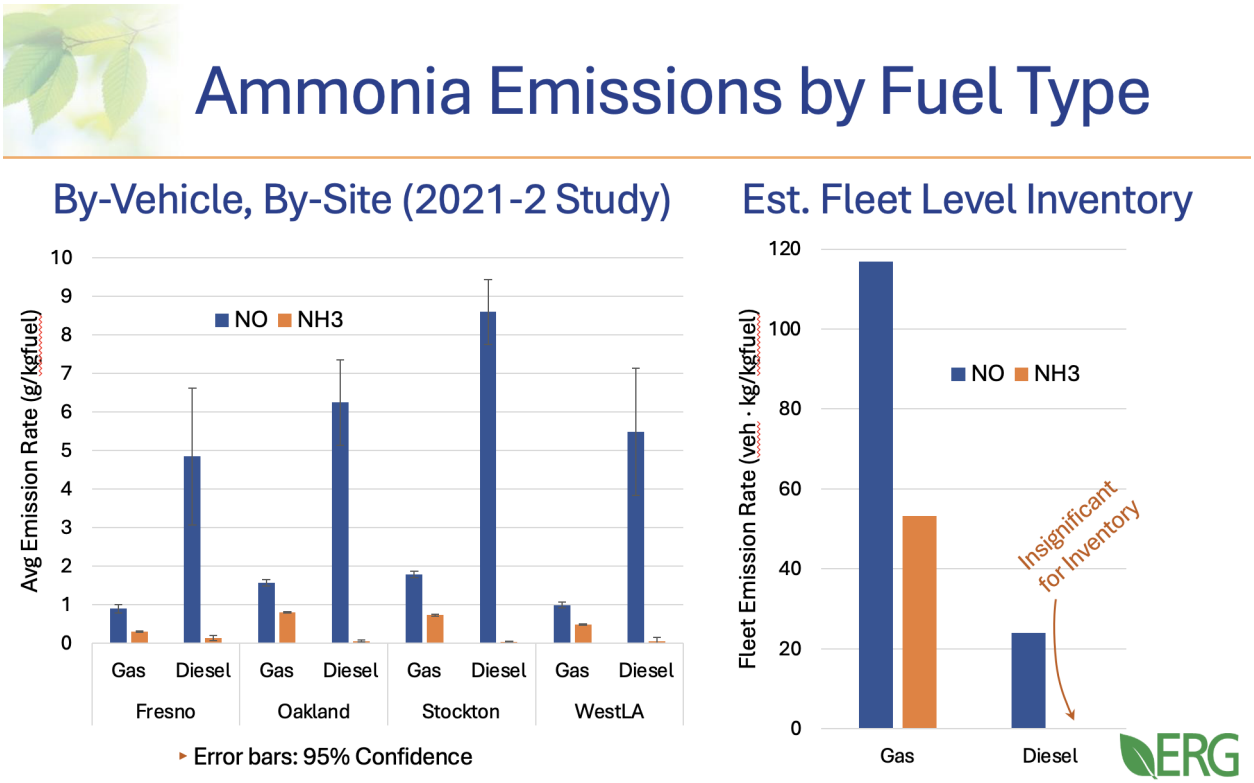
The next presentation from the University of Southern California addressed the significant environmental justice concerns related to heavy-duty vehicle emissions, noting that disadvantaged communities in Southern California were disproportionately exposed to truck-related air pollution. The presentation highlighted that while CARB has adopted the Advanced Clean Trucks (ACT) and Advanced Clean Fleets (ACF) regulations to drive the transition to zero-emission vehicles, there was a gap in understanding their long-term impact on air quality and non-tailpipe emissions like brake and tire wear. The project sought to quantify the effects of these adopted regulations on PM2.5, NO2, and ozone concentrations in the South Coast Air Basin, specifically investigating the future contribution of non-tailpipe sources as electrification progressed.




To achieve these goals, the researchers developed a high-resolution modeling framework using the WRF-Chem model with detailed truck activity data derived from telematics. They compared a baseline scenario against projections for the year 2045, simulating both the ACT and ACF regulatory impacts. The findings indicated that these regulations would reduce PM2.5 concentrations by up to 0.4 micrograms per cubic meter, with the most significant benefits in densely populated areas. Preliminary model results showed that the contribution of non-tailpipe emissions to surface $PM_{2.5}$ concentrations were highest near roadways, reaching up to 5.7% of ambient $PM_{2.5}$ In 2045, adopting ACT and ACF could decrease both tailpipe and non-tailpipe $PM_{2.5}$ concentrations and their contributions to total surface $PM_{2.5}$ concentrations. Furthermore, the results revealed that as tailpipe emissions declined due to electrification, brake and tire wear would become the dominant contributors to primary truck-related $PM_{2.5}$ emissions, necessitating a continued focus on non-exhaust particle management.

3) <u>Continuing Remote Sensing Emissions Measurements of the California Vehicle Fleet - Alan Stanard (ERG)</u>

The next presentation from the Eastern Research Group discussed the use of remote sensing devices (RSD) to capture real-time, non-intrusive snapshot emission measurements of the California vehicle fleet. The presentation noted that CARB contracted this ongoing work to better understand the effectiveness of various air quality initiatives and to identify emission trends across different communities, particularly focusing on socioeconomic disparities and the rate of electric vehicle adoption. The project aimed to provide robust data on both regulated and unregulated pollutants by analyzing thousands of vehicle scans conducted across multiple sites, including West Los Angeles and Fresno, over several decades of operation.

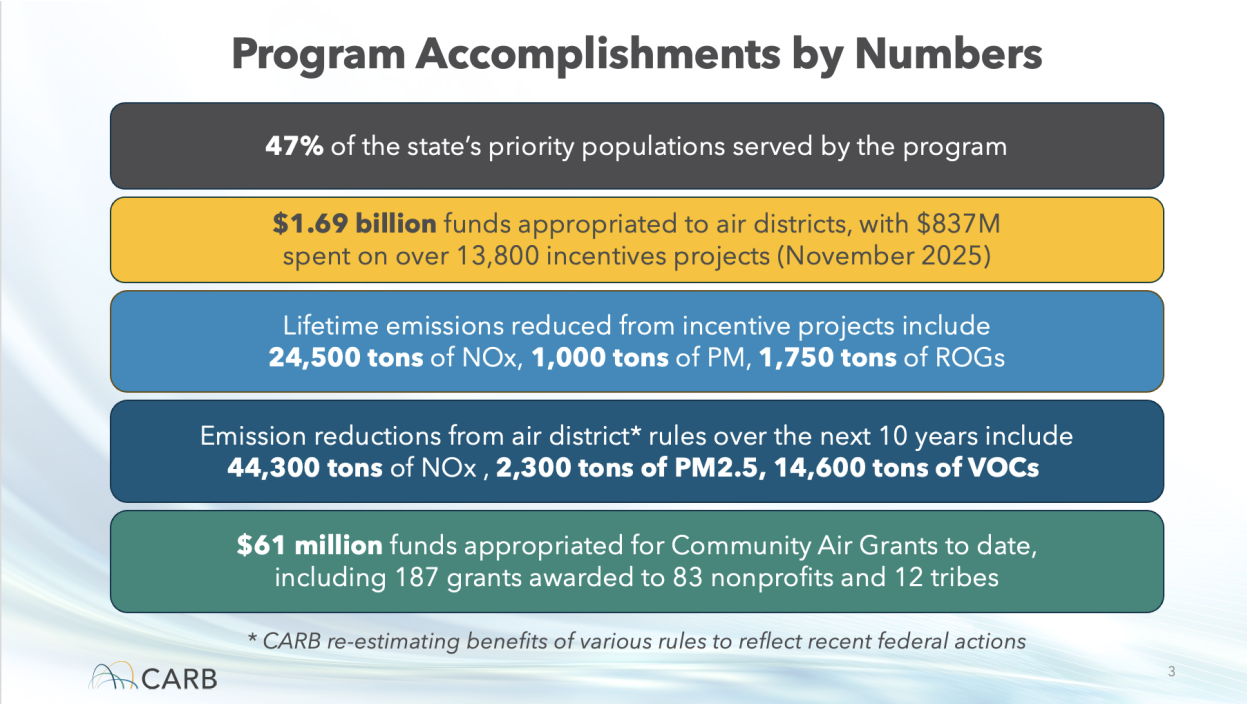



The team's approach involved using optical sensors to measure light attenuation in exhaust plumes, matching these scans to vehicle registration data. The presentation reported that the analysis demonstrated clear effects of fleet turnover and recent regulations on declining emission rates. Additionally, the study highlighted the importance of monitoring ammonia emissions as a byproduct of modern exhaust catalysts. The findings confirmed that while nitrogen oxide emissions had declined significantly, the project provided a vital tool for CARB to prioritize future air quality interventions and validate current emission inventories.

4) Community Air Protection Program: Stories of Impact and the Road Ahead -Amaya Hernandez (CARB)

The next presentation from CARB described the ongoing progress of the Community Air Protection Program, which was established under Assembly Bill 617 to address persistent health

disparities in communities disproportionately burdened by poor air quality. The presentation explained that the program was designed to empower nineteen selected communities to develop and implement their own Community Emissions Reduction Programs and Community Air Monitoring Plans. The program's overarching goal was to reduce local air pollution through a combination of community-focused enforcement, grant-funded educational and technical projects, and targeted incentive strategies.




The presentation detailed how the program had leveraged nearly two billion dollars in funding to support various air quality improvement projects, successfully reducing thousands of tons of PM and NOx. The program's approach has evolved over the last nine years, leading to the creation of new tools and resources such as AQView and the Technology Clearinghouse to help track progress and share community stories. The presentation concluded by highlighting the importance of sustaining these efforts by fostering collaboration between local air districts and community members as the initial five-year implementation commitments for the first cohort of communities reached completion.

5) Accountability Studies on Air Pollution and Health: State of the Science and Future Directions - Dan Crouse (HEI)

The last presentation of the workshop was presented by HEI, and provided an overview of "accountability research," a field dedicated to examining whether air quality regulations and control programs are genuinely effective at reducing emissions and improving public health outcomes. He explained that because these policy actions often involve significant economic

costs, it is vital to establish a clear causal link between interventions and measurable health benefits. The project sought to synthesize lessons learned from previous HEI-supported studies—ranging from low-emission zones in Europe to coal bans in Ireland—to provide decision-makers with relevant feedback for crafting more effective, science-based policies.




The presentation highlighted that while accountability studies remain a crucial "chain" of evidence, the field faces significant methodological challenges, including difficulties in distinguishing the effects of simultaneous policies and adjusting for background trends. It was noted that while smaller-scale, short-term interventions are easier to analyze, investigating large-scale, multiyear regulatory programs like those under the Clean Air Act is complex and requires robust, continuous data. The presentation emphasized that although effective air quality management has clearly reduced pollution levels globally, future efforts must prioritize rigorous, quasi-experimental methods to better understand the specific health benefits of complex, multi-layered regulatory environments.