

# AGENDA

## 35th CRC REAL WORLD EMISSIONS WORKSHOP

### *Co-Sponsors*

California Air Resources Board

South Coast Air Quality Management District

National Renewable Energy Laboratory

### *Workshop Organizers*

Paul Loeper, Chevron (Co-Chair)

Michael Moore, Stellantis (Co-Chair)

Michael Aldridge, US Environmental Protection Agency

Sam Cao, South Coast Air Quality Management District

Yusuf Khan, Cummins Inc.

Andrew Kotz, National Renewable Energy Laboratory

Joseph Martin, US Environmental Protection Agency

Rada Purushothaman, Caterpillar

Heidi Vreeland, US Environmental Protection Agency

Laxmi Reddy Yatavelli, California Air Resources Board

Seungju Yoon, California Air Resources Board

Marriott Long Beach Downtown

April 13-16, 2025

The purpose of this workshop is free exchange of ideas, research, data, etc. Please do not record or take photos of presentations. All submitted presentation content will be available to participants in the Workshop Proceedings. Sponsorship of or participation in the workshop by CRC or others does not reflect any endorsement of information.

Sunday, April 13, 2025			
4:30-6:00 PM	Registration and Poster Setup in Farrell's Lounge		
6:00-7:00 PM	Welcome Reception in Dawson and Landmark Patio (3rd Floor Terrace)		
Monday, April 14, 2025			
All sessions take place in Bixby Ballroom, unless otherwise noted			
7:00 AM	Registration in Bixby Foyer and Continental Breakfast in Farrell's Lounge		
8:00 AM	Welcome from the Chairs: Paul Loeper, Chevron & Michael Moore, Stellantis		
8:15 AM	Keynote Address: Keynote 1		
SESSION 1			
9:00 AM	Air Quality and Regional Emissions Impacts		
Introduction by Session Leaders, Heidi Vreeland and Joe Martin, US EPA, Sam Cao, SCAQMD; Yusuf Khan, Cummins			
9:05 AM	ADDRESSING DIESEL POLLUTION IN ENVIRONMENTAL JUSTICE COMMUNITIES: A WEST OAKLAND CASE STUDY	Stephen Reid	Bay Area Air Quality Management District
9:20 AM	COMMUNITY-LEVEL EQUITY ANALYSIS OF TRUCK EMISSIONS BASED ON HIGH-RESOLUTION EMISSION INVENTORY	Sahar Fazelvalipour	University of Southern California
9:35 AM	THE IMPACT OF PHASE 2 GHG REGULATIONS ON CALIFORNIA HEAVY-DUTY VEHICLE INVENTORY AND EMISSIONS	Hamid Niakani	California Air Resources Board
9:50 AM	ATTRIBUTING SOURCE CONTRIBUTIONS TO ENVIRONMENTAL CHANGES	Karl Ropkins	University of Leeds
10:05 AM	FINE-SCALE DAILY PM2.5 SOURCE IMPACTS FROM 2011 TO 2020 ACROSS THE UNITED STATES	Ting Zhang	George Mason University
10:20 AM	General Discussion and Open Q & A		
10:35 AM	Poster Session and Demonstrations in Farrell's Lounge		
SESSION 2			
11:10 AM	Decarbonization: Technologies, Complications, and Mitigation Strategies / Electric and Hybrid Vehicles		
Introduction by Session Leader: Andrew Kotz, NREL			
11:15 AM	VEHICLE ACTIVITY PROFILES: A STUDY OF DIFFERENCES BETWEEN HEAVY-DUTY BATTERY ELECTRIC AND CONVENTIONAL DRAYAGE TRUCKS	Georges Saliba	California Air Resources Board
11:30 AM	IMPACT OF DRIVER BEHAVIOR ON EMISSIONS: INSIGHTS FROM A LARGE-SCALE CONNECTED VEHICLE DATASET	Will Northrop	University of Minnesota - Twin Cities
11:45 AM	ASSESSING THE IMPACTS OF ELECTRIFICATION ON MEDIUM- AND HEAVY-DUTY VEHICLE CRITERIA POLLUTANT EMISSIONS	Polina Alexeenko	National Renewable Energy Laboratory
12:00 PM	H2-ICE AFTERTREATMENT FOR ON-ROAD HEAVY-DUTY APPLICATIONS	Bryan Zavala	Southwest Research Institute
12:15 PM	ASSESSING THE LONG-TERM POTENTIAL IMPACT OF BIODIESEL CONTAMINANTS ON LOW NOX EMISSIONS CONTROL SYSTEM PERFORMANCE	Christopher Sharp	Southwest Research Institute
12:30 PM	General Discussion and Open Q & A		
12:45 PM	Lunch Break in Pike Ballroom		

Monday, April 14, 2025				
SESSION 3				
2:15 PM	Emissions Measurement Methods			
Introduction by Session Leader: Yusuf Khan, Cummins, Inc.				
2:20 PM	CHALLENGES AND SUCCESSES OF MEASURING NEAR-ZERO PM LEVELS OVER CHASSIS DYNAMOMETER CERTIFICATION CYCLES	Benjamin Shade	AVL	
2:35 PM	LIGHT DUTY PEMS PHASE 3: PEMS PERFORMANCE AT ALTITUDE, GRADE AND LOW TEMPERATURE TEST PROGRAM (CRC PROJECT NO. E-134)	Matt Panec	44 Energy	
2:50 PM	APPLICATION OF A DIFFUSION CHARGER TO QUANTIFY TRANSIENT PARTICLE EMISSIONS FROM VERY LOW TO HIGH EMITTING LIGHT-DUTY VEHICLES	Heejung Jung	University of California, Riverside	
3:05 PM	INFLUENCE OF NOx CONCENTRATIONS AND SAMPLING SYSTEM ON ANALYZER NOISE	Jimmy Williamson	AVL Test System Inc	
3:20 PM	Poster Session and Demonstrations in Farrell's Lounge			
SESSION 3				
3:50 PM	Emissions Measurement Methods (Continued)			
Welcome Back by Session Leader: Yusuf Khan, Cummins Inc.				
3:55 PM	MIDAS- A NEW TOOL FOR CENTRALIZED DATA COLLECTION FROM VEHICLES	Christina Reynolds	US Environmental Protection Agency	
4:10 PM	DEVELOPMENT OF HEAVY-DUTY ELECTRIC VEHICLE ENERGY RATES FOR EPA MOVES MODEL	Setayesh Fakhimi	National Renewable Energy Laboratory (NREL)	
4:25 PM	VEHICLE DIGITAL TWINNING WITHOUT A DYNAMOMETER OR LABORATORY	Phil Roberts	HORIBA MIRA (UK)	
4:40 PM	General Discussion and Open Q & A			
4:55 PM	Logistics for Dinner Event	Jan Tucker	Coordinating Research Council, Inc.	
5:00 PM	END OF DAY			
5:45 PM	Meet in Lobby to Leave for Networking Dinner, Last Bus Leaving at 6:00 PM			

Tuesday, April 15, 2025			
7:00 AM	Registration in Bixby Foyer and Continental Breakfast in Farrell's Lounge		
8:00 AM	Keynote Introduction by Workshop Co-Chair, Michael Moore, Stellantis		
8:05 AM	Keynote Address: Keynote 2		
SESSION 4			
8:55 AM	In Use Exhaust Emissions: On Road, Off Road, and Non-Road		
	Introduction by Session Leader: Rada Purushothaman, Caterpillar		
9:00 AM	A COMPARISON OF IN-USE TEST RESULTS USING NTE AND MAW FOR ENGINES SUBJECTED TO US EPA TEST ORDERS		US Environmental Protection Agency
9:15 AM	MOBILE HYDRAULIC ENGINE DYNAMOMETER		California Air Resources Board
9:30 AM	EXHAUST EMISSIONS FROM OFF-ROAD EQUIPMENT ON MOBILE HYDRAULIC DYNAMOMETER (MOHYD)		California Air Resources Board
9:45 AM	DRIVING BEHAVIOR QUANTIFIED BY AGGRESSIVE-DYNAMICS METRICS DERIVED FROM ON-ROAD PEMS TESTING AND ITS CORRELATIONS WITH FUEL CONSUMPTION AND EMISSIONS		California Air Resources Board
10:00 AM	General Discussion and Open Q & A		
10:15 AM	Poster Session and Demonstrations in Farrell's Lounge		
SESSION 4			
10:45 AM	In Use Exhaust Emissions: On Road, Off Road, and Non-Road		
	Welcome Back by Session Leader: Rada Purushothaman, Caterpillar		
10:50 AM	REAL-WORLD TAILPIPE AMMONIA EMISSIONS FROM LIGHT-DUTY GASOLINE VEHICLES	Troy Hurren	University of California, Riverside
11:05 AM	EFFORTS TO IDENTIFY AND QUANTIFY THE PREVALANCE AND EMISSIONS IMPACT OF MEDIUM- AND HEAVY-DUTY DIESEL VEHICLE TAMPERING	Carl Fulper	US Environmental Protection Agency
11:20 AM	General Discussion and Open Q & A		
11:35 AM	Lunch in Pike Ballroom		

**Tuesday, April 15, 2025**

## SESSION 5

1:05 PM **Alternate Fuel and Zero-Emissions Vehicles (Hydrogen, Non-Carbon Fuels, Battery-**

*Introduction by Session Leader: Andrew Kotz, NREL*

1:10 PM FUEL/ENGINE COMBUSTION TECHNOLOGIES WITH HIGH SOLID SUB-23 NM PARTICLE NUMBER & ULTRA LOW SOOT MASS Imad Khalek Southwest Research Institute

1:25 PM INFLUENCE OF HYDROGEN BLENDING ON ENGINE PERFORMANCE AND EMISSIONS FROM AN ULTRA-LOW NOX NATURAL GAS HEAVY-DUTY ENGINE Troy Hurren University of California, Riverside

1:40 PM EMISSIONS FROM MULTI-GAS ENGINES USED IN GENERATORS FOR THE UK CONSTRUCTION SECTOR Carl Desouza Imperial College London

1:55 PM COMPARISON OF BRAKING ACTIVITY FROM ZERO-EMISSION AND CONVENTIONAL HEAVY-DUTY VEHICLES Michelia Dam California Air Resources Board

2:10 PM CRC SMC UPDATE Elana Chapman General Motors

2:25 PM General Discussion and Open Q & A

2:35 PM **Poster Session and Demonstrations in Farrell's Lounge**

## SESSION 6

3:05 PM **Emissions Control Measures: I/M, OBD, Technologies and Strategies**

*Introduction by Session Leader: Laxmi Reddy Yatavelli, CARB*

3:10 PM THE STORY OF THE (NEAR) ELIMINATION OF GASOLINE VEHICLE EMISSIONS – CRC PROJECT E-130 S. Kent Hoekman Desert Research Institute

3:25 PM HEAVY-DUTY VEHICLE INSPECTION AND MAINTENANCE PROGRAM IN CALIFORNIA – THE CLEAN TRUCK CHECK, CARBTST REFEREE PROGRAM Tom Durbin University of California, Riverside

3:40 PM NEW EMISSIONS VERIFICATION DURING PERIODIC TECHNICAL INSPECTION (PTI) Ricardo Suarez-Bertoa European Commission, Joint Research Centre

3:55 PM AN EXTREME VALUE THEORY VIEW OF HIGH EMITTER TRENDS FROM ROADSIDE REMOTE SENSING DATA Matti Maricq Forest Glen Consulting

4:10 PM ON-BOARD EMISSION MEASUREMENT WITH NOX SENSORS Yang Li Cummins Corp R&T

4:25 PM General Discussion and Open Q & A

4:40 PM **END OF DAY**

5:20 PM **Poster Session, Demonstrations, and Evening Reception in Farrell's Lounge**

Wednesday, April 16, 2025			
7:00 AM	Registration in Bixby Foyer and Continental Breakfast in Farrell's Lounge		
SESSION 7			
8:00 AM	Emissions Modeling		
Introduction by Session Leader: Michael Aldridge, US EPA			
8:05 AM	AN OVERVIEW OF EMFAC202Y UPDATES	Cindy Yañez	California Air Resources Board
8:20 AM	MOVES5 UPDATES AND RESULT COMPARISONS	Megan Beardsley	US Environmental Protection Agency
8:35 AM	SENSITIVITY OF MOVES4.0 ENERGY USE AND EMISSION RATES ACROSS MULTIPLE INPUT VARIABLE DIMENSIONS	Hongyu Lu	Georgia Institute of Technology
8:50 AM	UPDATING LD VMT SPEED-DISTRIBUTIONS AND SPEED CORRECTION FACTORS IN EMFAC2020Y TO BETTER CAPTURE EMISSIONS OF HIGH-SPEED DRIVING	Lucas Algrim	California Air Resources Board
9:05 AM	General Discussion and Open Q & A		
9:20 AM	Poster Session and Demonstrations in Farrell's Lounge		
SESSION 7			
10:05 AM	Emissions Modeling		
Welcome Back by Session Leader: Michael Aldridge, US EPA			
10:10 AM	ENHANCING AIR QUALITY IMPACT ASSESSMENT OF FREIGHT-RELATED EMISSION WITH LARGE-SCALE, REAL-WORLD TRUCK ACTIVITY DATA	Yejia Liao	University of California, Riverside
10:25 AM	DEVELOPMENT OF TEXAS-SPECIFIC DRIVE CYCLES FOR ELECTRICAL AND CONVENTIONAL VEHICLES USING WEJO DATA	Madhusudhan Venugopal	Texas A&M Transportation Institute
10:40 AM	DEVELOPMENT OF A RESEARCH TOOL TO ESTIMATE EMISSIONS INVENTORY IMPACTS OF TAMPERED HEAVY-DUTY DIESEL VEHICLES	Jaehoon Han	US Environmental Protection Agency
10:55 AM	General Discussion and Open Q & A		
11:10 AM	Lunch in Pike Ballroom		

Wednesday, April 16, 2025

SESSION 8

12:30 PM Non-Exhaust Emissions

Introduction by Session Leader: Seungju Yoon, California Air Resources Board

12:35 PM MOBILE SOURCE NON-EXHAUST EMISSIONS: RESEARCH NEEDS FOR REGIONAL AIR QUALITY, COMMUNITY EXPOSURE/HEALTH EFFECTS, AND GREENHOUSE GAS EMISSIONS IN CALIFORNIA Seungju Yoon California Air Resources Board

12:50 PM LIGHT-DUTY VEHICLE TIRE-WEAR PARTICLE EMISSIONS Elizabeth DeFrance University of California, Riverside

1:05 PM CHARACTERIZING NON-EXHAUST EMISSIONS FROM CONVENTIONAL AND ELECTRIC VEHICLES OVER CHASSIS DYNAMOMETER TEST CYCLES Okjoo Park California Air Resources Board

1:20 PM IDENTIFICATION OF ORGANIC VOLATILES AS SPECIFIC MARKERS FROM BRAKE AND TIRE WEAR Veronique Perraud University of California, Irvine

1:35 PM TIRE AND ROAD WEAR NANOPARTICLE EMISSIONS: WHERE DO THEY COME FROM AND HOW MANY ARE THERE? Adam Boies Stanford University

1:50 PM SPATIOTEMPORAL CHARACTERIZATION OF NON-TAILPIPE EMISSIONS FROM MOBILE AND STATIONARY MEASUREMENTS Cheol-Heon Jeong University of Toronto

2:05 PM TIRE EMISSIONS FACTORS, ENVIRONMENTAL RISKS AND MITIGATIONS Nick Molden Emissions Analytics

2:20 PM General Discussion and Open Q & A

2:35 PM Closing Remarks from Workshop Chairs Paul Loeper, Chevron Michael Moore, Stellantis

2:45 PM END OF WORKSHOP

## POSTERS

### The Impact of Policy on Environmental Justice and Regional Emissions

URBAN MEASUREMENTS OF ULTRAFINE PARTICLES IN AMBIENT AIR WITH THE AVL ULTRAFINE PARTICLE MONITOR	Manfred Linke	AVL Graz
HEAVY-DUTY VOCATIONAL VEHICLE NOX EMISSION IMPACTS ON DISADVANTAGED COMMUNITIES	Troy Hurren	University of California, Riverside

### Decarbonization: Technologies, Complications, and Mitigation Strategies / Electric and Hybrid Vehicles

ACTIVITY DATA OF ZERO AND NEAR-ZERO PORT-RELATED EQUIPMENT AND VEHICLES	Tom Durbin	University of California, Riverside
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### Emissions Measurement Methods

HEAVY-DUTY DIESEL EMISSIONS MONITORING USING LOW-COST SENSORS	Spencer Larson	Brigham Young University
DEVELOPMENT OF AN EXPERIMENTAL SETUP FOR PEMS RDE USING PORTABLE FTIR	Vahid Hosseini	Simon Fraser University
INVESTIGATION OF EXHAUST LEAK EMISSIONS WITH A SPECIAL FOCUS ON HEAVY-DUTY NATURAL GAS VEHICLES	Zisimos Toumasatos	University of California, Riverside

### In Use Exhaust Emissions: On Road, Off Road, and Non-Road

EFFECTS OF AMBIENT TEMPERATURE AND AGE ON NOX EMISSIONS FROM HEAVY-DUTY VEHICLES MEASURED IN UTAH AND CALIFORNIA	Amber Allen	Brigham Young University
RESULTS OF SENSOR BASED ONBOARD SENSING ANALYSIS AND REPORTING FROM VARIOUS FLEETS DURING A TWO MONTH TIMEFRAME	Grace Johnson	University of California, Riverside
EMISSIONS FROM OFF-HIGHWAY CONSTRUCTION EQUIPMENT IN EUROPE	Nick Molden	Emissions Analytics
REAL WORLD LASER SPECTROSCOPY-BASED IN-SITU EMISSIONS TESTING ON DIESEL TRUCKS	Ritobrata Sur	Indrio Technologies Inc.
REAL-WORLD MEASUREMENTS OF MAIN ENGINE FUEL USE AND EMISSIONS FROM TWO PASSENGER FERRY VESSELS	Sebastian Larrahondo	North Carolina State University
APPLICATION OF PHYSICS-INFORMED NEURAL NETWORKS FOR SIMULATION OF SELECTIVE CATALYTIC REDUCTION CATALYST	Venkata Rajesh Chundru	Southwest Research Institute
SCOPING STUDY ASSESSMENT OF TECHNOLOGY AND FUEL PROPERTY EFFECTS ON PARTICLE EMISSION FROM MODERN LIGHT-DUTY GASOLINE VEHICLES	Steve McConnell	Marathon Petroleum, Inc.

### Alternate Fuel and Zero-Emissions Vehicles (Hydrogen, Non-Carbon Fuels, Battery-Electric fuel cells)

COMPARATIVE ANALYSIS OF LIFECYCLE GREENHOUSE GAS EMISSIONS OF PROPANE POWERED FORKLIFTS WITH ELECTRIC FORKLIFTS FROM A MARGINAL AND AVERAGE GRID EMISSIONS PERSPECTIVE	Sai Satish Guda	Propane Education & Research Council
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### Emissions Control Measures: I/M, OBD, Technologies and Strategies

INVESTIGATING VEHICLE EMISSIONS IN NIGERIA USING AN UPDATED I/M PROCEDURE	Daisy Thomas	3DATX Corporation
TELEMATICS DATA AND VEHICLE SPEED: CHANGES BETWEEN 2020 AND 2022	John Koupal	ERG

POSTERS		
Emissions Modeling		
ANALYSIS OF NEW NATIONAL GASOLINE SURVEY DATA AND ITS APPLICATION IN MOVES5	Aron Butler	US Environmental Protection Agency
COMPARISON OF REAL-WORLD EMISSIONS FROM HEAVY-DUTY DIESEL VEHICLES TO MOVES4.	Emma Reeves	Brigham Young University
DEVELOPMENT OF 2023 TEXAS STATEWIDE AERR AIRPORT EMISSIONS INVENTORY AND 2011 THROUGH 2050 TREND INVENTORIES	Venugopal, Madhusudhan	Texas A&M Transportation institute
Non-Exhaust Emissions		
LABORATORY STUDY OF THE CONTRIBUTION OF PHENOLIC RESIN THERMAL DEGRADATION TO AUTOMOTIVE BRAKE EMISSIONS	Berenice Rojas	University of California, Irvine
EVALUATION OF THE NON-EXHAUST PARTICLE EMISSIONS COLLECTED FROM A VEHICLE DRIVING ON THE REAL ROAD	HWANSOO CHONG	National Institute of Environmental Research
CHEMICAL COMPOSITION ANALYSIS OF TIRE-ROAD-WEAR PARTICLES FROM A VEHICLE IN REAL ROAD DRIVING CONDITION	Lim, Yunsung	National Institute of Environmental Research
COMPREHENSIVE ASSESSMENT OF PM EMISSIONS IN ELECTRIFICATION STRATEGIES FOR VEHICLES	Seokhwan Lee	Korea Institute of Machinery and Materials
MEASUREMENT OF NON-EXHAUST PARTICULATE MATTER EMISSIONS FROM MOBILE SOURCES USING RUNNING LOSS SEALED HOUSING FOR EVAPORATIVE DETERMINATION	Yilin Ma	California Air Resources Board
UCR BRAKE-WEAR AND TIRE-WEAR SAMPLING SYSTEM DEVELOPMENT – TECHNOLOGY DEMONSTRATION AND UPDATES	Zisimos Toumasatos	University of California, Riverside
DEMONSTRATIONS		
FAST RESPONSE GAS ANALYSERS	Jerry Hall	Cambustion
	Richard Frazee	IAG-ng Inc.
REAL TIME BRAKE/TIRE/COMBUSTION PARTICULATE MEASUREMENTS AND OXIDATION FLOW REACTOR	Erkki Lamminen	Dekati Ltd
	Earl Leatherland	Global MRV, Inc.
	Jimmy Williamson	AVL