

Coordinating Research Council, Inc.



# Preliminary AGENDA

## 34th CRC REAL WORLD EMISSIONS WORKSHOP

### *Co-Sponsors*

California Air Resources Board  
Truck and Engine Manufacturers Association  
US Environmental Protection Agency  
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

Hyatt Regency Mission Bay  
March 10-13, 2024

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

## Sunday, March 10, 2024

4:30-6:00 PM Registration in the Bayview Foyer and Poster Setup in the Regatta Pavilion

6:00-7:00 PM Welcome Reception in Banyan Court and Lawn

## Monday, March 11, 2024

*All sessions take place in Bayview Ballroom, unless otherwise noted*

7:00 AM Registration in Bayview Foyer and Continental Breakfast in Regatta Pavilion

8:00 AM Welcome from the Chairs: Paul Loeper, Chevron & Michael Moore, Stellantis

8:15 AM **Keynote Address:**

### SESSION 1

9:00 AM **In-Use Heavy Duty and Low Carbon Vehicle Technologies**

*Introduction by Session Leaders: Andrew Kotz, National Renewable Energy Laboratory*

9:05 AM	EXAMINATION OF N <sub>2</sub> O EMISSIONS FROM IN-USE HEAVY-DUTY TRUCKS	Hee Je Seong	California Air Resources Board
9:20 AM	H <sub>2</sub> ICE AFTERTREATMENT CATALYST CHARACTERIZATION	Bryan Zavala	Southwest Research Institute
9:35 AM	ANALYSIS OF ONBOARD CARBON CAPTURE AND STORAGE FOR HEAVY DUTY TRUCKS, RAIL, AND MARINE	Mike Kass	Oak Ridge National Laboratory
9:50 AM	DEVELOPING TOOLS TO QUICKLY FIND POTENTIALLY HIGH EMITTING HEAVY-DUTY VEHICLES	Carl Fulper	US Environmental Protection Agency
10:05 AM	General Discussion and Open Q & A		

10:20 AM **Poster Session and Demonstrations in Regatta Pavilion**

### SESSION 2

10:55 AM **Non-Exhaust Emissions**

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

11:00 AM	REAL-WORLD MEASUREMENTS OF PARTICLE EMISSIONS FROM BRAKE AND TIRE WEAR	Louisa Kramer	Ricardo
11:15 AM	ASSESSING REAL-WORLD BRAKE WEAR PARTICLE EMISSIONS ON PUBLIC ROADS	Michael Peter Huber	Institute of Automotive Engineering of the Technical University of Graz
11:30 AM	CHARACTERISTIC OF TIRE WEAR AND TIRE-ROAD WEAR PARTICLES FROM VEHICLES DRIVING ON REAL ROADS	Hwansoo Chong	National Institute of Environmental Research
11:45 AM	HOW EV TECHNOLOGY CHANGE BRAKE- AND TIRE-WEAR PM EMISSIONS: A STUDY OF DIFFERENCES BETWEEN BATTERY ELECTRIC AND CONVENTIONAL HEAVY-DUTY VEHICLES	Qi Yao	California Air Resources Board
12:00 PM	RECONSTRUCTION OF PM SPECIATION PROFILES FROM HEAVY-DUTY VEHICLE BRAKE WEAR PARTICULATE MATTER EMISSION	Chia-Li Chen	California Air Resources Board
12:15 PM	General Discussion and Open Q & A		

12:30 PM **Lunch Break in Banyan Court and Lawn**

**Monday, March 11, 2024**

**SESSION 3**

**2:00 PM Emissions Measurement Methods**

*Introduction by Session Leader: Rada Purushothaman, Caterpillar, and Joseph Martin, US Environmental Protection Agency*

2:05 PM	FIRST LOOK AT ETHYLENE OXIDE EMISSION FROM MOBILE SOURCES	Aiko Matsunaga	California Air Resources Board
2:20 PM	EVALUATION OF ANALYZER ACCURACY, NOISE, AND REPEATABILITY AT LOW NOX CONCENTRATIONS	Benjamin Shade	AVL Test Systems, Inc.
2:35 PM	PRACTICAL ANALYSIS OF MINI-PEMS DATA TO SCORE IN-USE EMISSIONS	Gregory Banish	Calibrated Success
2:50 PM	General Discussion and Open Q & A		

**3:05 PM Poster Session and Demonstrations in Regatta Pavilion**

**SESSION 4**

**3:35 PM Emissions Measurement Methods (Continued)**

*Introduction by Session Leader: Rada Purushothaman, Caterpillar, and Joseph Martin, US Environmental Protection Agency*

3:40 PM	ENHANCING REAL-WORLD EMISSION FACTOR MEASUREMENTS FOR HEAVY-DUTY VEHICLES USING ADVANCED TECHNOLOGY	Okjoo Park	California Air Resources Board
3:55 PM	FUTURE CHALLENGES FOR PEMS FT-IR MEASUREMENT OF CARBON/NON-CARBON BASED EXHAUST	Philipp Jakubec	IAG Test Cell Technology
4:10 PM	REAL WORLD LASER SPECTROSCOPY-BASED EMISSIONS TESTING ON A DIESEL CARGO VAN	Ritobrata Sur	Indrio Technologies
4:25 PM	General Discussion and Open Q & A		
4:40 PM	Logistics for Dinner Event	Jan Tucker	Coordinating Research Council, Inc.
4:45 PM	<b>END OF DAY</b>		
5:45 PM	Meet in Lobby to Leave for Networking Dinner, Last Bus Leaving at 6:00 PM		

## Tuesday, March 12, 2024

7:00 AM Registration in Bayview Foyer and Continental Breakfast in Regatta Pavilion

8:00 AM Keynote Introduction by Workshop Co-Chair, Michael Moore, Stellantis

8:05 AM **Keynote Address:**

### SESSION 5

8:50 AM **Improving the Emissions Inventory**

*Introduction by Session Leader: Sam Cao, South Coast AQMD*

8:55 AM INVESTIGATING THE IMPACT OF PORT CONGESTION ON AIR POLLUTANT AND GREENHOUSE GAS EMISSIONS FROM OPERATIONS AT THE PORTS OF LONG BEACH AND LOS ANGELES: INSIGHTS FROM THE COVID-19 ERA AND THE INFLUENCE OF CLEAN TRANSPORTATION POLICIES David Quiros California Air Resources Board

9:10 AM DEVELOPMENT OF A STATEWIDE AIRCRAFT EMISSIONS INVENTORY IN CALIFORNIA Kaishan Zhang California Air Resources Board

9:25 AM APPROACHES FOR USING PORTABLE EMISSIONS MEASUREMENT SYSTEM (PEMS) DATA FOR INVENTORY DEVELOPMENT Mo Chen California Air Resources Board

9:40 AM ADVANCEMENTS IN LATIN AMERICAN EMISSION INVENTORIES USING MOVES: A FRAMEWORK FOR INTERNATIONAL APPLICATION John Koupal ERG

9:55 AM General Discussion and Open Q & A

10:05 AM **Poster Session and Demonstrations in Regatta Pavilion**

### SESSION 6

10:30 AM **Emissions Modeling**

*Introduction by Session Leader: Michael Aldridge, US Environmental Protection Agency*

10:35 AM APPLICABILITY OF MICROSCALE SPATIALLY RESOLVED ONROAD EMISSIONS FOR EVALUATING ENVIRONMENTAL JUSTICE IMPLICATIONS Christina Quaassdorff Technical University of Madrid

10:50 AM DEVELOPMENT OF NEW HEAVY-DUTY VEHICLE BRAKE WEAR EMISSION RATES FOR EPA'S MOVES MODEL Jaehoon Han US Environmental Protection Agency

11:05 AM MODELING ELECTRIC VEHICLE IMPACTS ON AIR QUALITY – AN ANALYSIS OF EMISSION CHANGES DUE TO ADOPTION OF PLUG-IN ELECTRIC VEHICLE IN DALLAS-FORT WORTH METROPOLITAN AREA Madhusudhan Venugopal Texas A&M Transportation Institute

11:20 AM ACCOUNTING FOR LOCAL PROFILE VARIATION WHEN SOURCE APPORTIONING AIRBORNE PARTICULATE MATTER DATA USING THE US EPA'S SPECIATE Karl Ropkins University of Leeds

11:35 AM COMPREHENSIVE SIMULATION PLATFORM FOR ENABLING LOW EMISSION MD/HD VEHICLES Andrea Strzelec USCAR

11:50 AM General Discussion and Open Q & A

12:05 PM **Lunch Break in Banyan Court and Lawn**

**Tuesday, March 12, 2024**

**SESSION 7**

**1:35 PM Electric and Hybrid Vehicles**

*Introduction by Session Leader: Laxmi Reddy Yatavelli, California Air Resources Board*

1:40 PM DISTINGUISHING BRAKING ACTIVITY PATTERNS: A STUDY OF DIFFERENCES BETWEEN HEAVY-DUTY BATTERY ELECTRIC AND CONVENTIONAL VEHICLES Georges Saliba California Air Resources Board

1:55 PM VEHICLE ACTIVITY AND ENERGY USE PROFILES: A STUDY OF DIFFERENCES BETWEEN HEAVY-DUTY BATTERY ELECTRIC AND CONVENTIONAL VEHICLES Hanwei Zhu California Air Resources Board

2:10 PM IMPROVING ESTIMATION OF ENERGY CONSUMPTION RATES FOR ZERO-EMISSION VEHICLES IN EMFAC 202Y Lucas Algrim California Air Resources Board

2:25 PM ACTIVITY DATA OF ZERO AND NEAR-ZERO EMISSIONS VEHICLES AND EQUIPMENT Tom Durbin University of California, Riverside

2:40 PM ENERGY-EFFICIENT ADAPTIVE CRUISE CONTROL Piyush Bhagdikar Southwest Research Institute

2:55 PM General Discussion and Open Q & A

**3:05 PM Poster Session and Demonstrations in Regatta Pavilion**

**SESSION 8**

**3:35 PM Alternate Fuel and Zero-Emissions Vehicles (Hydrogen, Non-Carbon Fuels, Battery-Electric fuel cells)**

*Introduction by Session Leaders: Andrew Kotz, National Renewable Energy Laboratory*

3:40 PM UNDERSTANDING DC POWER TRANSFER WITH ELECTRIC VEHICLES Sandesh Rao Southwest Research Institute

3:55 PM IMPACT OF HYDROGEN BLENDING ON EMISSIONS OF NATURAL GAS UTILITY ENGINE John Sparrow Intertek

4:10 PM NITROGEN SPECIES EMISSIONS FROM GREEN AMMONIA-FUELED YARD TRACTORS Will Northrop University of Minnesota

4:25 PM SOLUTIONS TO MAKE GREEN METHANOL AN EASY LOW CARBON FUEL WITH REDUCED EMISSIONS IN COMPRESSION IGNITION ENGINES. Anne-Gaëlle Morin VeryOne

4:40 PM General Discussion and Open Q & A

**4:50 PM END OF DAY**

**5:35 PM Evening Poster and Demonstration Reception in Regatta Pavilion**

## Wednesday, March 13, 2024

7:00 AM Registration in Bayview Foyer and Continental Breakfast in Regatta Pavilion

### SESSION 9

8:00 AM **Conventional and Alternative Fuel Effects on Emissions (Low-Carbon Fuels, etc.)**

*Introduction by Session Leaders: Yusuf Khan, Cummins Inc.*

8:05 AM LOW NOX EMISSIONS IMPACT OF HIGH BIODIESEL BLENDS - EVALUATION AND ENGINE RECALIBRATION Christopher Sharp Southwest Research Institute

8:20 AM IMPACT OF ULSD FUEL ANALYSES VARIATION ON BSCO<sub>2</sub> BASED ON SIX INTER-LAB STUDY. Atharva Desai Cummins

8:35 AM EMISSIONS AND EFFICIENCY IMPACTS OF BIO-OIL/VERY LOW SULFUR FUEL OIL BLENDS IN THE ENTERPRISE 2-STROKE MARINE DIESEL RESEARCH ENGINE Brian Kaul Oak Ridge National Laboratory

8:50 AM COMPARING REGULATED AND UNREGULATED REAL DRIVING EMISSIONS FROM EURO 6D VEHICLES RUNNING ON E0 AND E10 GASOLINE BLENDS Nick Molden Emissions Analytics

9:05 AM General Discussion and Open Q & A

9:20 AM **Poster Session and Demonstrations in Regatta Pavilion**

### SESSION 10

9:50 AM **Off-Road / Non-Road Emissions**

*Introduction by Session Leaders: Rada Purushothaman, Caterpillar*

9:55 AM NEW NOX EMISSION FACTORS FOR OFF-ROAD ENGINES Julie Schiffman California Air Resources Board

10:10 AM MOBILE HYDRAULIC ENGINE DYNAMOMETER Axel Freund California Air Resources Board

10:25 AM EMISSIONS MEASUREMENT FROM OCEAN GOING CONTAINER AND ROLL ON/ROLL OFF VESSELS USING A CAPTURE AND CONTROL SYSTEM Tianbo Tang\* University of California, Riverside

10:40 AM EMISSION RESULTS FROM TRANSPORT REFRIGERATION UNIT (TRU) ENGINES USING PEMS IN A SIMULATED IN-USE TEST CONDITION Michael R Olson California Air Resources Board

10:55 AM General Discussion and Open Q & A

11:10 AM **Lunch Break in Banyan Court and Lawn**

## Wednesday, March 13, 2024

### SESSION 11

#### 12:30 PM Emissions Control Measures: I/M, OBD, Technologies and Strategies

*Introduction by Session Leaders: Seungju Yoon, California Air Resources Board*

12:35 PM	CLEANING THE AIR IN NIGERIA - LESSONS FROM AN I/M CAMPAIGN	Daisy Thomas	3DATX
12:50 PM	PRELIMINARY RESULTS OF SENSOR BASED ONBOARD SENSING ANALYSIS AND REPORTING FROM FIVE FLEETS DURING A TWO MONTH TIMEFRAME	Grace Johnson*	University of California, Riverside
1:05 PM	HEAVY-DUTY VEHICLE ENFORCEMENT WITH ROADSIDE EMISSIONS MONITORING DEVICES FOR CARB'S CLEAN TRUCK CHECK PROGRAM: CURRENT STATUS AND FUTURE PLANS	Hang Liu	California Air Resources Board
1:20 PM	HEAVY-DUTY VEHICLE INSPECTION AND MAINTENANCE PROGRAM IN CALIFORNIA – THE CLEAN TRUCK CHECK, CARBTEST REFEREE PROGRAM	Tom Durbin	University of California, Riverside
1:35 PM	General Discussion and Open Q & A		

### SESSION 12

#### 1:50 PM Air Quality and Impact of Regional Emissions Changes on Environmental Justice

*Introduction by Session Leaders: Heidi Vreeland, US EPA*

1:55 PM	WORKER EXPOSURE TO DIESEL EXHAUST FROM NON-ROAD MOBILE MACHINERY USED IN THE UK CONSTRUCTION SECTOR	Carl Desouza	Imperial College London
2:10 PM	AIR QUALITY IMPACTS AND NOX EMISSIONS EXPOSURES IN DISADVANTAGED COMMUNITIES FROM HEAVY-DUTY VOCATIONAL VEHICLES	Troy Hurren*	University of California, Riverside
2:25 PM	PEMS MEASUREMENTS OF TAILPIPE EMISSIONS FOR BUILDING A VOLUNTARY MOBILE SOURCE CARBON OFFSET PROGRAM – A CASE STUDY FROM AFRICA	Alberto Ayala	3DATX
2:40 PM	QUANTIFYING THE OCCUPATIONAL EXPOSURE TO PM2.5 AND STAFF SICKNESS ABSENCE ON THE LONDON UNDERGROUND	Justie Mak	Imperial College London
2:55 PM	REAL-WORLD EMISSIONS APPLICATIONS IN FRA'S NEW CLIMATE AND SUSTAINABILITY PROGRAM	Matthew Simon	U.S. Department of Transportation
3:10 PM	General Discussion and Open Q & A		
3:25 PM	<b>Closing Remarks from Workshop Chairs</b> <b>Paul Loeper, Chevron</b> <b>Michael Moore, Stellantis</b>		
3:35 PM	<b>END OF WORKSHOP</b>		

## POSTERS

### IN-USE HEAVY DUTY AND LOW CARBON VEHICLE TECHNOLOGIES

CHARACTERIZING THE GASEOUS TOXIC POLLUTANTS, PARTICULATE EMISSIONS AND THEIR TOXICITY FROM A PHEV OPERATING WITH ETHANOL BLENDS	Maedeh Makki*	University of California, Riverside
MEASUREMENT OF NOX EMISSIONS FROM HEAVY DUTY VEHICLES UNDER REAL-WORLD DRIVING CONDITIONS	Louisa Kramer	Ricardo
CURRENT HEAVY-DUTY DIESEL AND NATURAL GAS VEHICLE TECHNOLOGY CAN MEET FUTURE EPA IN-USE NOX EMISSIONS STANDARDS	Troy Hurren*	University of California, Riverside
HOW GHG REGULATIONS AND VARIOUS VEHICLE TECHNOLOGIES IMPACT IN-USE CO2 EMISSIONS IN THE HEAVY-DUTY TRANSPORTATION SECTOR	Troy Hurren*	University of California, Riverside

### NON-EXHAUST EMISSIONS

QUANTIFYING TYRE EMISSIONS IN ENVIRONMENTAL SAMPLES	Nick Molden	Emissions Analytics
STUDY OF EMISSION CHARACTERISTICS OF NON-EXHAUST PARTICULATE MATTER AS A FUNCTION OF SEPARATION DISTANCE ON AUTOMOBILE ROADS	YUNSONG LIM	National Institute of Environmental Research
BRAKE WEAR PARTICLE EMISSION MEASUREMENTS BASED ON SEVERAL REAL URBAN DRIVING CYCLES ON LABORATORY EXPERIMENTS	Hiroyuki Hagino	Japan Automobile Research Institute

### EMISSIONS MEASUREMENT METHODS

PERFORMANCE EVALUATION OF THE AVL M.O.V.E FT - A NEW PORTABLE FTIR FOR IN-VEHICLE MEASUREMENTS	Benjamin Shade	AVL Test Systems, Inc.
FUEL COMPOSITION EFFECTS OF SPECIATED EMISSIONS FROM GASOLINE ENGINES	Justine Geidosch	US Environmental Protection Agency
VEHICLE EMISSIONS AND FUEL CONSUMPTION IN LABORATORY AND ON-ROAD: A CASE STUDY FOR THE QUITO METROPOLITAN AREA	Luis Tipanluisa	Escuela Superior Politécnica de Chimborazo
EVALUATION OF AN FT-IR/TDLAS MEASUREMENT SYSTEM DESIGNED FOR SIMULTANEOUS MEASUREMENT OF LOW NOX AND AMMONIA	Richard Frazee	EigenValue Emission Solutions, Inc.
TESTING OF PEMS	Stephan Newl	AVL



## POSTERS

### ALTERNATE FUEL AND ZERO-EMISSIONS VEHICLES (HYDROGEN, NON-CARBON FUELS, BATTERY-ELECTRIC FUEL CELLS)

UTILISING AN INTEGRATED PORTABLE EMISSIONS MEASUREMENT SYSTEM (IPEMS) TO MEASURE EMISSIONS FROM A MULTI-GAS FUELLED GENERATOR.	Carl Desouza	Imperial College London
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### AIR QUALITY AND IMPACT OF REGIONAL EMISSIONS CHANGES ON ENVIRONMENTAL JUSTICE

THE PROBLEM WITH PUBLIC TRANSPORT: POLLUTION EXPOSURE FOR TRAVELLERS, AND WHAT TO DO ABOUT IT	Nick Molden	Emissions Analytics
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INFLUENCE OF LONDON'S CLEAN AIR ZONES FOR CONSTRUCTION SITES	Carl Desouza	Imperial College London
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AIR POLLUTION MAPPING COUPLED WITH MACHINE LEARNING TO REVEAL COMMUNITY-LEVEL EXPOSURES	Haofei Zhang	University of California, Riverside
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### CONVENTIONAL AND ALTERNATIVE FUEL EFFECTS ON EMISSIONS (LOW-CARBON FUELS, ETC.)

EFFECT OF TEST TEMPERATURE AND FUEL PROPERTIES ON PM EMISSIONS FROM A 2018 TOYOTA CAMRY	Aron Butler	US Environmental Protection Agency
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### DECARBONIZATION: TECHNOLOGIES, COMPLICATIONS, AND MITIGATION STRATEGIES

ROUTE MAP TO DECARBONISATION AND ACHIEVING NET-ZERO CONSTRUCTION IN THE UK	Carl Desouza	Imperial College London
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### PARTICULATE EMISSIONS AND MEASUREMENT

MEASUREMENT OF NANOPARTICLES EMITTED FROM DIESEL ENGINES	Jeonghoon Lee	Korea University of Technology and Education
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ULTRAFINE PARTICLE MEASUREMENT CAMPAIGN IN THE CITY OF GRAZ USING AN AVL CPC		AVL
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A PORTABLE OPTOACOUSTIC SENSOR FOR BLACK CARBON EXHAUST EMISSIONS MEASUREMENT	Ioannis Raptis	Aristotle University of Thessaloniki
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DEMONSTRATION OF AN APPROACH FOR QUANTIFYING REAL-WORLD ENGINE FUEL USE AND EMISSION RATES OF A FERRY VESSEL	Tongchuan Wei	North Carolina State University
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## DEMONSTRATIONS

RELIABILITY ANALYSIS OF EMOBILITY POWER'S ELECTRIC VEHICLE CHARGING NETWORK	David N. Patterson	El Camino Consulting
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ON-BOARD FTIR SYSTEM	Stefan Handler	IAG-ng
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FAST GAS ANALYZERS	Jerry Hall	Cambustion
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