



# AGENDA

## 32nd CRC REAL WORLD EMISSIONS WORKSHOP

### *Co-Sponsors*

California Air Resources Board

US Environmental Protection Agency

National Renewable Energy Laboratory

### *Workshop Organizers*

Michael Viola (Co-Chair), General Motors

Scott Mason (Co-Chair), Phillips 66

Tao Huai, California Air Resources Board

Andrew Kotz, National Renewable Energy Laboratory

Seungju Yoon, California Air Resources Board

Joseph Martin, US Environmental Protection Agency

Alexander Voice, Aramco

David Choi, US Environmental Protection Agency

Rada Purushothaman, Caterpillar

Sam Cao, South Coast Air Quality Management District

Aaron Katzenstein, South Coast Air Quality Management District

Yusuf Khan, Cummins

Heidi Vreeland, US Environmental Protection Agency

Hyatt Regency Mission Bay, San Diego, CA

March 13-16, 2022

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, March 13, 2022

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

### DAY ONE

## Monday, March 14, 2022

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

7:00 AM 8:00 AM **Registration in Bayview Foyer and Continental Breakfast in Regatta Pavilion**

15 8:00 AM 8:15 AM **Welcome from the Chairs: Mike Viola, General Motors, & Scott Mason, Phillips 66**

45 8:15 AM 9:00 AM **Keynote Address:  
Tim Seidel, Phillips 66**

### SESSION 1

9:00 AM **In-Use Emissions for Light- and Heavy-Duty Vehicles**

5 9:05 AM *Introduction by Session Leader: Tao Huai, California Air Resources Board, and Andrew Kotz, NREL*

15 9:05 AM 9:20 AM Wintertime Measurements of Heavy-duty Vehicle Emissions at a Utah Port of Entry Molly Haugen University of Cambridge

15 9:20 AM 9:35 AM IN-USE EMISSIONS TESTING AND FUEL USAGE PROFILE OF ON-ROAD HEAVY-DUTY VEHICLES – 200 VEHICLE STUDY CHASSIS Hanwei Zhu University of California, Riverside

15 9:35 AM 9:50 AM Analysis and Summary of Manufacturers In-Use Testing Data Collected from Heavy-Duty Diesel Engines for 2012-2019 Test Orders Using PEMS Systems Allen Duncan US EPA

15 9:50 AM 10:05 AM Comparison of NOx and Greenhouse Gas Emissions between Diesel and Natural Gas Heavy-Duty Vehicles During Real-World Operation Arvind Thiruvengadam West Virginia University

35 10:05 AM 10:40 AM **Poster Session Break and Demonstrations in Regatta Pavilion**

15 10:40 AM 10:55 AM Development, application, and demonstration of a sensor-based onboard sensing, analysis, and reporting (OSAR) for emission and Activity data collection Kent Johnson University of California, Riverside

15 10:55 AM 11:10 AM Port Drayage Electrification for Coastal and Inland Ports Andrew Kotz National Renewable Energy Laboratory

15 11:10 AM 11:25 AM Estimating Limits of Quantitation in Remote Sensing of Automobile Emissions James Warila US EPA

15 11:25 AM 11:40 AM Impact of Regenerative Braking, Heating, and Air Conditioning on Energy Consumption of Light-Duty Plug-in Electric Vehicles Chris Ruehl California Air Resources Board

90 11:40 AM 1:10 PM **Lunch Break in Banyan Court and Lawn**

5 1:10 PM 1:15 PM **5 Minute Lightning Round Talks**  
*Introduction by Scott Mason, Phillips 66*

6 1:15 PM 1:21 PM Ozone Trends in the South Coast Air Basin Through 2021 and Their Implications on Ozone Mitigation Control Strategies Ralph Morris Ramboll

6 1:21 PM 1:27 PM SECONDARY ORGANIC AEROSOL FORMATION FROM UNBURNED FUEL VAPORS Shaokai Gao Phillips 66

6 1:27 PM 1:33 PM Technical approach towards the development of recommendations for the Euro-7 emission standards Zisis Samaras Aristotle University

6 1:33 PM 1:39 PM REAL-WORLD DRIVING EMISSION ANALYSIS OF EURO 4 MOTORCYCLES Ernst Pucher Vienna University of Technology

6 1:39 PM 1:45 PM Absorber Windows for Very Low Soot Mass Concentration using a Photoacoustic Instrument Imad Khalek Southwest Research Institute

# 1:45 PM 1:55 PM Real-world speciated volatile organic compounds: comparison of old and new gasoline cars Nick Molden Emissions Analytics

**DAY ONE**

**Monday, March 16, 2020**

**SESSION 2**

1:55 PM		<b>Emissions Control Measures: I/M, OBD, Technologies and Strategies</b>		
5	2:00 PM	<i>Introduction by Seungju Yoon, CARB</i>		
15	2:00 PM	2:15 PM	THE STORY OF THE (NEAR) ELIMINATION OF GASOLINE VEHICLE EMISSIONS – CRC PROJECT E-130	Kent Hoekman Desert Research Institute
15	2:15 PM	2:30 PM	California’s Heavy-Duty I/M Pilot Study – Evaluation of Best Practices for a Full-Scale Program	Michael Sabisch Eastern Research Group
15	2:30 PM	2:45 PM	IDENTIFYING HIGH EMITTING HEAVY DUTYDIESELVEHICLESUSING PORTABLE EMISSION ACQUISITION SYSTEMS (PEAQS)TO SUPPORT ROADSIDE ENFORCEMENTIN CALIFORNIA	Isaac Lino California Air Resources Board
15	2:45 PM	3:00 PM	DEMONSTRATION OF SENSOR TECHNOLOGIES FOR ON-ROAD AND OFF-ROAD HEAVY-DUTY DIESEL VEHICLES	Kent Johnson University of California, Riverside
15	3:00 PM	3:15 PM	Advanced inspection and maintenance methods to identify high emitters.	Daisy Thomas 3DATX Corporation
10	3:15 PM	3:25 PM	General Discussion of Session 2	
20	3:25 PM	3:45 PM	<b>Poster Session Break and Demonstrations in Regatta Pavilion</b>	
<b>SESSION 3</b>				
5	3:45 PM	3:50 PM	<b>Emissions Measurement Methods</b>	
5	3:50 PM	4:05 PM	<i>Introduction by Joseph Martin, U.S. Environmental Protection Agency</i>	
15	3:50 PM	4:05 PM	Opening the “CAN” - Exploiting the Wealthof Data within a Vehicle’s ECM	Carl Fulper US EPA
15	4:05 PM	4:20 PM	Technical Perspective of the Roadside Exhaust Plume Capture Emissions Measurement System for Heavy-Duty Vehicles	Okjoo Park California Air Resources Board
15	4:20 PM	4:35 PM	APPORTIONING EMISSIONS TO TRU AND HD TRUCKS FROM ON-ROAD REMOTE SENSING	Daniel Phillips California Air Resources Board
15	4:35 PM	4:50 PM	DENVER ON-ROAD RUNNING LOSS TRENDS BY REMOTE SENSING	Tim DeFries Eastern Research Group
15	4:50 PM	5:05 PM	An Update on Continuing Progress at SwRI Towards 2027 Heavy Duty Low NOX Targets	Chris Sharp Southwest Research Institute
10	5:05 PM	5:15 PM	General Discussion of Session 3	
5	5:15 PM	5:20 PM	Logistics for Dinner Event	Jan Tucker Coordinating Research Council, Inc.
15	5:20 PM	5:35 PM	<b>END OF DAY</b>	
	5:45 PM		Meet in Lobby to Leave for Networking Dinner, Last Bus Leaving at 6:00 PM	

DAY TWO		Tuesday, March 15, 2022		
60	7:00 AM	8:00 AM	Registration in Bayview Foyer and Continental Breakfast in Regatta Pavilion	
5	8:00 AM	8:05 AM	Keynote Introduction by Workshop Co-Chair, Mike Viola, General Motors	
	8:05 AM	8:45 AM	<p><i>Keynote Address: TBD</i></p> <p><i>Invited: Lianne Rudolph, CARB Board Chair</i></p>	
40				
SESSION 4				
	8:45 AM		<b>Fuel Effects on Exhaust Emissions</b>	
5		8:50 AM	<i>Introduction by Session Leader: Alexander Voice??, Aramco</i>	
	8:50 AM	9:05 AM	Aiming at the increase of California's ethanol 'blend wall': gaseous and particulate emissions evaluation from a fleet of GDI and PFI vehicles operated on E10 and E15 fuels	Tianbo Tang University of California, Riverside
15				
	9:05 AM	9:20 AM	Quantifying Ethanol Carbon Intensity in Gasoline Blends	Nigel Clark Transport Energy Strategies
15				
	9:20 AM	9:35 AM	Sampling of gas-phase intermediate pyrolytic species at various temperatures and residence times during the pyrolysis of methane, ethane, and butane in a high-temperature flow reactor	Zuhaib Khan University College London
15				
	9:35 AM	9:50 AM	Impact of aromatic content and species optimization on engine compatibility and PM emissions	Bhupendra Khandelwal University of Alabama
15				
	9:50 AM	10:05 AM	Exhaust emissions from a heavy-duty engine running on DME fuel	Gilles Hardy Ivan Tate FPT Motorenforschung AG
15				
	10:05 AM	10:20 AM	Fuel effects on engine out and tailpipe emissions of an ultra-low emissions vehicle	Alexander Voice Aramco
15				
10	10:20 AM	10:30 AM	General Discussion of Session 4	
25	10:30 AM	10:55 AM	<b>Poster Session Break and Demonstrations in Regatta Pavilion</b>	
SESSION 5				
	10:55 AM		<b>Emissions Modeling</b>	
5		11:00 AM	<i>Introduction by Session Leader: David Choi, U.S. Environmental Protection Agency</i>	
	11:00 AM	11:15 AM	ACCURACY OF THE PREDICTIONS OF MODELED EMISSION HOTSPOTS BASED ON REAL-WORLD MEASURED TRAFFIC ACTIVITY AND EMISSIONS.	Christina Quaassdorff Universidad Politécnica de Madrid / North Carolina State University
15				
	11:15 AM	11:30 AM	Predicting Light-Duty Vehicle Emission Using Deep Neural Networks	Abdul Motin Howlader California Air Resources Board
15				
	11:30 AM	11:45 AM	MOVES 3 EXPERIENCES, RESULTS, AND OBSERVATIONS BY THE DFW METROPOLITAN PLANNING ORGANIZATION	Chris Klaus North Central Texas Council of Governments
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10	11:45 AM	11:55 AM	General Discussion of Session 5	
	11:55 AM	1:25 PM	<b>Lunch Break in Banyan Court and Lawn</b>	
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5	1:25 PM	1:30 PM	<b>5 Minute Lightning Round Talks</b>	
			<i>Introduction by Scott Mason, Phillips 66</i>	
	1:30 PM	1:36 PM	Integrated Simulation Platform to Enable Near-Zero Emissions Heavy-Duty Vehicles	Andrea Strzelec University of Wisconsin-Madison
6				
	1:36 PM	1:42 PM	UPDATING AND IMPROVING THE NATIONAL INVENTORY FOR MOBILE SOURCES IN MEXICO USING MOVES-MEXICO	Mauro Alvarado-Castillo LT Consulting Group
6				
	1:42 PM	1:48 PM	Real-world Gaseous and Particulate Emissions Characteristics from Current Technology Heavy-Duty Diesel and Natural Gas Vehicles	Tianyi Ma University of California, Riverside
6				
	1:48 PM	1:54 PM	Activity and Performance for Heavy-duty Diesel and Battery Electric Vehicles in Real-world Operations	Tianyi Ma University of California, Riverside
6				
	1:54 PM	2:00 PM	Activity of Zero and Near-Zero Emissions Vehicles and Equipment	Chas Frederickson University of California, Riverside
6				
#	2:00 PM	2:10 PM	PRACTICES OF DIVERSE AEROSOL GENERATORS TO IMPROVE THE MEASUREMENT OF PARTICULATE MATTER	Qianfeng Li California Air Resources Board

**DAY TWO**

**Tuesday, March 17, 2020**

**SESSION 6**

	2:10 PM		<b>Off-Road / Non-Road Emissions</b>		
5		2:15 PM	<i>Introduction by Rada Purushothaman</i>		
15	2:15 PM	2:30 PM	Application of the 3-Bin Moving Average Window Method for Off-Road Diesel Engines	Yi Tan	California Air Resources Board
#	2:30 PM	2:45 PM	In-use Particle Measurements of Maritime Emissions in Rafina, Greece	Molly Haugen	University of Cambridge
15	2:45 PM	3:00 PM	CALIFORNIA'S ALL NEW 2021 FORESTRY EQUIPMENT EMISSIONS INVENTORY	Julie Schiffman	California Air Resources Board
10	3:00 PM	3:10 PM	General Discussion of Session 6		
25	3:10 PM	3:35 PM	<b>Poster Session Break and Demonstrations in Regatta Pavilion</b>		

**SESSION 7**

	3:35 PM		<b>Improving the Emissions Inventory</b>		
5		3:40 PM	<i>Introduction by Sam Cao and Aaron Katzenstein, SCAQMD</i>		
15	3:40 PM	3:55 PM	Causes of 2020 Ozone and Ability of Photochemical Models to Predict Observed Ozone Changes in the South Coast Air Basin Due to Emissions Reductions from COVID-19	Ralph Morris	Ramboll
15	<del>3:55 PM</del>	<del>4:10 PM</del>	Low CO <sub>2</sub> , Ultralow NO <sub>x</sub> Heavy Duty Diesel Engine	Fabien Redon	AchatesPower
15	4:10 PM	4:25 PM	Characterizing PM <sub>2.5</sub> and NO <sub>x</sub> Emissions for Off-Road Construction Equipment with DPF and SCR Using an Engine Power Binning Method	Qi Yao	California Air Resources Board
15	4:25 PM	4:40 PM	Modeling The Emissions Impact of Heavy-Duty Inspection and Maintenance Program	Ali Davari	California Air Resources Board
15	<del>4:40 PM</del>	<del>4:55 PM</del>	Investigating real-world emissions from light-duty vehicles across Mexico using remote sensing measurements.	Claudia Toro	Eastern Research Group
15	4:55 PM	5:10 PM	Air conditioning refrigerant leakage for model year 2021 heavy-duty vehicles certified for sale in California	Tao Zhan	California Air Resources Board
15	5:10 PM	5:25 PM	Characterization of Trip Starts, Including Initial Idle Time and Acceleration, for 82 Real-world Internal Combustion Engine Light-duty Vehicles	Chris Ruehl	California Air Resources Board
10	5:25 PM	5:35 PM	General Discussion of Session 7		
50	5:35 PM	6:25 PM	<b>END OF DAY</b>		
60	6:25 PM	7:25 PM	<b>Evening Poster and Demonstration Reception in Regatta Pavilion</b>		

DAY THREE		Wednesday, March 16, 2022		
7:30 AM	8:00 AM	Registration in Bayview Foyer and Continental Breakfast in Regatta Pavilion		
<b>SESSION 8</b>				
8:00 AM		<b>Brake and Tire Wear</b>		
5	8:05 AM	<i>Introduction by Seungju Yoon, CARB</i>		
15	8:05 AM	8:20 AM	NEW RESEARCH ON BRAKE WEAR PARTICULATE MATTER EMISSIONS FROM SEVERAL HEAVY TRUCK VOCATIONS IN CALIFORNIA	John Koupal Eastern Research Group
15	8:20 AM	8:35 AM	<del>Investigations on the characteristic of the real driving non-exhaust particulate emissions from a vehicle</del>	<del>Hwansoo Chong National Institute of Environmental Research</del>
15	8:35 AM	8:50 AM	Contribution of non-exhaust vehicle emissions to near-road PM2.5 and PM10: A chemical mass balance study	Antony Chen University of Nevada
15	8:50 AM	9:05 AM	Concentration and Chemical Characteristics of PM2.5 and PM10 near California Highways with a Focus on Non-Tailpipe Emissions	Xiaoliang Wang Desert Research Institute
15	9:05 AM	9:20 AM	Instrumentation and Methods for Quantifying Brake Emissions	Andrea Tiwari TSI Inc.
	9:20 AM	9:20 AM	<del>Investigation of tire road wear particle characteristics using high volume sampler near sidewalk</del>	<del>Yunsung Lim National Institute of Environmental Research</del>
10	9:20 AM	9:30 AM	General Discussion of Session 8	
30	9:30 AM	10:00 AM	<b>Poster Session and Demonstrations in Regatta Pavilion</b>	
<b>SESSION 9</b>				
5	10:00 AM		<b>Particulate Emissions</b>	
	10:05 AM	<i>Introduction by Yusuf Khan, Cummins and Heidi Vreeland, US EPA</i>		
15	10:05 AM	10:20 AM	Influence of Combustion Strategy and Fuel Ethanol Content on Effective Density, Concentration, and Size of Particles Emitted by a Lean Burn Gasoline Direct Injection Engine	David Kittelson University of Minnesota
15	10:20 AM	10:35 AM	Evaluation of Tailpipe Solid Particle Number Measurement Methodologies for Euro VII	Yusuf Khan Cummins Inc.
15	10:35 AM	10:50 AM	Evaluation of Finnish vehicle fleet exhaust solid particle number emissions with respect to upcoming European periodic testing legislation	Erkki Lamminen Dekati Ltd.
15	10:50 AM	11:05 AM	Evaluation of a New TSI Engine Exhaust Particle Sizer with Two-stage Dilution and Catalytic Stripper for Solid Particle Number Measurements	Yusuf Khan Cummins Inc.
15	11:05 AM	11:20 AM	In-Use Vehicle Emissions of Black Carbon (BC) and Brown Carbon (BrC) from roadside field campaigns using a Portable Emissions AcQuisition System (PEAQs)	Michael Olson California Air Resources Board
15	11:20 AM	11:35 AM	PAH Emissions from a GPF-Equipped Light Duty Truck during Soot Accumulation and Regeneration	Stanislav Bohac US EPA
10	11:35 AM	11:45 AM	General Discussion of Session 9	
10	11:45 AM	11:55 AM	<b>Closing Remarks from Real World Group Chairs</b> <b>Scott Mason, Phillips 66</b> <b>Mike Viola, General Motors</b>	
80	11:55 AM	1:15 PM	<b>Lunch in Banyan Court and Lawn</b>	
15	1:15 PM	<b>END OF WORKSHOP</b>		

## POSTERS

### Brake and Tire Wear

Chemical fingerprinting tires to understand tire wear emissions Nick Molden

TiO<sub>2</sub> Enhanced Roadways to Reduce Vehicular Emissions & Microplastic Debris Michael Durante

### Emissions Control Measures

Effects of Porosity, Wall Thickness and Length on the Filtration Efficiency of Gasoline Particulate Filters Fadi Araji

### Emissions Measurement Methods

On-Road Light-Duty Vehicle Emissions Measurements Using a Plume Capture Method Okjoo Park

### Emissions Modeling

Intermodal Comparison of Tailpipe Emission Rates between Transit Buses and Private Vehicles for On-Road Passenger Transport Tongchuan Wei

RDE Plus – Rapid Characterisation of Vehicle and Powertrain Performance and Emissions using Digital Twin, Dynamic Design of Experiments and Environmental Emulation Hardware Methodologies Phil Roberts

### Fuel Effects on Exhaust Emissions

ANALYSIS OF VEHICLE EMISSIONS WITH DIFFERENT FUEL FORMULATIONS IN MEXICO Mauro Alvarado-Castillo

### Improving the Emissions Inventory

UPDATING AND IMPROVING THE NATIONAL INVENTORY FOR MOBILE SOURCES IN MEXICO USING MOVES-MEXICO Mauro Alvarado-Castillo

Comparison of Phase 1 and Phase 2 GHG Regulations, Emissions and Technology Improvements Jade Jiang

### In-Use HD

IN-USE EMISSIONS TESTING AND FUEL USAGE PROFILE OF ON-ROAD HEAVY-DUTY VEHICLES – 200 VEHICLE STUDY ON ROAD Hanwei Zhu

### Off-Road/Non-Road

In-use Equipment and Engine Activities of Construction Equipment in California Chas Frederickson

CARB's Off-road In-Use Compliance Pilot Program Hyun Ji (Julie) Lee

### Particulate Emissions and Measurement

Innovative approaches to measuring and improving cabin air quality using filtration Ameya Joshi

Recalibration of the parSYNC© particulate calculation matrix and investigations into PN and PM reported from different emissions measurement systems during chassis dynamometer testing of a GDI vehicle. Daisy Thomas

Measuring real-world ambient particulate concentrations using mobile monitoring within urban communities. Angus Craig

PRACTICES OF DIVERSE AEROSOL GENERATORS TO IMPROVE THE MEASUREMENT OF PARTICULATE MATTER Qianfeng Li California Air Resources Board

