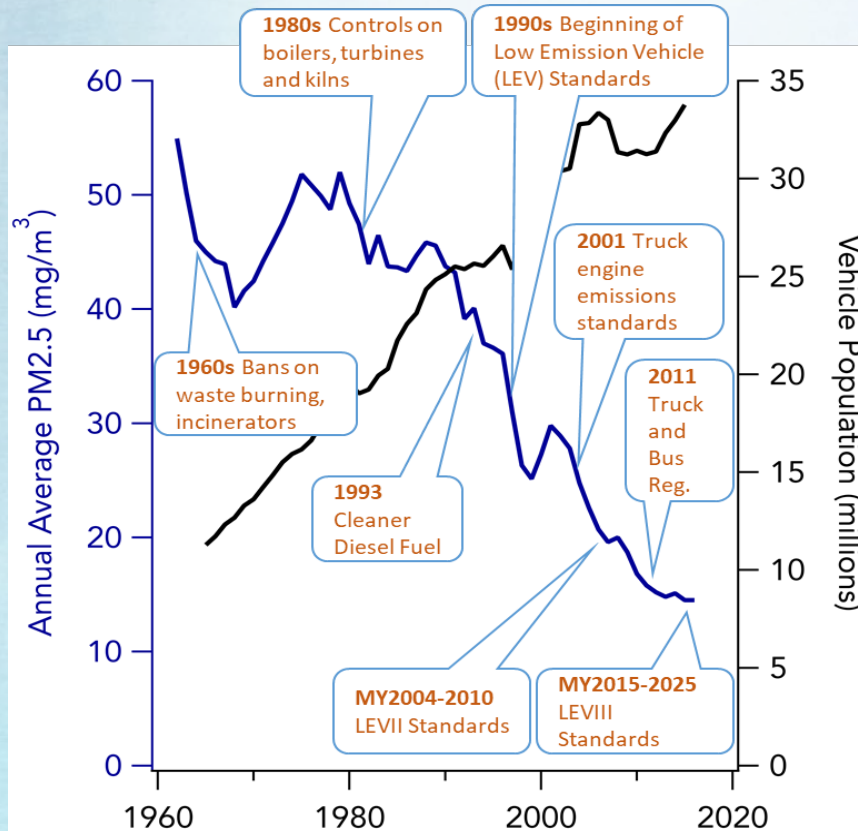




Non-Exhaust Emissions Research at the California Air Resources Board

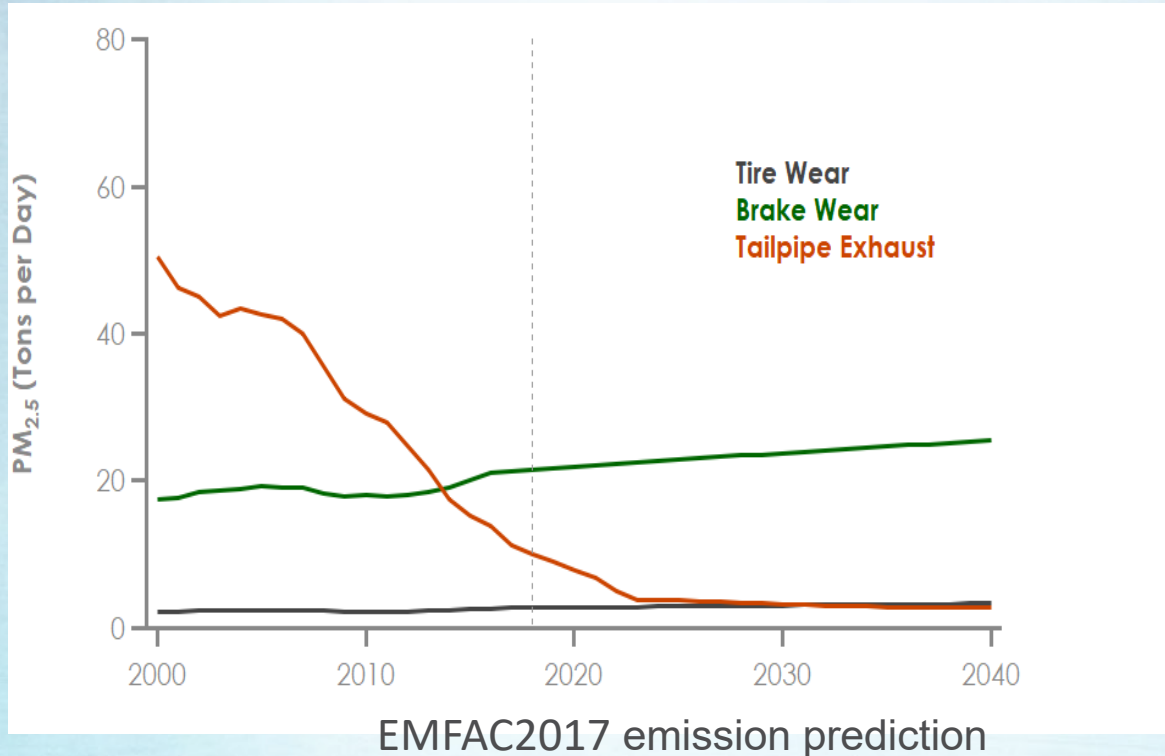
Qi Yao, Sonya Collier, Seungju Yoon,
Barbara Weller, Jorn Herner,
Bonnie Holmes-Gen

Background: Non-exhaust emissions



- Reductions in PM achieved through California regulations, most recently in transport
- Brake and tire-wear unregulated, estimated to contribute more than half of primary on-road vehicle PM

Background: Non-exhaust emissions

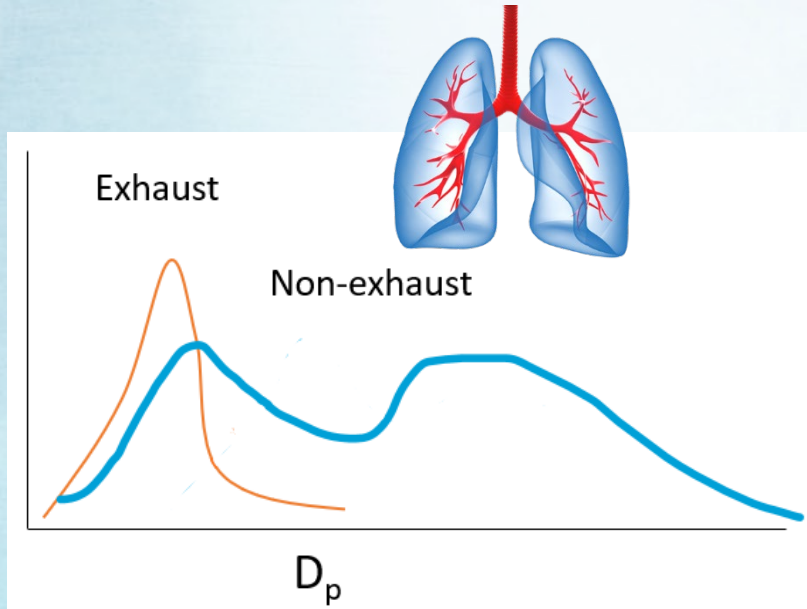


- Tailpipe PM emission reduced due to regulations and incentive programs
- Brake and tire-wear PM emissions predicted to have no change under the current circumstances

Background: Health Impact of Non-Exhaust PM



Background: Health Impact of Non-Exhaust PM



Current Health-related Issues:

- Evaluate importance of non-exhaust
- Evaluate impact of new technologies
- Determine composition of non-exhaust PM
- Determine real-world exposure to non-exhaust PM

Non-exhaust PM likely a localized rather than regional problem



BRAKE WEAR

- Emissions dependent upon driving behavior, vehicle type/weight, materials, component temperature
- Emissions from freeways, on/off ramps, intersections, high traffic roads
- Larger PM



TIRE/ROAD WEAR



ROAD-DUST RESUSPENSION

- Localized community exposure a major concern
- Implications for AB 617 program

CARB Non-Exhaust Research Efforts and Goals:

Problem Identification

- Projected increases in PM2.5
- Older data and significant data gaps

Solution Approach

- 1st step: Inventory
 - New standardized methods
 - On-road fleet and driving behavior
 - Data driven
- Next phase: Health and Exposure
 - Ambient measurements and exposure assessment
 - Exposure assessment and health outcomes

CARB Current Projects – Airborne PM

- **Health implications**
- **Verify importance of non-exhaust**
- **Evaluate impact of new technologies**
- **Composition of non-exhaust**
- **Real-world exposure to non-exhaust**

17RD012: Estimate spatial variations of PM metals and reactive oxygen species (ROS) associated with brake and tire wear

17RD016: Light duty vehicle braking and regenerative braking technology

CalTrans Project: Heavy duty vehicle braking and regenerative braking technology

18RD017: Roadside PM study

CARB Current Projects – Airborne PM

Contract #17RD012:
Exposure study

- Health implications
- Composition of non-exhaust

“Effects of Brake and Tire Wear on Particulate Matter Composition, Reactive Oxygen Species, Placental Development and Birth Outcomes in Los Angeles”

- Estimate spatial variations of PM metals and reactive oxygen species (ROS) associated with brake and tire wear
- Determine linkages between placental development and birth outcomes and exposures to brake and tire wear PM

CARB Current Projects – Airborne PM

Contract #17RD016:
LDV brake wear

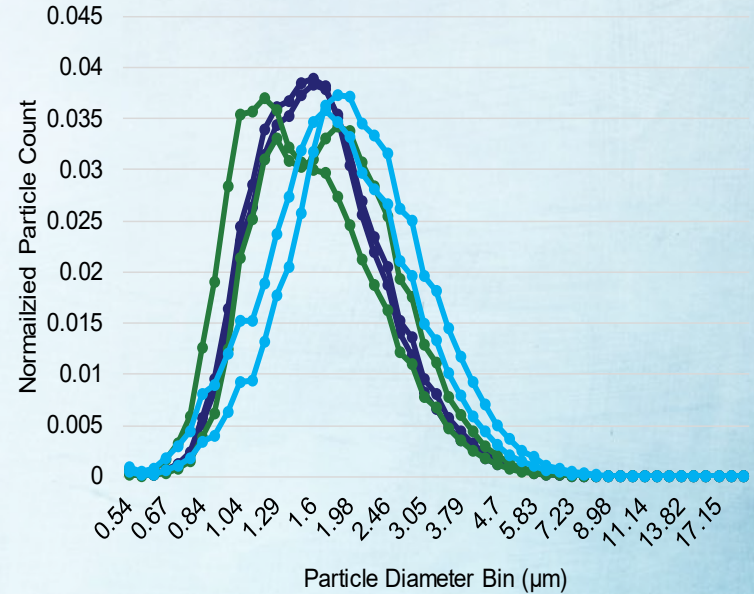
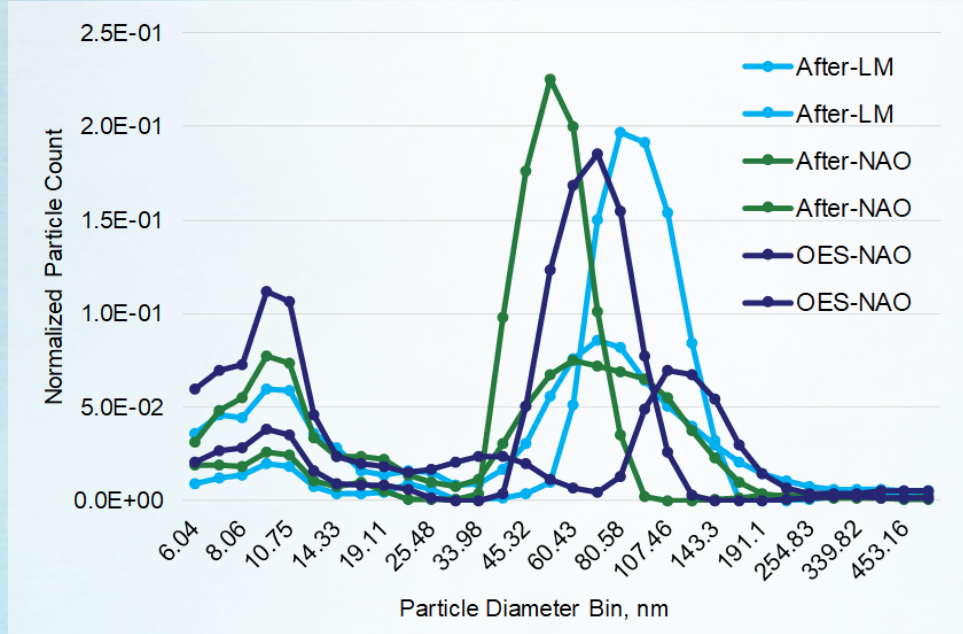
- **Verify importance of non-exhaust**
- **Evaluate impact of new technologies**
- **Composition of non-exhaust**

- Lab method to quantify airborne fraction of brake wear PM from LDVs
- Characterize size distributions, composition of pure brake PM
- Determine PM emission factor for different types of brakes from LDVs



CARB Current Projects – Airborne PM

Contract #17RD016:

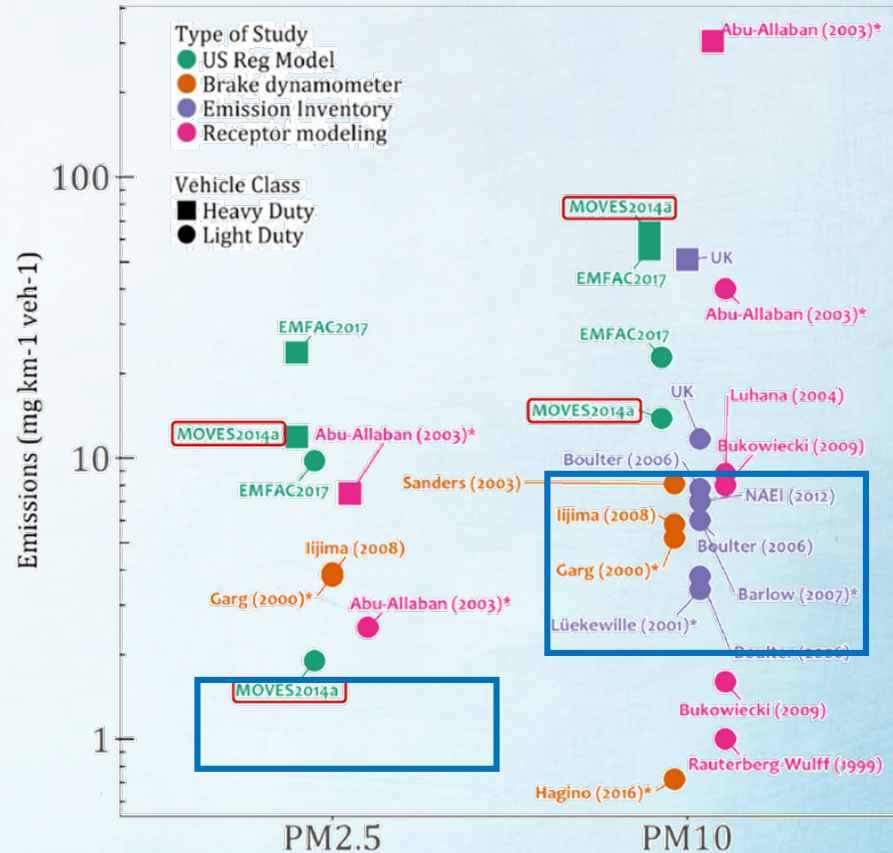


Size distribution of Camry rear brake PM as measured by EEPs (left) and APS (right)

CARB Current Projects – Airborne PM

Contract #17RD016:

- Brake emissions comparison between values reported by this study (Blue boxes) and literatures

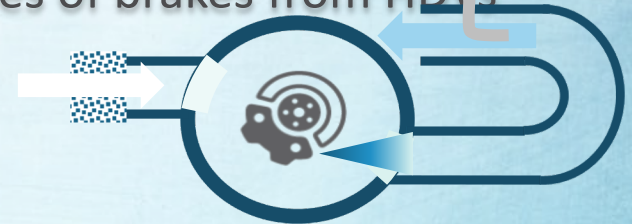


CARB Current Projects – Airborne PM

CalTrans Project: HDV brake wear

- **Verify importance of non-exhaust**
- **Evaluate impact of new technologies**
- **Composition of non-exhaust**

- Heavy duty vehicle braking and regenerative braking technology
- Lab method to quantify airborne fraction of brake wear PM from HDVs
- Determine PM emission factor for different types of brakes from HDV's



CARB Current Projects – Airborne PM

Contract #18RD017:
Roadside measurements

- **Verify importance of non-exhaust**
- **Composition of non-exhaust**
- **Real-world exposure to non-exhaust**

- Use laboratory derived source profiles
- Use location with varying speeds and fleet mixes
- Derive emission factors based on roadside collection results
- Use results to construct dispersion model: predict exposure of downwind communities

Summary

- Bottom up approach
 - Full chassis dyno tests
 - Updated brake emission factor for LDVs
 - Updated brake emission factor for HDVs
- Top down approach
 - Roadside measurements
 - Dispersion model
 - Fraction of exhaust to non-exhaust
- Health effects
 - Health effect indicators

CARB next steps

- Impact of future brake technologies
 - Regenerative braking
- Brake wear PM composition study
- Tire-wear PM
- Health impacts
 - Exposure and cardiovascular health effects major unknowns
- Explore mitigation methods

Acknowledgment



Thank you

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