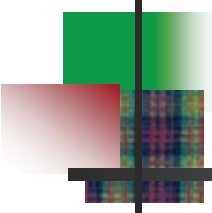


US EPA ARCHIVE DOCUMENT

Improving Chemical Transport Model Predictions of Organic Aerosol: Measurement and Simulation of Semivolatile Organic Emissions from Mobile and Non-Mobile Sources



Allen L. Robinson

Center for Atmospheric Particle Studies

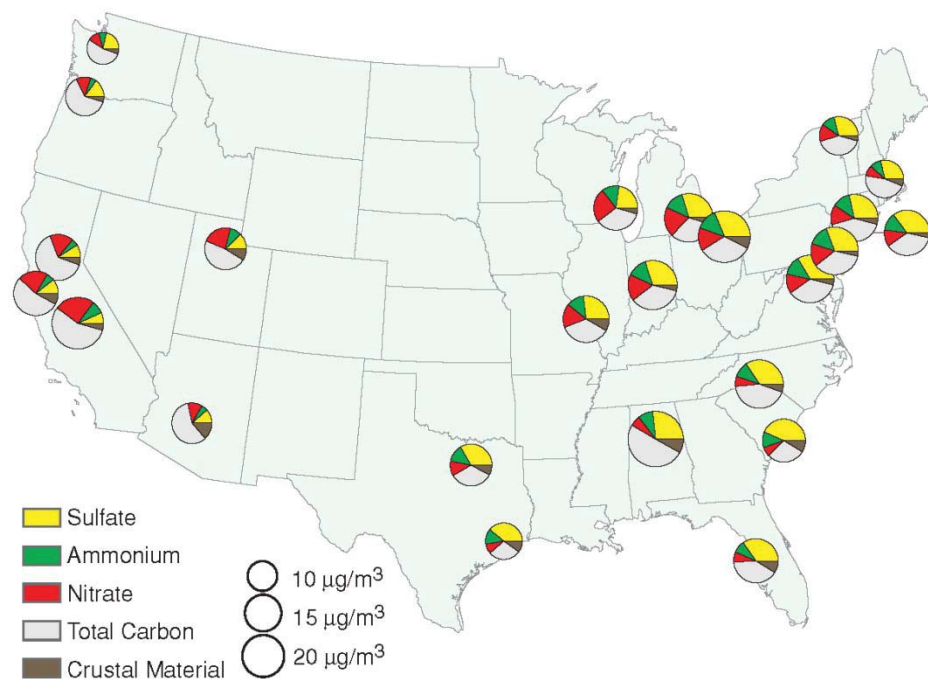
Carnegie Mellon University

Presented at EPA STAR-OTAQ Transportation Emissions Research Forum,
U.S. Environmental Protection Agency, RTP, NC, March 4-5, 2014.

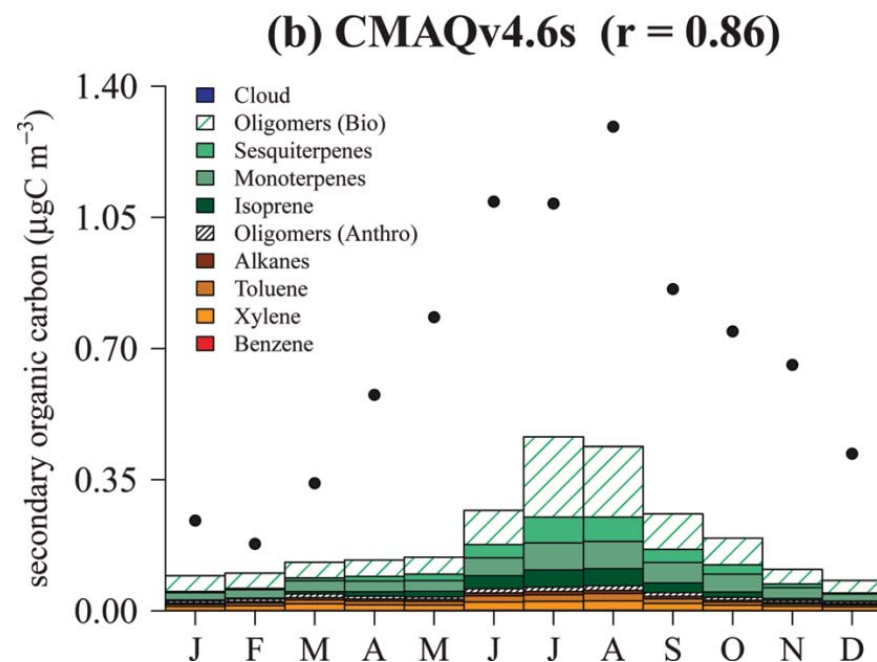
Carnegie Mellon

2

Organic aerosols are ubiquitous, but often underpredicted by CTMs



(NARSTO PM Assessment 2004)



(Carlton et al. EST 2010)

How do PM emissions evolve after leaving a source?

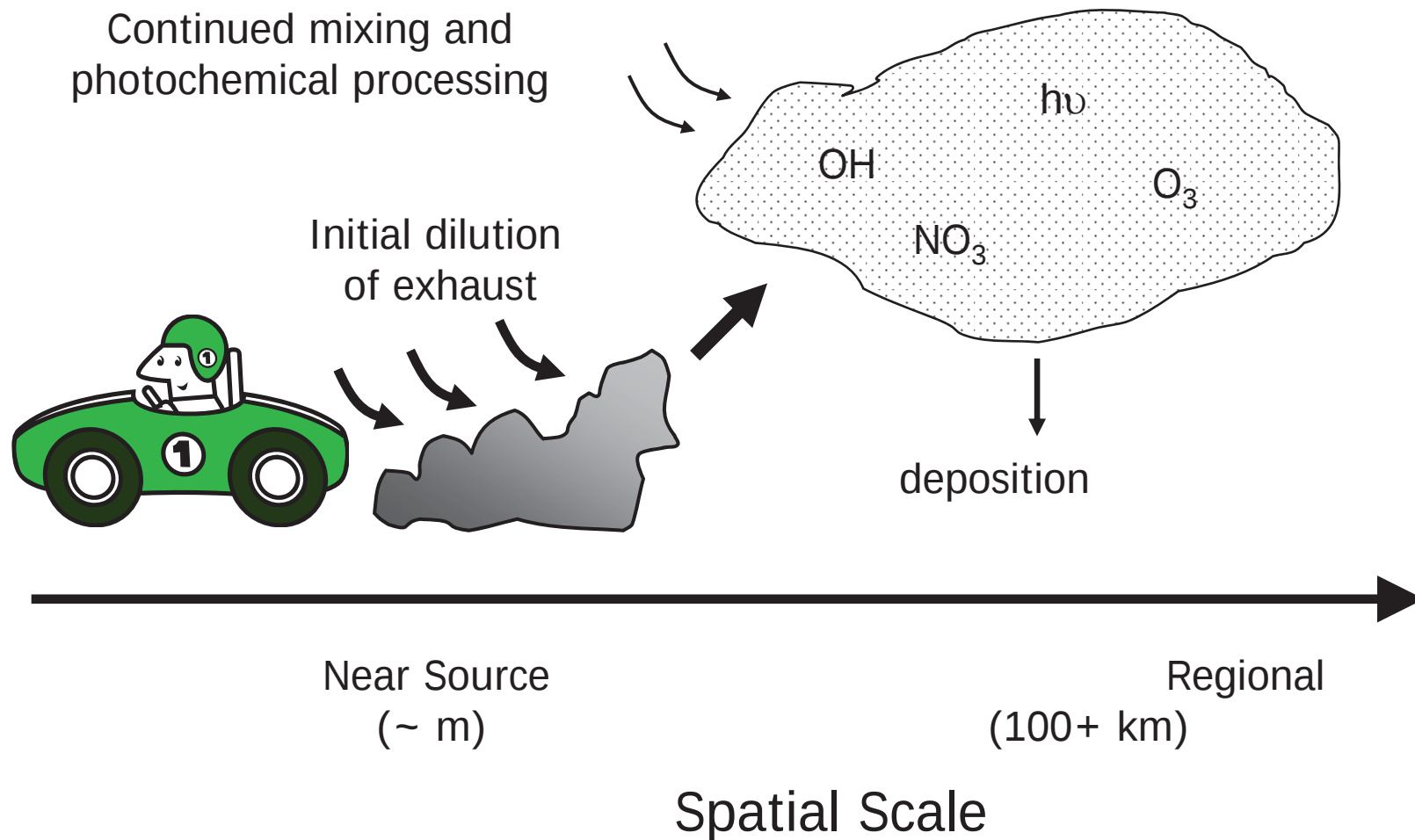
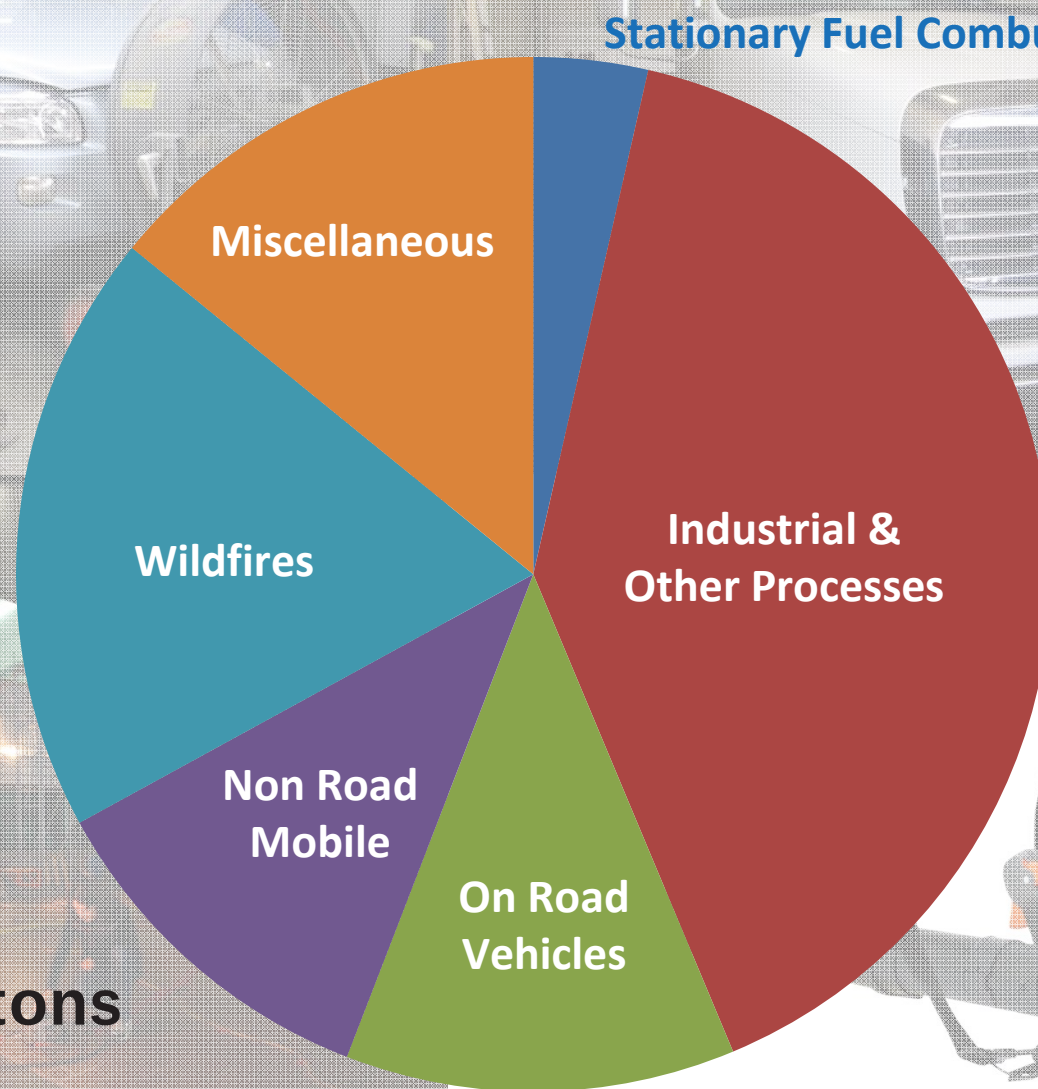




Photo: Daniel Welsh-Bon



US Anthropogenic VOC Emissions



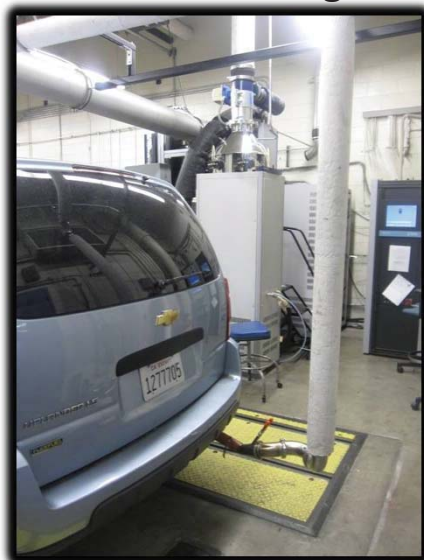
2013
17,624 short tons

<http://www.epa.gov/ttnchie1/trends/> Daniel Welsh-Bon

Experimental Set-up



Light-duty vehicles tested using cold start Unified Cycle



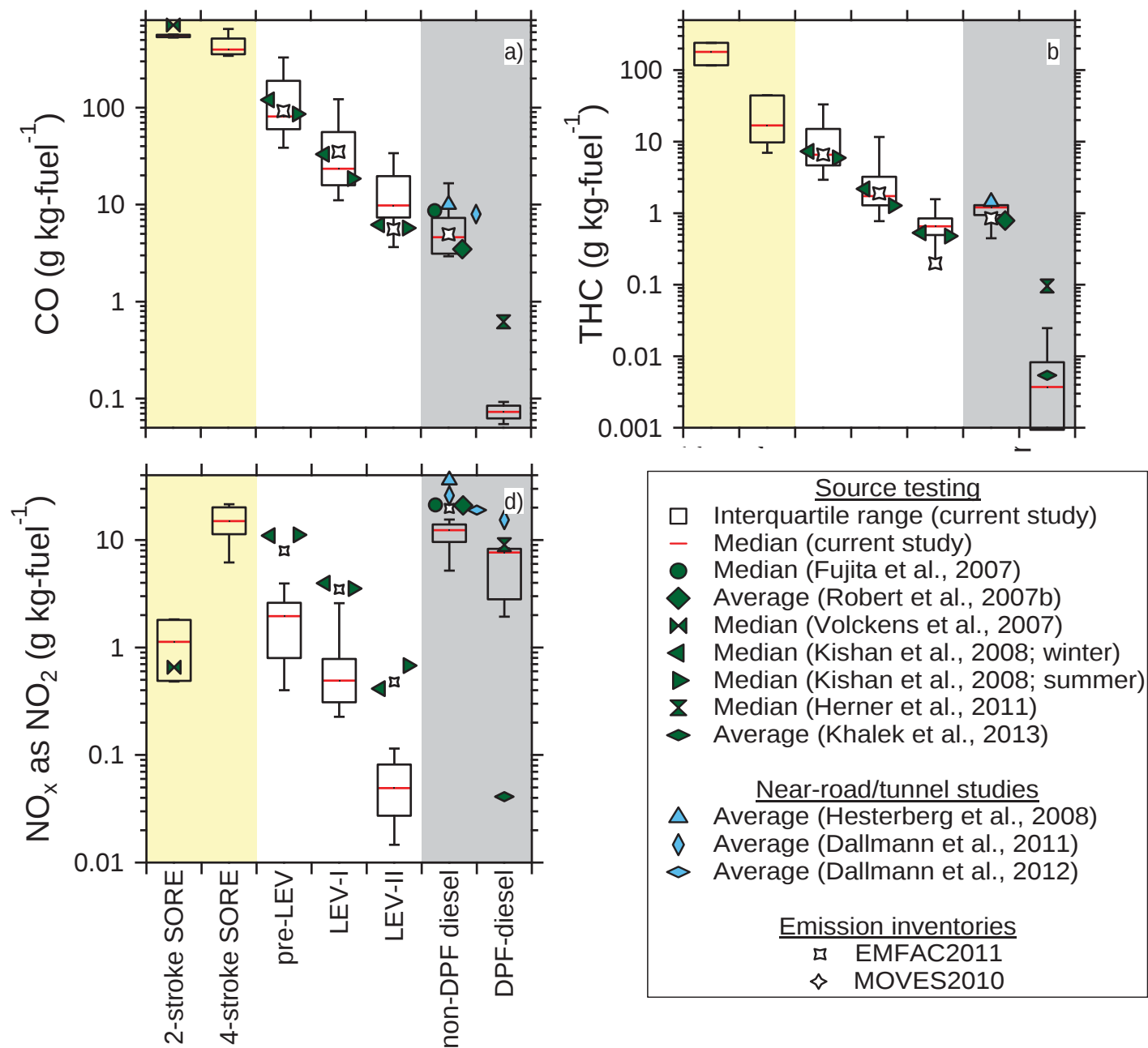
Primary emissions characterized with CVS



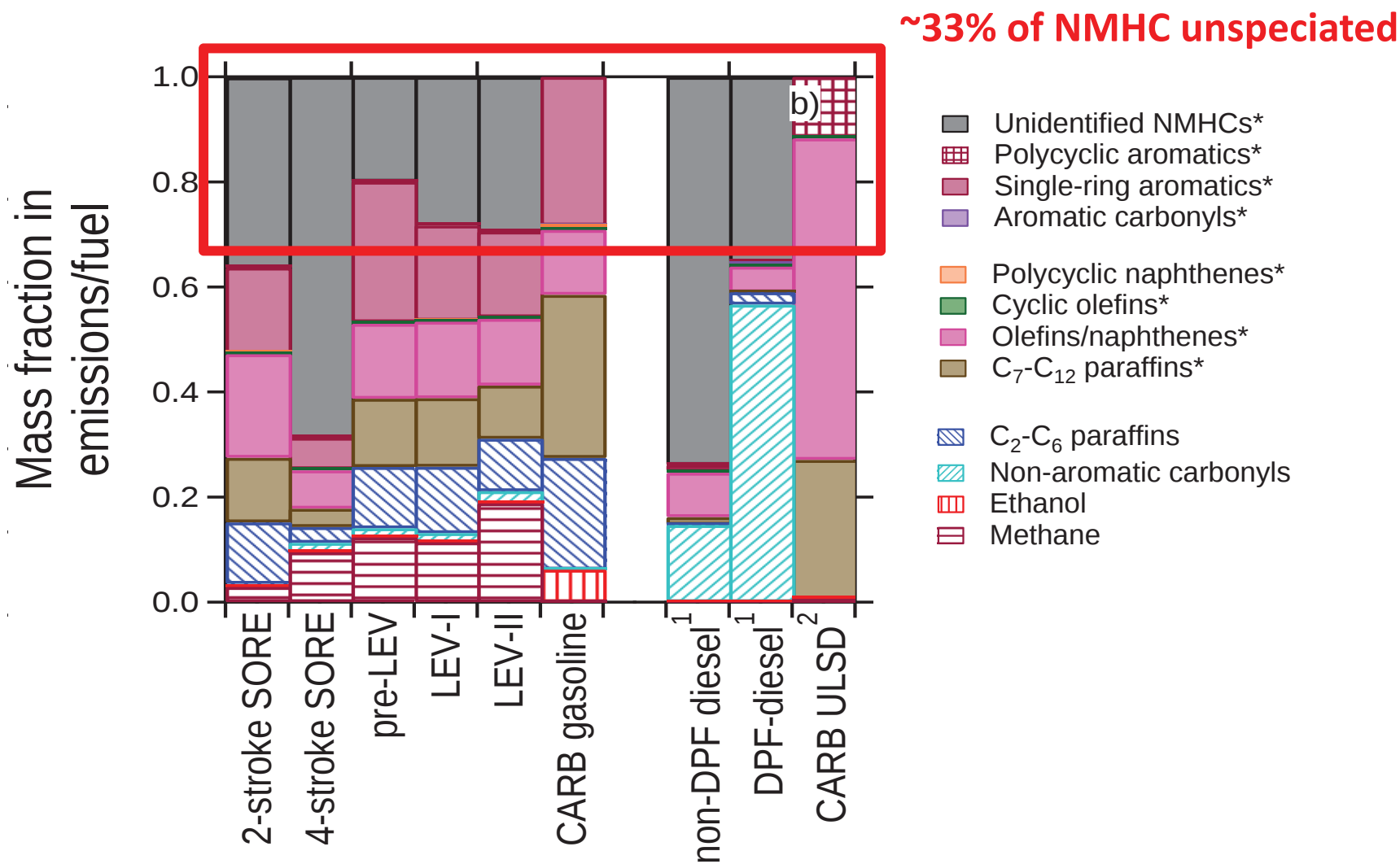
Secondary aerosol production investigated with portable smog

May et al. AE in press

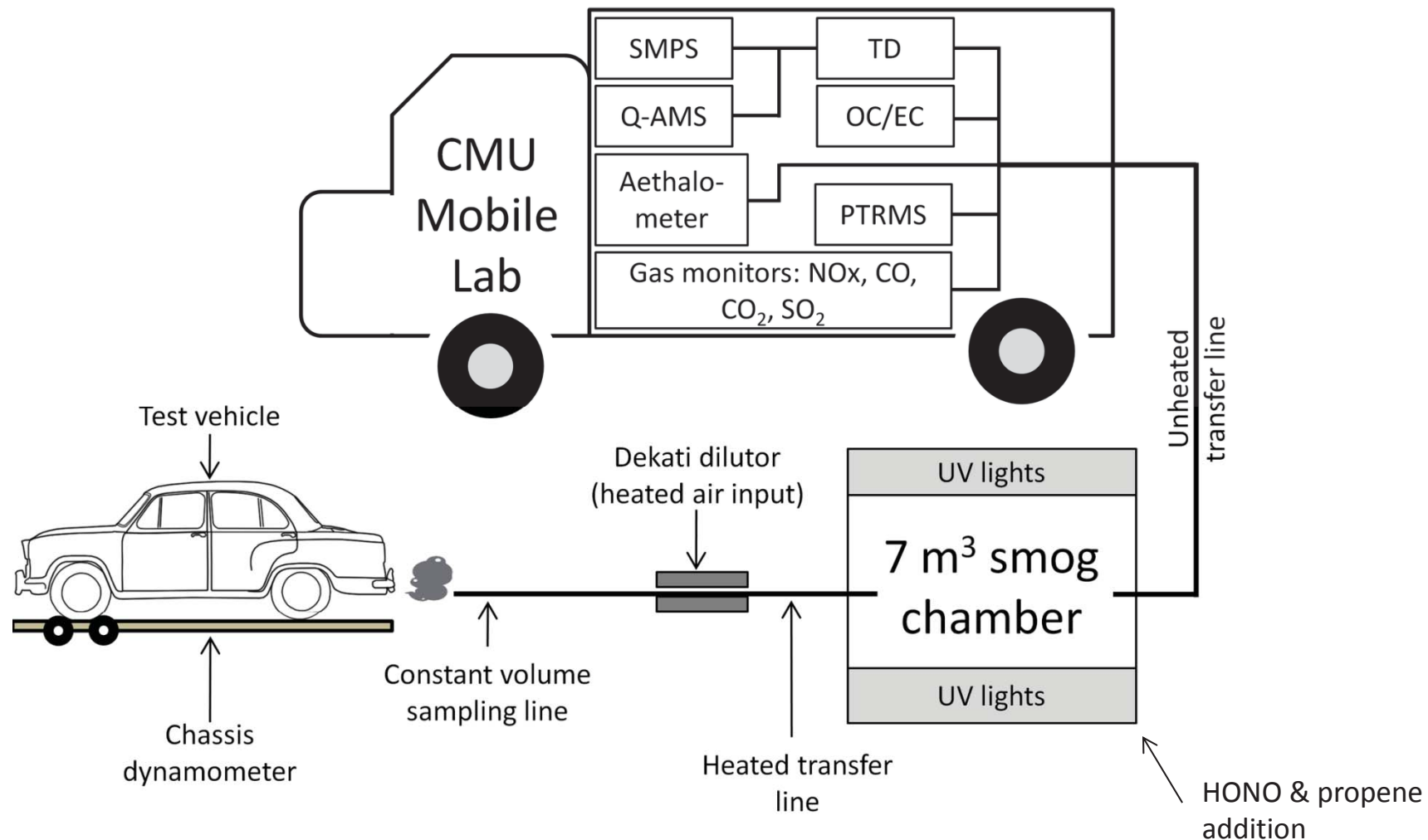
Gaseous Emissions



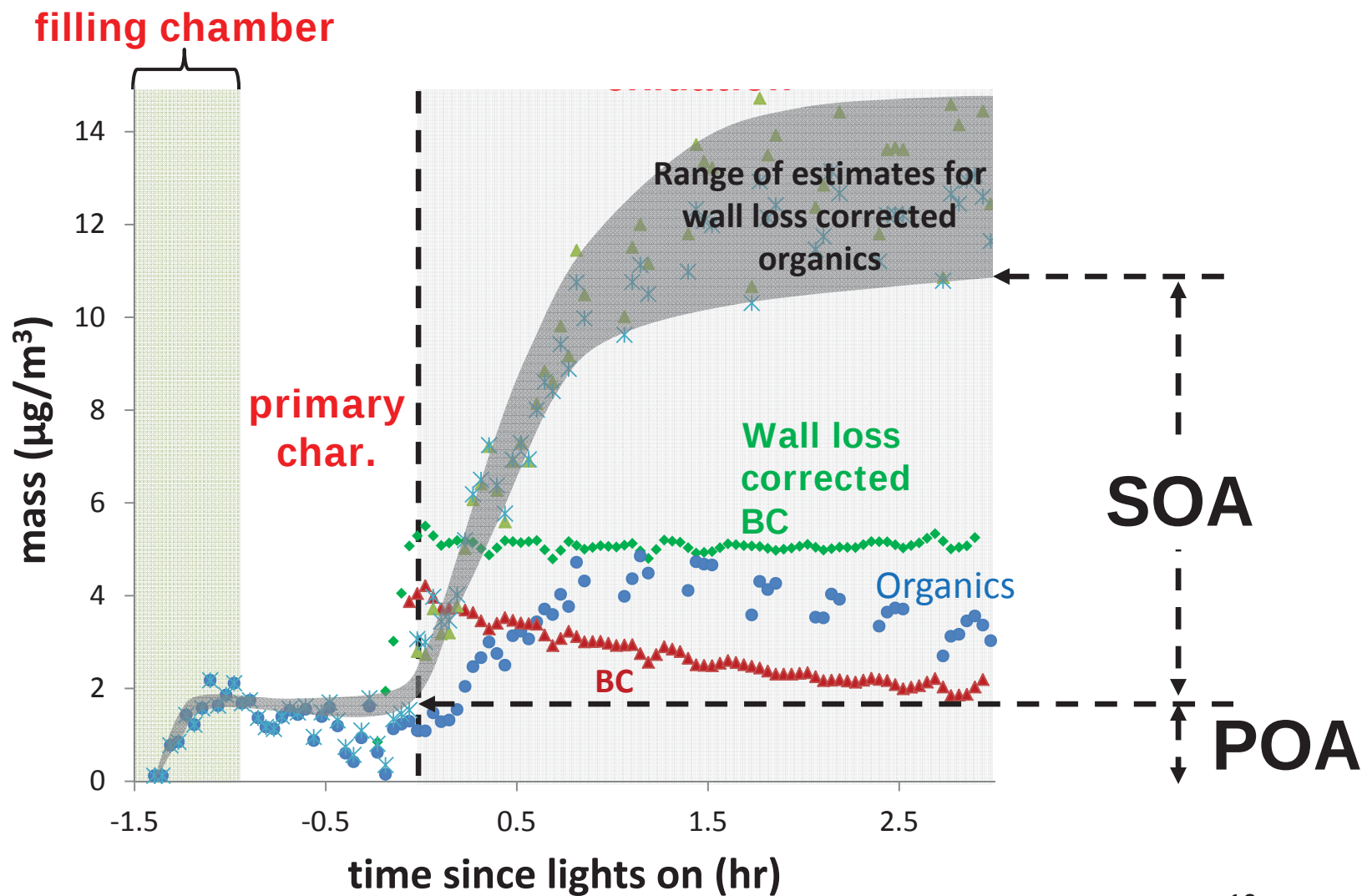
VOC speciation



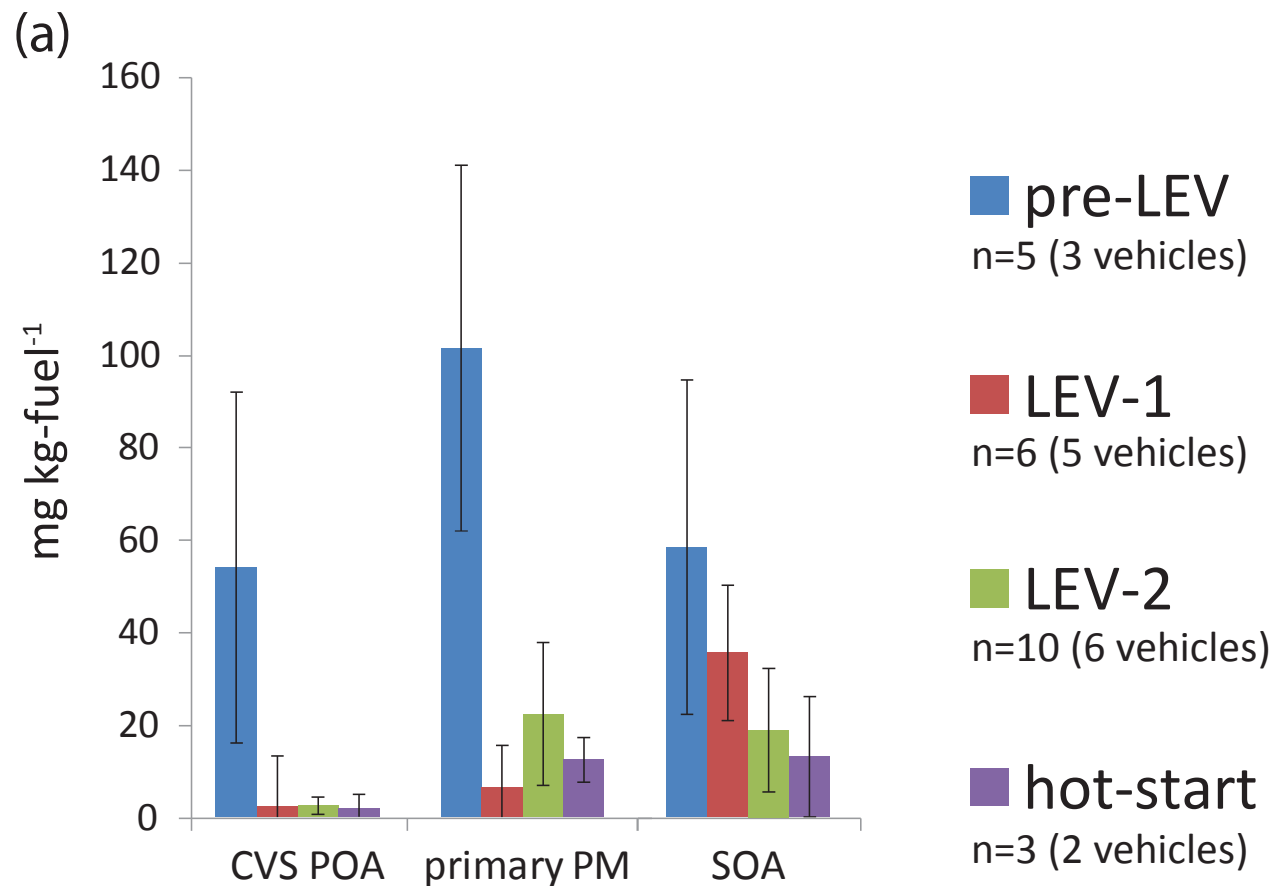
Smog chamber aging experiments



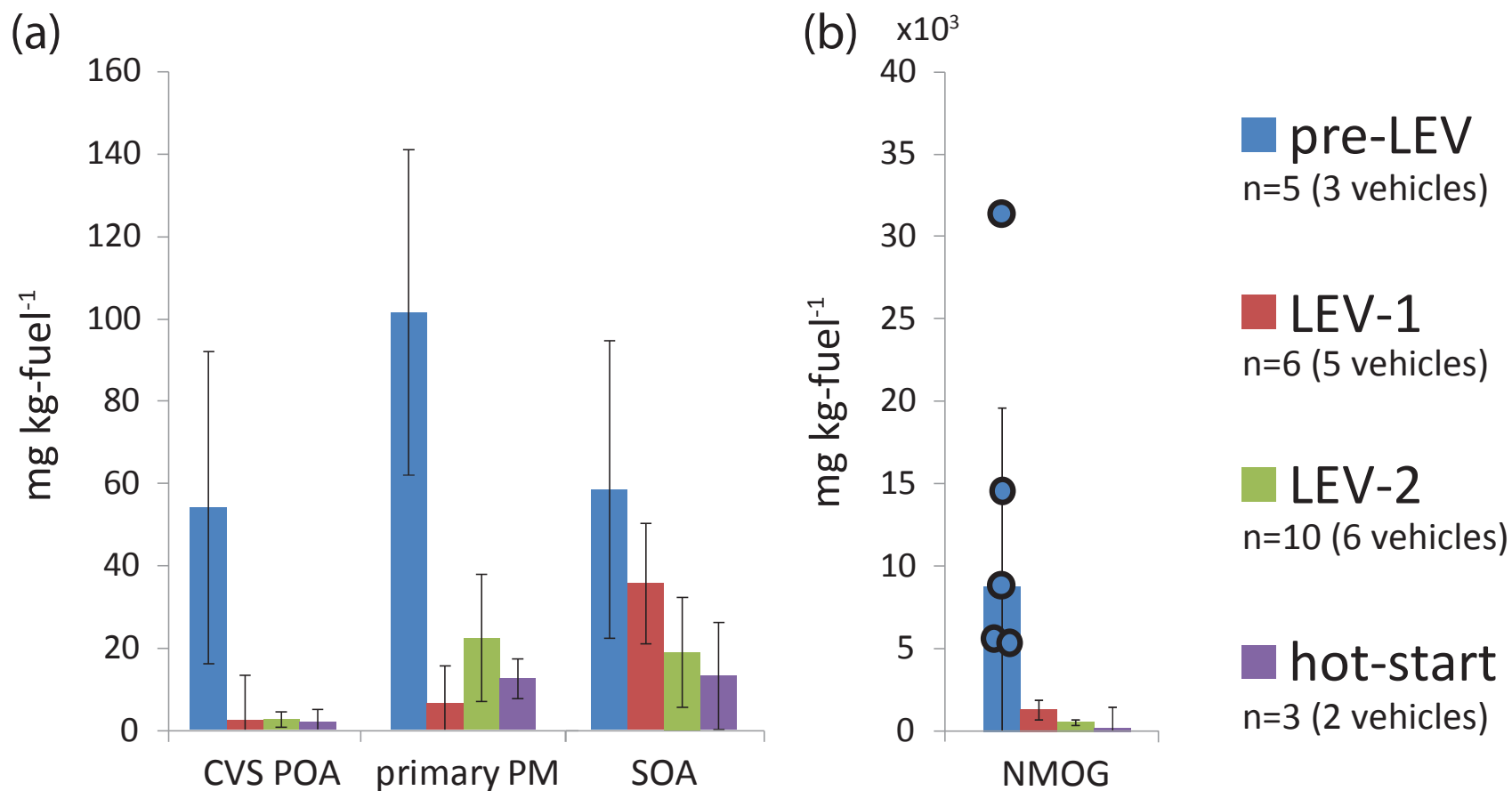
Production of Secondary Organic Aerosol



Summary of LDGV Results

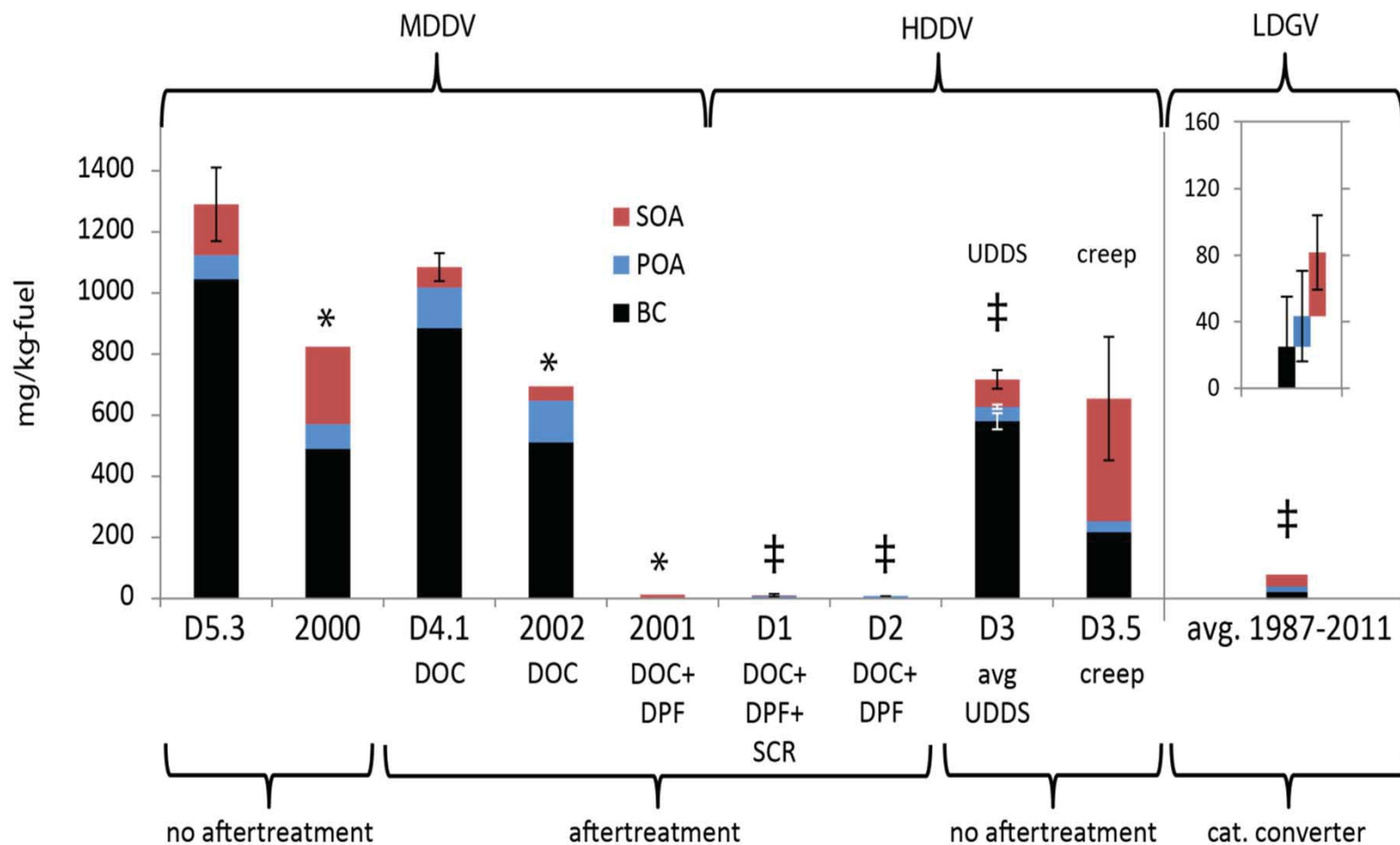


Summary of LDGV Results



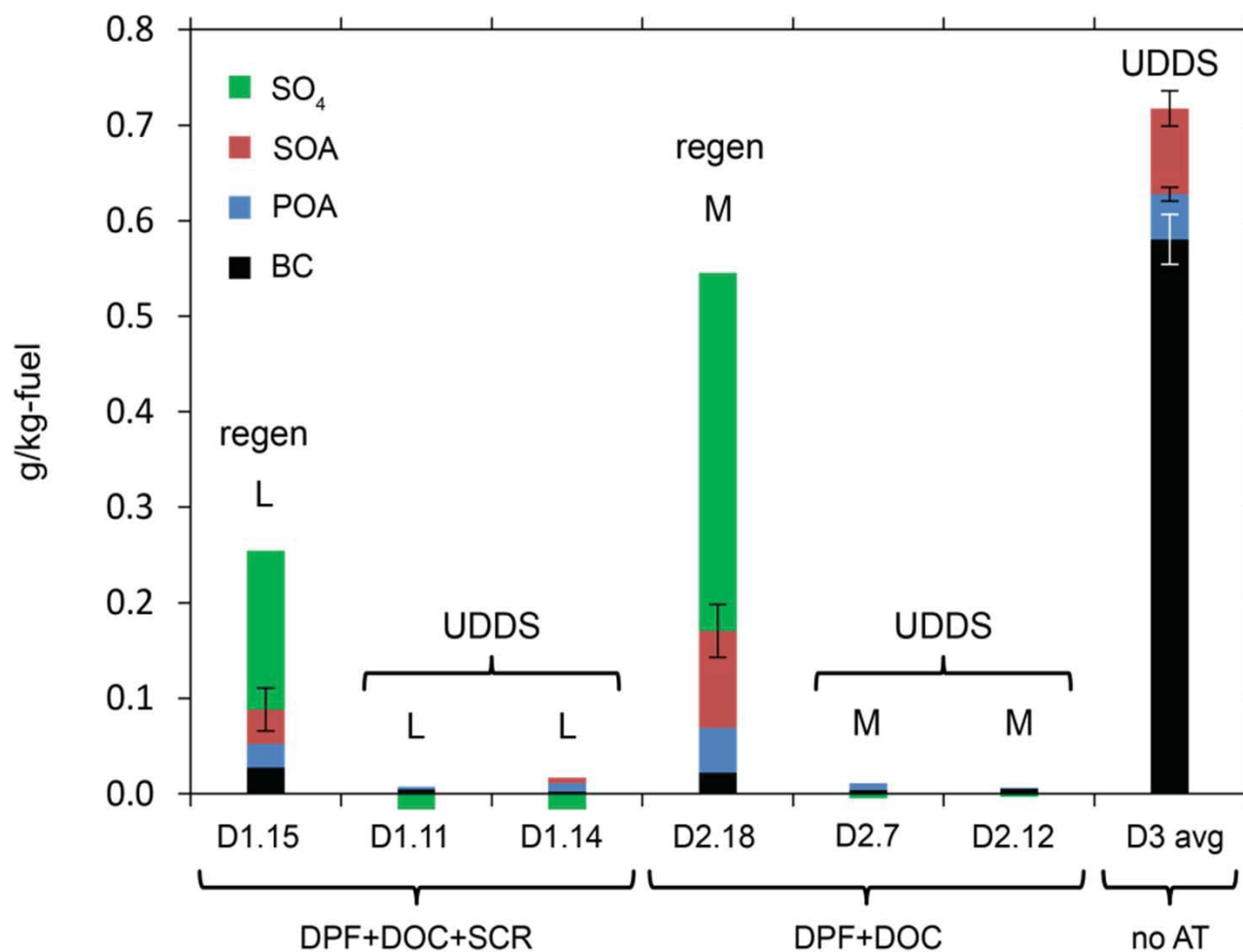
Reduction in SOA < Reduction in NMOG → LEV2 emissions more potent SOA precursors ?

Diesel SOA

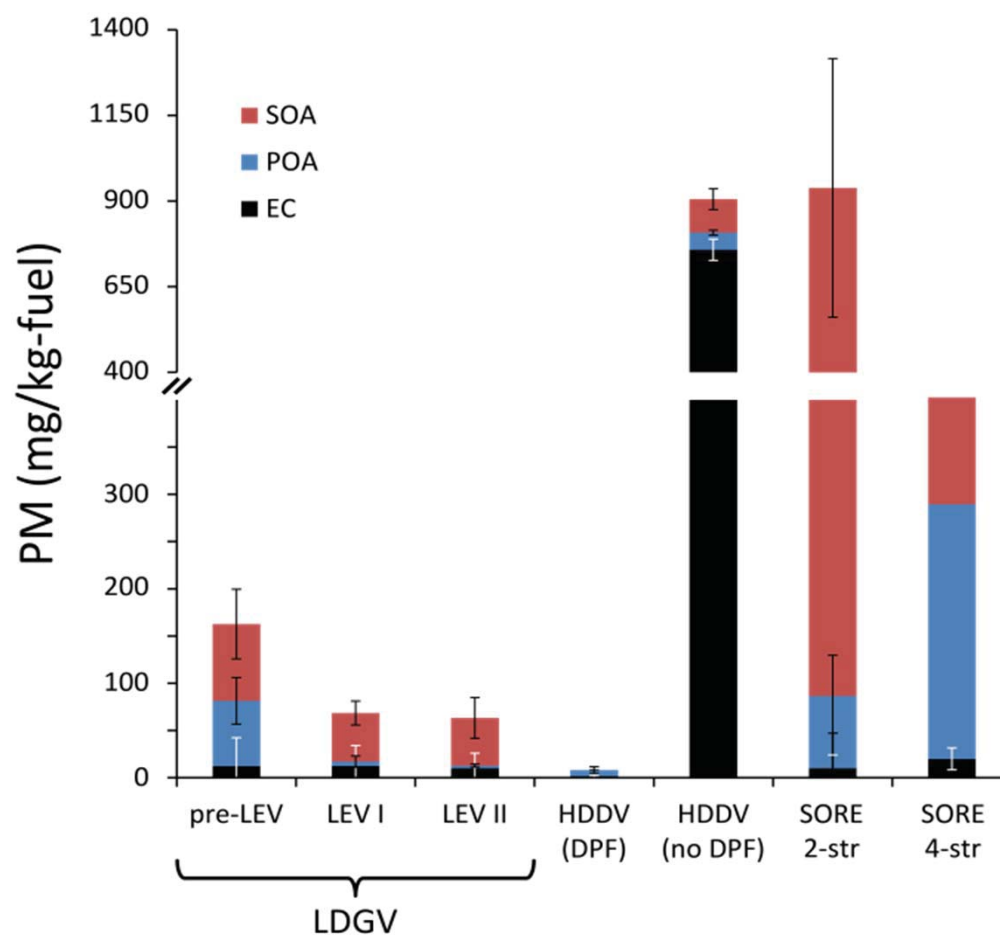


DPF – very effective. Non-DPF – primary PM (BC) very significant

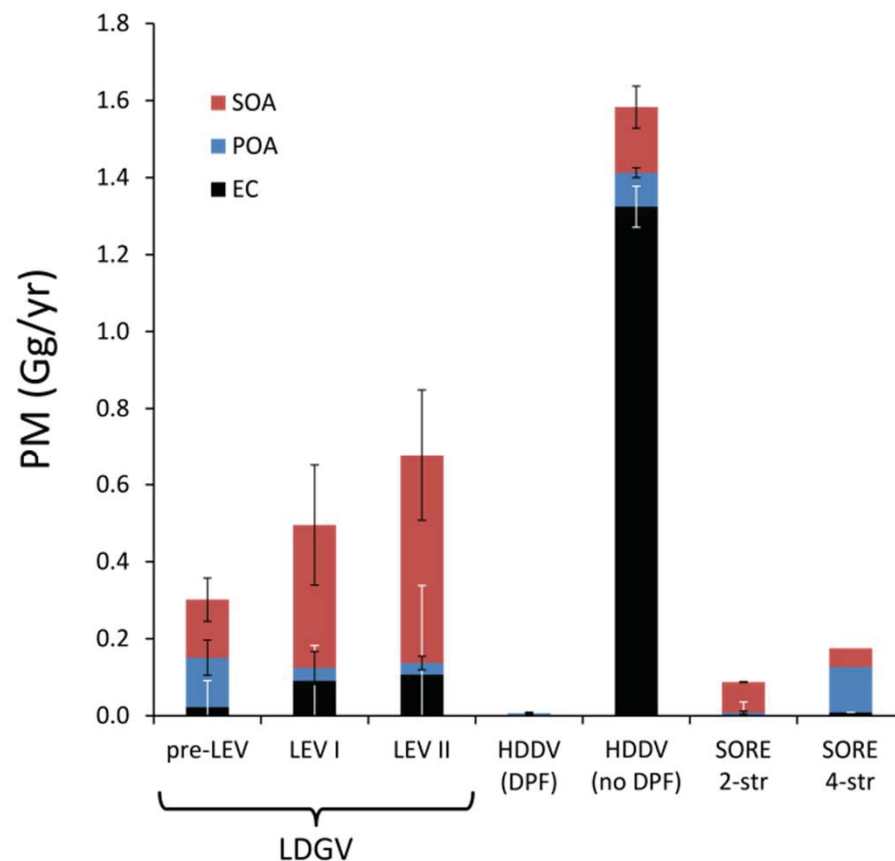
Active Forced Regeneration



Summary of Mobile Source Data



Scaling Data by SoCAB Fuel Consumption



Conclusions

- LDGV
 - Lots of SOA relative to POA or primary PM
 - LEV2 emissions appear to have more potent SOA precursor mix than emissions from older vehicles
- Diesel
 - DPF– Very clean (except for forced regeneration)
 - Non-DPF – some SOA formation but primary PM dominated
- SORE
 - Lots of SOA formation (and primary PM)
- SoCAB budget:
 - After three hours of oxidation: diesel PM (mainly BC) ~ gasoline PM (mainly SOA)
 - **What happens at longer time scales?**
- Unspeciated organics appear to be important SOA precursors
- SOA yields parameterized with volatility basis set

Papers

Primary Emissions data

- “Gas- and particle-phase primary emissions from in-use, on-road gasoline and diesel vehicles” (A.A. May et al.) Atmospheric Environment, in press.
- “Primary Gas- and Particle-Phase Emissions and Secondary Organic Aerosol Production from Gasoline and Diesel Off-Road Engines” (T.D. Gordon et al.), Environmental Science & Technology, 47 (24), pp 14137–14146, 2013.

Secondary Organic Aerosol Formation

- “Secondary Organic Aerosol Formation Exceeds Primary Particulate Matter Emissions for Light-Duty Gasoline Vehicles” (T.D. Gordon et al.), Atmospheric Chemistry and Physics, in press (discussion paper is online <http://www.atmos-chem-phys-discuss.net/13/23173/2013/acpd-13-23173-2013.html>).
- “Secondary Organic Aerosol Production from Diesel Vehicle Exhaust: Impact of Aftertreatment, Fuel Chemistry and Driving Cycle” (T.D. Gordon et al.), Atmospheric Chemistry and Physics, in press (discussion paper is online <http://www.atmos-chem-phys-discuss.net/13/24223/2013/acpd-13-24223-2013.html>).
- “Primary Gas- and Particle-Phase Emissions and Secondary Organic Aerosol Production from Gasoline and Diesel Off-Road Engines” (T.D. Gordon et al.), Environmental Science & Technology, 47 (24), pp 14137–14146, 2013.
- “Primary to secondary organic aerosol: evolution of organic emissions from mobile combustion sources” (A. A. Presto et al.) Atmospheric Chemistry and Physics, submitted (discussion paper is online <http://www.atmos-chem-phys-discuss.net/13/24263/2013/acpd-13-24263-2013.html>).

Gas-particle partitioning of primary organic aerosol

- “Gas-particle partitioning of primary organic aerosol emissions: (2) diesel vehicles” (A. A. May et al.) Environmental Science & Technology, 47 (15), 8288–8296, 2013.
- “Gas-particle partitioning of primary organic aerosol emissions: (1) gasoline vehicle exhaust” (A. A. May et al.) Atmospheric Environment, 77, 128-139, 2013.
- “Gas-particle partitioning of primary organic aerosol emissions 3. Biomass burning” (A.A. May et al.) Journal of Geophysical Research, 118(19), 2013JD020286, 2013.

Acknowledgments

- **CMU:** Albert Presto, Tim Gordon, Ngoc Nguyen, Chris Hennigan, Andy May, Mrunmayi Karve, Shantanu Jathar, Yunliang Zhao, Eric Lipsky, Neil Donahue, Peter Adams
- **ARB:** Alvaro Gutierrez, William H. Robertson, Mang Zhang, Oliver Chang, Shiyang Chen, Pablo Cicero-Fernandez, Mark Fuentes, Shiou-Mei Huang, Richard Ling, Jeff Long, Christine Maddox, John Massetti, Eileen McCauley, Kwangsam Na, Yanbo Pang, Paul Rieger, Todd Sax, Tin Truong, Thu Vo, Christopher Brandow, Lyman Dinkins, Richard Ong Antonio Miguel, Sulekha Chattopadhyay, Hector Maldonado, Bob Torres, Eileen McCauley
- **Ford:** Matti Maricq
- **Financial Support:**
 - EPA STAR – CMU primary emissions measurements
 - ARB – Vehicle procurement, testing, and emissions characterization
 - CRC A74/E96 – CMU smog chamber experiments
 - NSF – graduate student fellowships
- This presentation reflects the views of the authors and not any of the funding agencies. No official endorsement should be inferred.