United States
Environmental Protection
Agency

Clearing the Air:

An Overview of U.S. Mobile Source Emissions Research

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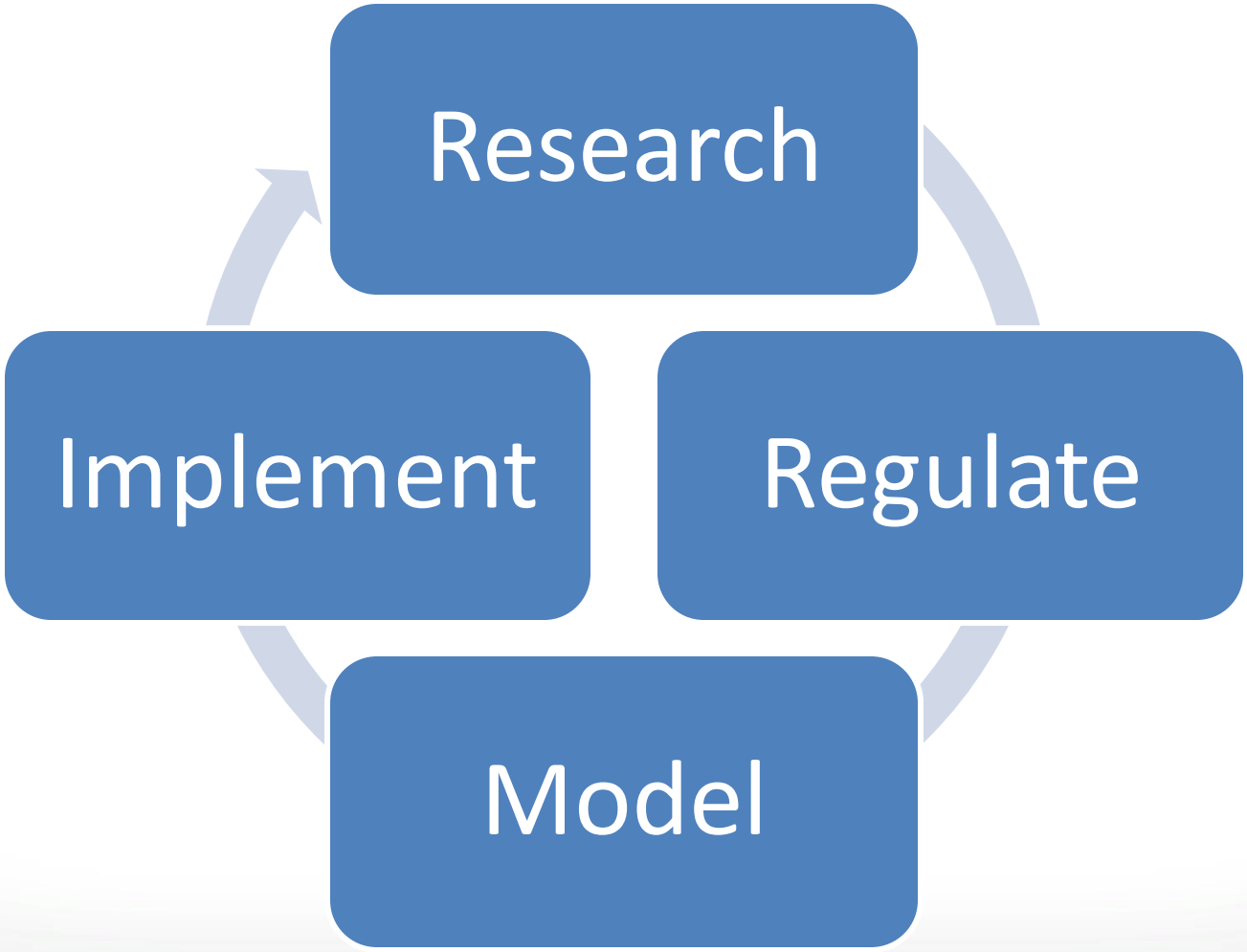
Part of the whole



How well does this work?

- **Clean Air Act 1970 to 2012**

Vehicle Miles Travelled	Human Population	Energy Consumption	Emissions of Criteria Pollutants
↑ +165%	↑ +53%	↑ +47%	↓ -72%

1. **Particulate Matter (PM)**
2. **Carbon Monoxide (CO)**
3. **Ozone**
4. **Lead**
5. **Nitrogen Dioxide (NO_2)**
6. **Sulfur Dioxide (SO_2)**

Regulations 1970-2010

- Light-Duty Vehicles
  - Clean Fuel Fleet -- exhaust emission standards
  - Clean Fuel Fleet flexible fuel and dual fuel vehicles non-methane organic gas standards
  - Tier 0, Tier 1, and Clean Fuel Vehicle (CFV) exhaust emission standards (light-duty trucks only)
  - Tier 0, Tier 1, and National Low Emission Vehicle (NLEV) implementation schedule
  - Tier 0, Tier 1, NLEV, and CFV exhaust emission standards
  - Tier 1 and NLEV Supplemental Federal Test Procedure (SFTP) exhaust emission standards
  - Tier 1 and NLEV evaporative emission standards and implementation schedule
  - Tier 2 and interim non-Tier 2 SFTP exhaust emission standards
  - Tier 2 evaporative emission standards
  - Tier 2 exhaust emission standards and implementation schedule
- Motorcycles
  - Highway motorcycles -- exhaust emission standards

Regulations since 2010

- Heavy-Duty Highway Engines and Vehicles
  - Clean Fuel Fleet -- exhaust emission standards
  - Compression-ignition (CI) engines and urban buses -- exhaust emission standards
  - Spark-ignition (SI) engines -- exhaust emission standards
  - CI and SI engines -- evaporative emission standards

Regulations since 2010

- 2012 Light-Duty Greenhouse Gas & Fuel Economy Standards: MY 2017-2025
  - Decrease in light-duty energy consumption rates starting MY 2017
- Tier 3 Motor Vehicle & Fuel Standards Program: MY 2017-2025
  - Decrease in light-duty and medium-duty emission rates starting MY 2017 and 2018 respectively
  - Gasoline fuel sulfur level of 10 ppm on average starting CY2017
  - Incorporated new fuel effects model in MOVES2014
  - Significant reductions in evaporative hydrocarbon emissions from lower diurnal and hot soak emissions, and reduce prevalence of vapor and liquid leaks
- Heavy-Duty Greenhouse Gas & Fuel Economy Standards: MY 2014-2018
  - Decrease in heavy-duty energy consumption rates starting MY2014+
  - Decrease in criteria pollutant emissions as a result of mass reduction and lower aerodynamic drag and rolling resistance
  - Increase use of auxiliary power units

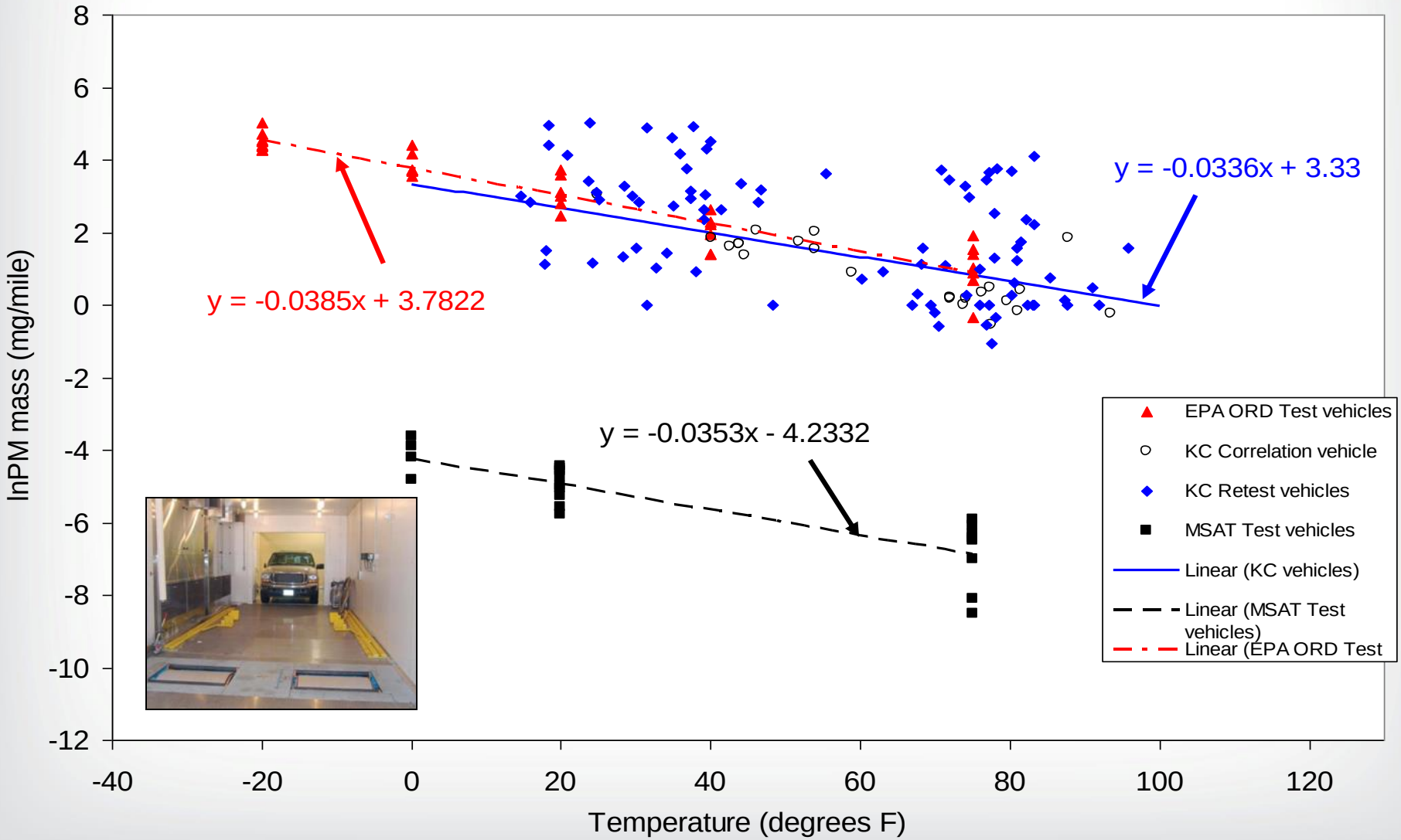
Emission Test Programs & Data

- Fuel Effects Programs
  - HD diesel chassis testing (CRC E-55/59)
  - EPAct study on gasoline fuel effects
  - EPA In-Use Sulfur Test Program
  - E85 emission effects
  - Updated MOVES renewable fuel usage and future fuel supply based on AEO2014 early release and RFS

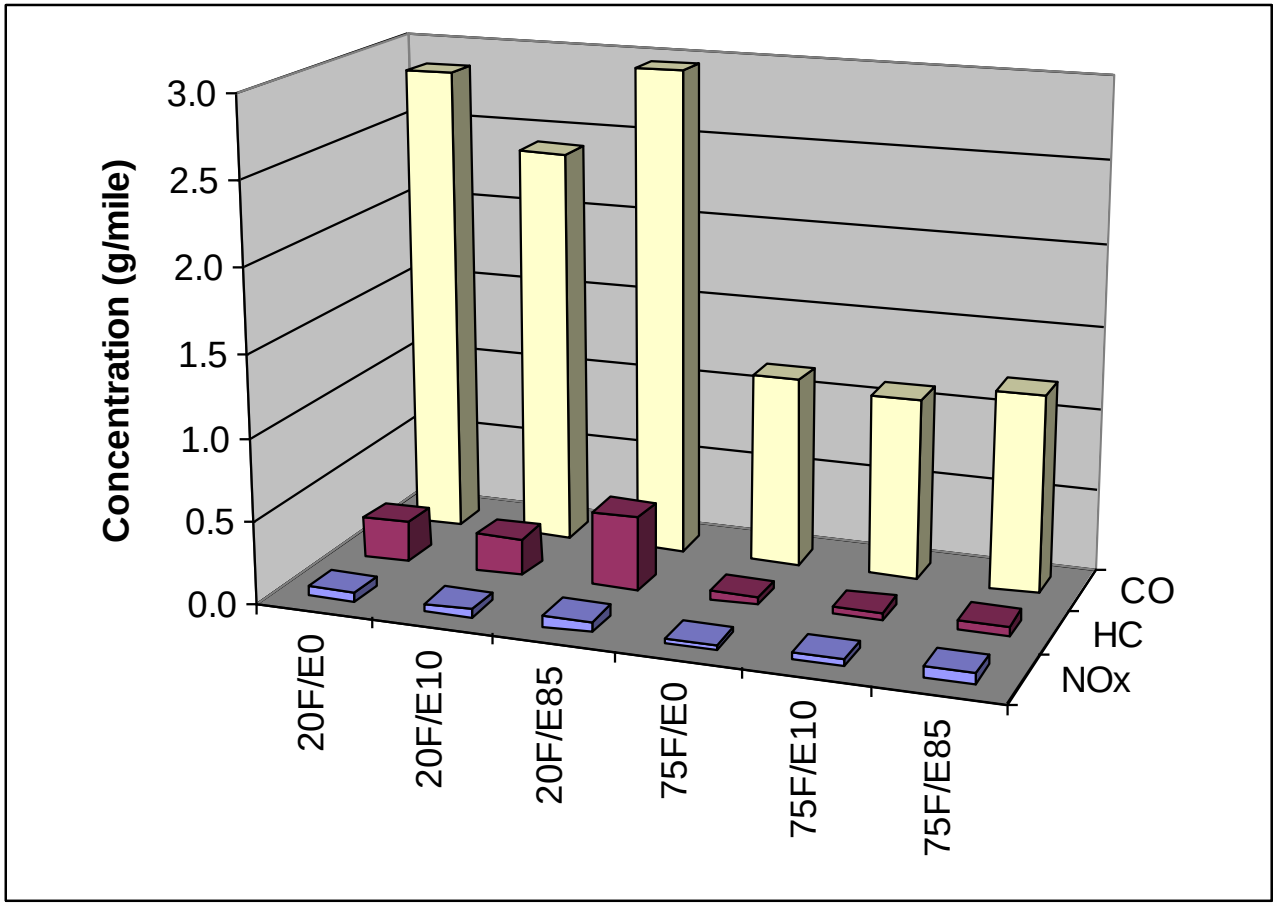
Emission Test Programs & Data

- Speciation and Temperature Effects Programs
  - Kansas City Light-duty Gasoline Study (CRC E-69)
  - EPA Cold Temperature Study
  - EPAct
    - fuel effects for major air toxics
    - EPAct speciation profiles
  - Advanced Collaborative Emissions Study
  - Diesel Unregulated Emission Characterization (CRC E-75)
  - CNG chassis tests (CARB studies)
  - MHDDT Biodiesel Speciated Fuel Effects (2014)
  - Light-duty Truck Towing Study (2015)

Ambient Temperature Effects

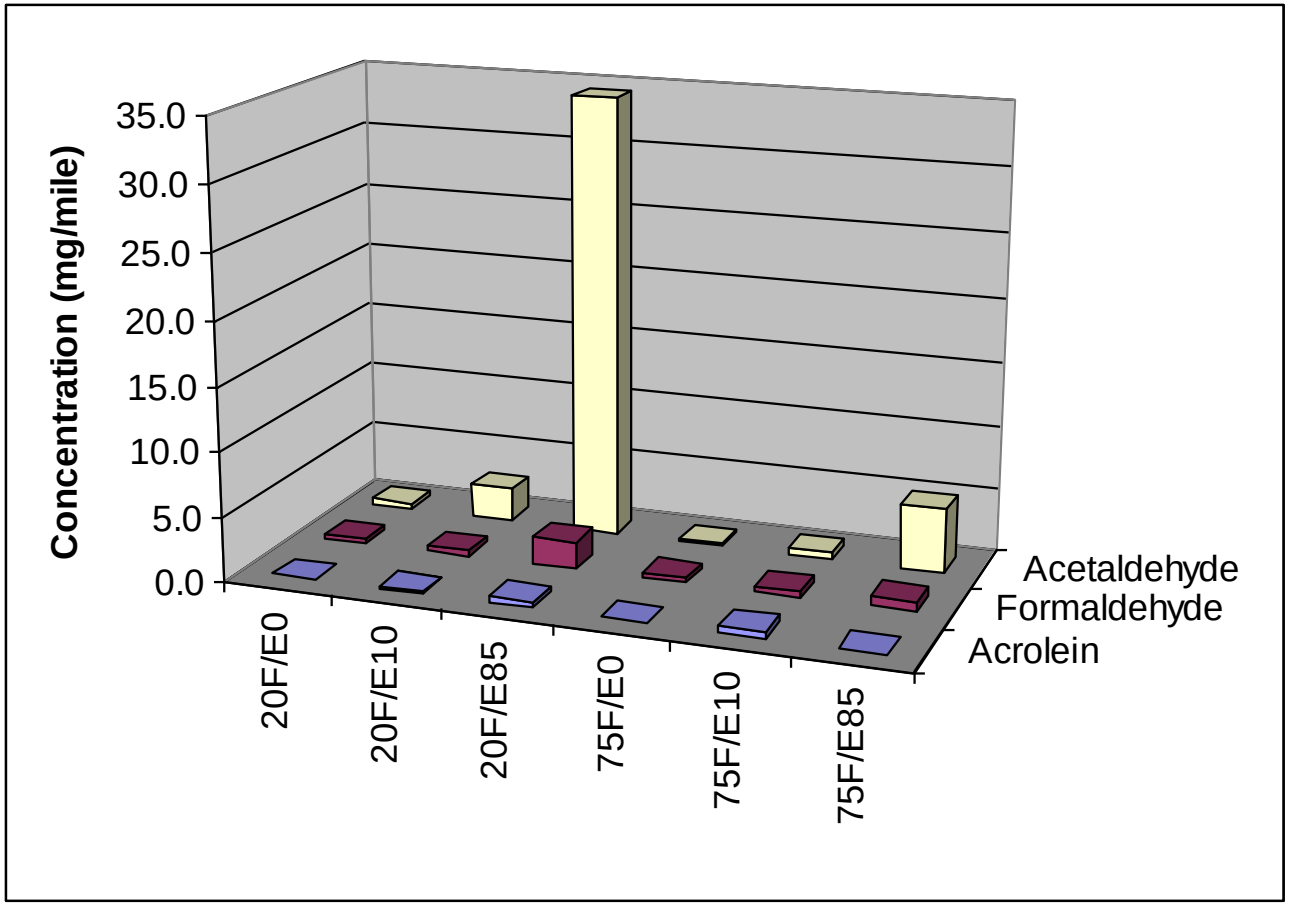


Fuel Effects (EPAct)



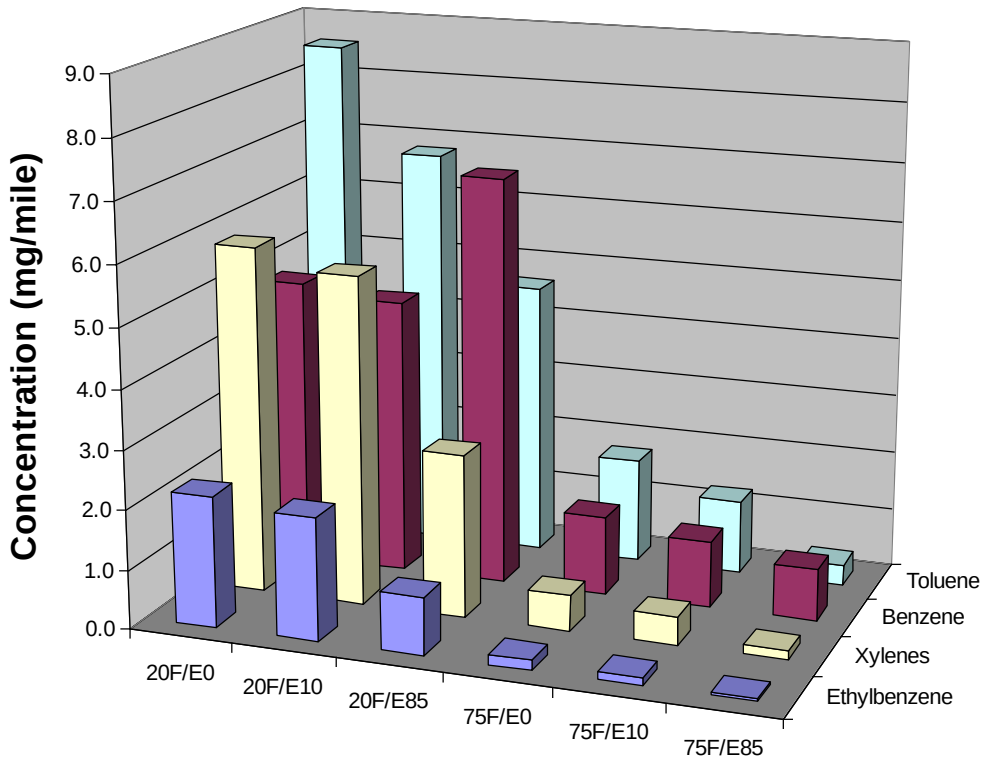
Criteria pollutant emission rates

Fuel Effects (EPAct)



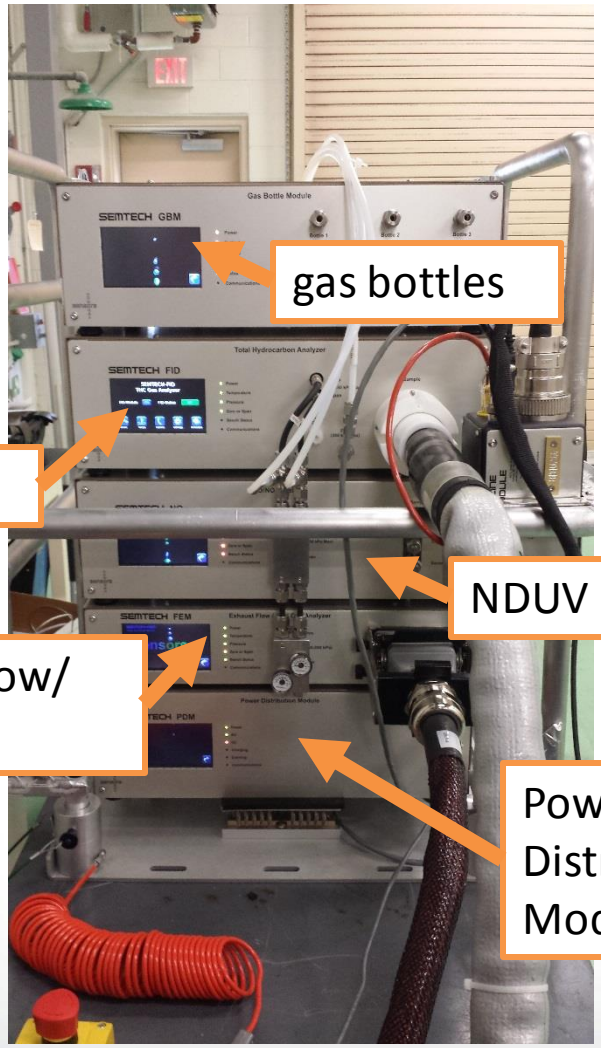
Aldehyde emission rates

Fuel Effects (EPAct)

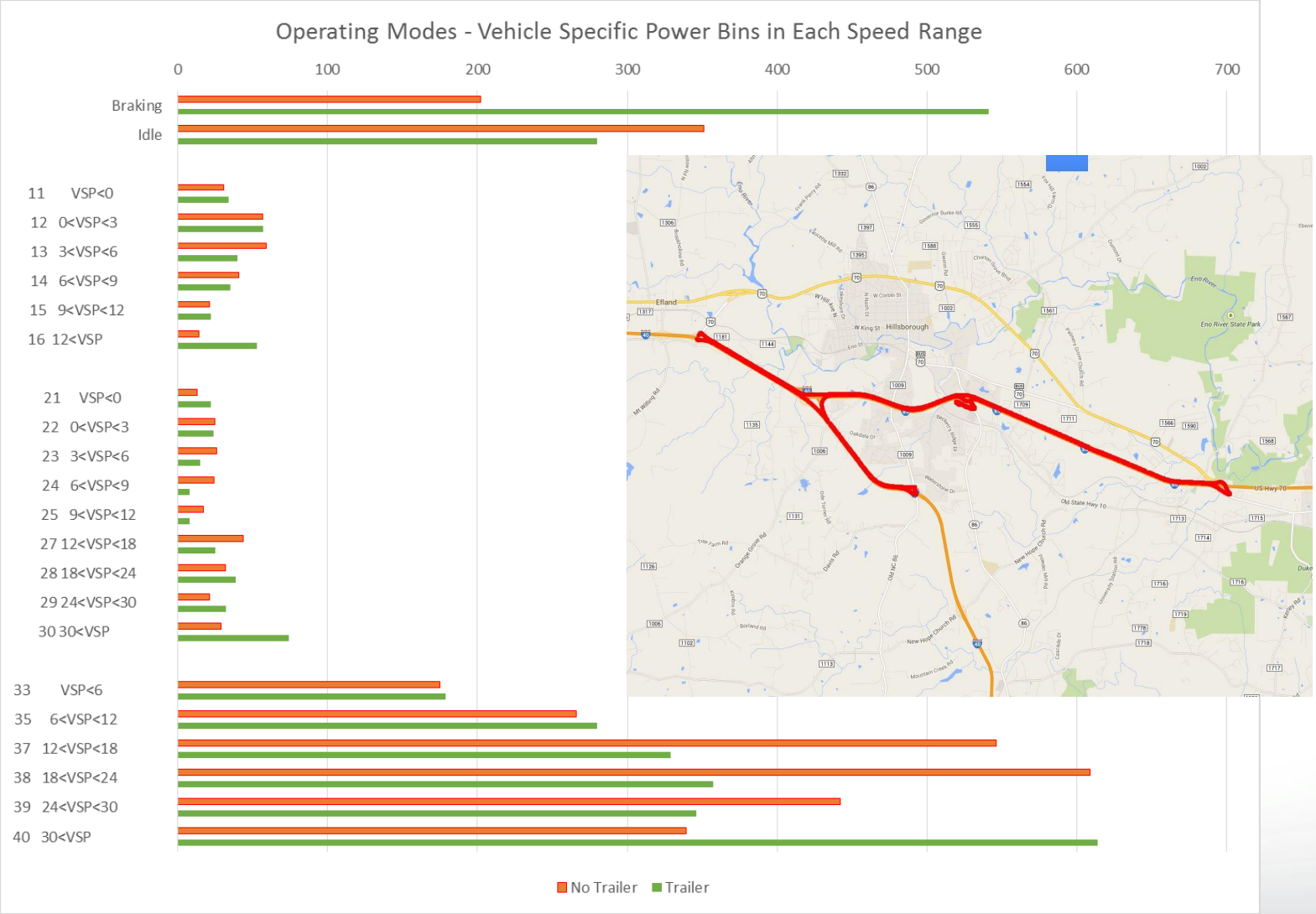


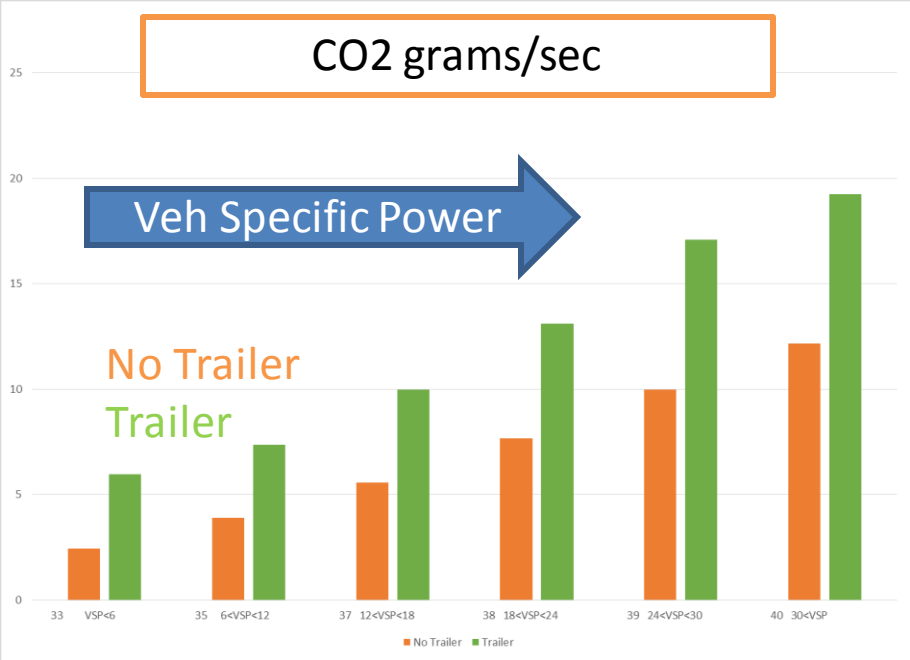
BTEX emission rates

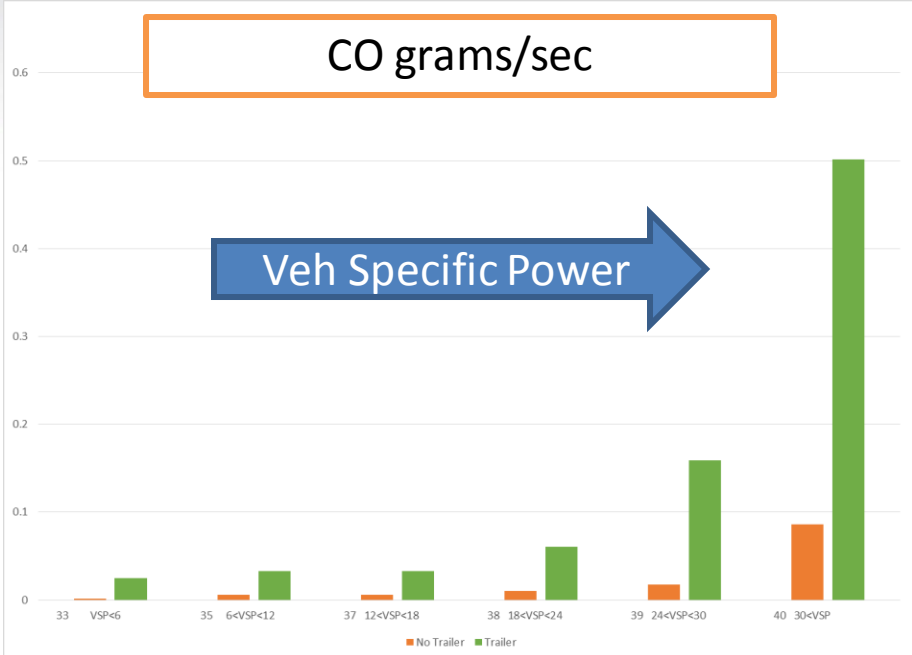
Grade and Load Effects

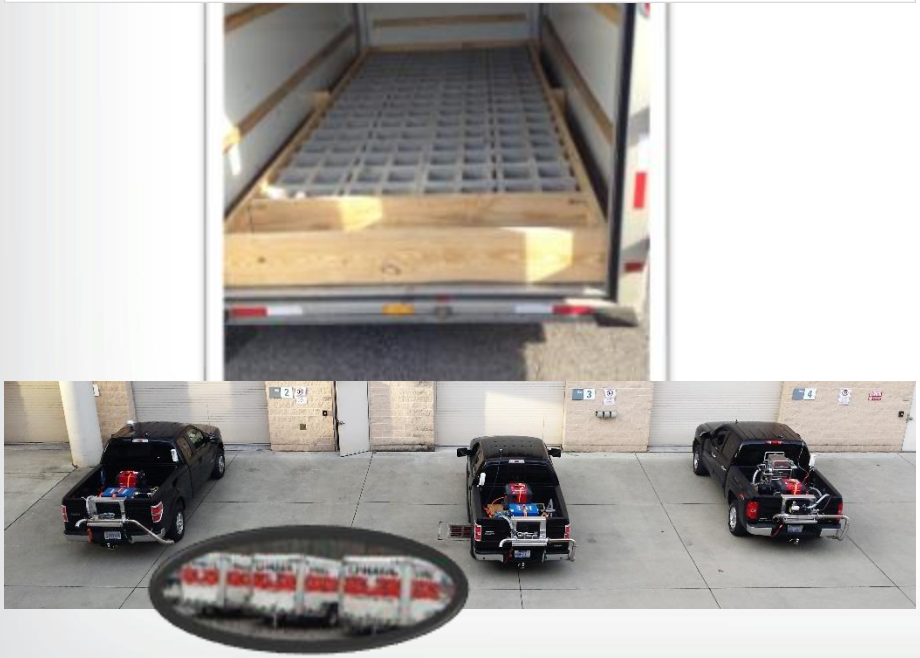


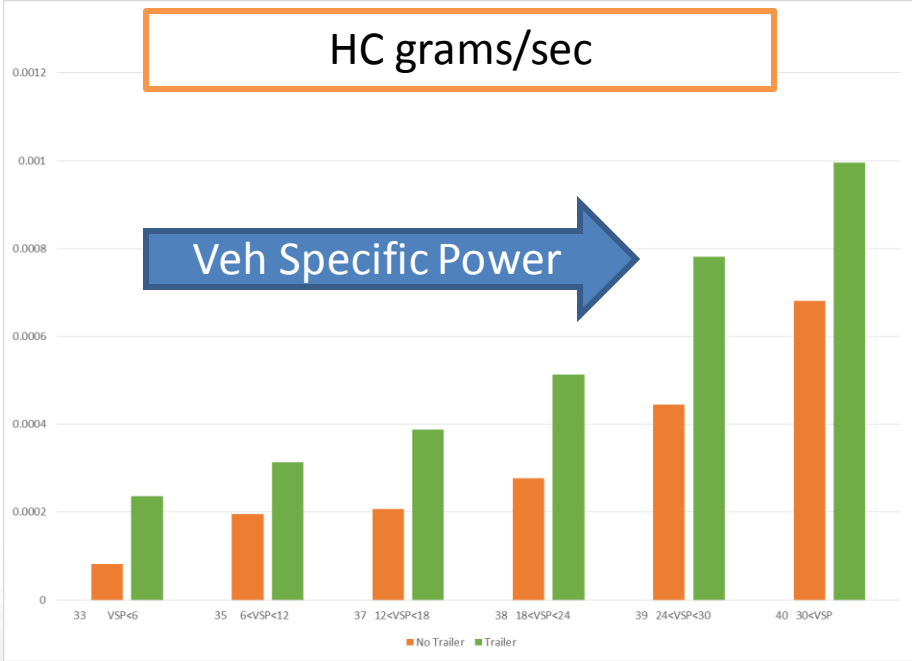
Grade and Load Effects




CO2 grams/sec
Veh Specific Power
No Trailer
Trailer
25
20
15
10
5
0
33 VSP<6
35 6<VSP<12
37 12<VSP<18
38 18<VSP<24
39 24<VSP<30
40 30<VSP
No Trailer
Trailer

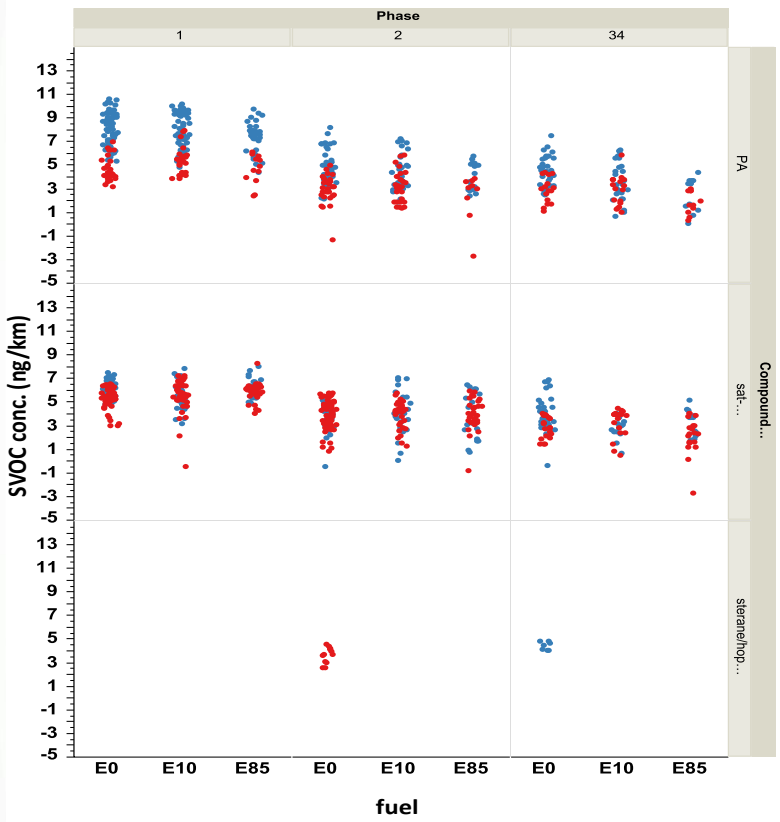

CO grams/sec
Veh Specific Power
0.6
0.5
0.4
0.3
0.2
0.1
0
33 VSP<6
35 6<VSP<12
37 12<VSP<18
38 18<VSP<24
39 24<VSP<30
40 30<VSP
No Trailer
Trailer

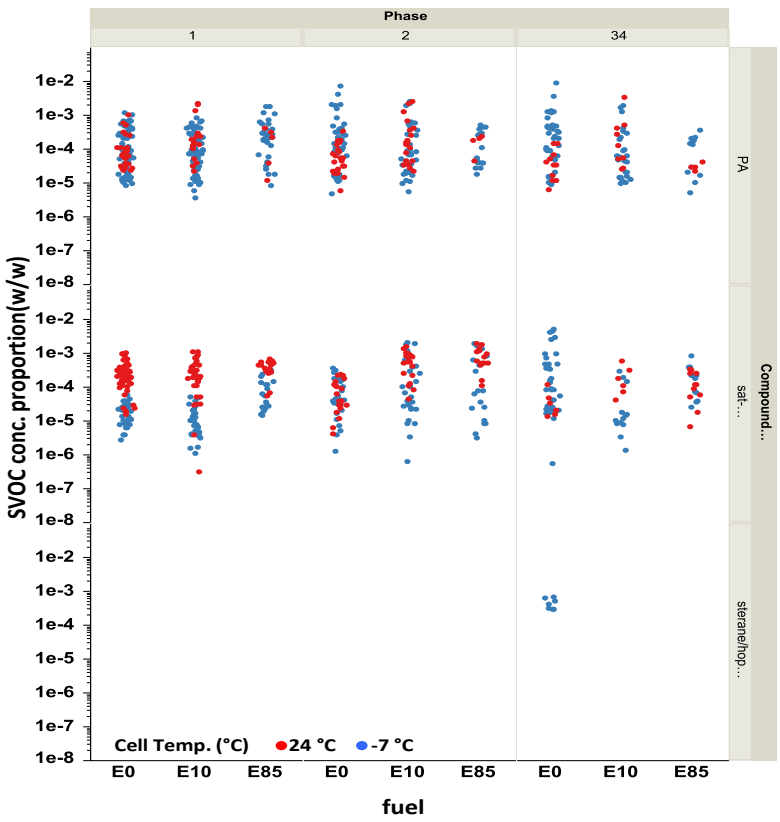



HC grams/sec
Veh Specific Power
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
33 VSP<6
35 6<VSP<12
37 12<VSP<18
38 18<VSP<24
39 24<VSP<30
40 30<VSP
No Trailer
Trailer

PM: Fuel, Temperature, Driving Effects

Hays et al, E(2013)





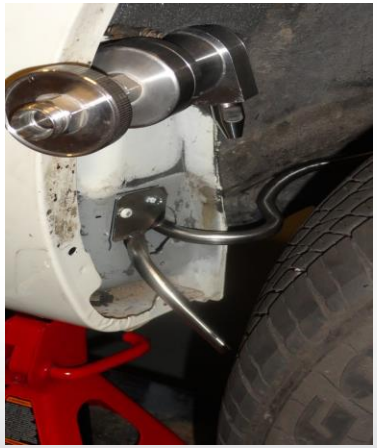
Advanced analytical techniques provide speciated PM emissions by operating conditions. Cold temperatures/cold start and high acceleration increased PAH emissions more than saturated-HCs

Beyond the tailpipe

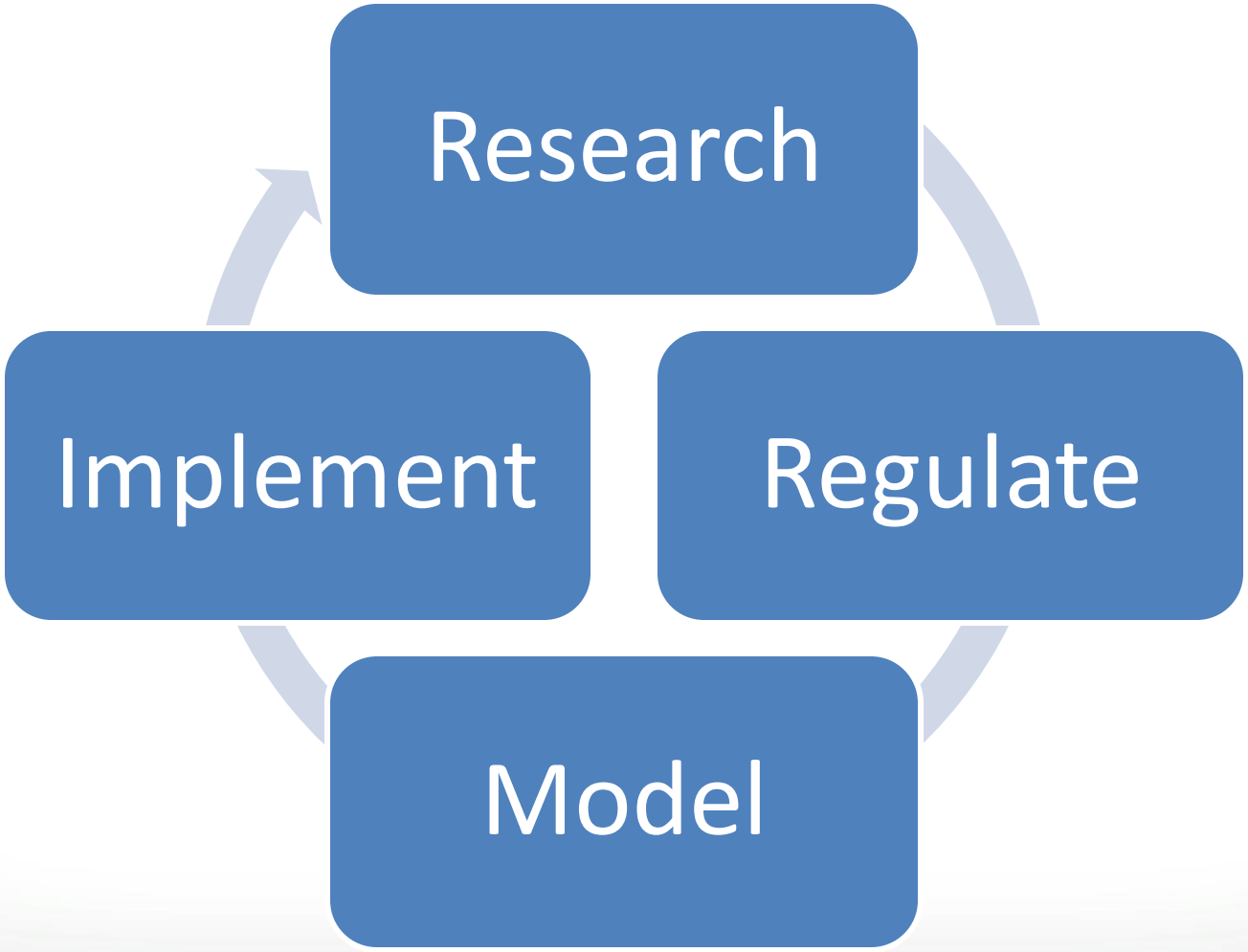
- Transportation research in ORD integrates many disciplines to meet scientific and programmatic needs on emissions, air quality, exposures, and health effects
- This research also addresses broader scientific questions and community planning issues
  - What mitigation can reduce/eliminate public health concerns related to traffic emission exposures?
  - How can we design more sustainable transportation systems?
  - How can we promote more healthy, livable communities?
- Transportation research in ORD primarily implemented through two programs:
  - Air, Climate and Energy (ACE)
  - Sustainable and Healthy Communities (SHC)

Beyond the tailpipe

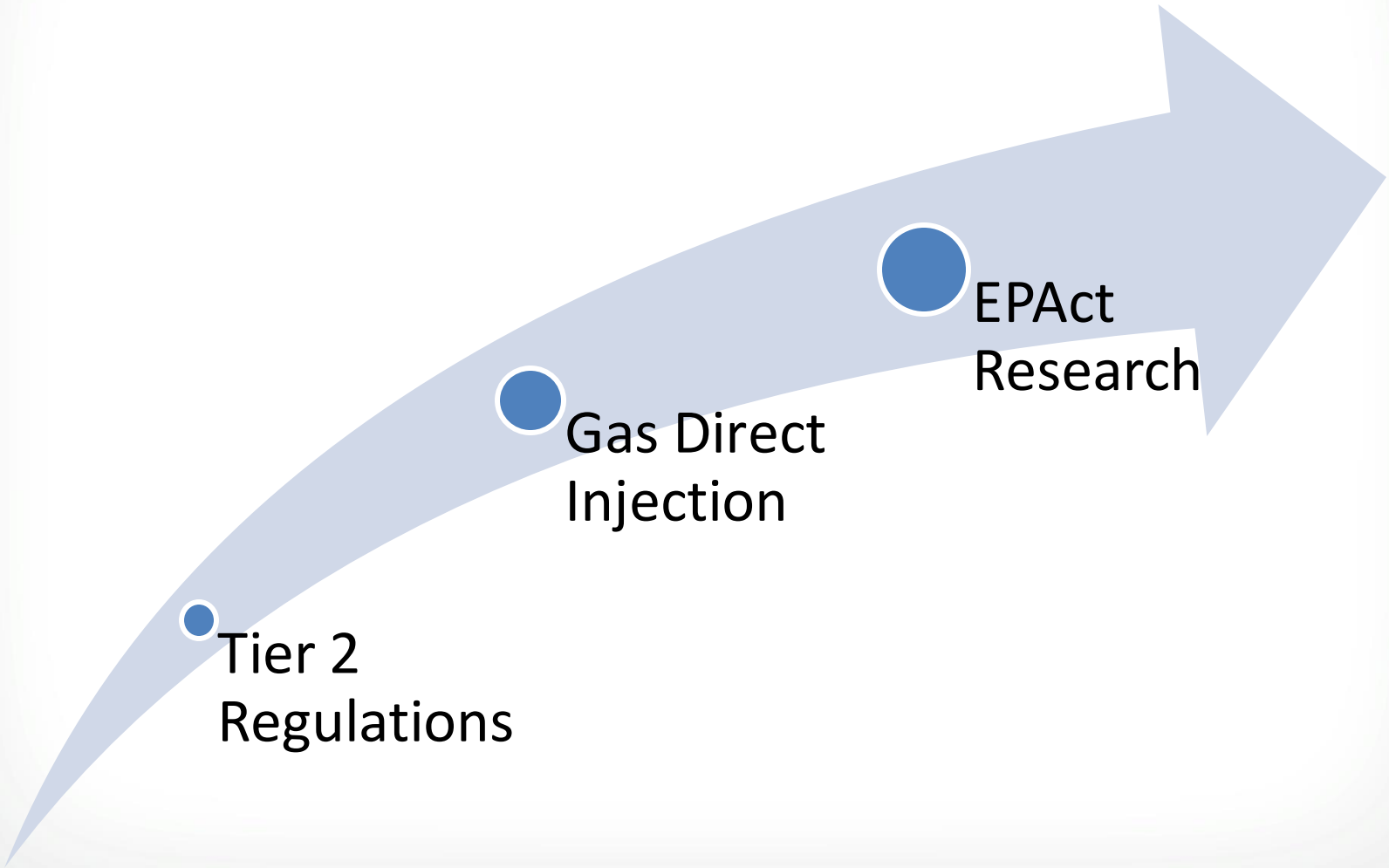
- Air Quality and Exposures Near Major Transportation Facilities
  - Highways
  - Railyards
  - Ports
- Air Quality and Adverse Health Effect Associations
- Effectiveness of Mitigation Strategies
  - Emission standards
  - Reduced vehicle activity
  - Roadway design
- Brake and Tire Wear



An Example of the System



Example



Future Work/Directions

- Multiple Sectors
  - On-road transportation
    - Personal vehicles
    - Freight movement
  - Rail/Railyards
  - Marine Ports (coastal and inland)
  - Airports/Aircraft
- Land Use and Transportation Planning
- Climate impacts and mitigation

The End

- **Acknowledgements for Contributions**
  - **Richard Baldauf**
  - **Mike Hays**
  - **Megan Beardsley**