South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Air Sensors International Conference 2022
Session 5C2: Mobile Monitoring/Monitoring Mobile Sources

Air Quality Sensors Deployed on Mobile Platforms: A Performance Evaluation Protocol and Recent Advances

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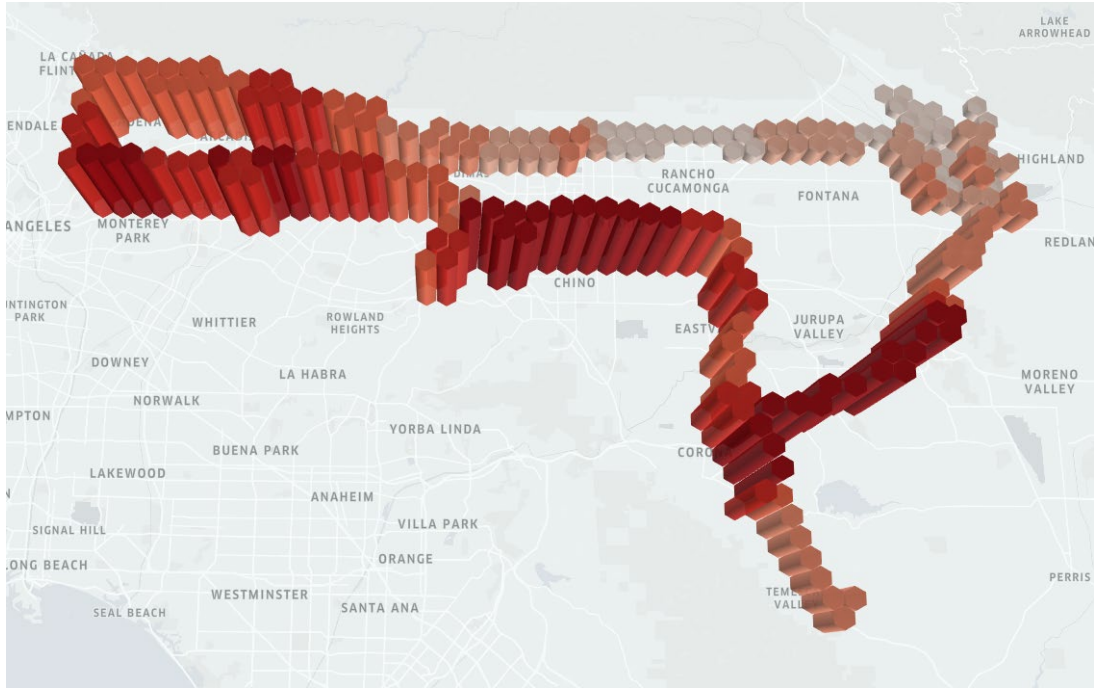
Background – Stationary Sensor Evaluations

- AQ-SPEC has evaluated 170+ air quality sensors and posted publicly-available reports on website (www.aqmd.gov/aq-spec)
- Sensor evaluations so far have been for stationary applications
  - Field colocations
  - Laboratory tests
- Sensors that perform well in stationary evaluations have potential to also provide useful air monitoring data if deployed in mobile applications

http://www.aqmd.gov/aq-spec/special-projects/mobile-sensors

Background – Mobile Deployment of Sensors

- Mobile Measurements
  - Higher spatial resolution and coverage for less capital cost
  - Potential to sample difficult locations
  - Space and power constraints
  - Labor intensive (e.g. driver)
- Air Quality Sensors
  - Less capital cost (~1-2 orders of magnitude)
  - Less space and power needs
  - Data interpretation can be difficult
- Performance evaluation protocol needed for sensors to gauge usefulness for mobile deployment



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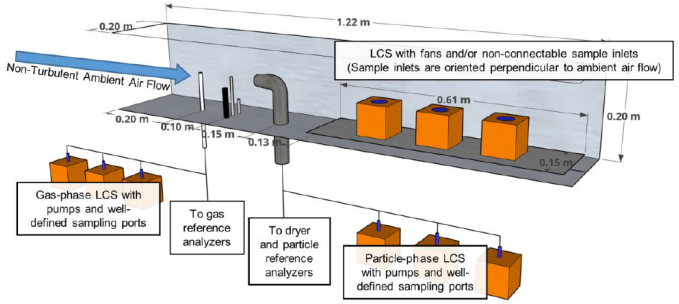
Mobile Sensor Evaluation Protocol

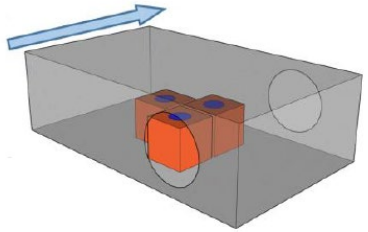
Scenario 1

Controlled Flow Duct



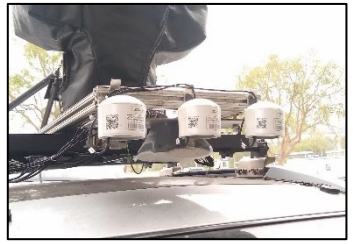
Scenario 2

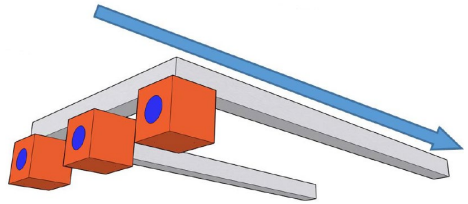
Partially Controlled Rooftop Enclosure

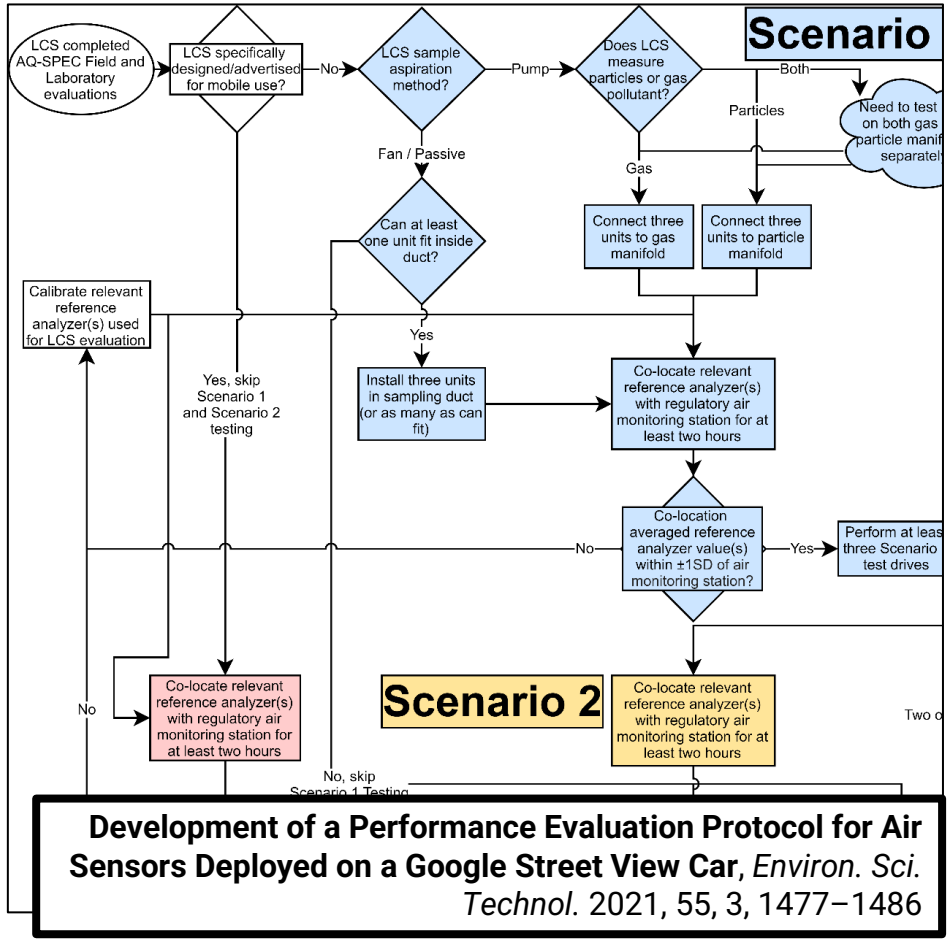


Scenario 3

Uncontrolled Rooftop







Development of a Performance Evaluation Protocol for Air Sensors Deployed on a Google Street View Car, *Environ. Sci. Technol.* 2021, 55, 3, 1477−1486

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Mobile Evaluation Test Routes

- Historical pollutant concentrations
- Variety of roadway types and vehicle speeds (local, arterial, freeway)
- Variety of climates experienced
- Air monitoring sites available for stationary co-locations
- Route duration and distance
- Inland Empire – San Gabriel Valley route (dark blue)

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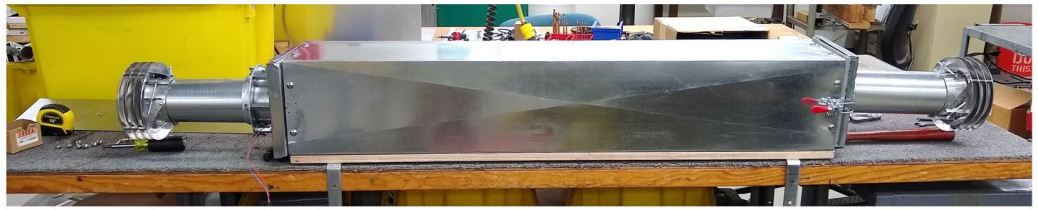
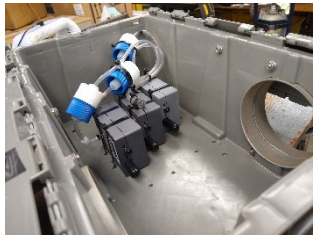
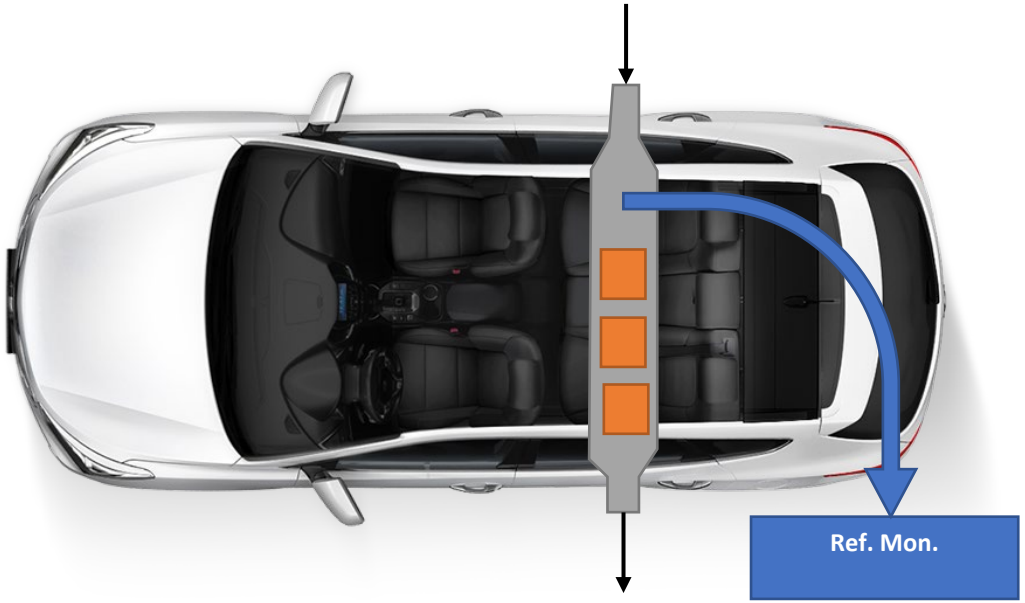
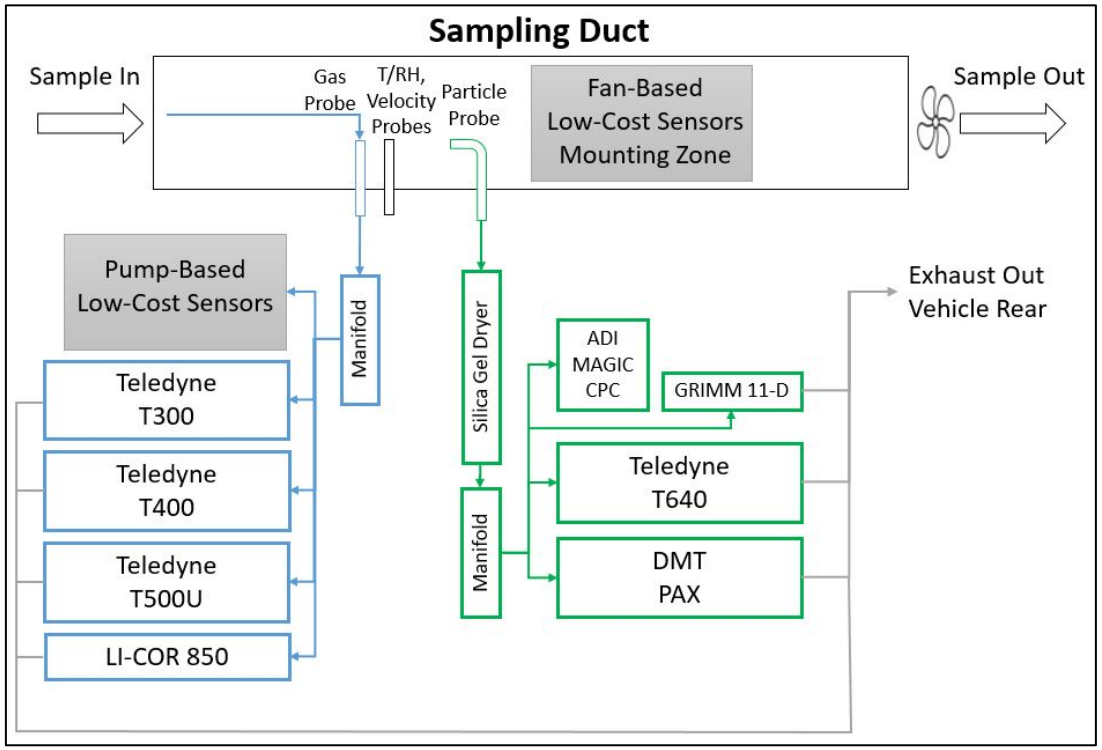
Mobile Platform (Earlier Generation Used for Protocol Development)









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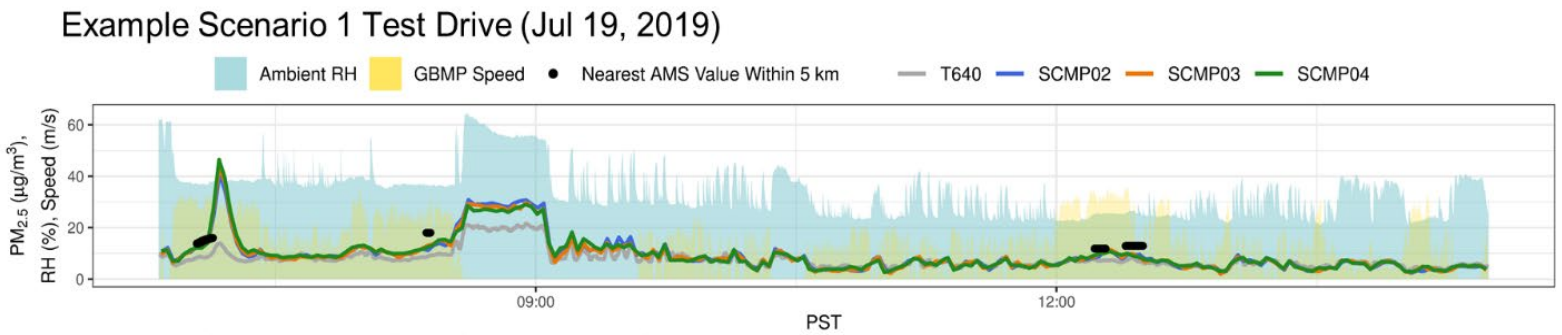
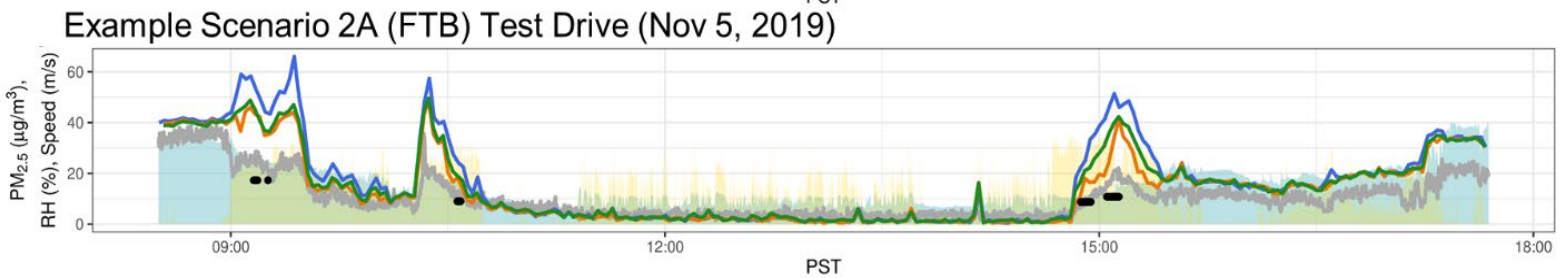
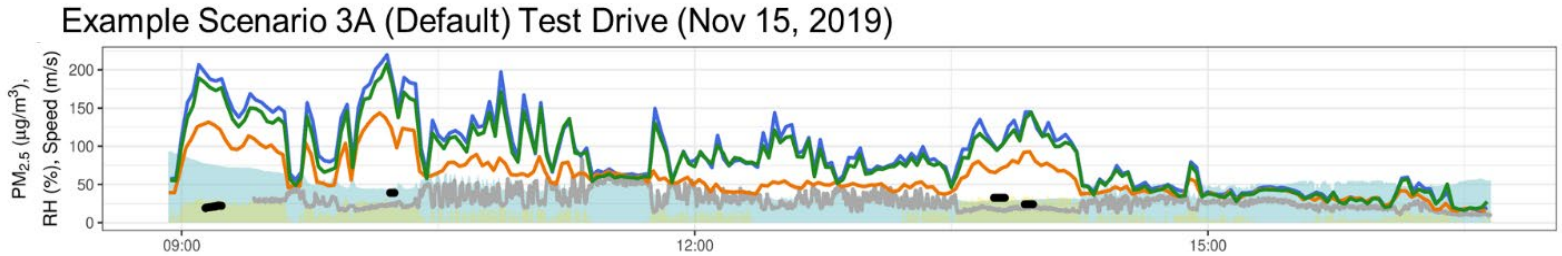
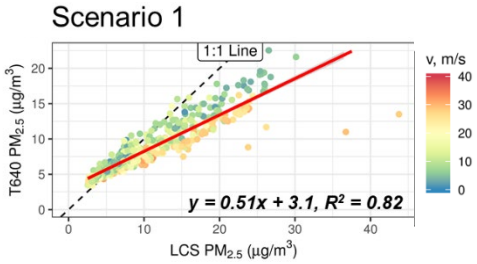
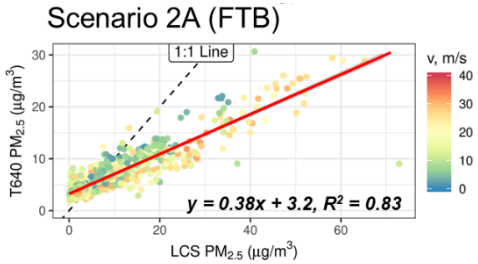
Example Mobile Testing Results

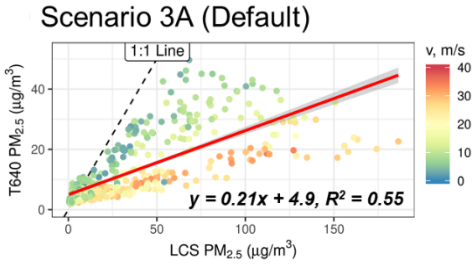












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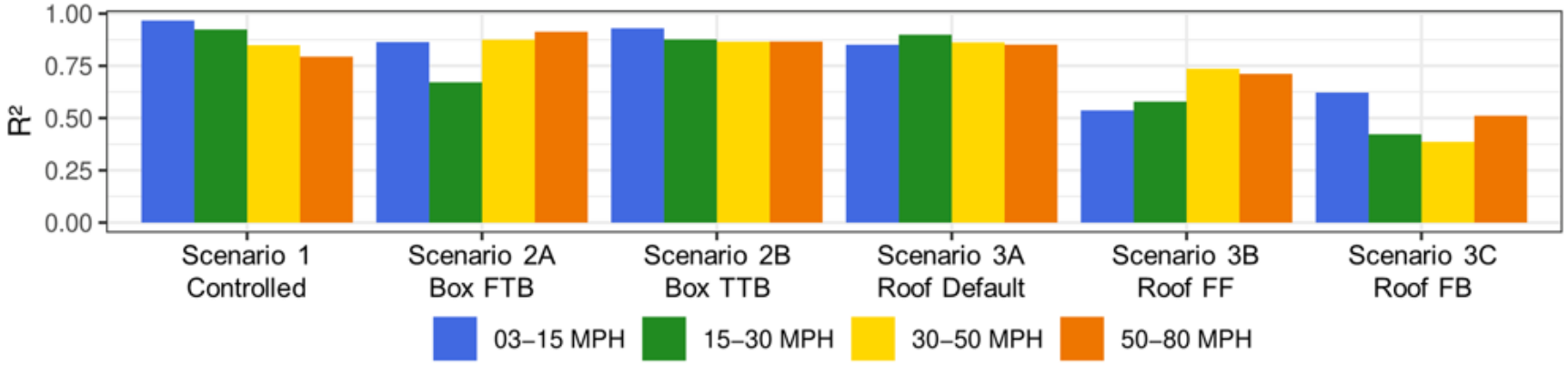
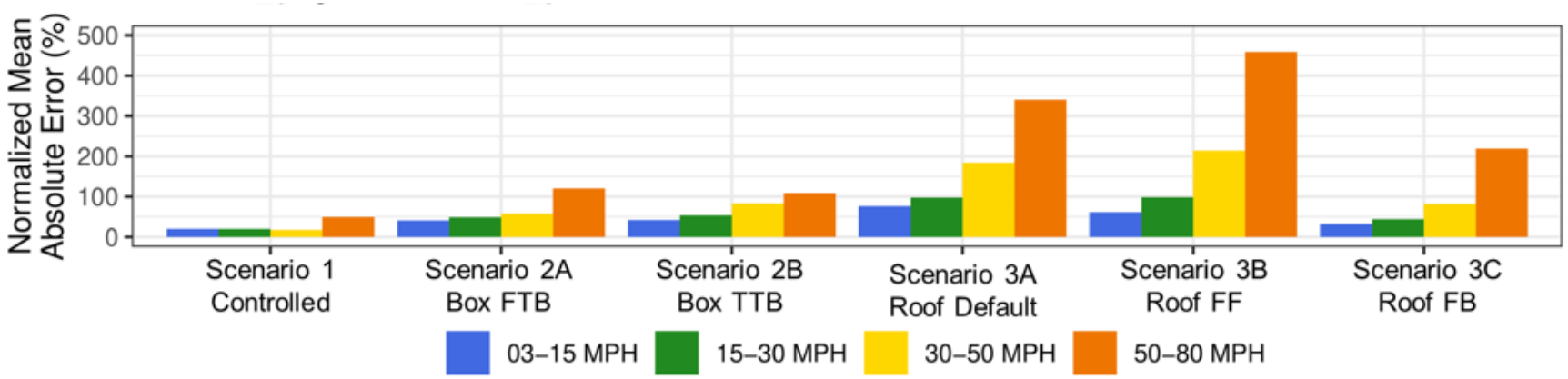
Example User Guidance

- Correlation to Reference
  - Consistently high across roadway speeds for several scenarios
  - Correlation less ideal in Scenario 2 when box flow path is FTB
  - Correlation degrades in Scenario 3 when sensors installed FF or FB
- Error
  - Best in Scenario 1
  - Less ideal in Scenario 2
  - Very velocity-dependent in Scenario 3





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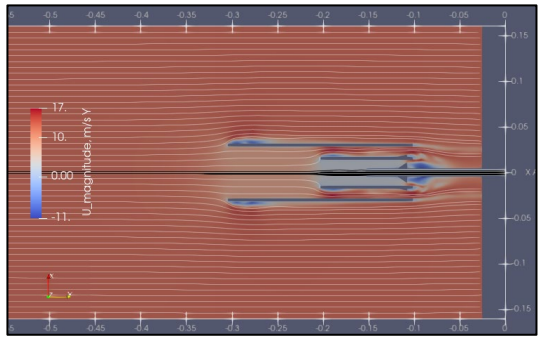
Next-Gen Mobile Platform and Protocol Improvements

- Reduce influence of platform's emissions on measurements
- Remove duct influence on reference measurements
- Use computational fluid dynamics (CFD) and particle trajectory simulation modeling to:
  - Improve PM_{10} sampling for reference measurements and for sensors mounted inside controlled-flow duct (Scenario 1)
  - Simplify rooftop enclosure testing procedures (Scenario 2)
  - Modify unprotected rooftop sensor mounting procedures to obtain more representative air samples (Scenario 3)



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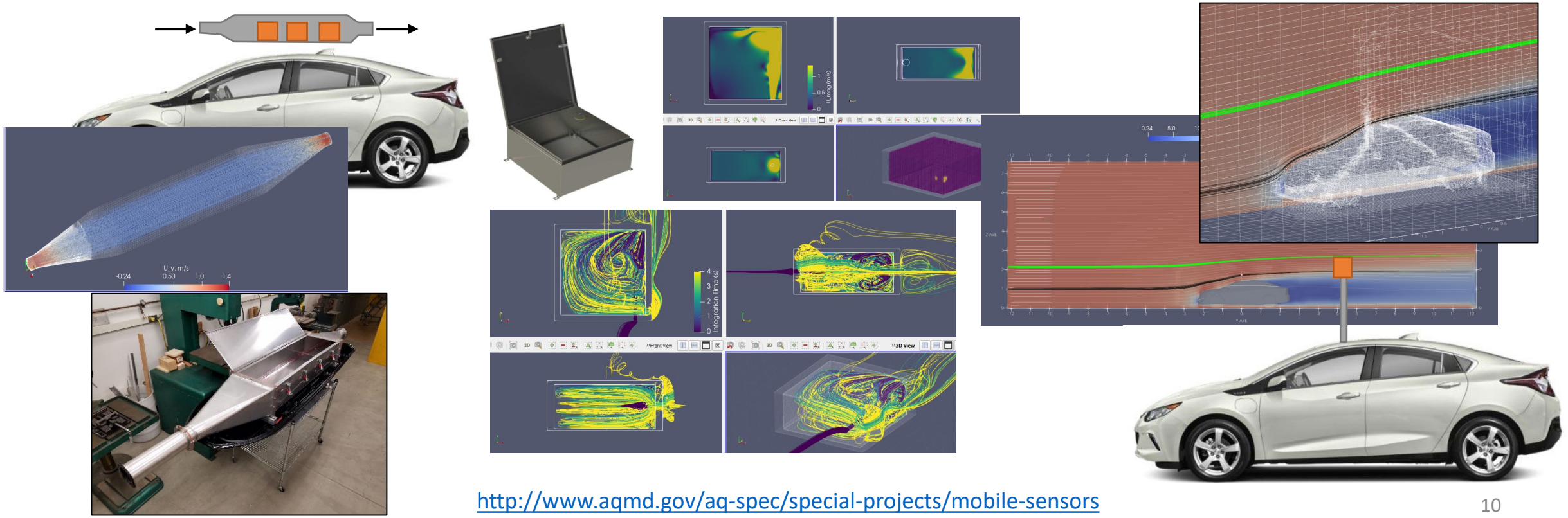
Next-Gen Mobile Platform and Protocol Improvements

Scenario 1: Controlled-Flow Sensor Duct | **Scenario 2: Partially-Controlled Sensor Box** | **Scenario 3: Unprotected Vehicle Rooftop**



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- Conclusions and Outlook
  - Mobile deployment of air quality sensors
    - Can be used to obtain air pollution measurements over broad area
    - Leveraging existing fleets can provide realtime hyperlocal monitoring
    - Data difficult to interpret, especially with effects of movement, turbulence, and sensor installation effects
  - Mobile sensor performance evaluation protocol developed
    - Co-locates sensors with reference monitors on a mobile platform
    - Test route provides variety of roadway/speed, climate, and pollutant concentration conditions
    - Testing scenarios cover three broad use-case scenarios (controlled-flow duct, partially-controlled rooftop box, completely unprotected rooftop)
    - Evaluations to start soon, reports to provide public with velocity- and installation-dependent sensor performance insights
  - Next-generation mobile platform under development
    - Incorporates advanced modeling and engineering designs
    - Streamlines mobile testing protocol for some scenarios

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Contact AQ-SPEC

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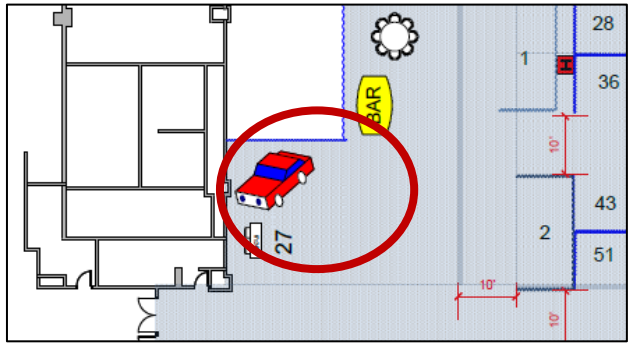
Check out our next-gen mobile platform at Booth 27!



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