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

http://www.aqmd.gov/aq-spec/special-projects/mobile-sensors
Mobile Sensor Evaluation Protocol

Scenario 1
Controlled Flow Duct

Scenario 2
Partially Controlled Rooftop Enclosure

Scenario 3
Uncontrolled Rooftop


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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

Example Scenario 1 Test Drive (Jul 19, 2019)

Example Scenario 2A (FTB) Test Drive (Nov 5, 2019)

Example Scenario 3A (Default) Test Drive (Nov 15, 2019)

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

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