Sensor Performance, Data Quality, and Novel Applications

My Air Quality: Using Sensors to Know What’s in Your Air

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Background

• Technology trend: smaller, faster, cheaper
  ➢ Example: PCs have evolved into tablets, and cell-phones have become small PCs.

• Most traditional air monitoring instruments are following the same trend

• Safe to assume that the performance of “low-cost” sensors will soon match that of FRM/FEM instruments…..but when?
Background

• Many deciding factors, including:
  - Advancements in sensor technology
  - Performance & cost of microprocessors
  - Growing public interest
  - Large tech-company involvement

“Researchers turn Google Glass into health sensor”
– wired (Sept. 2014)

• How can governmental agencies help?
  - Engage, educate, and empower the public
  - Work with sensor manufacturers & developers
  - Characterize sensors performance & data quality
• Evaluation (not certification) program
• Field and chamber testing
• Determine parameters affecting sensor performance and data quality:
  - Detection range
  - Linearity
  - Detection limit
  - Accuracy
  - Precision
  - Response time
  - Intra-model variability
  - Co-pollutant interference
  - RH and T influences
  - Durability
Categorize sensors based on performance

Several novel applications

- Characterize spatial variations
  - Wide area coverage
- Improve network design
  - Identify high concentration areas
- Permitting
  - Monitor before and after construction
- Fence-line monitoring
  - Large refineries and emission sources
- Community concerns
  - Local impact of freeways, airports, refineries, etc.
- Aerial measurements
  - Stack sampling, plume profiling, and much more

EPA’s “DRAFT Roadmap for Next Generation Air Monitoring”
Novel Applications (example): Characterize Spatial Variations

- **iSPEX**
  - < $4 add-on for smart-phone cameras to measure Aerosol Optical Thickness to estimate atmospheric aerosols!!!
  - Spectropolarimetric method
  - Daytime, cloud-free measurements only
  - Project led by Frans Snik, Leiden University (Netherlands)

- Thousands of (free) iSPEX used to for three days in 2013
- Results comparable to ground-based, network, and satellite measurements

http://ispex.nl/en/
Novel Applications (example): Aerial Measurements

- Unmanned Aerial Vehicles
  - Provide stable X-Y-Z platform for sample collection
  - Sensors can be mounted to provide integrated and real-time data (e.g., GPS, meteorological, gaseous, and particulate)
  - FAA Restrictions (commercial vs. recreational) and flight time limitations
  - Many potential uses: stack sampling, plume profiling, fence-line monitoring, gradient studies, previously unreachable locations

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NASA’s Global Hawk UAV (not properly “low-cost”)

T&B systems quadcopter (affordable!)

(...don’t call me DRONE!)

Quadruped Temperature and Ozone Sounding Using ZB POM

Courtesy of
Conclusions

• More comprehensive field and laboratory testing needed to:
  - Address sensor data quality issues
  - Correctly interpret sensor data
  - Appropriately select sensors for specific applications
  - Promote a more responsible sensor use
  - Improve performance of available sensors
  - Design the next generation sensor technology

• Available sensors are not as accurate and reliable as FRM/FEM (yet), but they can be used for many useful applications

• Many short- and long-term challenges, including:
  - Incorrect use of sensors and sensor data
  - Rapid proliferation
  - Dealing with “Big data”