Characterizing Air Quality in a Rapidly Changing World
SmoC Committee Webinar
3/08/2018

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Disclaimer: Material presented is for informational purposes only. EPA does not recommend nor endorse any particular sensor product or data management platform.
Proliferation of Sensors & Real-time Data

21st Century 'Canary in a Coal Mine'
The Pigeon Air Patrol — a joint project by tech companies Plume Labs and DigitalLB — released pigeons outfitted with air-monitoring packs to record and report real-time air pollution levels in London. This three-day venture was used to spread awareness on London’s smog problem.

WHAT IT IS
Racing pigeons wear a small fabric vest outfitted with a feather-light backpack.

Air monitor detects ozone and nitrogen dioxide

Lightweight fabric harness

One pigeon were a GPS device instead of an air monitor.

HOW IT WORKED
Londoners Tweeted their location to a Pigeon Air team member and received real-time results (via Twitter) of air quality in their area.

SOURCE:DigitalLB
The Landscape

25+ Domestic Projects

Inventory of Sensor Networks

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<th>Region</th>
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Creating millions of data points from thousands of new monitors...
Domestic Sensor Networks

**Project Goals (select examples):**

- **“Smart City” Development**
  - Use sensor, traffic and other REAL-TIME data to improve transportation options, livability (noise), public health, economic development, & civic engagement

- **Community Engagement**

- **Near-Source Emission Monitoring**
  - Volcanos, wood smoke, facilities

- **Personal Exposure Characterization**
  - Deploy stationary and/or mobile sensors & monitor health

https://arrayofthings.github.io/
Projects – Select Examples

Google Street View Cars

http://apte.caee.utexas.edu/google-air-mapping/

Weather Underground and Purple Air


Smart City Challenge Winner - LEaRN

https://www.us-ignite.org/apps/lafayette-engagement-and-research-network-learn/

Columbia Bike Study

Shared vision by partnering organizations:

A desire to advance air measurement technology to be easier to deploy, suitable to use for high concentration events, durable to withstand difficult field conditions, and report data continuously and wirelessly. Desired measurements: PM$_{2.5}$, O$_3$, CO, CO$_2$.

Partnering federal organizations:
Wine Country Fires

San Francisco North Bay Counties (October 2017)

Monitoring near fire (start/end):

- 3/3 FEM – Bay Area AQMD
- 0/6 eBAM – ARB/Bay Area AQMD
- 4/6 PurpleAir PM sensors

Questions

- How good are the Purple Air sensors?
- How long did it take to mobilize eBAMs?
- What’s needed to manage a hybrid monitoring network?

Analysis performed by Tim Dye (TD Environmental Services)
## Timing to Mobilize Air Monitoring

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### Temporary

| Sensors |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Murphy - MMCA81013 |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Robinson Park - MMCA81026 |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Petaluma - ST Trailer |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Napa Airport - MMCA81023 |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Fairfield West - MMCA81034 |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
| Sonoma - MMCA81035 |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
Project Goals (selected examples):
- Supplement network monitoring
- Fill in monitoring gaps
- Incorporation of sensors as part of traditional air monitoring network
Collection of Air Data

- United States is experiencing a **major shift** in the traditional role of government agencies as the *main resource* for collecting, storing, sharing, & communicating air data
  - Growing diversity of air monitoring…
    - Participants: Citizens, communities, researchers, academics, nonprofits, businesses
    - Data sets: Sensor, satellite remote-sensing, traditional monitoring networks
  - Information Technology (IT) companies & air quality data
    - Providing data storage & access, promoting use of cloud and advanced analytics (e.g. machine learning), developing consumer products (e.g. smartphone applications)

*Creating a need to make sense of it all*
Key Focus Areas:

- Standardize Performance Characterization
  - Exploring the development of an independent third-party voluntary certification program
- Data Interpretation
- Data Standards
Initial testing of individual sensors shows promise.
However, long-term (i.e., more than 12 month) performance generally poorly characterized,
Some sensors show progressive drift with time.

Research involving collocation of sensors with reference grade equipment near sources is needed – esp for localized pollutants.
Performance Benchmarks Deliberations

Announcing the “Deliberating Performance Targets for Air Quality Sensors” Workshop

June 25 and 26, 2018

EPA Research Triangle Park Campus in Durham, NC

Registration is now OPEN

Register via the Air Sensor Toolbox website: https://www.epa.gov/air-sensor-toolbox

- Seeking individual views on non-regulatory sensor targets for PM$_{2.5}$ & ozone
- Summary of individual perspectives in a journal or report in late 2018
- Findings may inform 3rd party conformity assessment organizations interested in developing consensus-based standards for air sensor certification requirements
• Governments recognize…
  – Tremendous opportunity to learn from localized datasets
  – More real-time air quality data is increasingly available
  • But, context is needed – in general, the science on air pollution and health doesn’t tell us what a few minutes of exposure to an elevated level of pollution means for an individual
  • There is a need to ensure air quality information is communicated with a scientifically-grounded approach & understand how people react to high-resolution data
  • Creation of unique air quality communication platforms, visualizations, interpretations, use of the AQI or AQI colors in different ways, and alerts have the potential to confuse the public
Communication Platforms

Current Conditions in Austin, TX ~3pm on 1/16/18
Communication Materials Update

• Finalizing PM\textsubscript{2.5} and O\textsubscript{3} sensor scale
  • [https://www.epa.gov/air-sensor-toolbox](https://www.epa.gov/air-sensor-toolbox)
• Launching revised Village Green website
  • FY 2018
• Developing communication materials and fact sheets for developers and sensor users
• Drafting SO\textsubscript{2}, NO\textsubscript{2}, CO, and benzene sensor scale
• Piloting interpretation of Purple Air monitoring data alongside data from regulatory monitors through partnership w/ South Coast
Feedback on Pilot Project

- Valuable, positive feedback.
- Focus group participants had limited knowledge about air pollutants and measurements – added additional explanations about O$_3$/PM$_{2.5}$ and units.
- However, there is familiarity with stop light colors and what they mean (identified red as a “panic color”) – important to differentiate from AQI colors.
- Made changes to pilot to address specific feedback:
  - Explain personal vs. area-wide information
  - Specify whether message applies indoors, outdoors, or both
  - Display trends

---------- (other feedback we couldn’t address at this point)
- Customize website and push alerts when levels changed (esp. to “high”).
- Use location services and include a map.
- Provide an option for crowdsourcing data.

https://www.epa.gov/air-sensor-toolbox
Sensor Scale Project

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<td>Consistent pattern</td>
<td>Regional</td>
<td>Asthematics</td>
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<td>PM$_{2.5}$</td>
<td>Variable with peaks</td>
<td>Common: indoors and outdoors</td>
<td>Age group</td>
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<td>Point source</td>
<td>CVD</td>
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<td>Benzene</td>
<td>Source-oriented peaks</td>
<td>Common and industrial</td>
<td>Asthmatics</td>
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<td>Minutes to Lifetime</td>
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<td>Everyone</td>
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Ozone

PM$_{2.5}$

SO$_2$

Benzene

1. Consistent pattern
2. Variable with peaks
3. Source-oriented peaks
Data Standards – Current State
Recent Legislation in the U.S.

- **CA AB 617**
  - “The bill would require the state board to select, based on the monitoring plan, the highest priority locations in the state for the deployment of community air monitoring systems. The bill would require an air district containing a selected location, by July 1, 2019, to deploy a system in the selection location.”
  - [https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB617](https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB617)

- **H.R. 3959**
  - Crowd Sourcing of Environmental Data Act of 2017
  - “To amend the Clean Air Act to give States the option of monitoring covered criteria air pollutants in designated areas by greatly increasing the number of air quality sensors in exchange for greater regulatory flexibility in the methods of monitoring, and for other purposes”
Air Sensors International Conference

Dates: September 12-14th, 2018
Location: Oakland Convention Center

Array of Topics Including…

☑ Sensors and Smart Cities
☑ Data Management Platforms
☑ Development of Technology
☑ Data Analytics and Communication

Much more…
https://sehall4.wixsite.com/asic/home-landing

Abstract Submission OPEN through April 23rd

Hosted by UC Davis in Partnership with U.S. EPA & CARB