Improvements in assessing HAPs (Hazardous Air Pollutants), not just NAAQS, using air sensors

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Early Air Sensors ...

- Initial products were very low cost
- Time-resolved streaming data was fun
- Maybe better at T or RH than tVOC

SO, are they useful or should be abandon them?



<u>Applications</u> Education

Project-Based Learning in Rural Schools9 years, 3000+ high school students,200 CU students



- Quantification is not critical
- Low cost opens more doors
- Support learning with CU students



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<u>Applications</u> Near source impact & emissions quantification



- Quantification of change of concentration is important
- Low cost opens spatial network to explore diffuse sources
- Multi-pollutant capability is critical

<u>Applications</u> Supporting communities that are concerned





- Quantification of spatial difference in concentration is important
- Low cost opens spatial network to that collects data over time
- Multi-pollutant capability is critical
- Short duration pollutant spikes





Spatial network study design



 O_3 (ppb) from C1



Spatial network study design



 O_3 (ppb) from C1

How does that look with real data?



(Slides from 2013 Air Sensors Conference) Quantification in the lab – Metal Oxide Sensors





In lab calibration takes time as you have to cover a lot of parameter space.

 $\frac{R}{R_o} = p_1 T \exp(p_2 C) + p_3 H \exp(p_4 C) + p_5 \exp(p_6 C)$

(Slides from 2013 Air Sensors Conference) Quantification Check – Metal Oxide Sensors

Reference data M-pod chamber calibrated concentration ppm 3 0 01/17 01/18 01/19 01/20 01/21 01/22 01/23



Lab-calibration applied to field data

- Substantial bias was seen in all CO sensors, possibly due to an unmeasured oxidizing gas interfering with the sensor
- Resolving this bias should involve adjustment to the R_o value, the sensor resistance in clean air

(Slides from 2013 Air Sensors Conference) Quantification with colocation – Metal Oxide Sensors



Colocation Calibration



Quantification, best case – Individual Calibration



Timeline	Colocation	Deployment	Colocation
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Colocation needs to be in similar environment as deployment – extrapolation is bad

Can we do something to simplify?



normalize the sensor signals

Quantification, simplest case – 1-Calibration



- If the sensor signals are normalized, then this isn't too bad.
- Challenging for spatial network that explores small differences.

Quantification, in between – 1-Hop



 $[tVOC]_{Reference Instr} = f(T_{Pod}, RH_{Pod}, MOx_1, MOx_2)$

 $[tVOC]_{BluePod} = g_i(T_{Pod}, RH_{Pod}, MOx_1, MOx_2)$





Quick check on new approach

	1-Нор	New
R2	0.89	0.96
RMSE	11.5	6.5
MBE	-1.5	0.09





mike basecase TVOC gradboost - Actual vs Predicted





Peak weighting can be useful

with peak weighting









