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Community air monitoring and the Village Green Project

Gayle Hagler[1], Ron Williams[1], Wan Jiao[1], Bobby Sharpe[2], Bill Mitchell[1], Kelly Leovic[1], Lewis Weinstock[3], Joann Rice[3], Esteban Herrera[4], Phil Dickerson[3], John White[3], Brad Johns[3], Kristen Benedict[3], Ron Evans[3], Ann Brown[1], Peter Louie[5]

1. EPA Office of Research and Development, Research Triangle Park, NC
2. ARCADIS, Durham, NC
3. EPA Office of Air Quality Planning and Standards, Research Triangle Park, NC
4. EPA Office of Enforcement and Compliance Assurance, Denver, CO
5. Hong Kong Environmental Protection Department, Hong Kong SAR, China

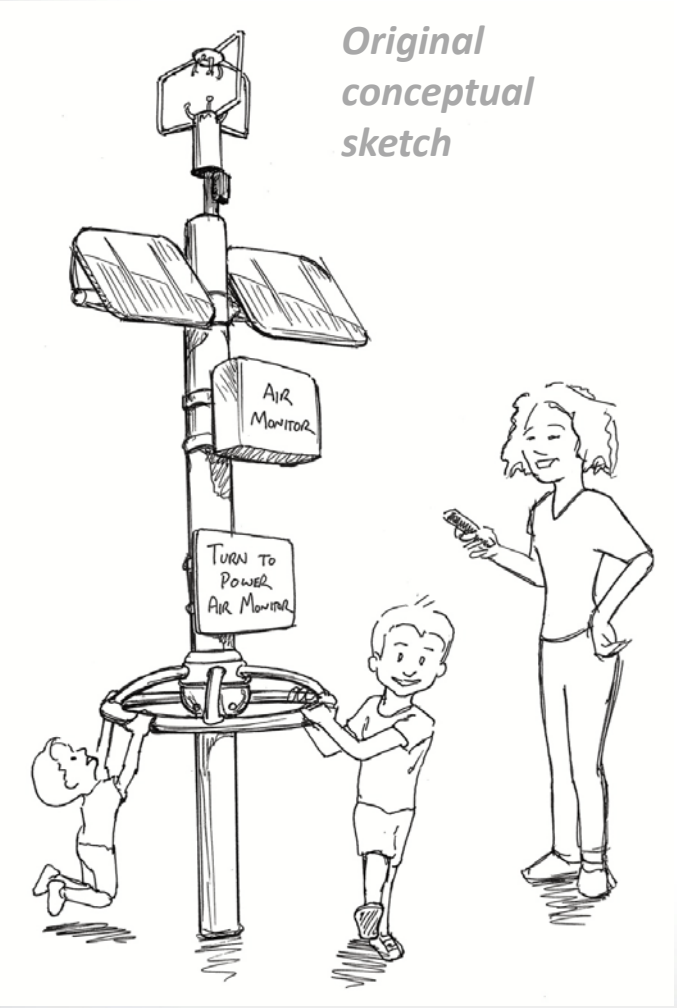
Goals of this talk

- Present on a new initiative at EPA to develop lower cost air measurement technology for long-term application in communities.
- Discuss the engineering challenges and design of the system.
- Review performance in terms of data collection completeness over a long-term timeframe and compare measurements against regulatory measurements nearby.

Background

- Technology development is needed to engage the community in understanding their local air quality
- Traditional / regulatory air monitoring stations are challenging to replicate in large number due to cost and siting limitations
- EPA's Village Green Project (VGP) seeks to address the technology gap by designing a proof-of-concept air monitor prototype

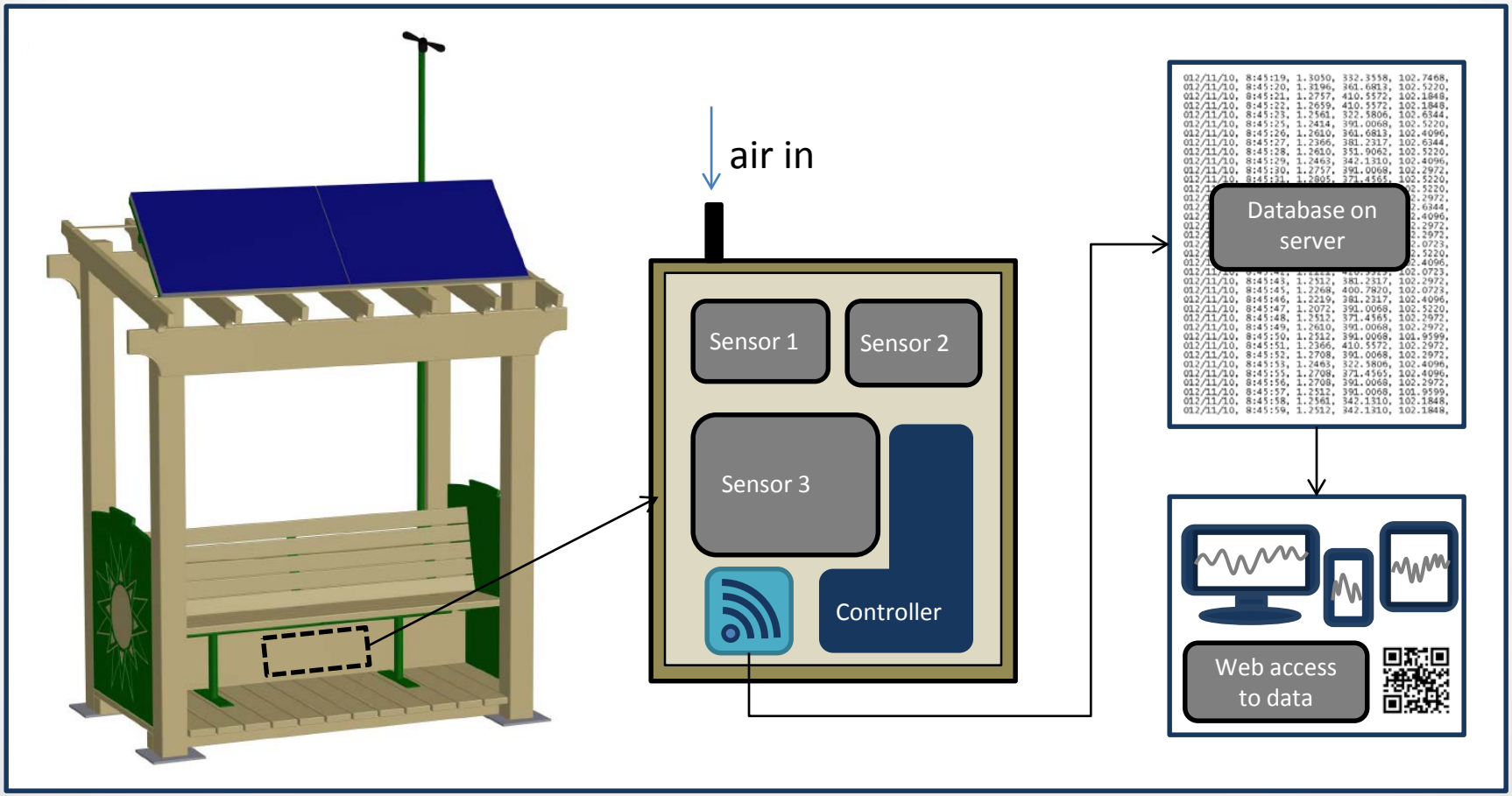
Village Green Project Vision



- Lower cost to install and run: sustainable, self-powered, minimum maintenance
- Provides real-time data: one minute data rate, automated quality checks
- Engages the community: in a community environment
- Accessible data and information: publically available on a website

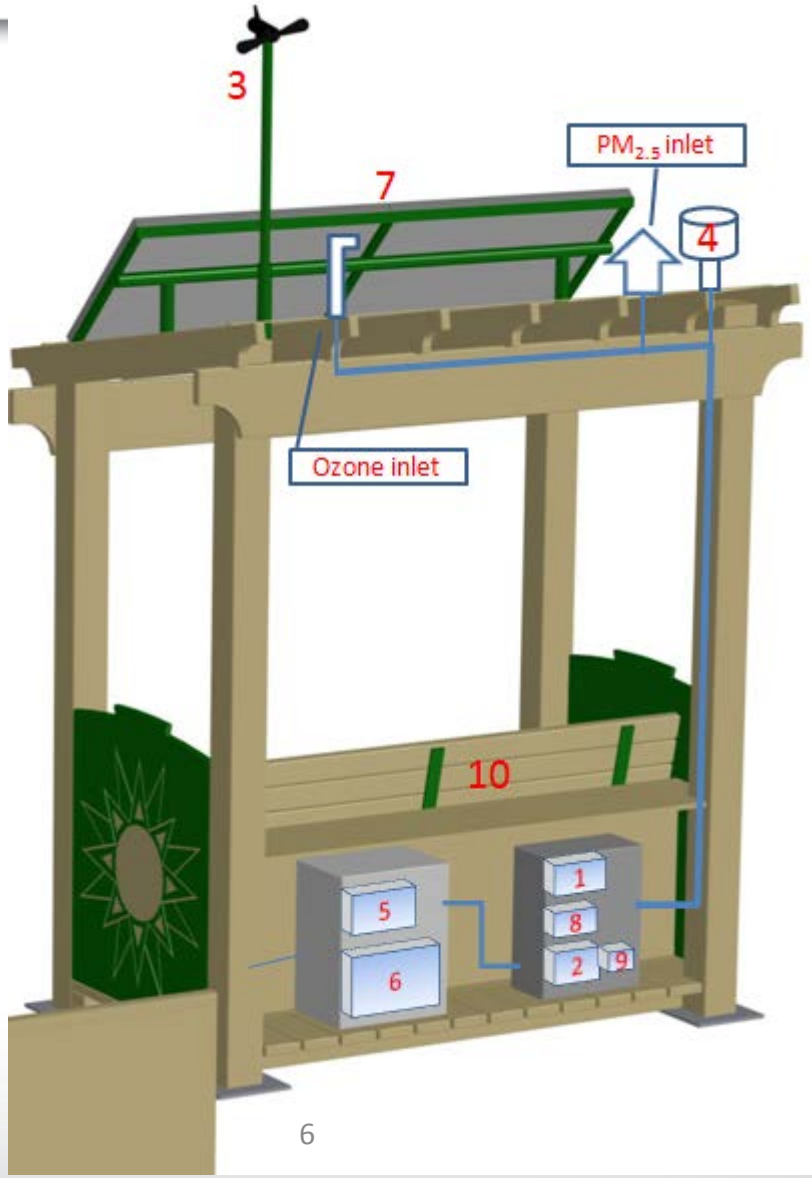
System design

Key constraints: physical footprint, power, instrumentation that can withstand no heating or A/C, minimize cost to the extent possible



System design

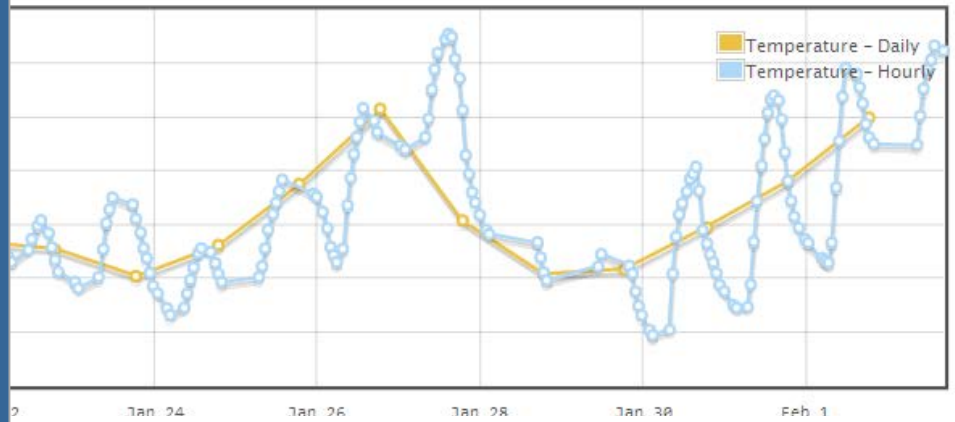
No.	Component (model)	Manufacturer
1	PM monitor (pDR-1500)	Thermo Scientific
2	Ozone monitor (OEM-106)	2B Technologies
3	Wind sensor (09101)	RM Young
4	Humidity and temperature sensor (HMP60)	Vaisala
5	Power controller (Sunsaver SS-10L-12V)	Morningstar
6	AGM battery (WKDC12-80P, 12V, 80Ah)	Werker
7	Solar panel (SLP085-12MKCT, 85W, 12 VDC)	Solarland
8	Microprocessor (Arduino Mega 2560)	Arduino
9	Cellular router (Airlink Raven XE)	Sierra Wireless
10	Bench structure	Safeplay Systems

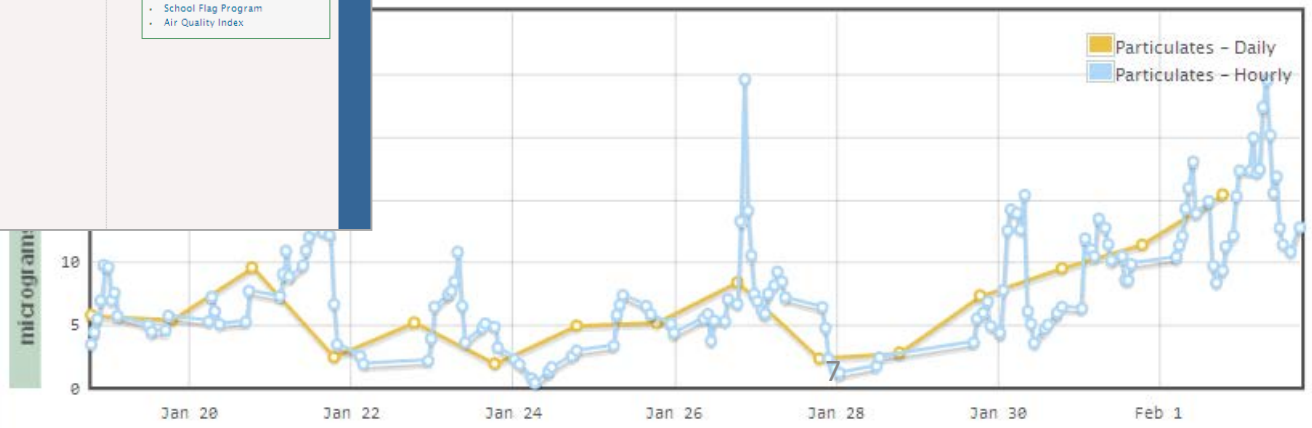


System design

Public website updated minute-by-minute

https://villagegreen.epa.gov/





Partnership with local library

Bench installed outside of a library in Durham, North Carolina in June, 2013. Still operating 16+ months later…

Partnership with local library

Sign next to station with information on the air monitoring project, explanation of the Air Quality Index, QR code for smartphones to easily connect to website

Does it actually work?

Continuous, round-the-clock logging of 1 minute data…

Month	Missing data (%) per month due to…				Overall completeness [a] (%)			
	Quality checks or maintenance		Low solar power	Comm. interruptions				
	Ozone	$PM_{2.5}$			Ozone	$PM_{2.5}$	Wind	Temp/RH
2013/06	0	0	0	4	96	96	96	96
2013/07	0	0	0	7	93	93	93	93
2013/08	0	0	0	0	100	100	100	100
2013/09	0	1	0	0	100	99	100	100
2013/10	0	59 [b]	17	0	83	24	83	83
2013/11	0	1	3	31	66	65	66	66
2013/12	43 [b]	1	11	10	36	79	79	79
2014/01	28 [b]	2	1	2	70	96	97	97
2014/02	9	8	9	0	82	83	91	91
2014/03	8	4	3	6	83	87	91	91

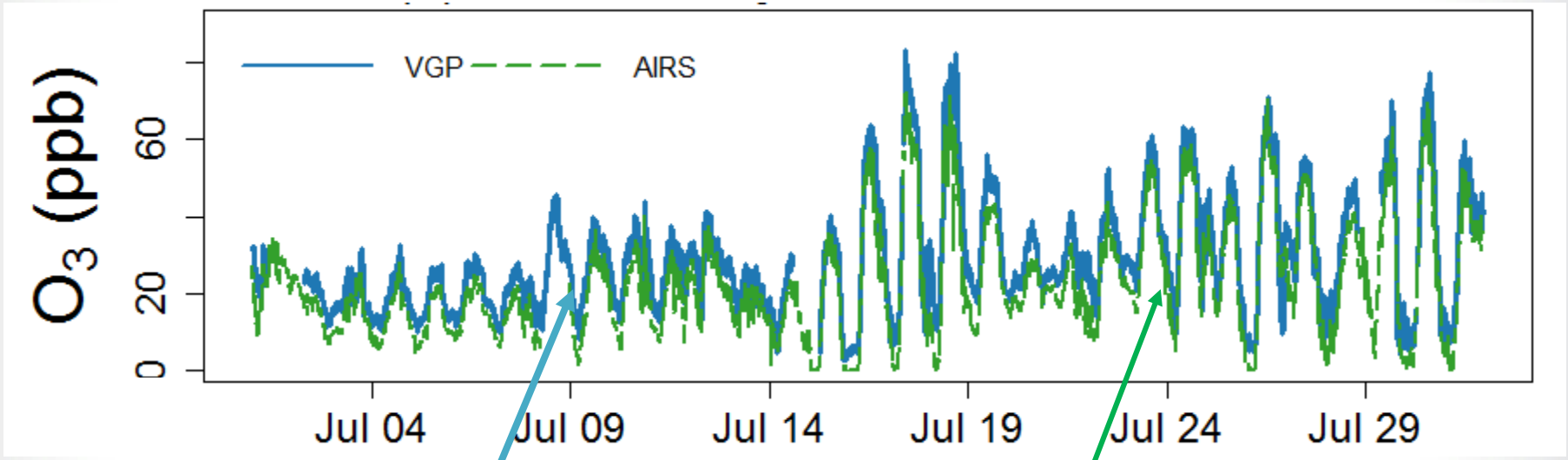
Solar panels provided sufficient power to operate ~94.5% of the time

Comparison with nearby benchmark instruments

EPA-RTP AIRS site (~1 mile away)

Comparison with nearby benchmark instruments

5-minute ozone measurements compared between sites located 1 mile apart

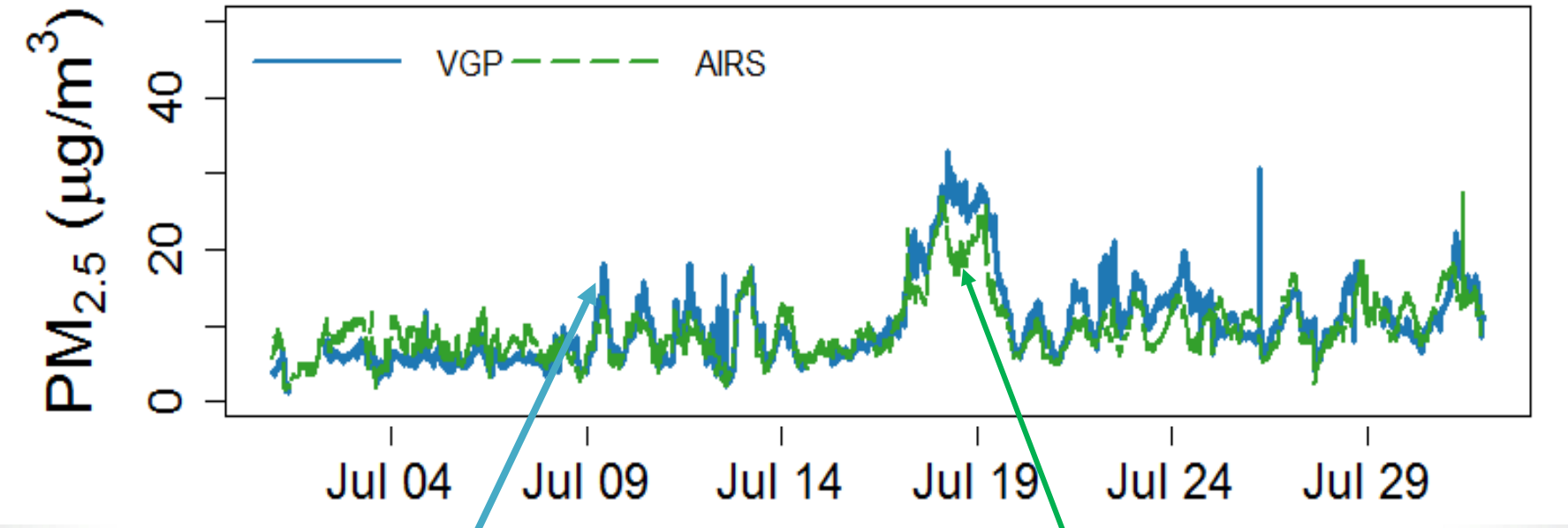


2B Technologies Model-106 exposed to ambient conditions, on solar power

Teledyne T265 in environmentally-conditioned trailer, on landpower

Comparison with nearby benchmark instruments

5-minute $PM_{2.5}$ measurements compared between sites located 1 mile apart



Thermo Scientific pDR-1500 utilizing light-scattering based measurement, exposed to environmental conditions, on solar power

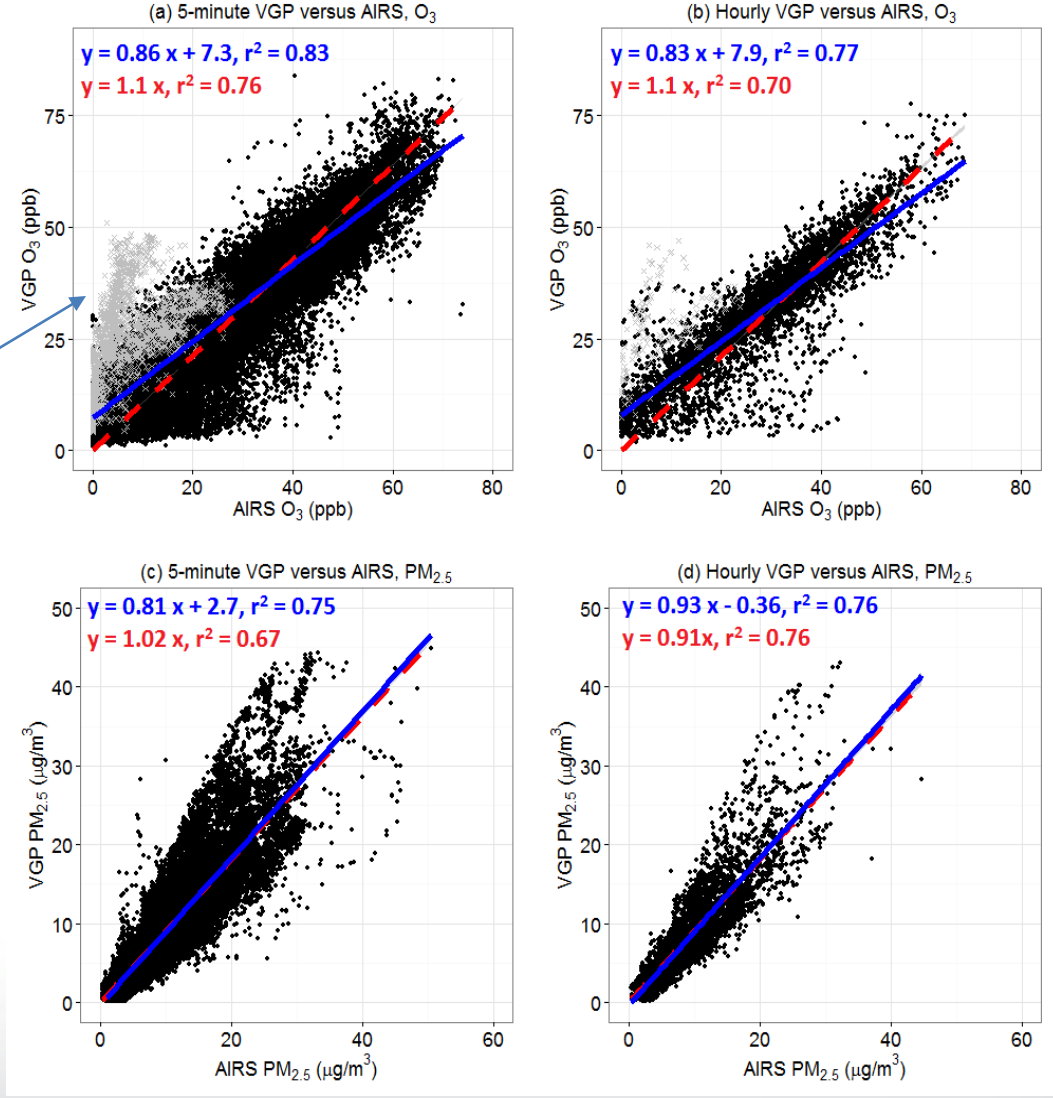
GRIMM Model 180, federal equivalent method for $PM_{2.5}$, in environmentally-conditioned trailer, on landpower

**0.32% of pDR-1500 data flagged and removed for apparent local exhaust ($|\Delta PM_{2.5}|$>15 µg/m^3 in 1 min)*

Comparison with nearby benchmark instruments

Overall good agreement for ozone and $PM_{2.5}$ data over a 10 month timeframe (r^2>0.7)

One week period of notable deviation, under investigation; removing this period leads to r^2 > 0.8



Overall: VGP station reports about 3.6 ppbv or 14% higher ozone; 0.86 µg/m^3 or 8.5% lower $PM_{2.5}$ readings

New effort: Village Green 2

Moving from “prototype” to “pilot” in the United States with state partners

Village Green II Goals:

- Expand on prototype for increased system capability and additional sensors
- Partner with states and communities
- Increase transparency through public access to real time data from multiple data sets
- Utilize AirNow and share IT services with increased data capacity
- Flexibility for long term expansion – platform design with capability to supplement and flexible to allow for interchangeable parts

New effort: Hong Kong collaboration

Collaboration between EPA and HKEPD to pilot-test of rooftop version of system in Hong Kong – interest to see performance for long-term monitoring under higher pollution levels

Expected station deployment by end of the year

Summary

- EPA scientists continue to utilize, test, and develop air monitoring technologies for a wide variety of applications – ranging from regulatory applications to emerging research questions.
- Village Green Project emerged out of an identified technology gap for non-regulatory air monitoring technology to apply in a community area and provide engagement/awareness.
- System design will be publically available and is designed to be flexible.
- Ideally, future versions will expand list of pollutant measures while maintaining goals of renewable power and small footprint.

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