HEI Meeting
Seattle, WA USA
6 May 2019

Slides at: https://tinyurl.com/hei2019

Harmonizing Disparate Global and Local Air Quality Data to Support Research and Communication

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A 501(c)(3) non-profit based in Washington, DC, USA
openaq.org

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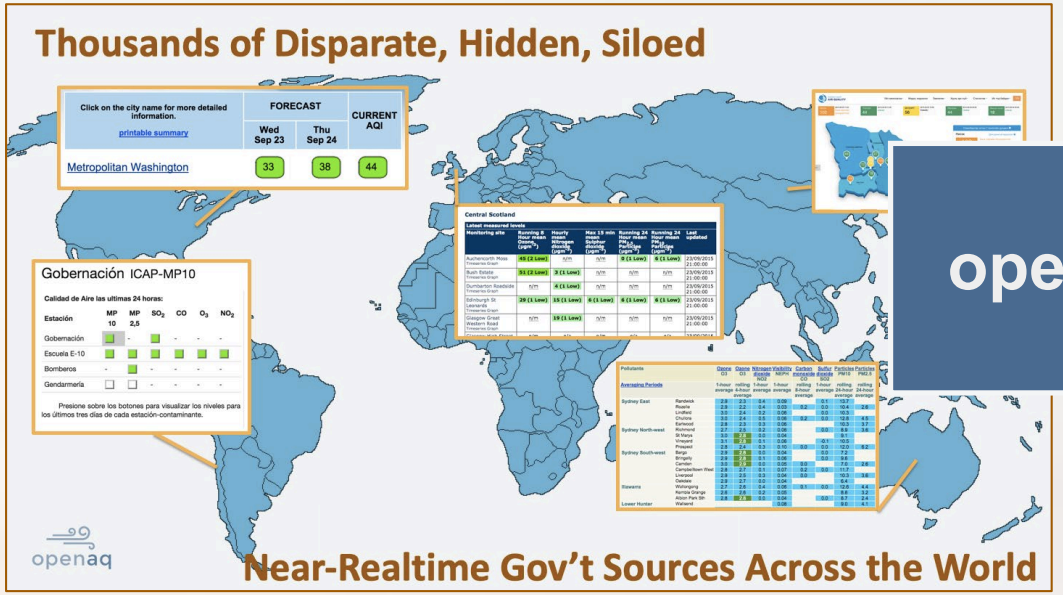
Context for Talk



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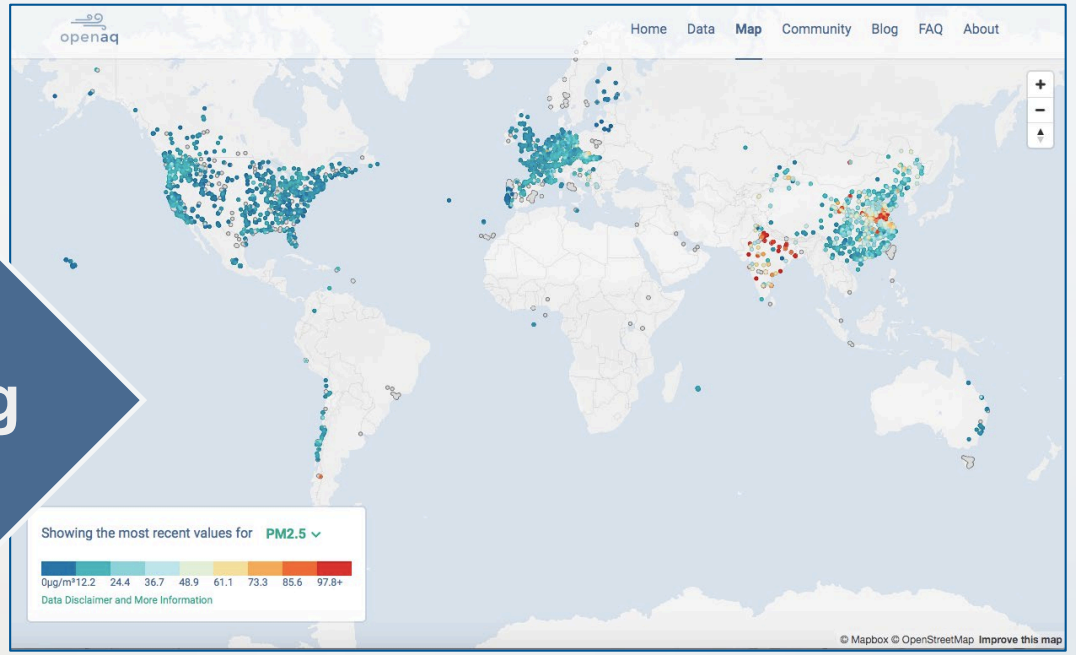

- Near-real time government ground monitoring data (15 min – hourly)
- $PM_{2.5}$, PM_{10}, SO_2, CO, NO_2, O_3 (and some BC)
- 70 countries, 2656 cities, 10000+ stations
- Automatic system checks for new data every 10 min
- Data are available in **one harmonized format** via several access points
- >400 million open data points since 2015, ~15 million data requests/month

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$PM_{2.5}$ and PM_{10} = particulate matter less than 2.5 and 10 micrometers in diameter
SO_2 = sulfur dioxide; CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; BC = black carbon

Talk Outline

1. Why Open, Harmonized Air Quality (AQ) Data?
2. Current Global Air Quality (AQ) Landscape *(government ground monitoring, ≤ annual)*
3. Scientific (and Other) Use-Cases
4. New Frontiers: Improving the Landscape

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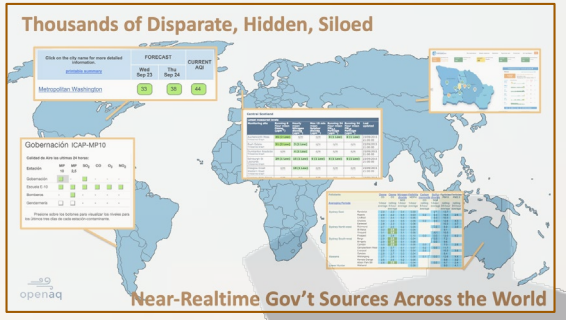
Why: OpenAQ's Non-Profit Mission: Fully maximizing existing open air quality data by connecting it to people in diverse sectors and geographies



Disparate AQ Open Data Collected Across the World

Open, Transparent, Accessible Universally-Formatted Data

Media

Government/Policy

Climate Change + Public Health Research

Private Sector

Educational Activities

OpenAQ

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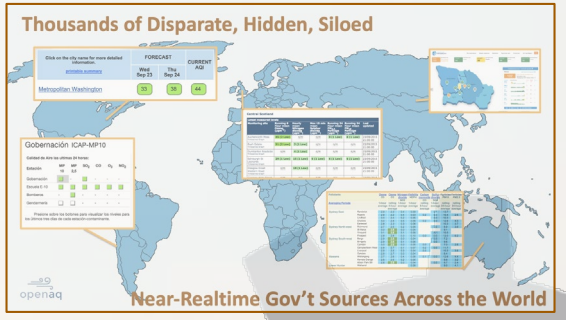

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Disparate AQ Open Data Collected Across the World

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Oper

7 out of 10

of the **most cited** large-cohort studies on impact of air pollution on health in *Web of Science* used open data provided by a government source

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2018 Annual Average $PM_{2.5}$ for Cities Across the World

All data from 2018

- Annual averages created from gov't ground monitoring data, collected over the **same period of time as one another**
- Similar annual averages could be created from near-real time (15 min to hourly) data for **O_3, NO_2, SO_2, CO, PM_{10}**
- **All near real-time government** data are harmonized and open on openaq.org, **open-source code for annual averages** is on github.com/openaq
- **Open-source code takes seconds to scan ~400 million data points** to calculate city-level averages, modifiable to a user's specific 'cleaning' regime

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Data accessed from openaq.org

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For combining GM + Satellite + CTM for GBD-related efforts - From Shaddick et al. (2017):

and other land use variables.

In the current implementation, a single annual average of ground measurements is used for each monitoring location. For 2014, 46% of the measurements from the WHO cities database come from that year with the remainder coming from the closest year for which data were available. This results in 82% of the measurements coming from 2014 or 2013 with the majority of the remainder coming from the period 2010–2012. As monitoring networks develop, in some areas there will be the possibility of multiple measurements at specific locations over time and future developments of the model might include a temporal component that would acknowledge the temporal aspect of the data, possibly with lower weight given to less recent measurements. At present, one approach to reducing the issues that might arise when comparing measurements

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GM = Gaussian model; CTM = chemical transport model; GBD = global burden of disease
$PM_{2.5}$ = fine particulate matter

Data accessed from openaq.org

2018 Annual Average $PM_{2.5}$ for Cities Across the World

All data from 2018

(Me, paraphrasing:

"It'd be great to have up-to-date ground monitoring data from more places and that are from the same time period.")

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Data accessed from openaq.org

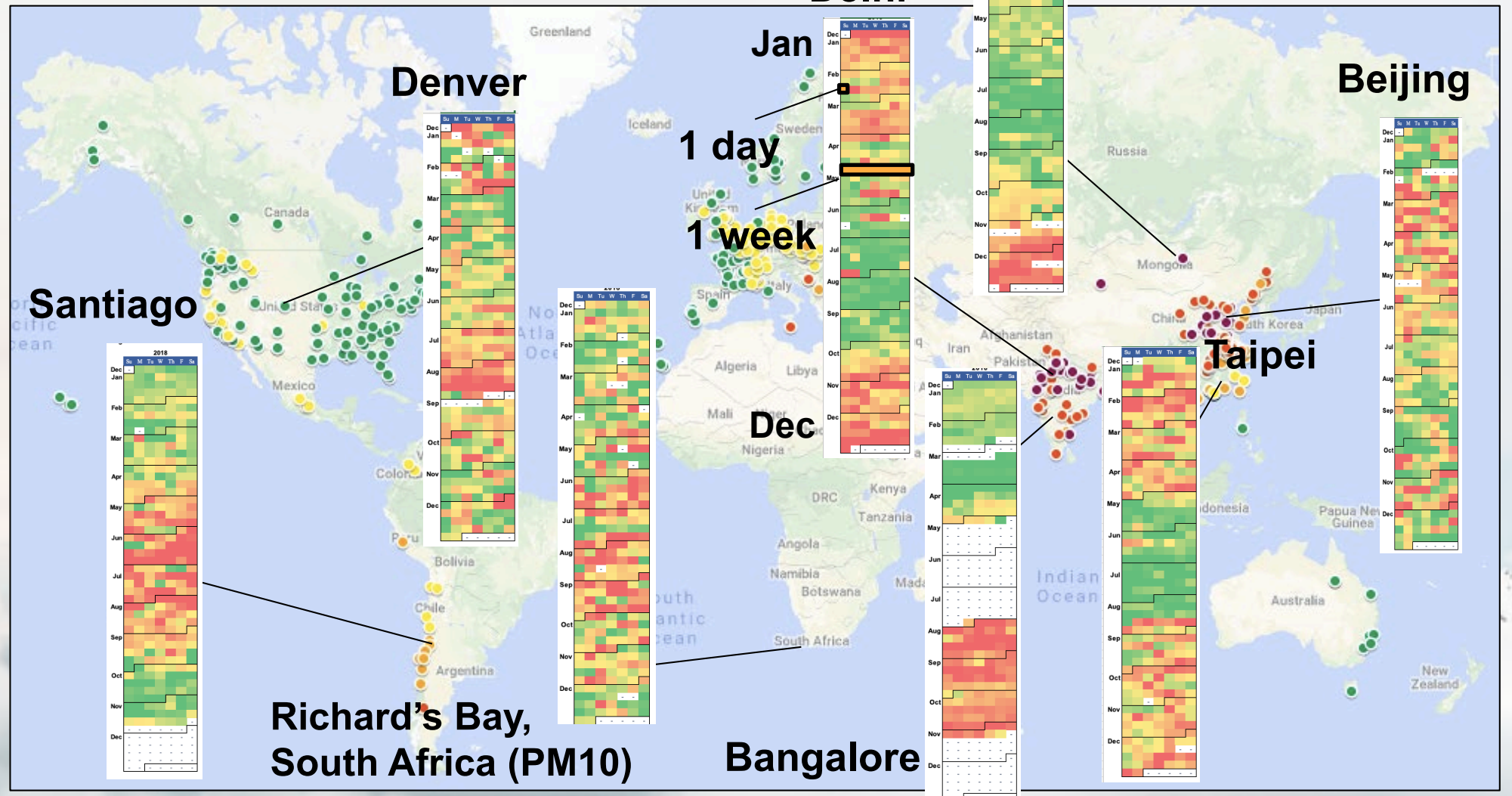
Comparison with WHO Outdoor Database

WHO = World Health Organization

	2018 WHO Outdoor AP Database	Data Accessed from OpenAQ
Ground Monitoring Type	Gov't stations, (small amount of research grade data)	Gov't stations, small amount of research grade data; distinguished in data format
Data Source	Primarily provided by gov'ts directly to WHO	Accessed in near-real time via through public gov't portals (website, API, ftp, etc.)
Pollutant Type	$PM_{2.5}$, PM_{10}	$PM_{2.5}$, PM_{10}, O_3, NO_2, CO, SO_2 (small amount of BC)
Coverage	11962 sub-city level, 4300 cities, 108 countries	10396 station-level, 2656 cities, 70 countries
Temporal Resolution	Annual	Near real-time data (typically 15 min – 1 hour)
Data Latency in Annual Average	1-10 years	None
Update Frequency	~2 years	Every ten minutes
Quality Control	May be performed by gov'ts, but process often not specified, nor uniform across countries	May be performed by gov'ts, but process often not specified, nor uniform across countries

The Global Landscape Beyond the Annual Average: $PM_{2.5}$ Daily Views - 2018

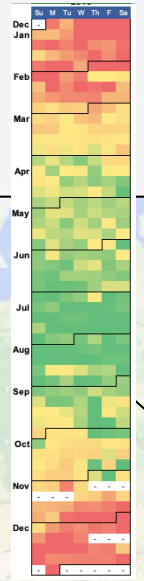
Data accessed from openaq.org



(Daily-average color-scales are only comparable between days in a given city; not across cities)

Local Trends Over Time

Ulaanbaatar



Data accessed from openaq.org

Ex. Comparing Ulaanbaatar, Mongolia Winters
including data from 2019

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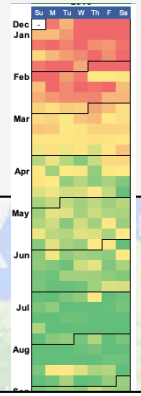
Local Trends Over Time

Ulaanbaatar



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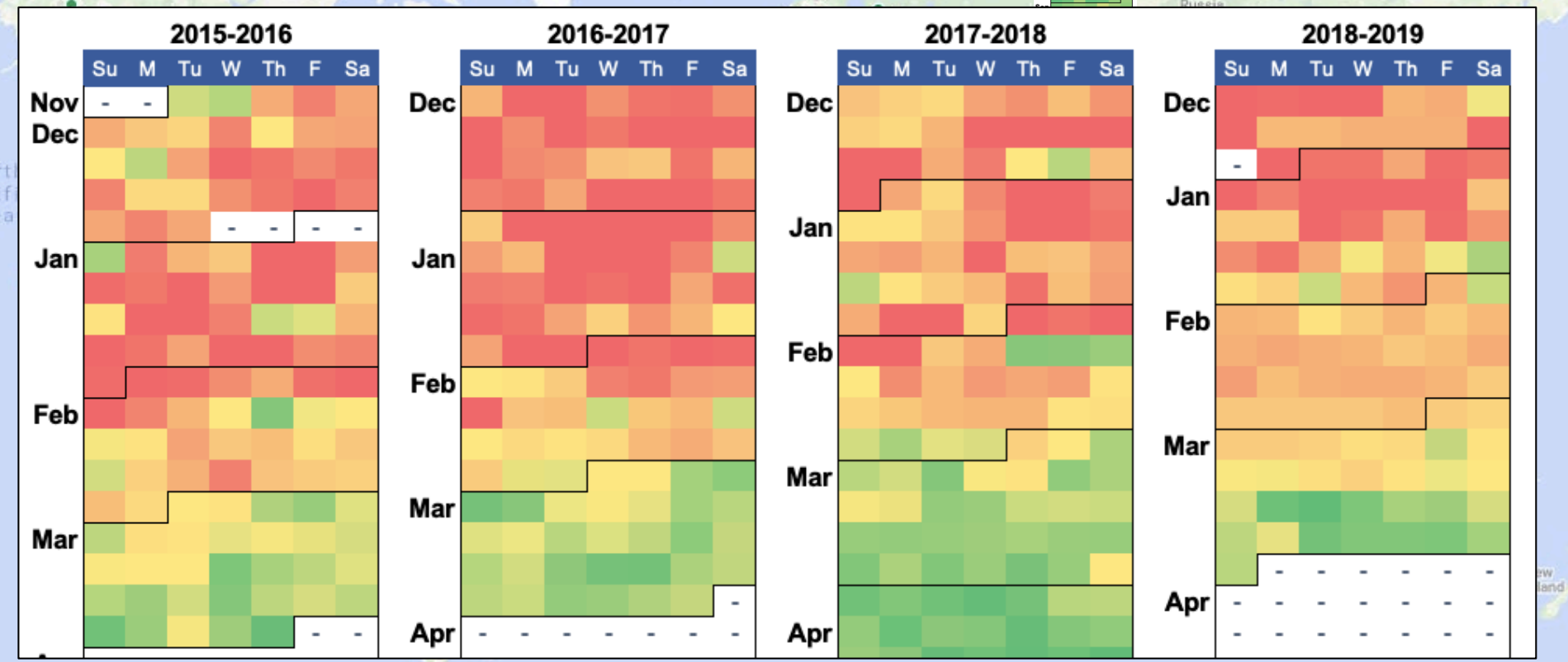

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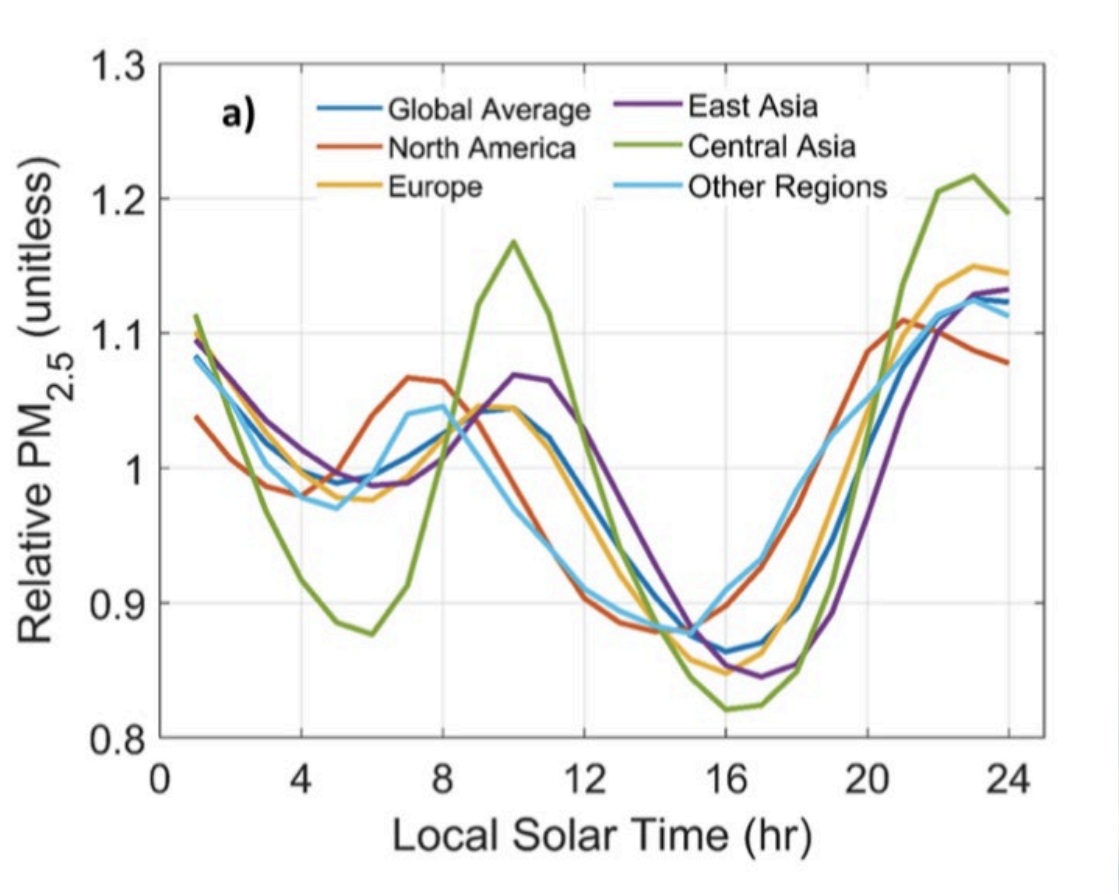
Use Case, Sub-Daily - What does the Daily Planetary "Heartbeat" of Air Pollution Look Like?



Manning et al., ES&T Letters (2018)

Max Manning, an undergraduate in Randall Martin's group at Dalhousie University, published a paper addressing **this basic question** by using open data accessed from the OpenAQ platform.

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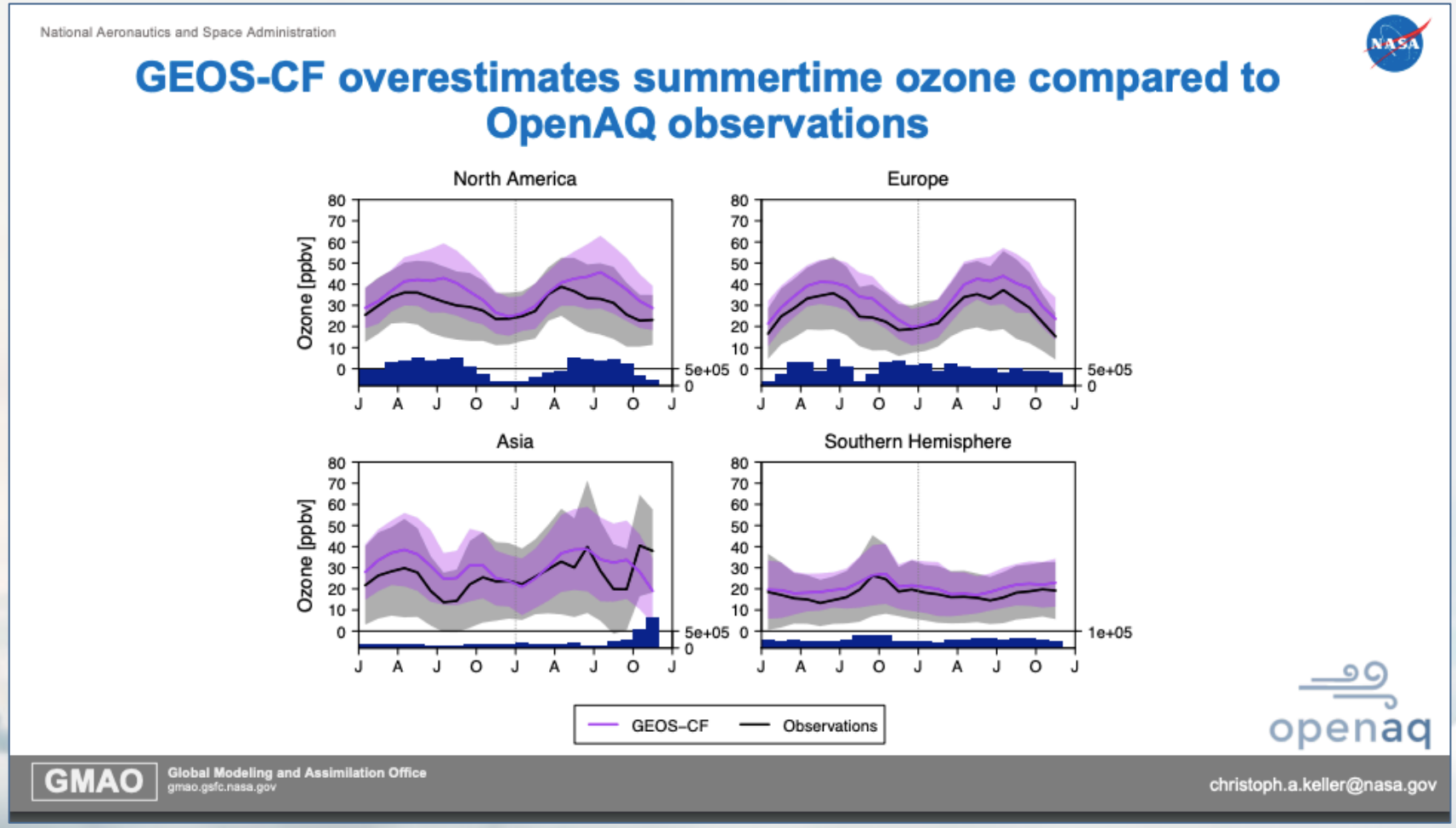
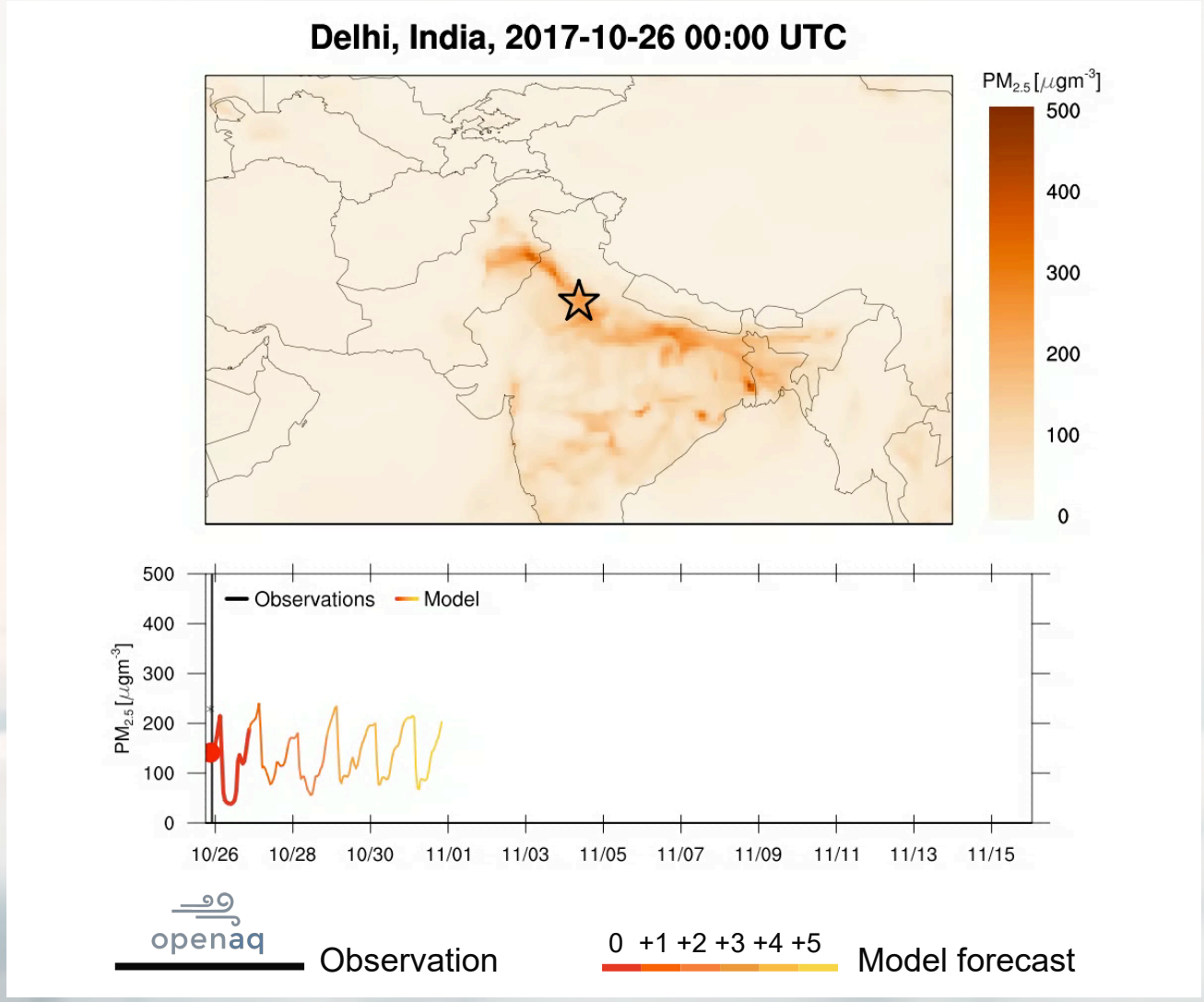
Use Case, Model Insights #1: More data from more cities unearth differences between observations and models



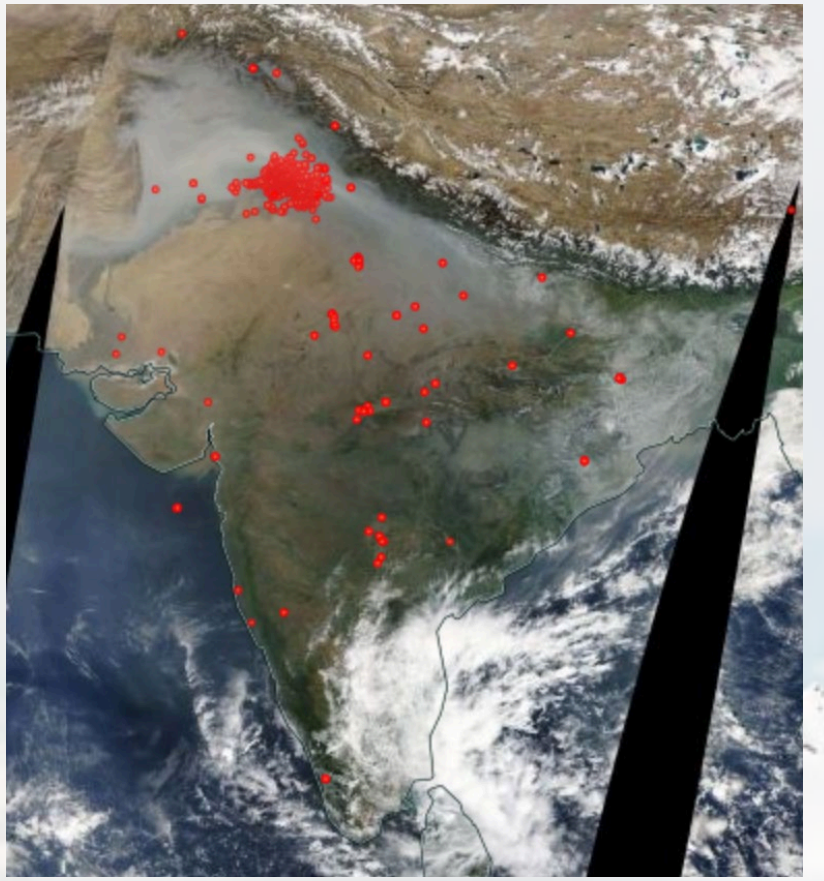
Slide courtesy: Christoph Keller, NASA

Use Case, Model Insights #2: Forecasting Air Quality (AQ) in India

Case study: agricultural fires in India



MODIS fires Nov 01, 2017



Slide courtesy: Christoph Keller, NASA

Lightning Round of Other Use Cases:

Calibrating sensors

Airveda

Airveda presents an air quality monitor designed and manufactured in India, for the Indian context. Airveda uses OpenAQ as a means to calibrate deployed monitors.

Learn More

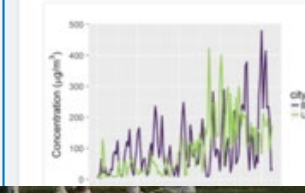
Smokey: Air Quality Bot

Amrit Sharma of New Delhi, India has built a free app to inform the public with air quality data and let them create customized alerts. His system pulls data from OpenAQ.

Learn More

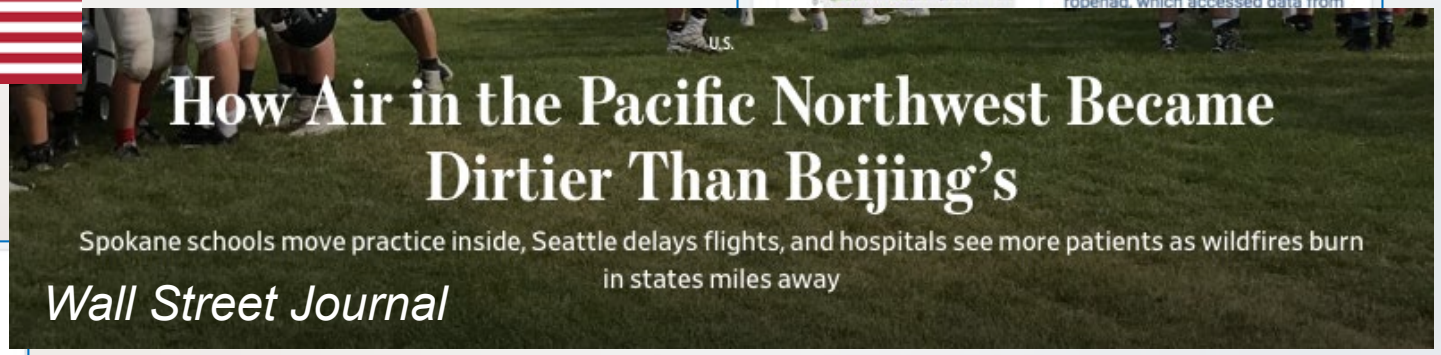
Building Apps

Data-driven journalism



Putting a magnifying glass on air pollution

An article in the UB Post by Oyungerel Munkhbat of Ulaanbaatar, Mongolia featured graphics generated by Maëlle Salmon via ropenag, which accessed data from



U.S.

How Air in the Pacific Northwest Became Dirtier Than Beijing's

Spokane schools move practice inside, Seattle delays flights, and hospitals see more patients as wildfires burn in states miles away

Wall Street Journal

Private Sector

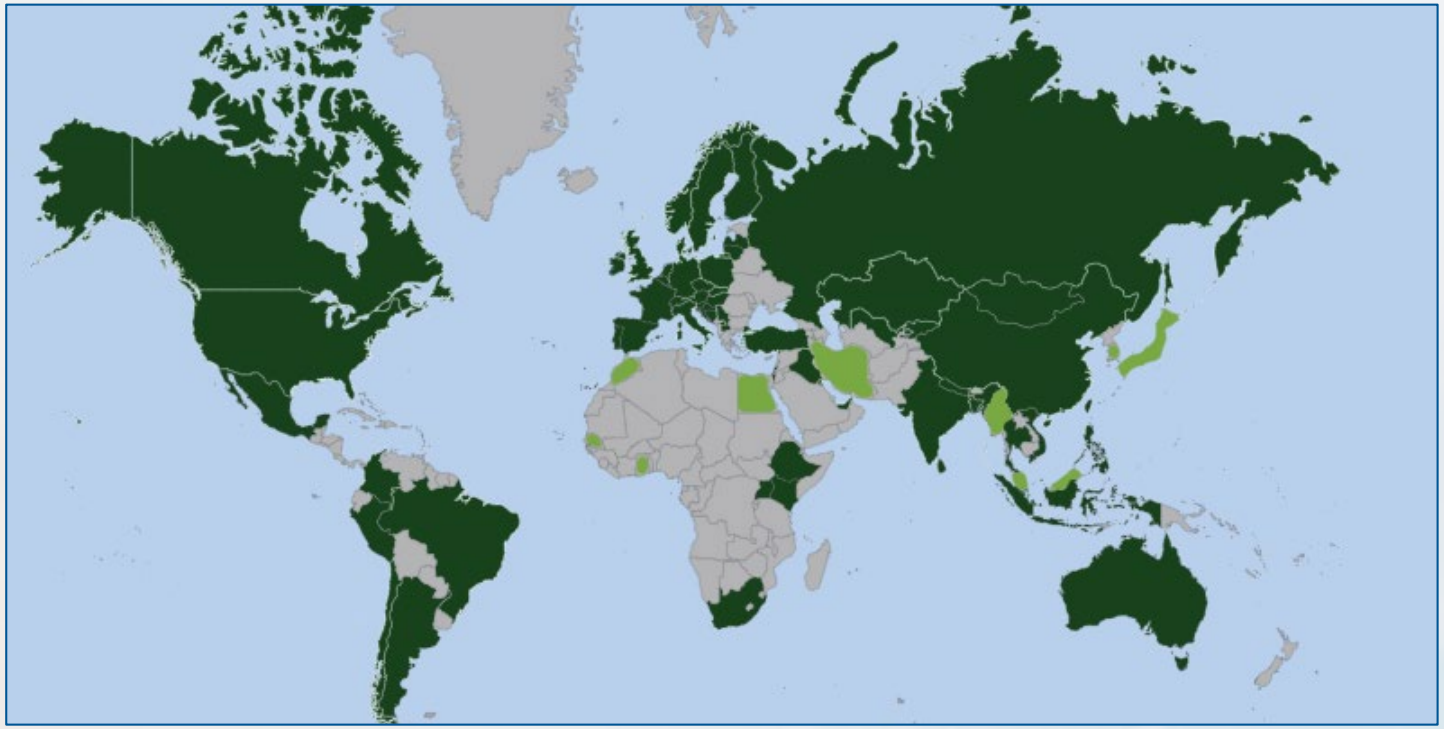
aclima

openaq

More Examples: https://openaq.org/#/community

New Frontiers: Improving the Sub-Annual AQ Landscape

- Filling data gaps – working with governments to share data more (and in better ways)
- Creating more open-source tools to wrangle data
- Launching a Meta Data Editor w/ Dr. Martin Schultz, Forschungszentrum Jülich, github.com/openaq



Countries with Air Quality (AQ) open data of some sort

Countries not on OpenAQ / monitor but *may* not share AQ data in an easily accessible way

Countries' AQ data status unknown (to us)

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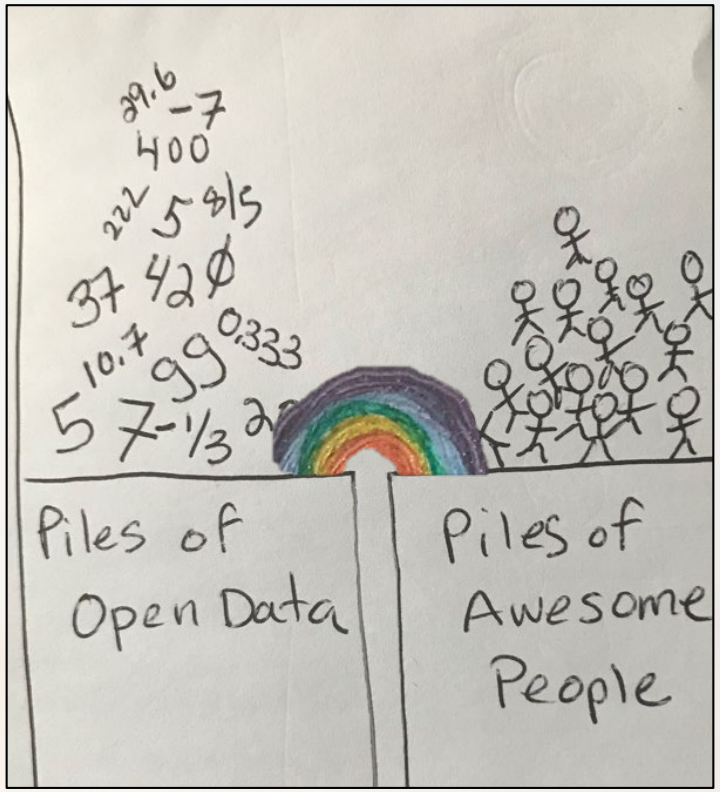

THANK-YOU!

Thanks to the OpenAQ Community and our Partners:

Slides at: https://tinyurl.com/hei2019

Contact: openaq.org | christa@openaq.org | @open_aq

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