

Air quality measurements of volcanic air pollution: Using low-cost sensors to monitor a major AQ event



Photo: Jim Ciszewski

Jesse Kroll¹, David Hagan¹, Benjamin Crawford¹, Colette Heald¹,
Kathleen Vandiver², Ilene Grossman³, Elizabeth Cole³



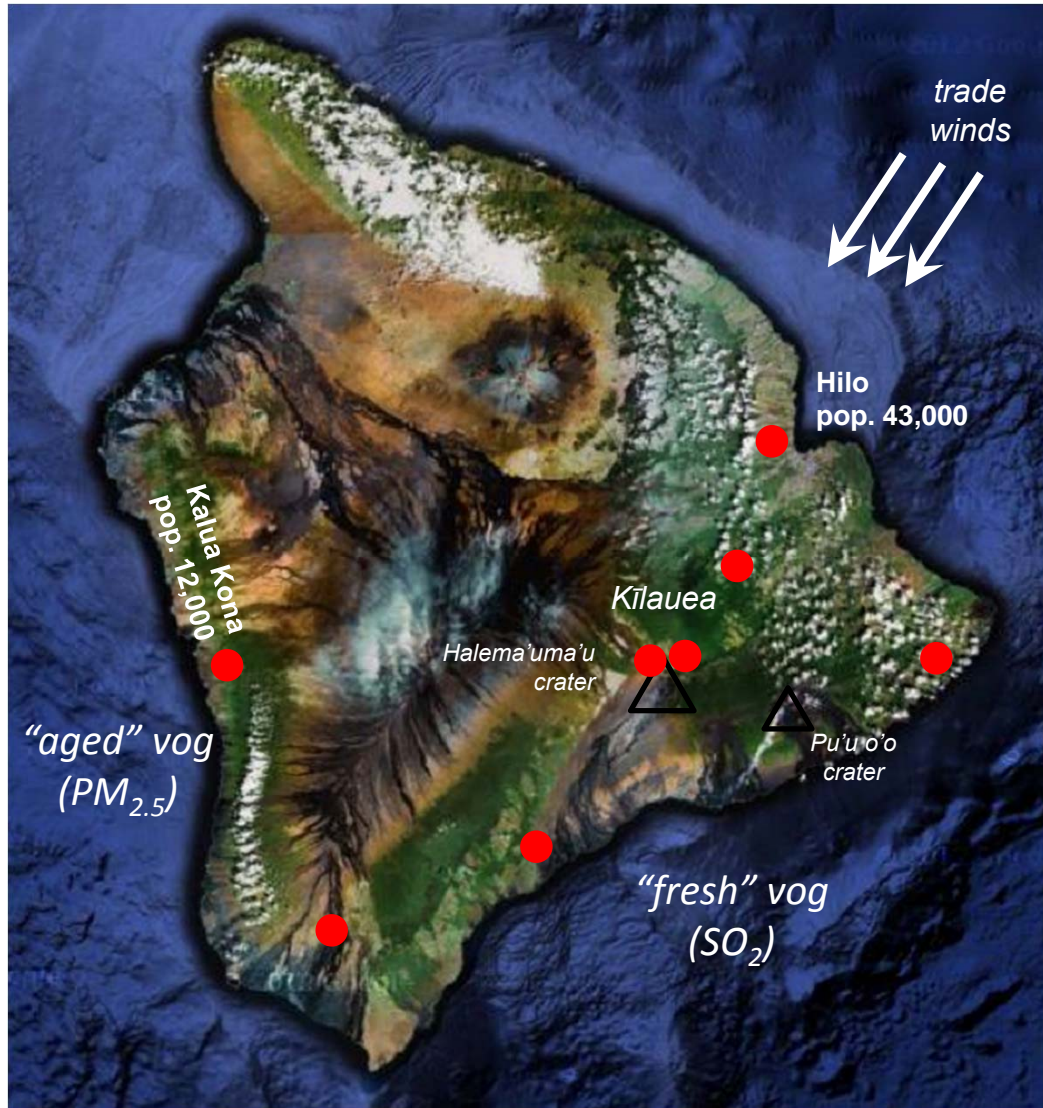
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Background: Air quality in Hawai'i



area 10,400 km²
pop. 187,000

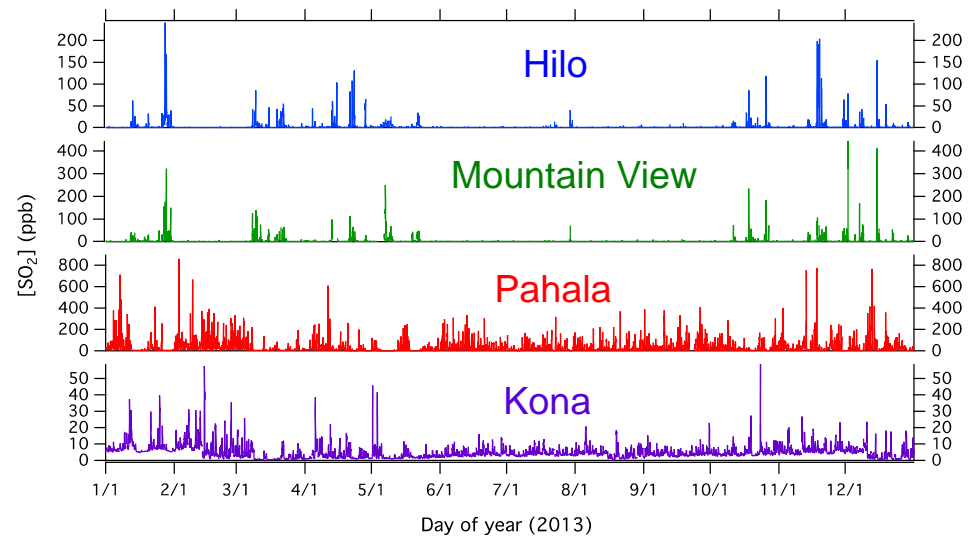
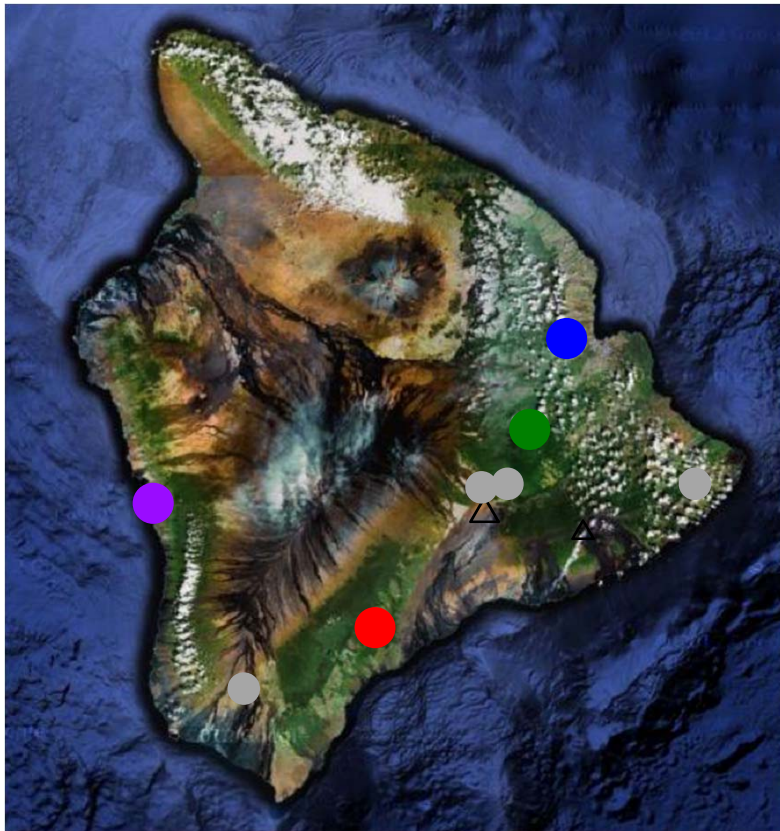
Kīlauea Volcano:

Largest point source of
SO₂ in the U.S. (~1 Tg/yr)

SO₂, PM_{2.5} (volcanic smog,
or “vog”) represent a local
nuisance and health concern

AQ monitoring stations
run by DOH, NPS, USGS

Spatial, temporal variability of the vog



data from Hawaii Dept. of Health Air Quality stations

*Our (original) objective:
Set up a network of SO₂+PM monitors around the island, as a
research testbed, community resource, educational tool*

...but then....

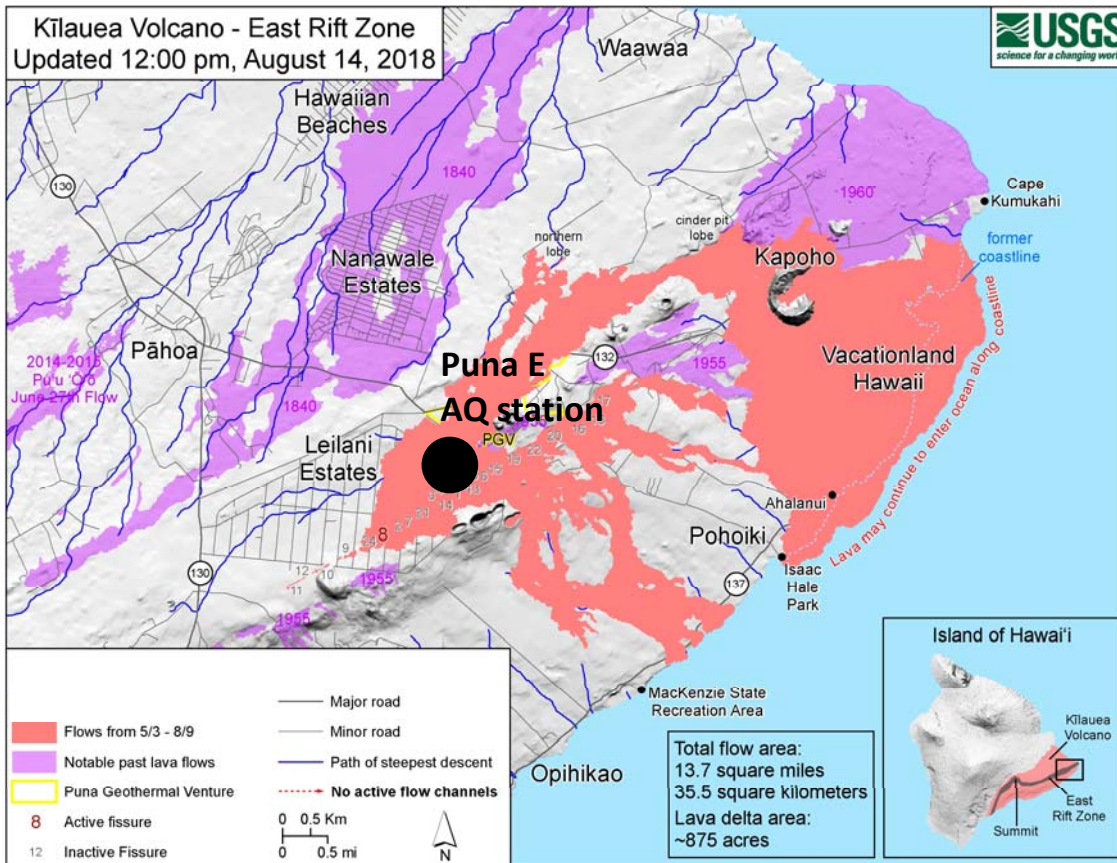
Lower East Rift Zone (LERZ) eruption, beginning on 3 May 2018



>700 homes
destroyed
35 km² of land
covered by lava
3.5 km² of new land
Increase in SO₂
emissions by >10x



AQ monitoring during the eruption



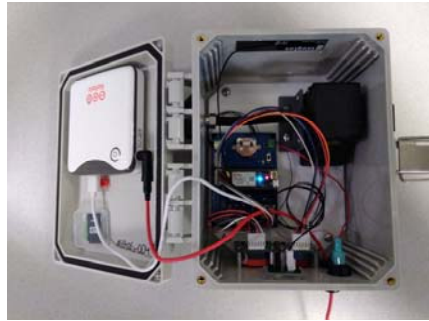
Puna AQ station first lost power (5 May), then was lost to the lava → no local AQ measurements

Request by DOH, community partners for AQ sensors

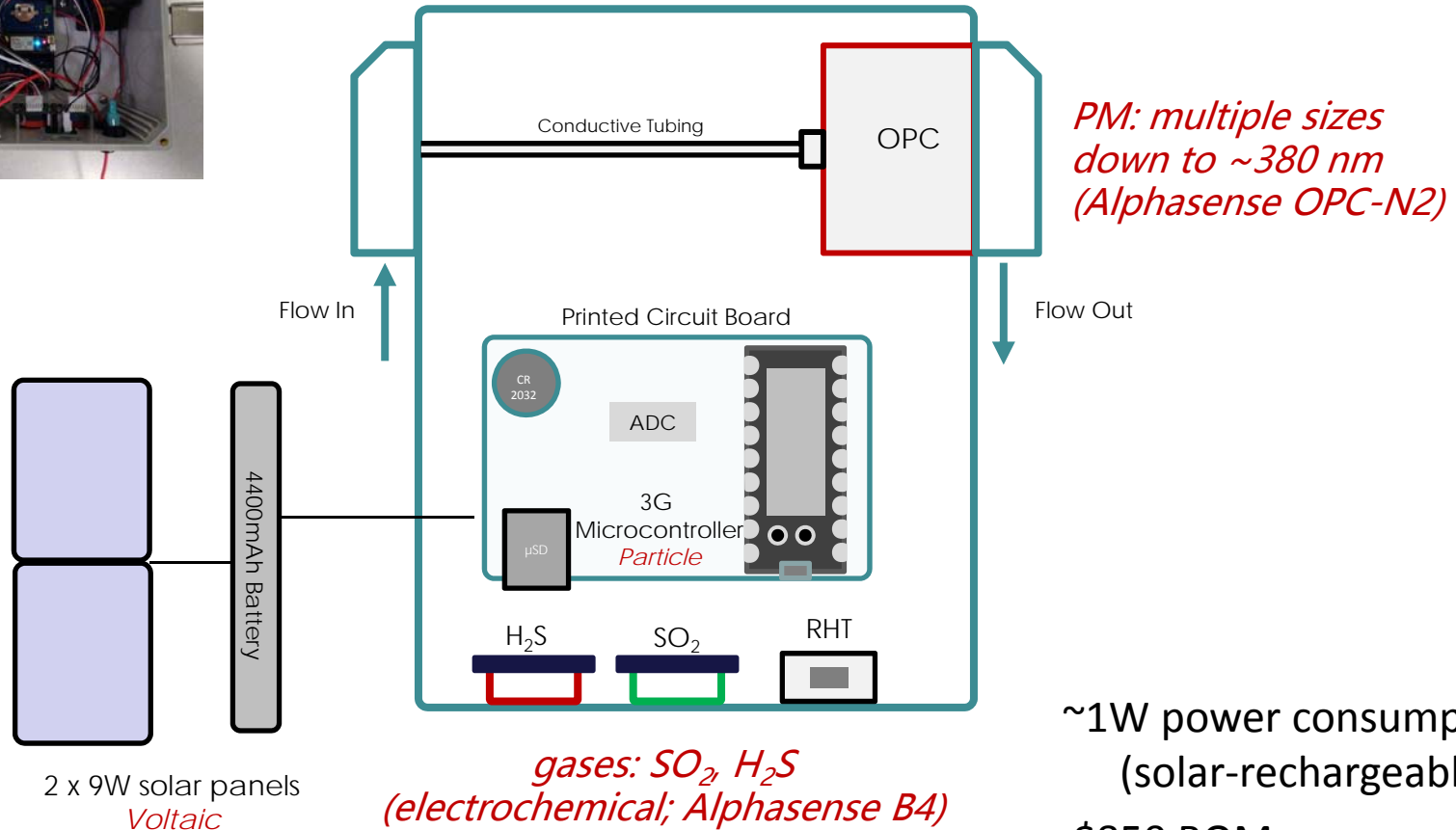
Sent several SO₂ sensors for use in Puna region (residential area, 10s of ppm SO₂)

Need for additional monitoring throughout the island

Hawai'i Multi-Pollutant Air Quality Sensor (HI-MPAQS)



Based on MPAQS design by David Hagan



PM: multiple sizes
down to ~380 nm
(Alphasense OPC-N2)

~1W power consumption
(solar-rechargeable)

\$850 BOM

data sent to server via 3G
every minute

Sensor deployment

20-27 May:

- 30 MPAQS units
- SO₂ calibration by co-location at DOH stations [Hagan et al., *AMT* 2018]
- Deployed throughout the island



David Hagan

Ben Crawford

Challenges

Major failure modes:

- Loss of battery power
- Loss (or lack) of 3G signal

Calibration: how much is enough?

Quantitative PM measurements
(broad range of particle sizes;
sulfate + high RH)



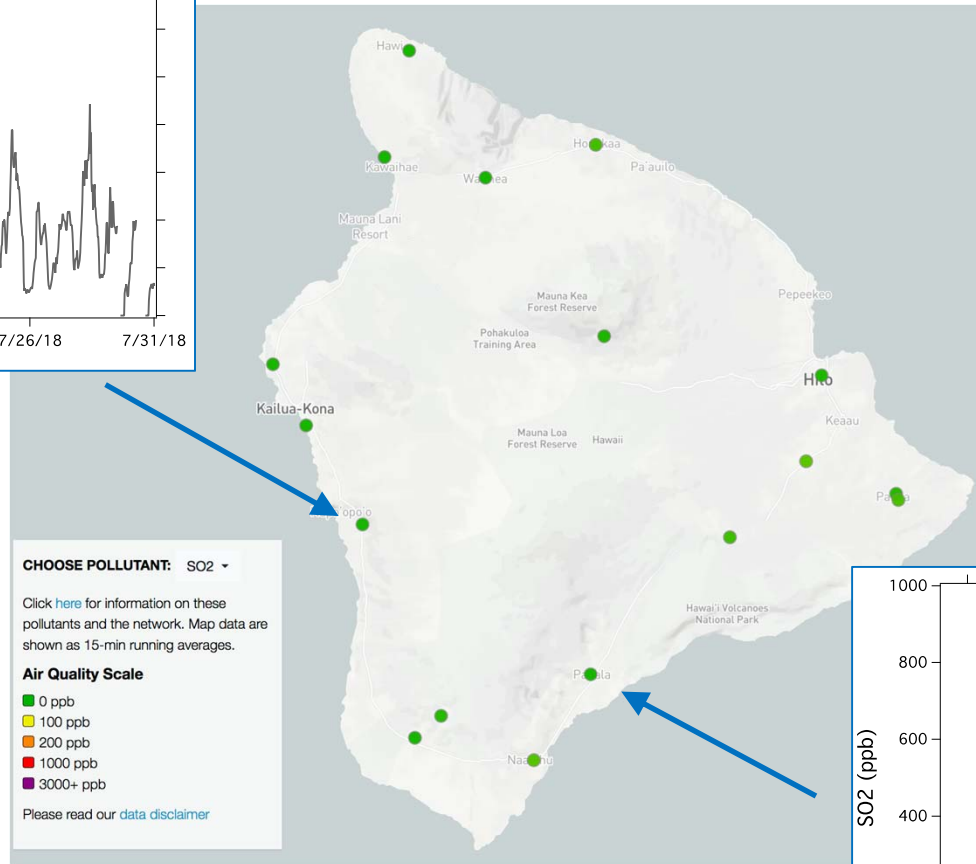
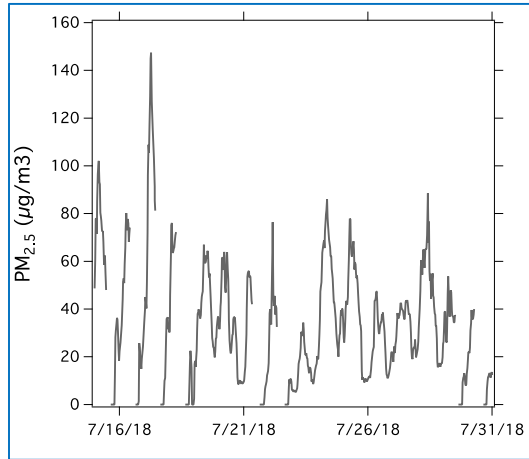
Ants

Hurricanes

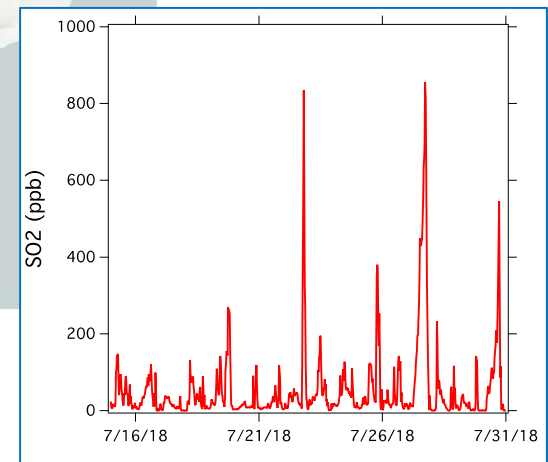
Lava



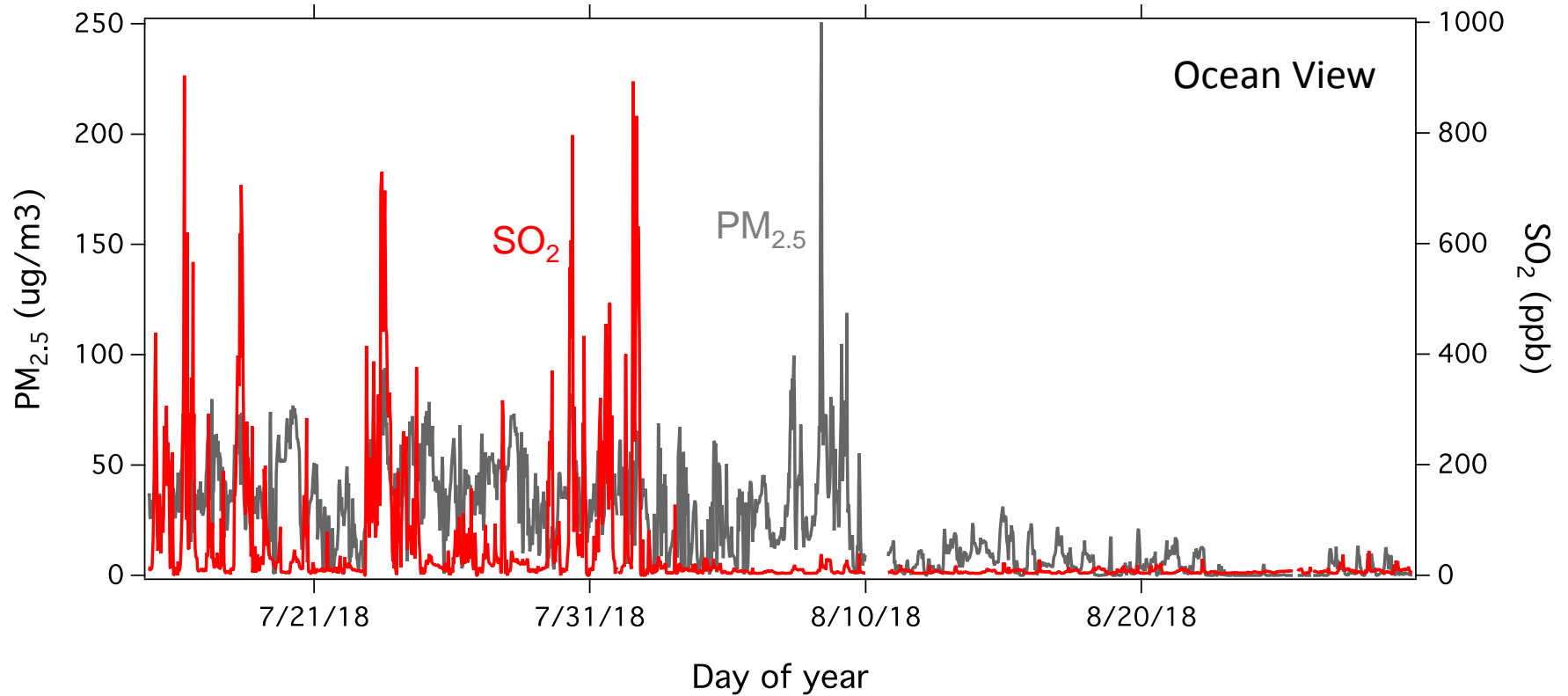
Current network



<http://www.voginfo.com>
database, website by David Hagan



...but then...



early August 2018: Cessation of volcanic activity
(cleanest air since 2007... possibly earlier?)

Major lessons (for us)

Community interest high (lack of available data), esp. among educators

Interactions with government agencies

AQ sensing for continual monitoring vs. sensing for emergency response:

- less time to troubleshoot, iterate on designs
- accuracy requirements (time for calibration, QA/QC)
- expectations about power, communication
- AQ events/emergencies can start, stop abruptly

Need to be ready!



Acknowledgements/collaborators



MIT CEE: **David Hagan, Ben Crawford**, Colette Heald

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Wallace, Jim Ciszewski

Alphasense, Ltd.: John Saffell

Eric Johnson (logistical support)

Sensor hosts (*too many to list here!*)

