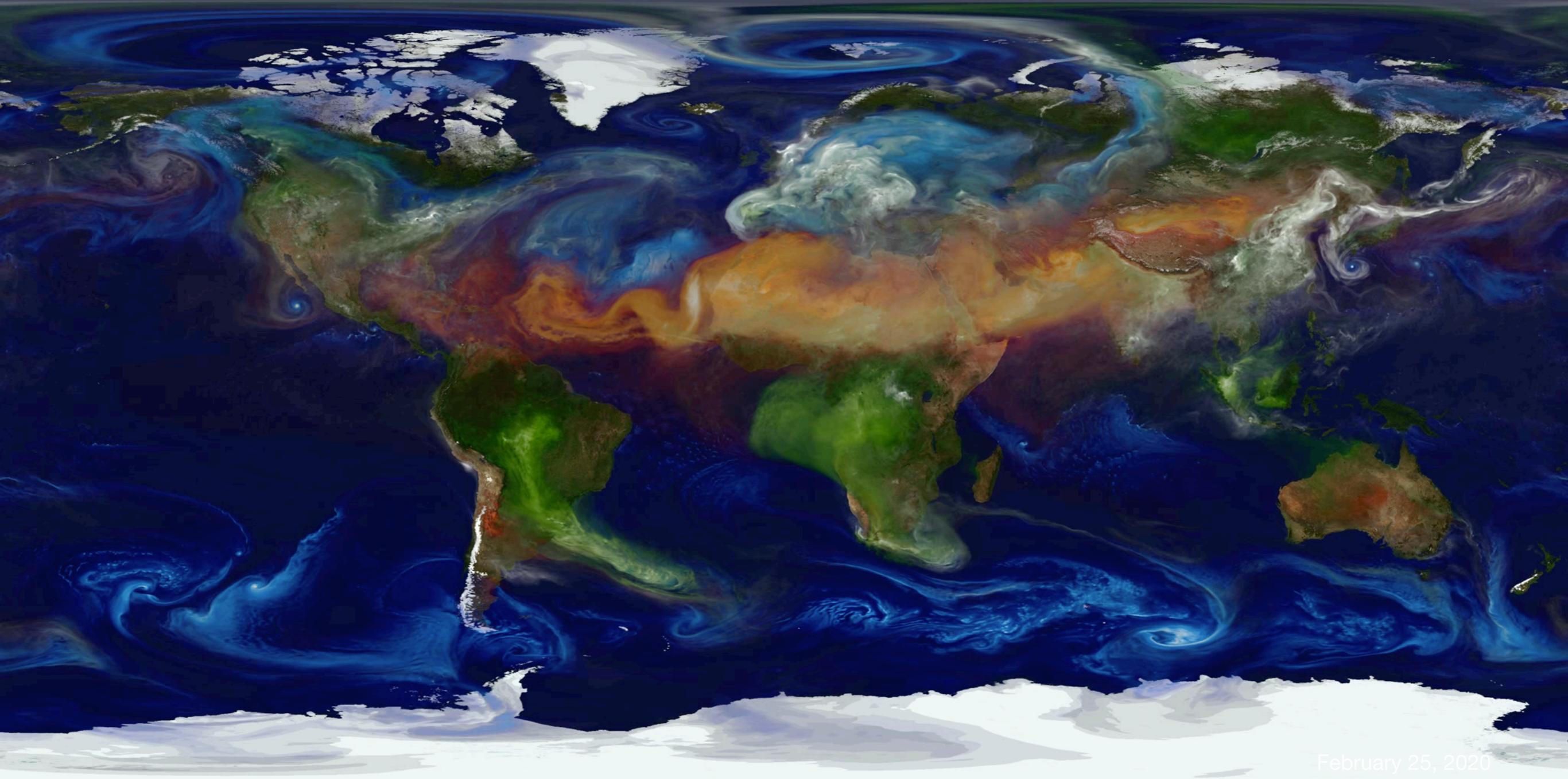


wheeCAIR Cullowhee Clean Air Sensor

Al Fischer, PhD
Instrumentation Specialist
Chemistry and Physics | Western Carolina University

THE AIR WHEE BREATHE | February 27, 2020

introduction | global aerosols

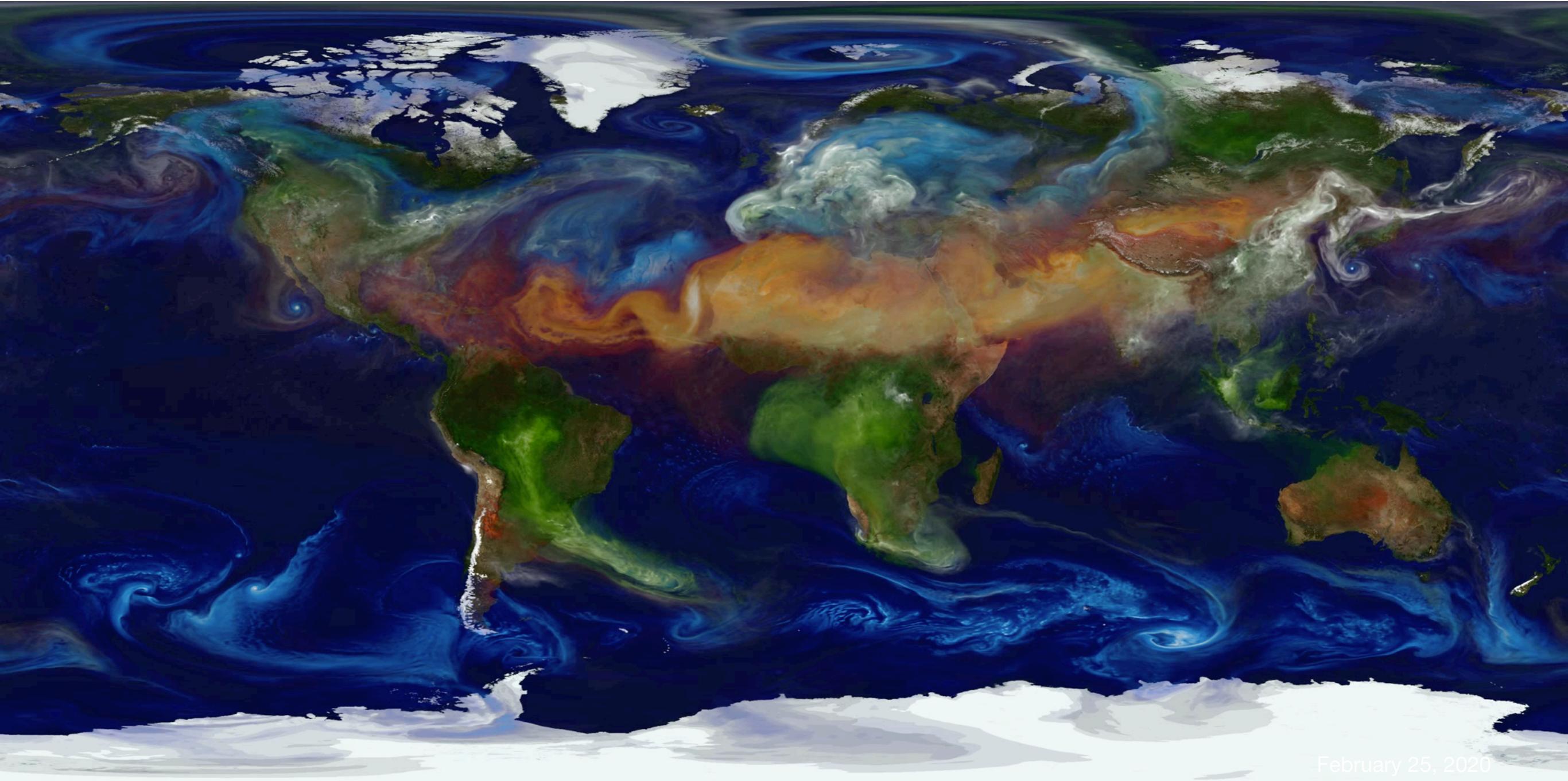


February 25, 2020

dust – smoke – sulfate – sea salt

William Putman, NASA/Goddard

introduction | global aerosols

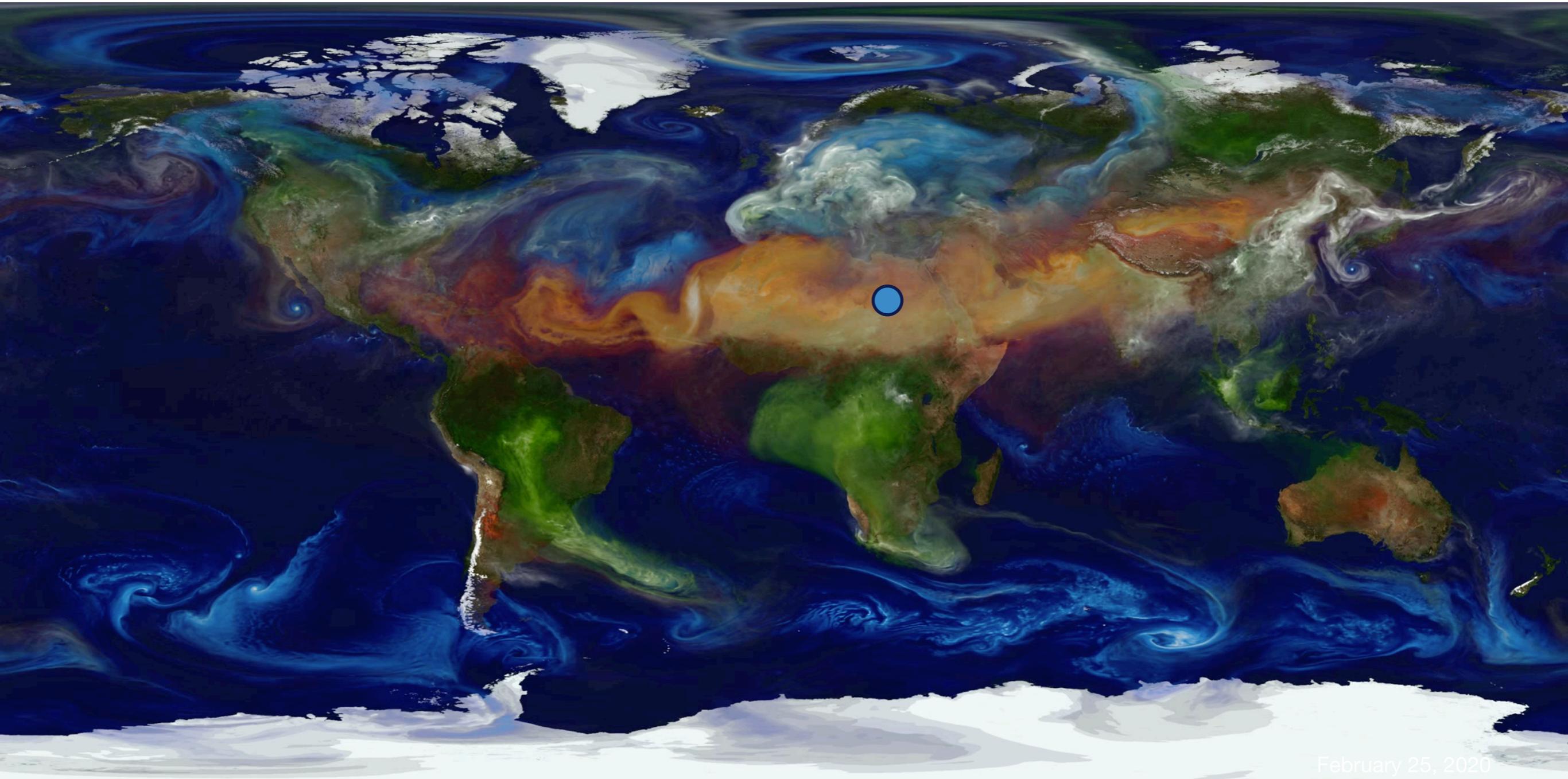


February 25, 2020

dust – smoke – sulfate – sea salt

William Putman, NASA/Goddard

introduction | global aerosols

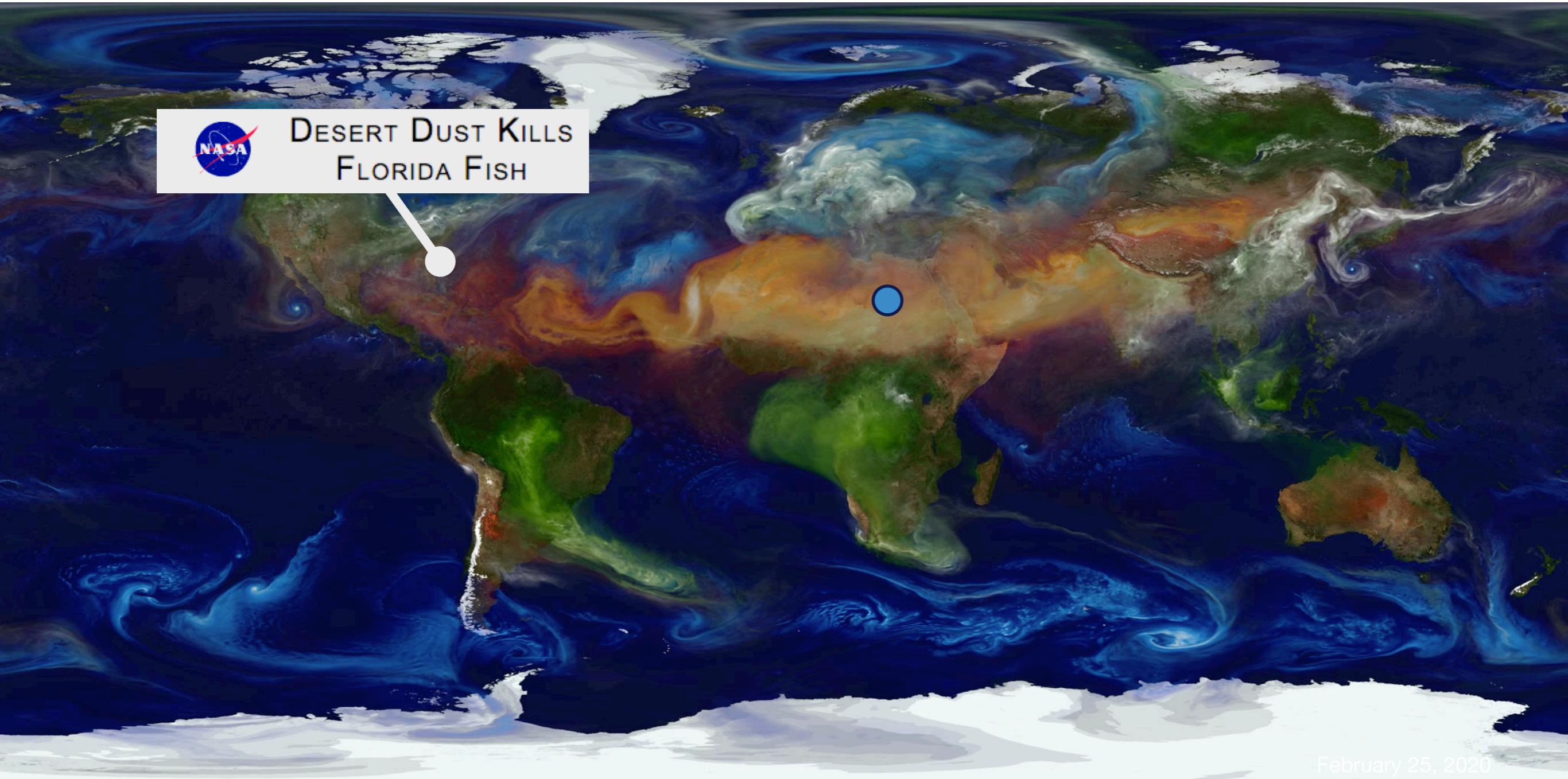


February 25, 2020

dust – smoke – sulfate – sea salt

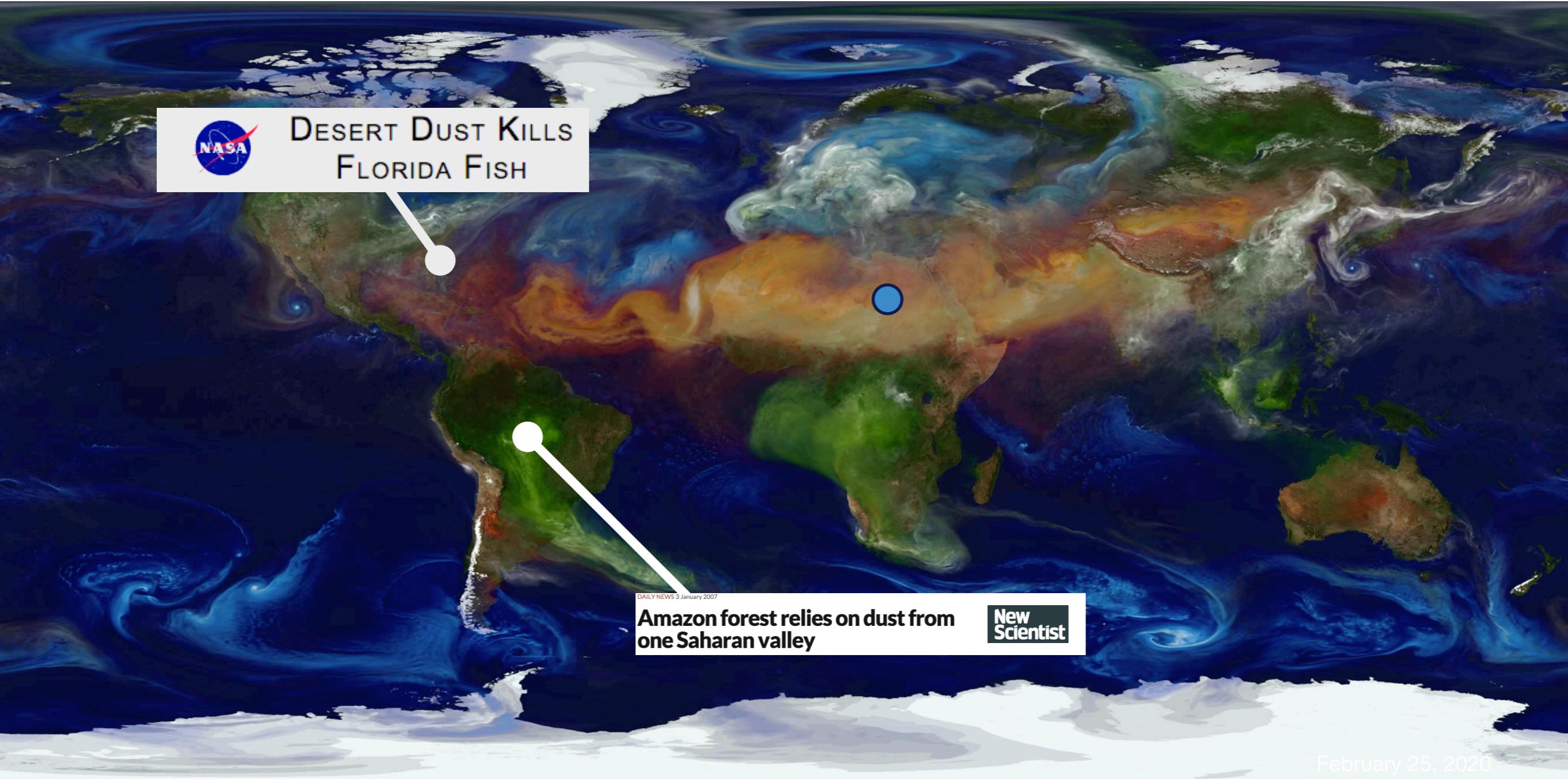
William Putman, NASA/Goddard

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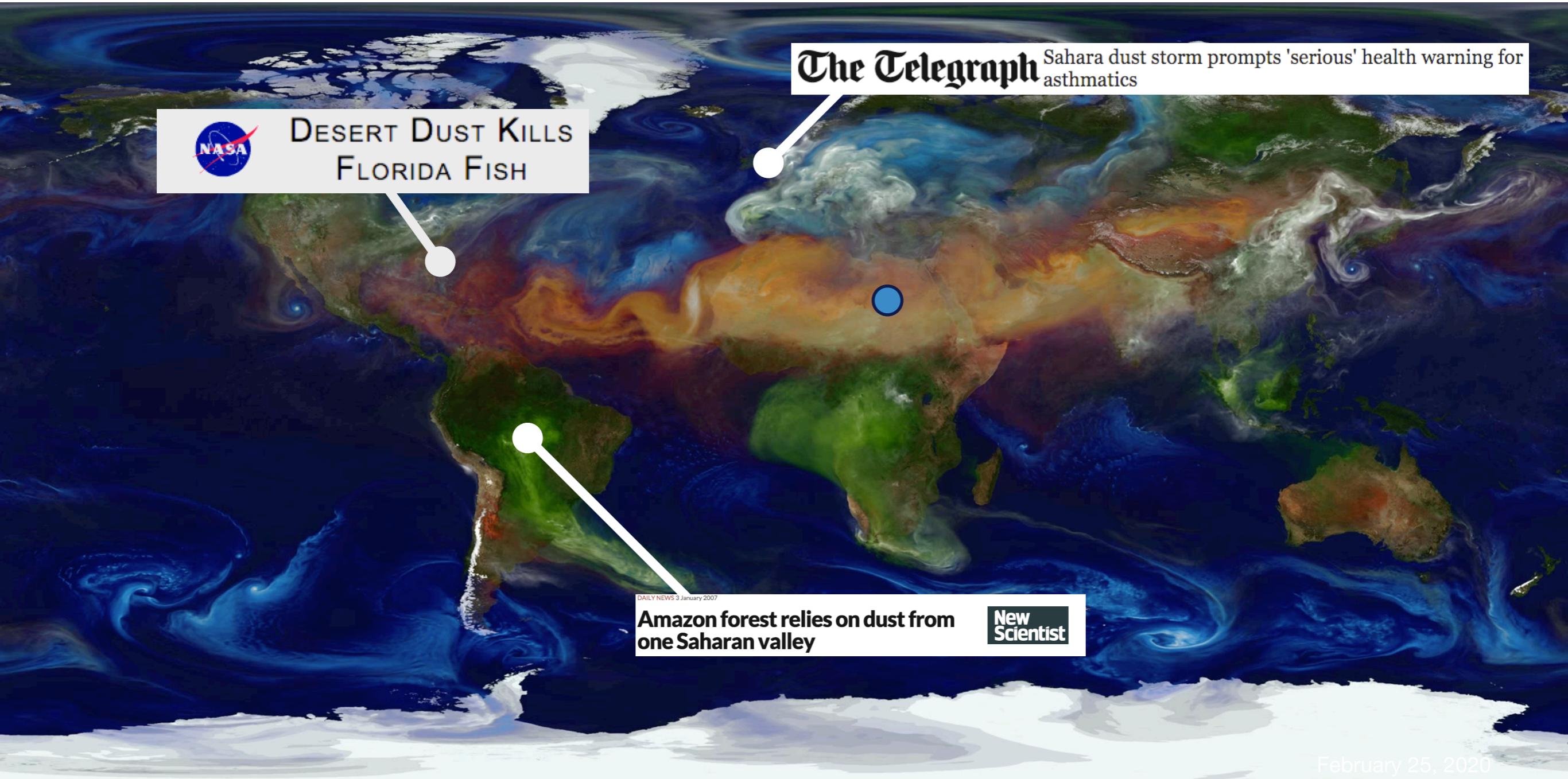
dust – smoke – sulfate – sea salt

introduction | global aerosols



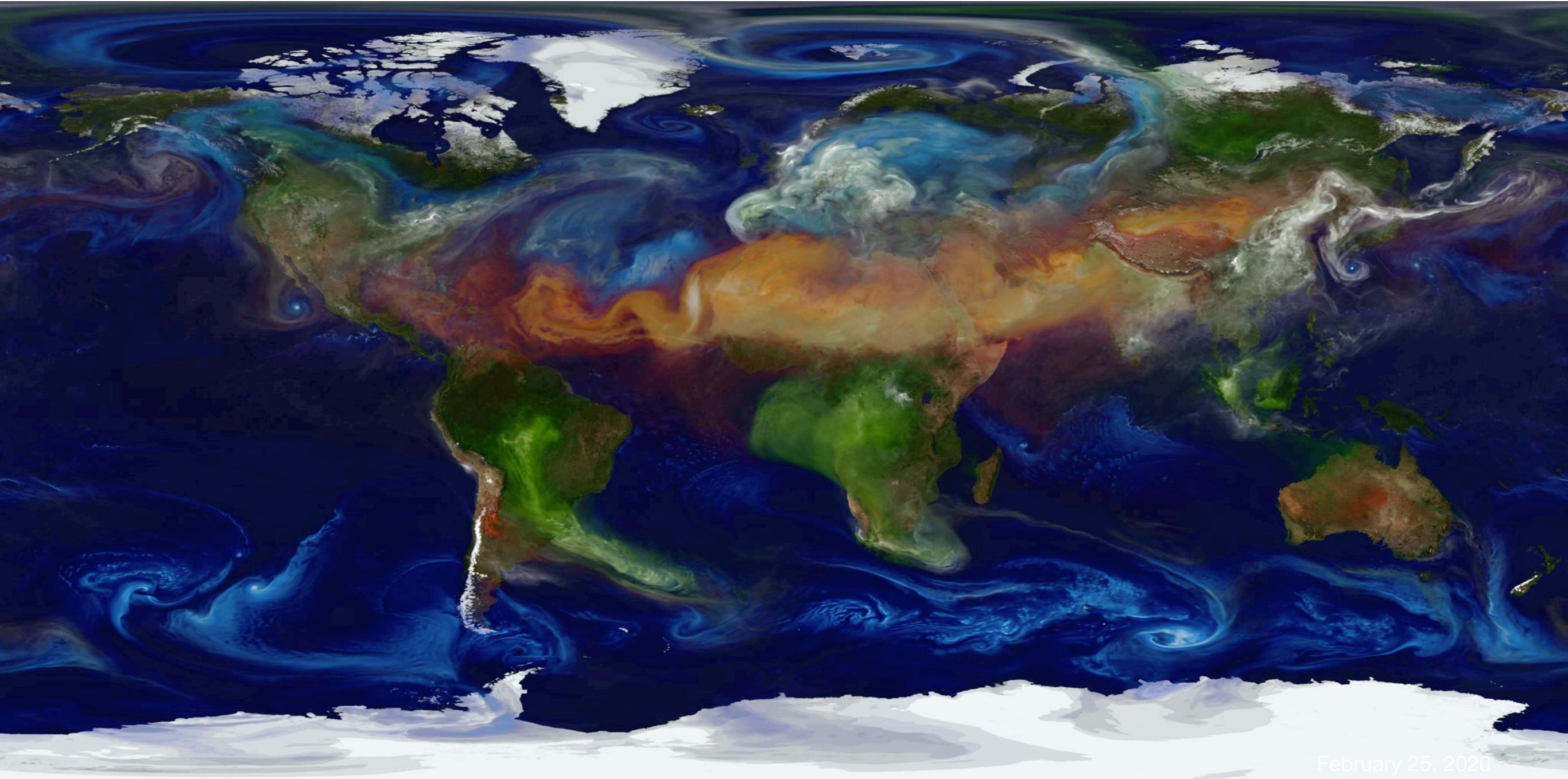
dust – smoke – sulfate – sea salt

introduction | global aerosols



dust – smoke – sulfate – sea salt

introduction | global aerosols



February 25, 2020

dust – smoke – sulfate – sea salt

William Putman, NASA/Goddard

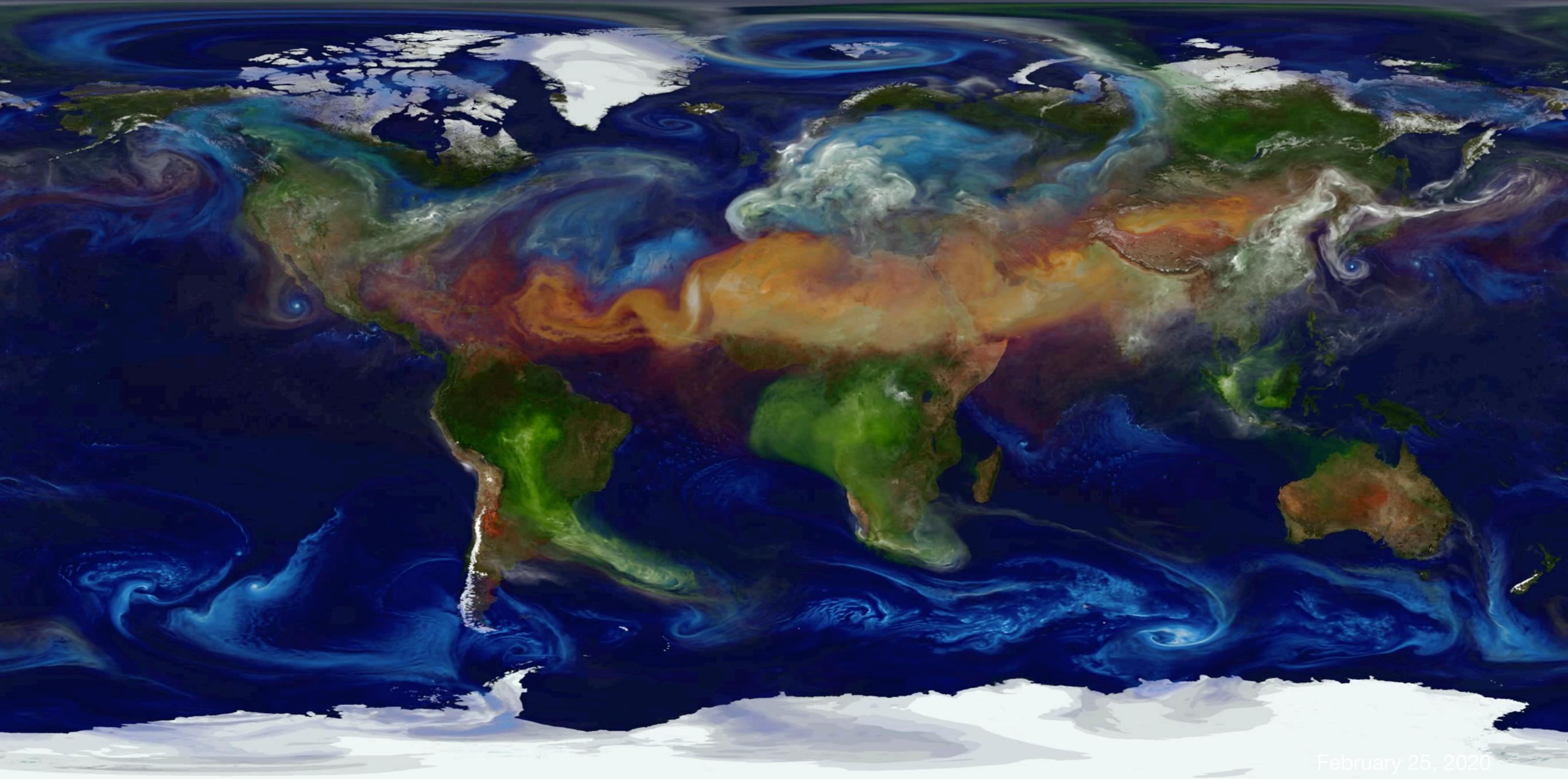
introduction | global aerosols



dust – smoke – sulfate – sea salt

William Putman, NASA/Goddard

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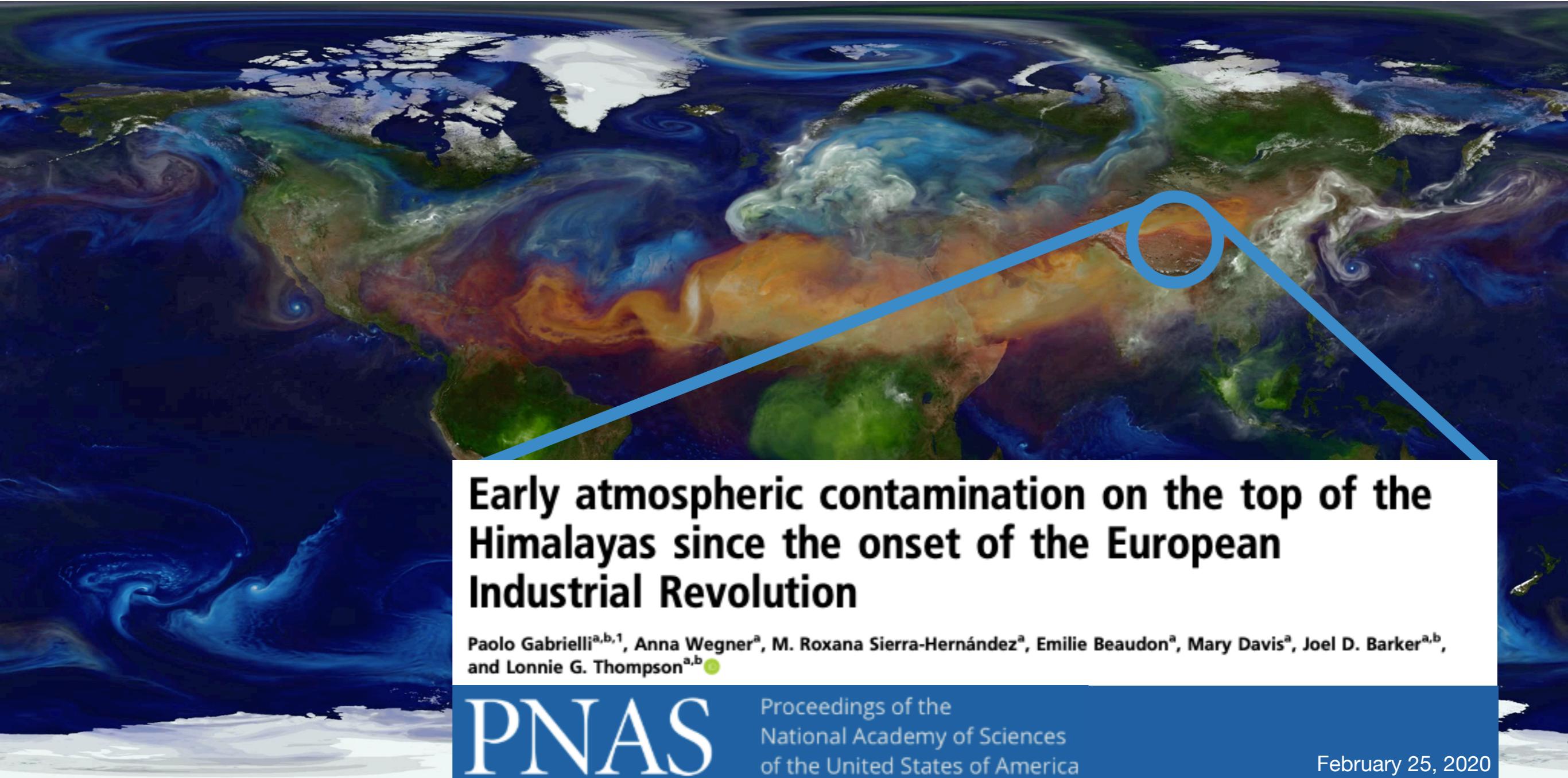


February 25, 2020

dust – smoke – sulfate – sea salt

William Putman, NASA/Goddard

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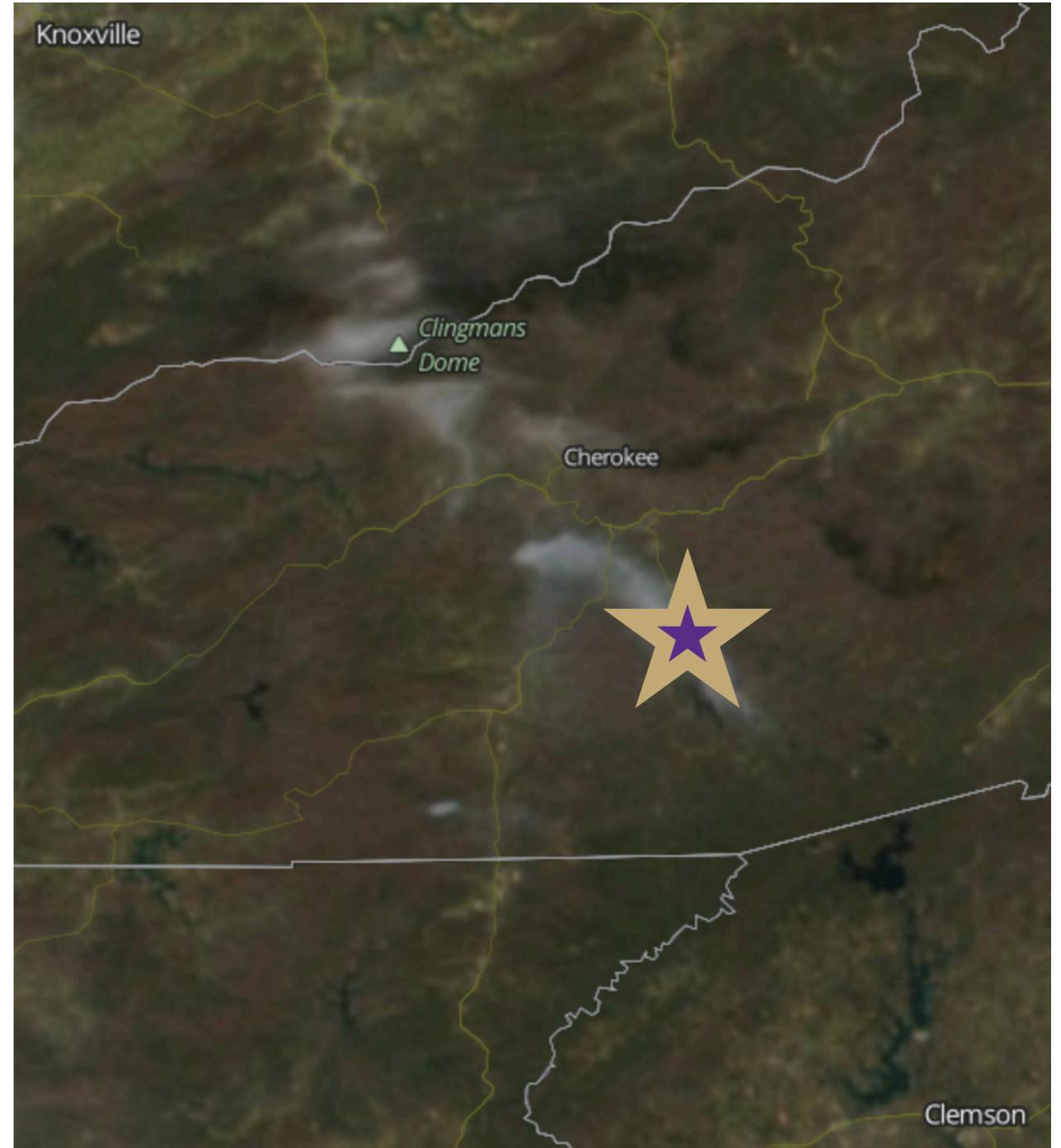
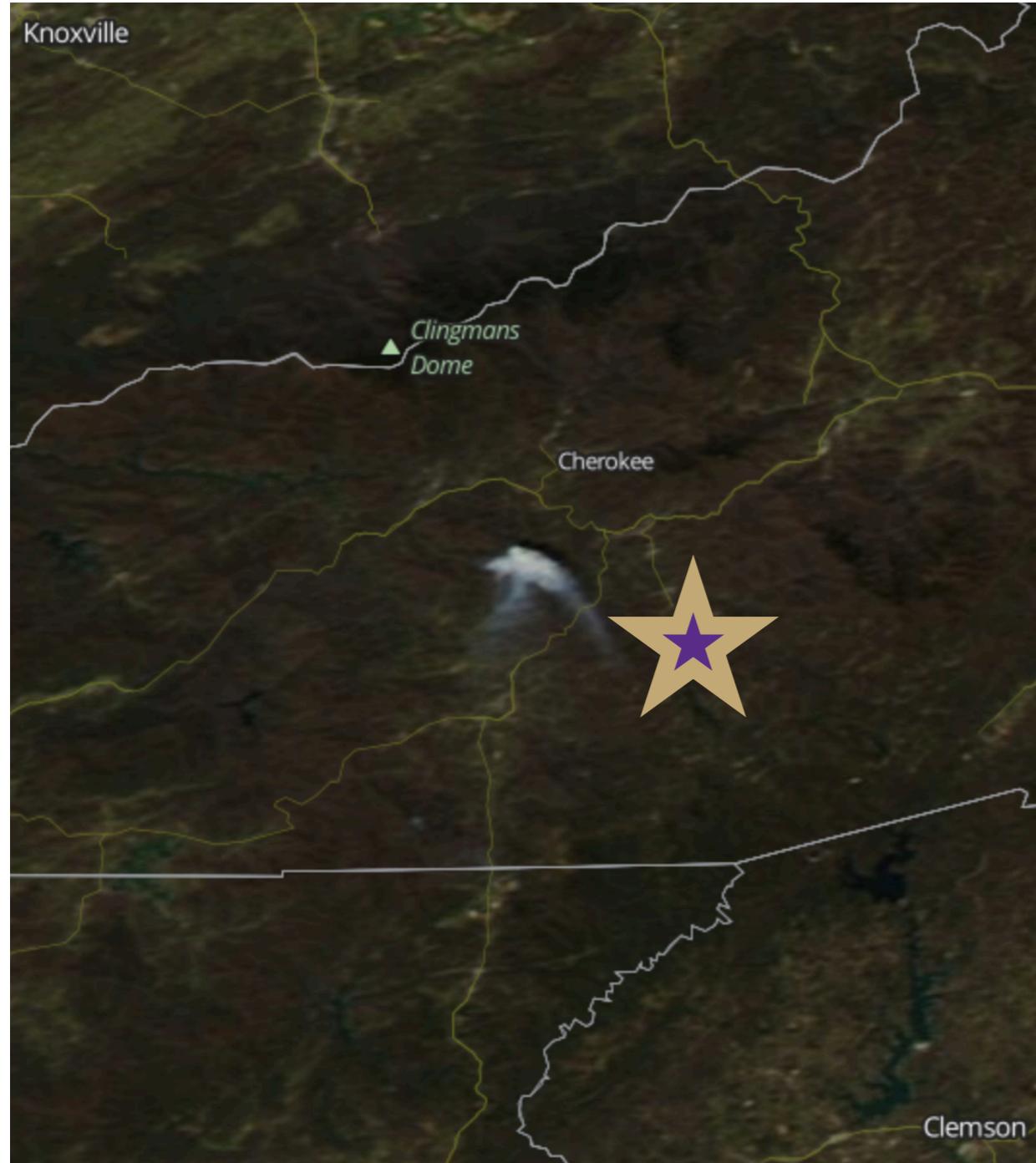


dust – smoke – sulfate – sea salt

introduction | local aerosols



introduction | local aerosols

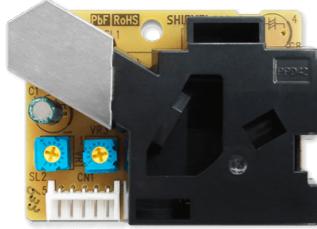


**how do we measure
aerosols?**

measuring PM | aerosol sensor options

Numerous low-cost sensors have come to market in recent years.

Component Grade



~\$20

Consumer Grade



~\$250

“Prosumer” Grade



~\$475

Research Grade

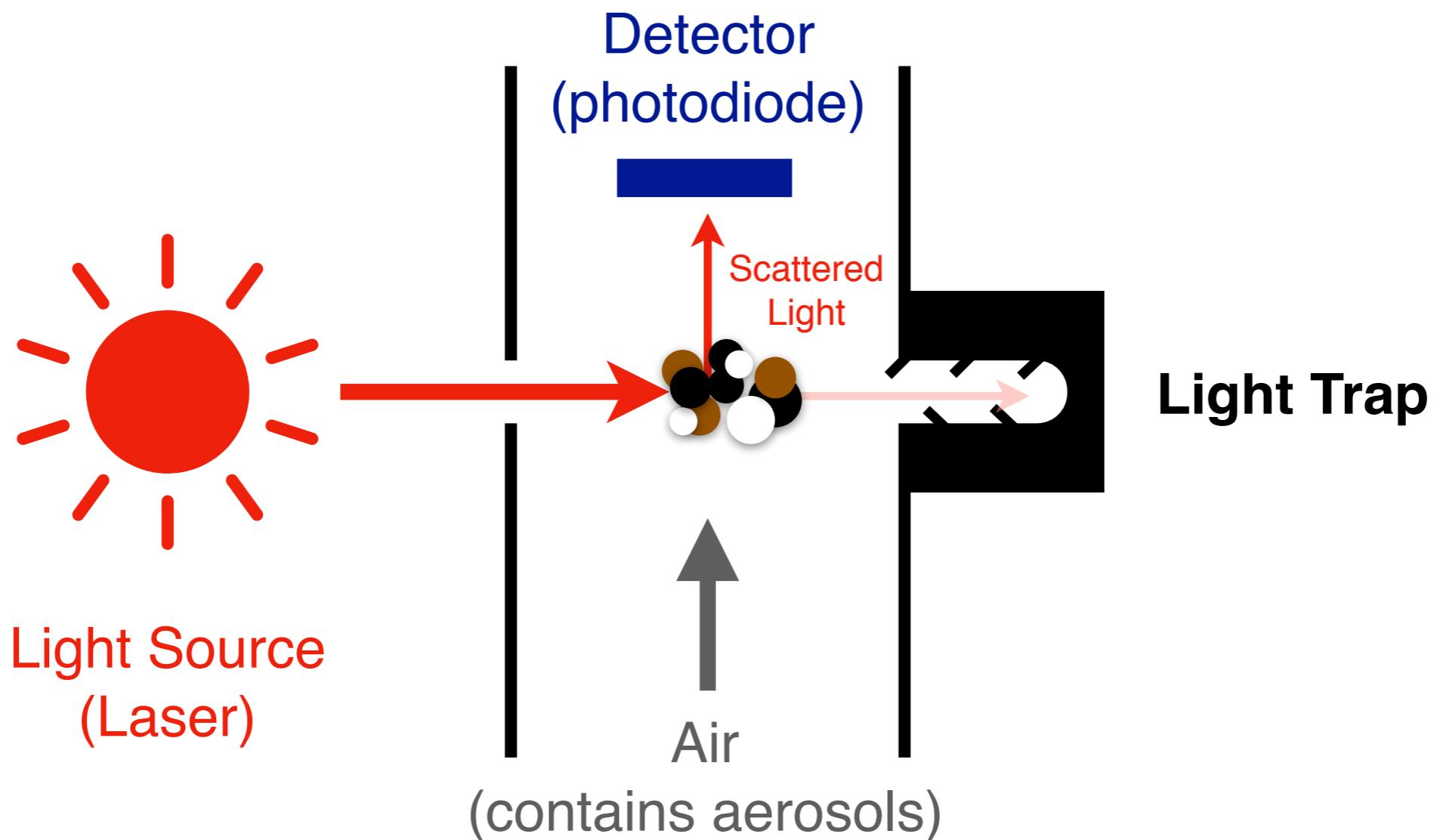


~\$40,000

images: Shinyei, AirBeam, PurpleAir, Dylos, TSI

introduction | detection scheme

Most low-cost sensors can be considered **nephelometers**, meaning they measure light scattered by aerosols.



measuring PM | wheeCAIR

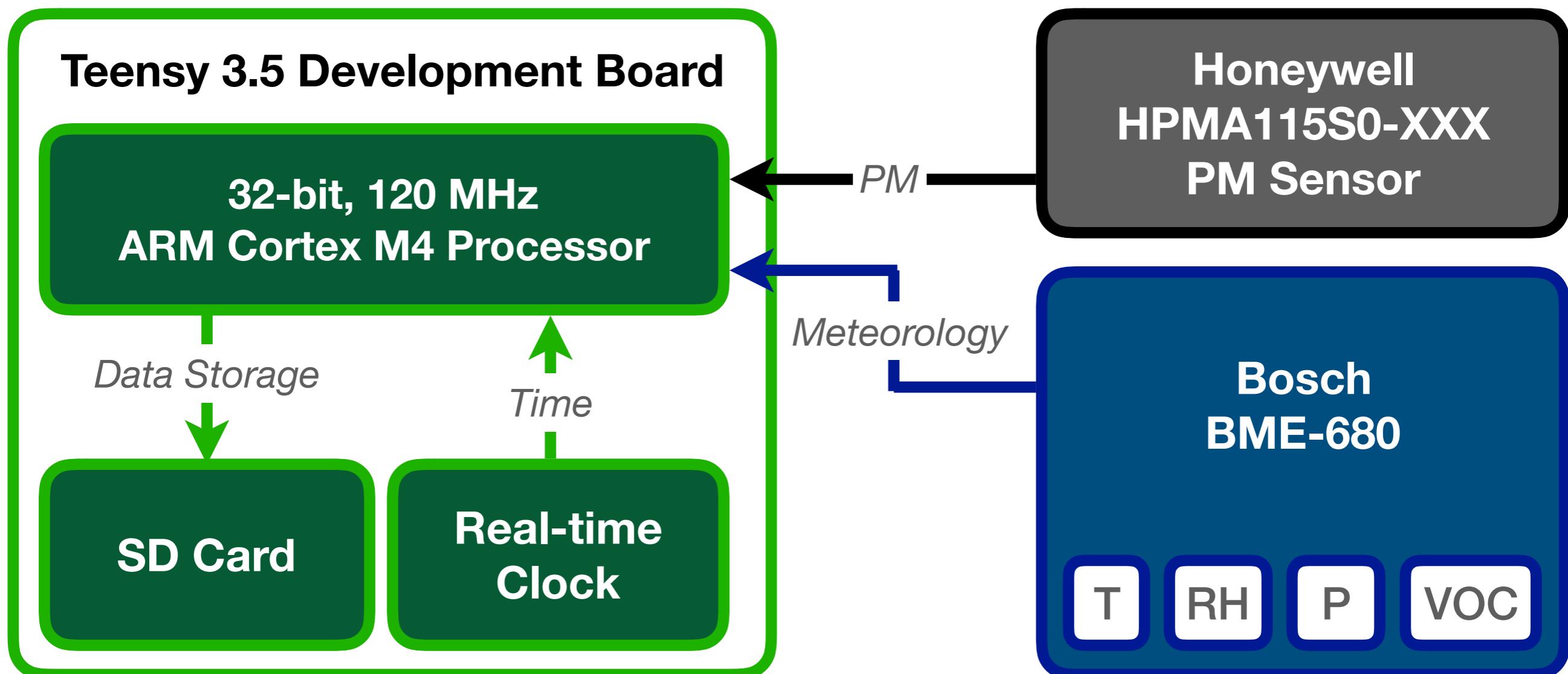
The Cullowhee Clean Air sensor must be weatherproof, battery-powered, and not require Wi-Fi/Cellular/Bluetooth connection.

Total cost: \$100 (+ Time)



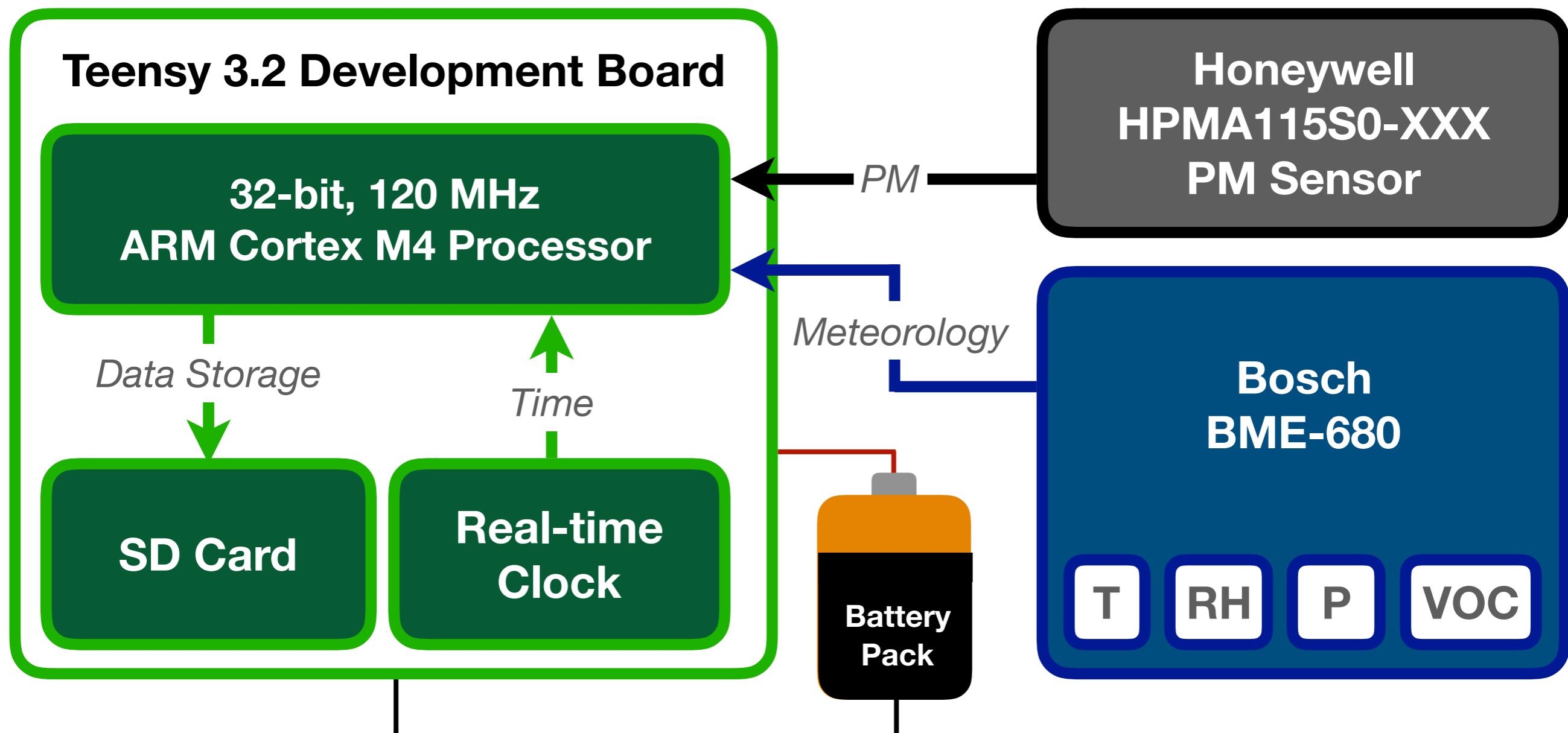
wheeCAIR | hardware

The device measures particulate matter, temperature, humidity, pressure, and volatile organic compounds.



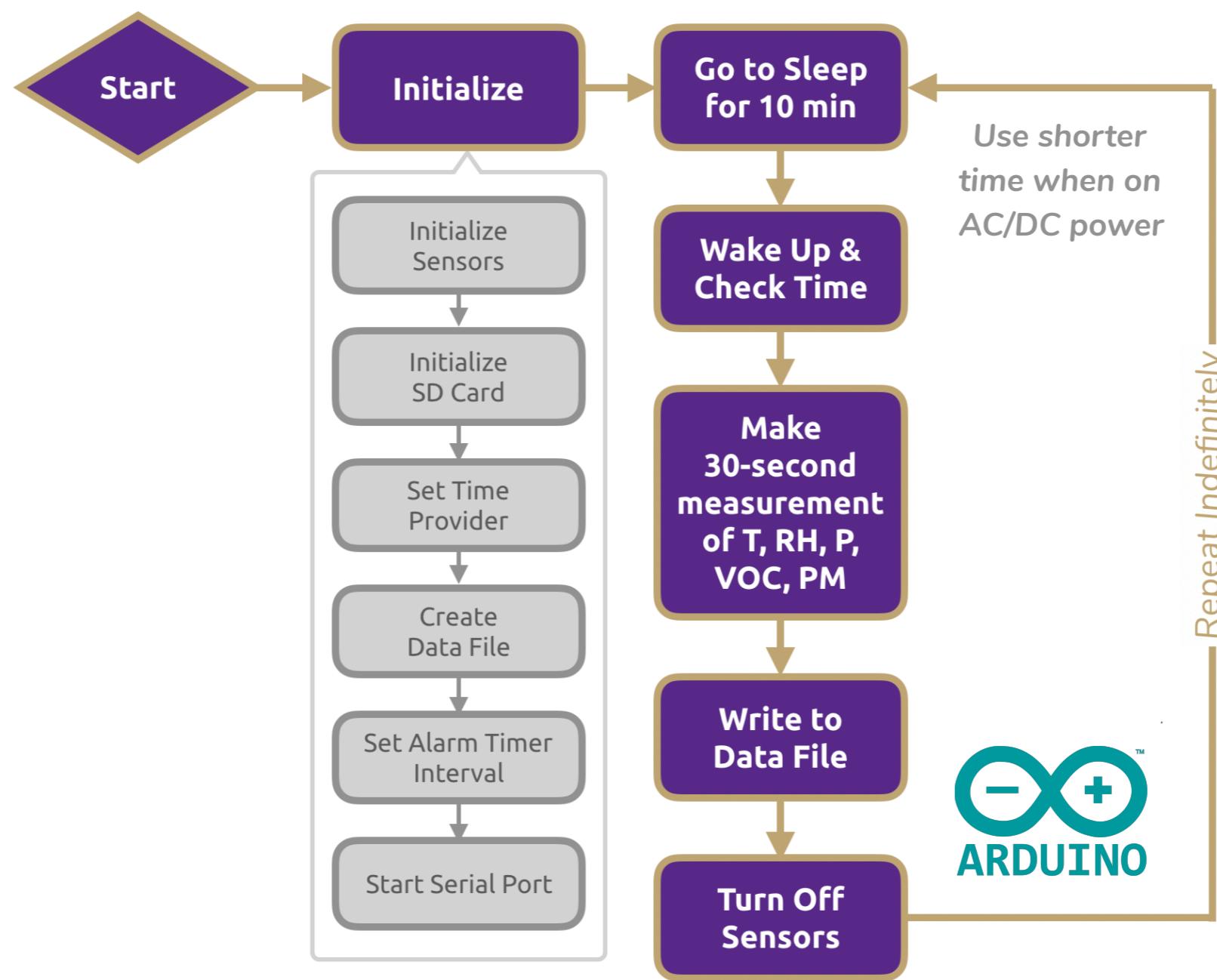
wheeCAIR | hardware

The wheeCAIR sensor does not require Wi-Fi or Bluetooth, and runs for >1 month on 3 C-type batteries (or indefinitely on AC power).



wheeCAIR | software

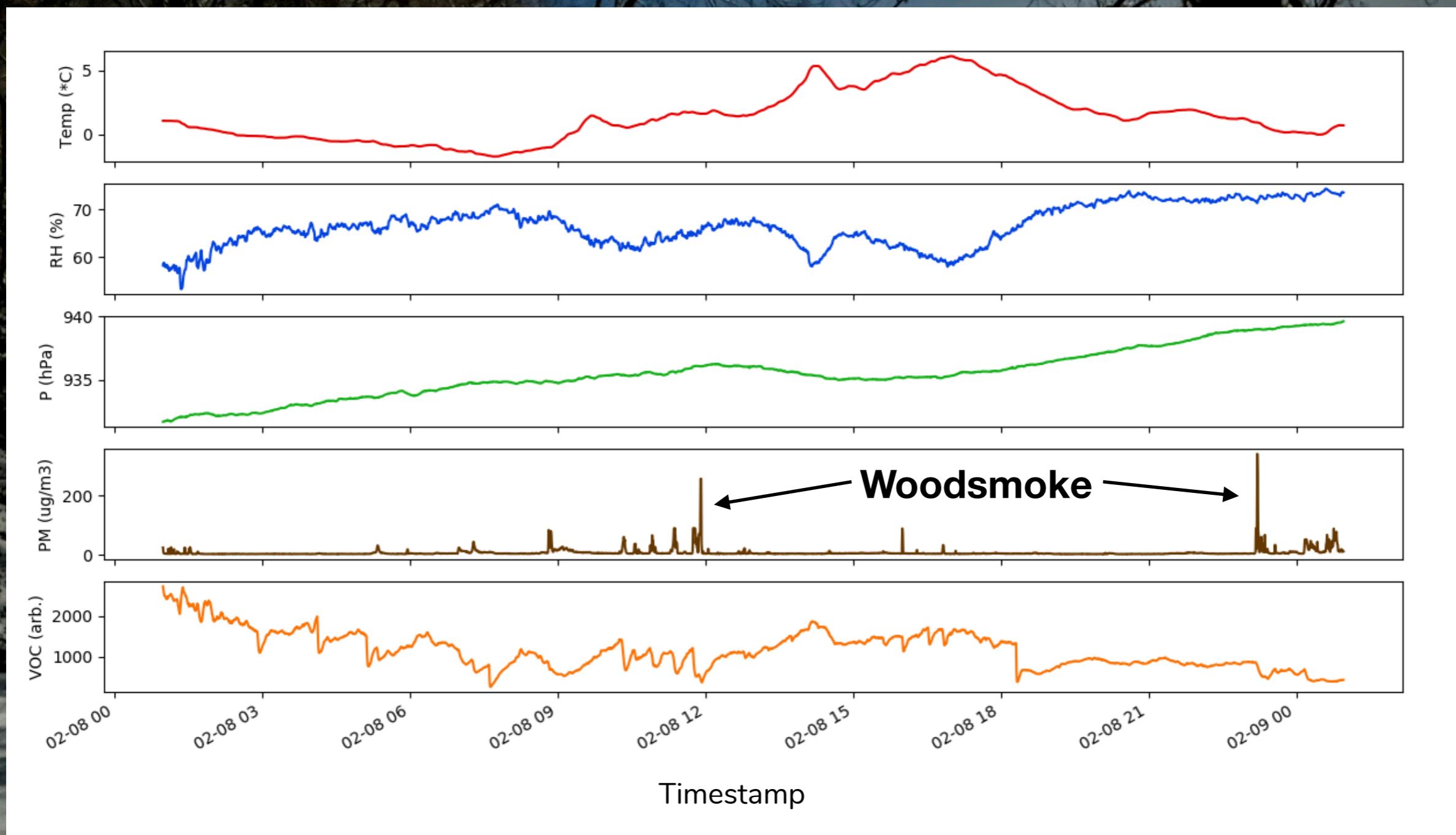
The sensor was programmed via Arduino.
Battery life was optimized via software.



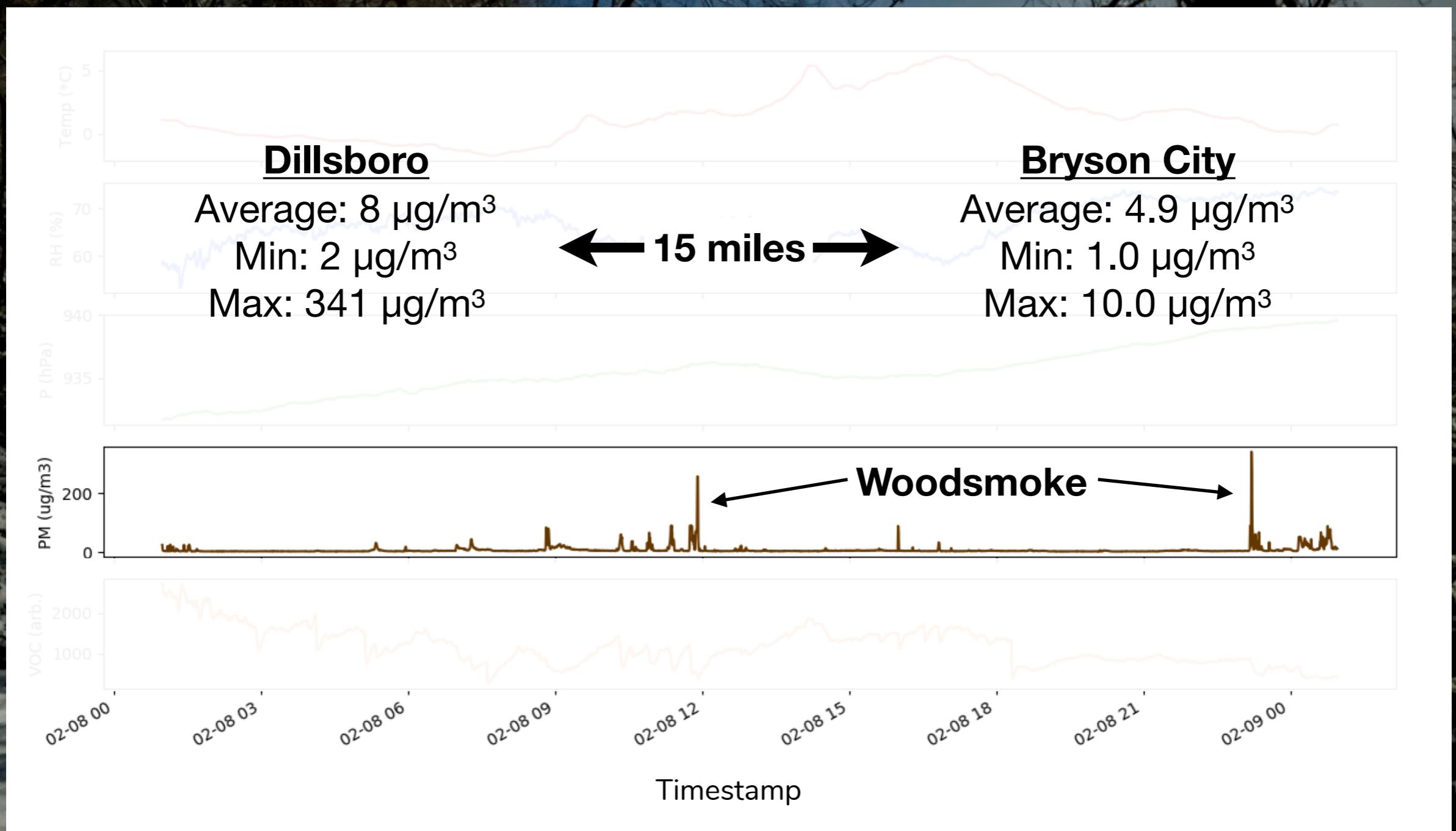
A photograph of a winter landscape in Dillsboro, North Carolina. The scene is covered in a layer of snow. In the foreground, there's a snow-covered road or driveway. To the left, a dark evergreen tree is heavily laden with snow. In the center background, there's a cluster of houses, one with a white roof and another with a dark roof. Bare deciduous trees stand in the middle ground, their branches reaching across the frame. Power lines and poles are visible on the right side. The sky is overcast and grey.

monitoring | dillsboro, nc

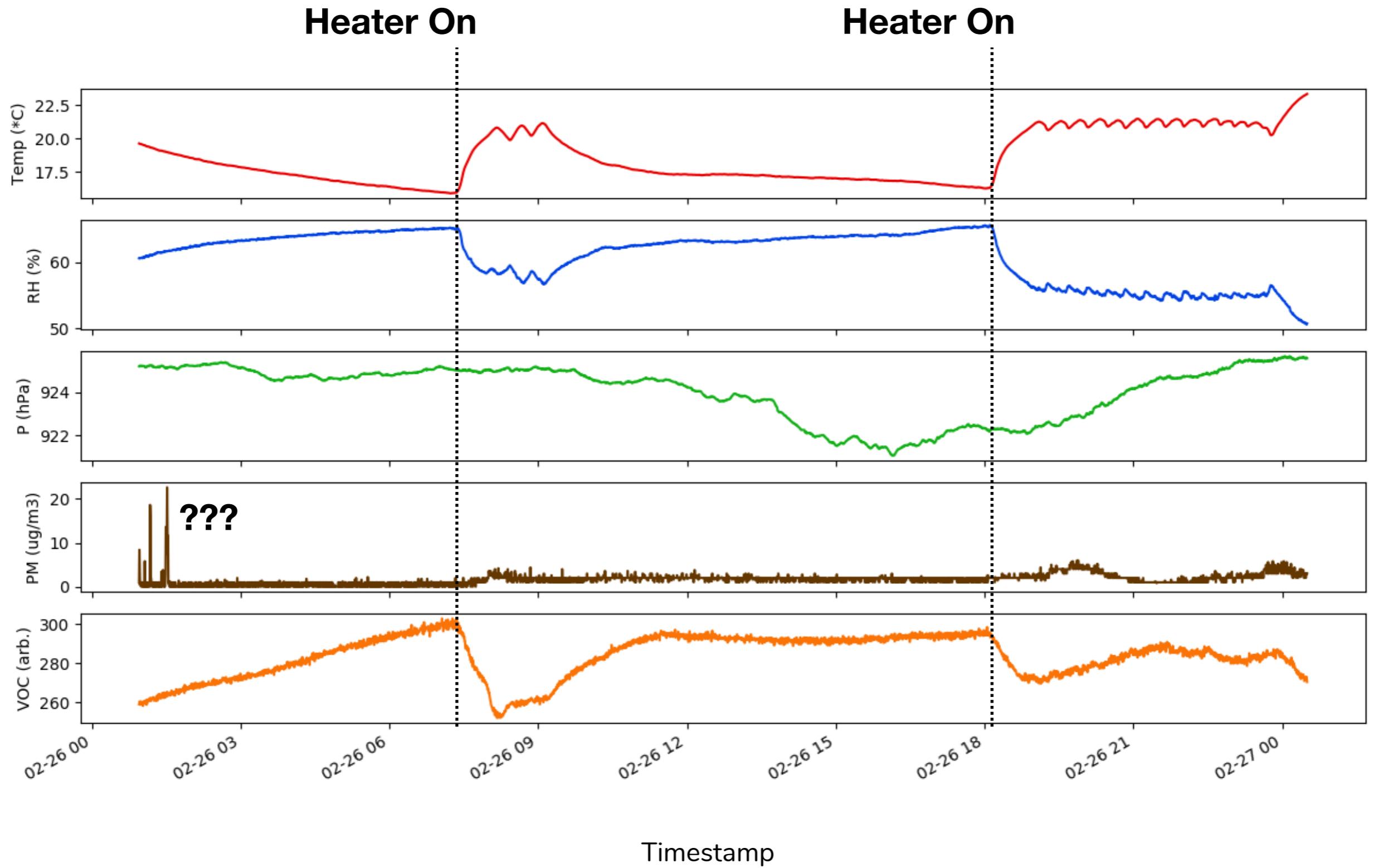
monitoring | dillsboro, nc



monitoring | dillsboro, nc



monitoring | indoor @ home



wheeCAIR | initial test



Study Site: Purchase Knob, NC (GRSM NP)

wheeCAIR | initial test

**Full NOAA Weather Station, Webcam,
and NC Ozone Site**



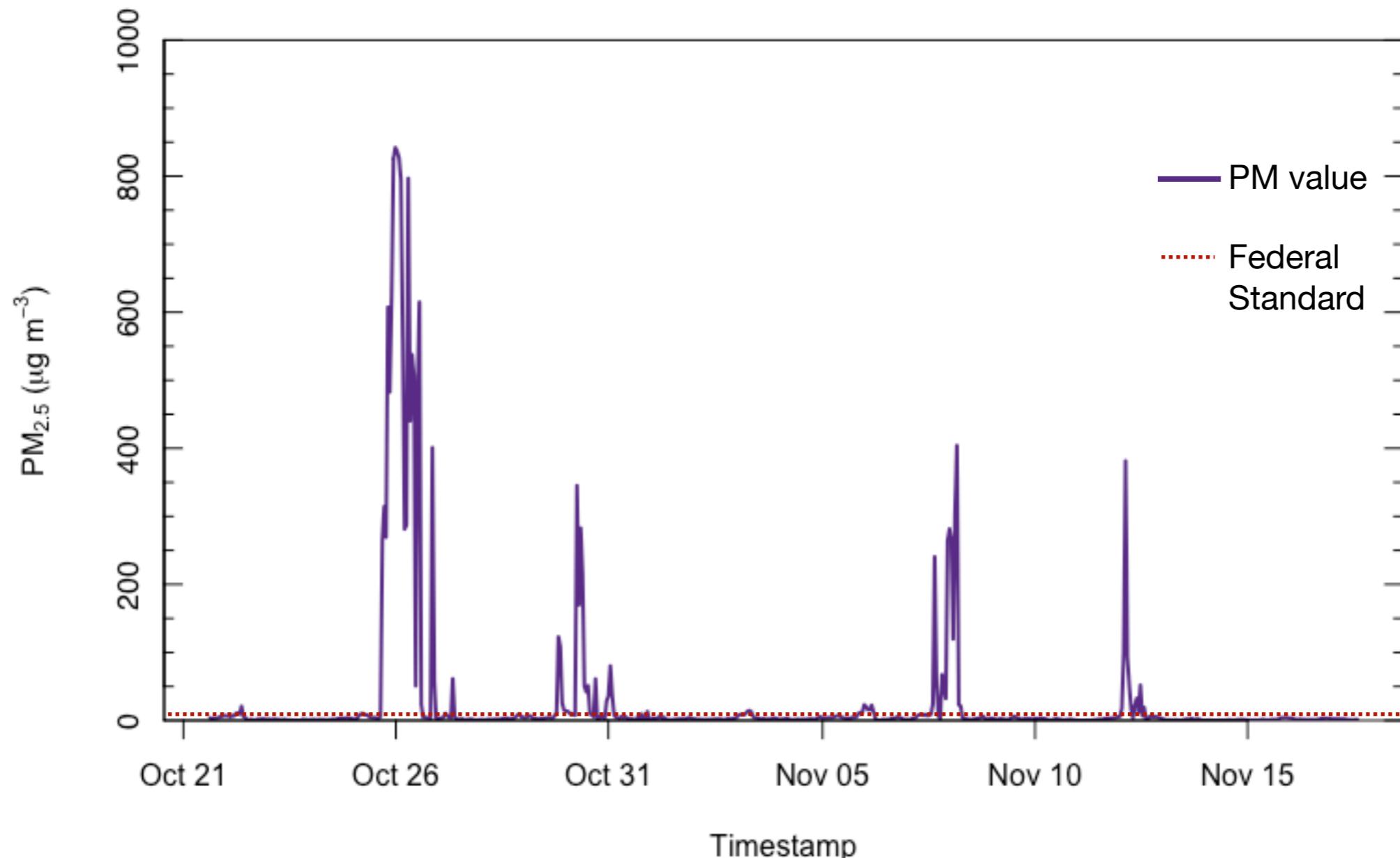
**Sensor Installed at
Purchase**



Study Site: Purchase Knob, NC (GRSM NP)

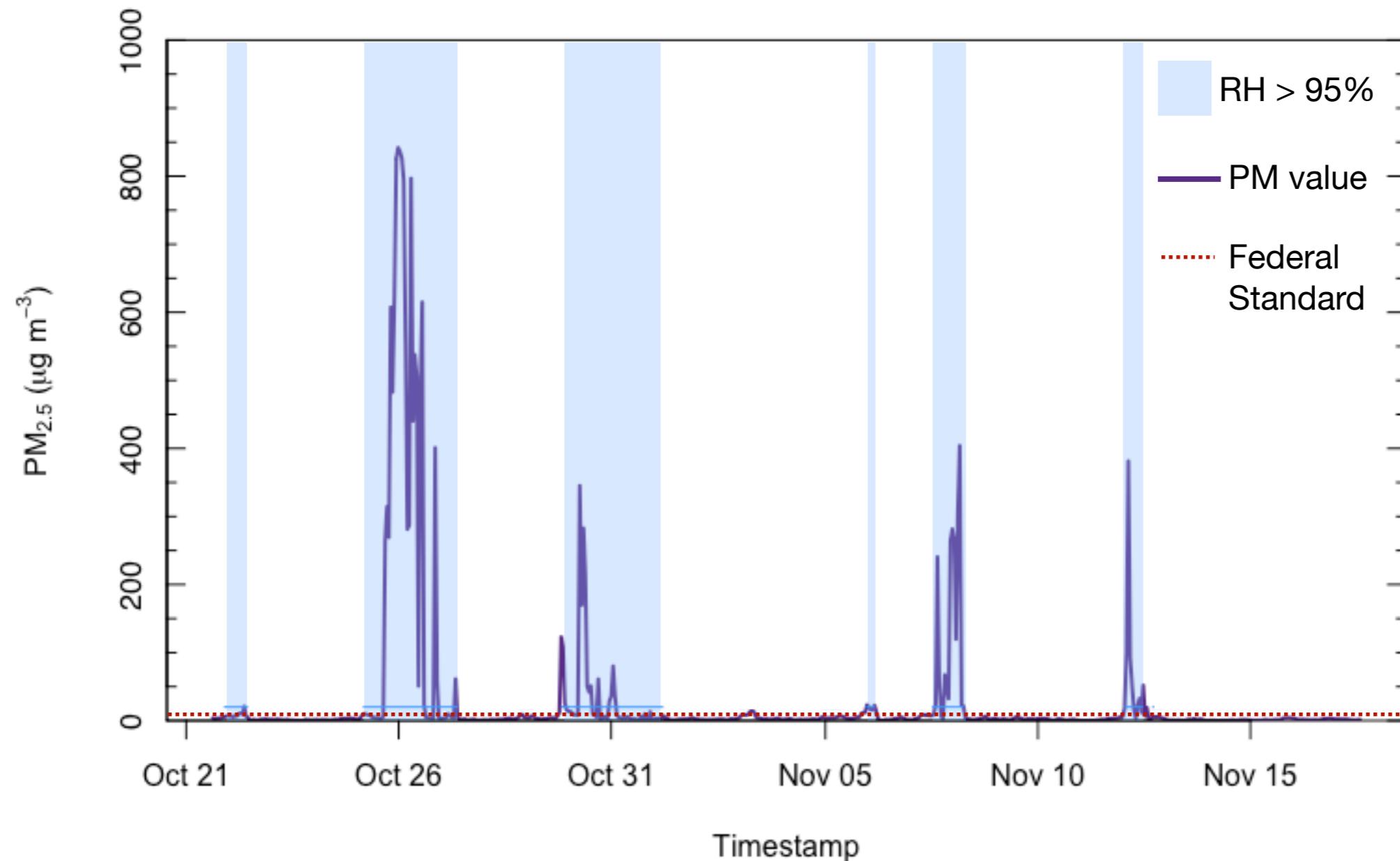
wheeCAIR | particulate matter

Large spikes were observed in the PM readings...
we expected 0-20 $\mu\text{g per m}^3$



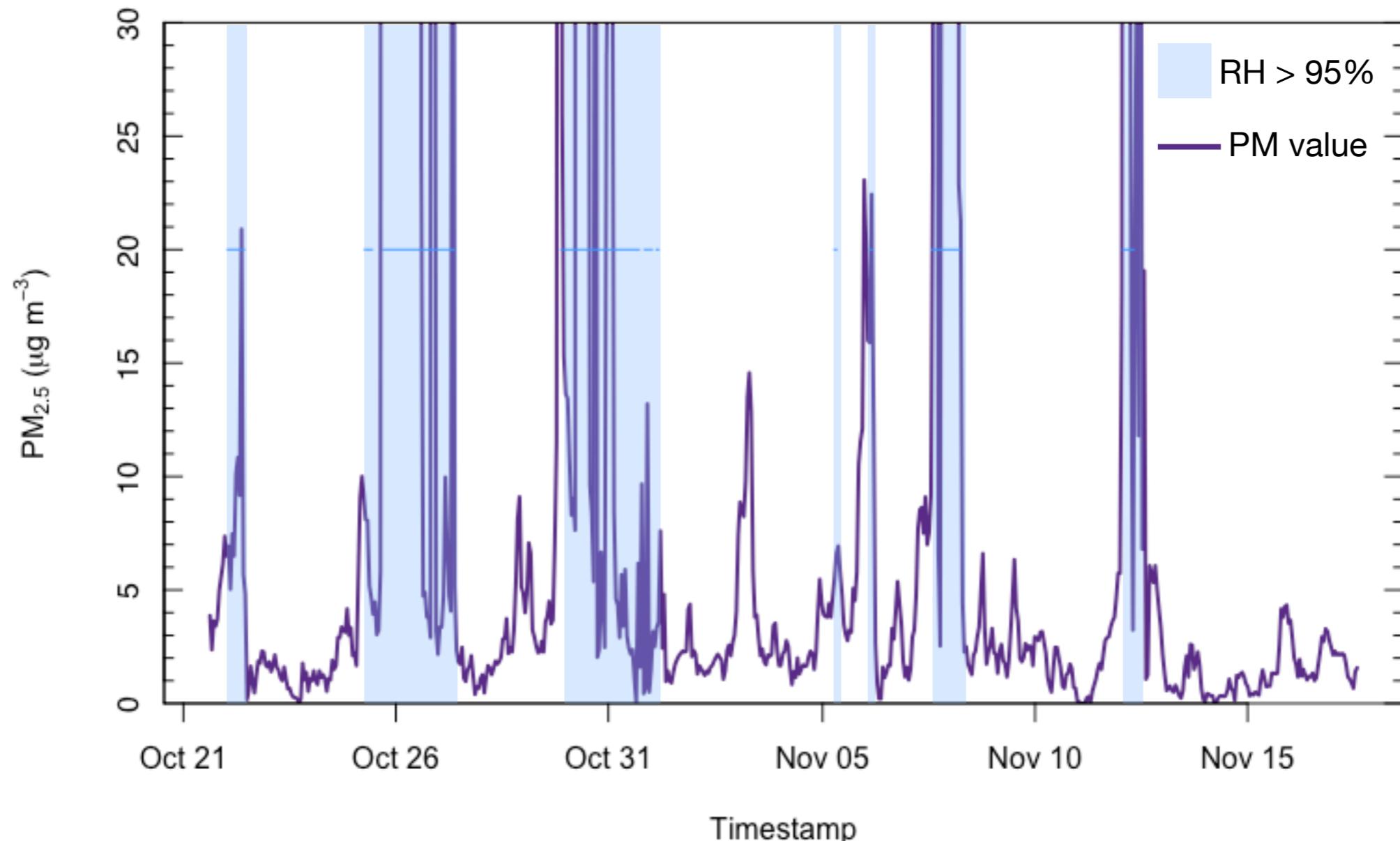
wheeCAIR | particulate matter

The PM reading is highly sensitive to fog.



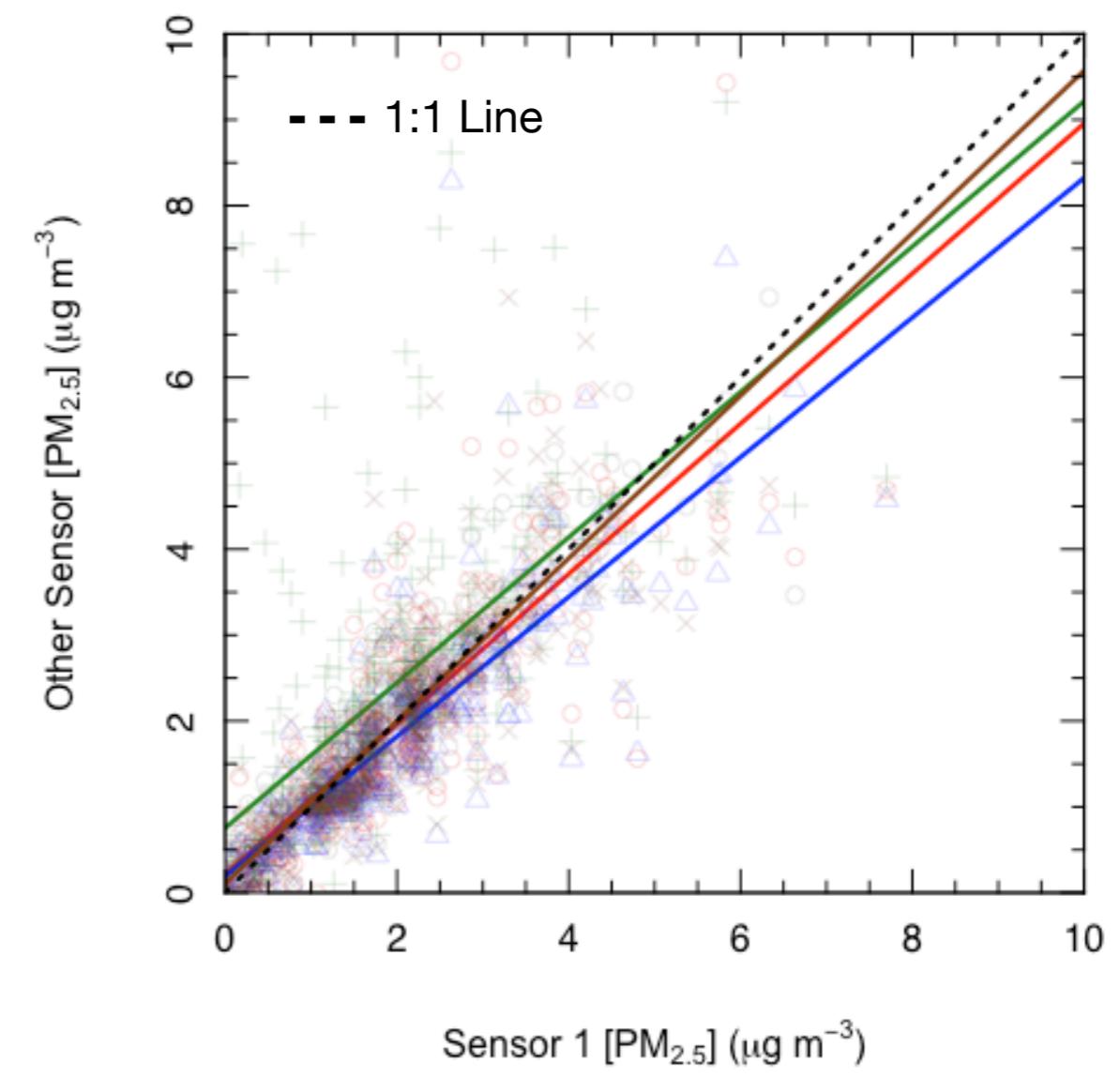
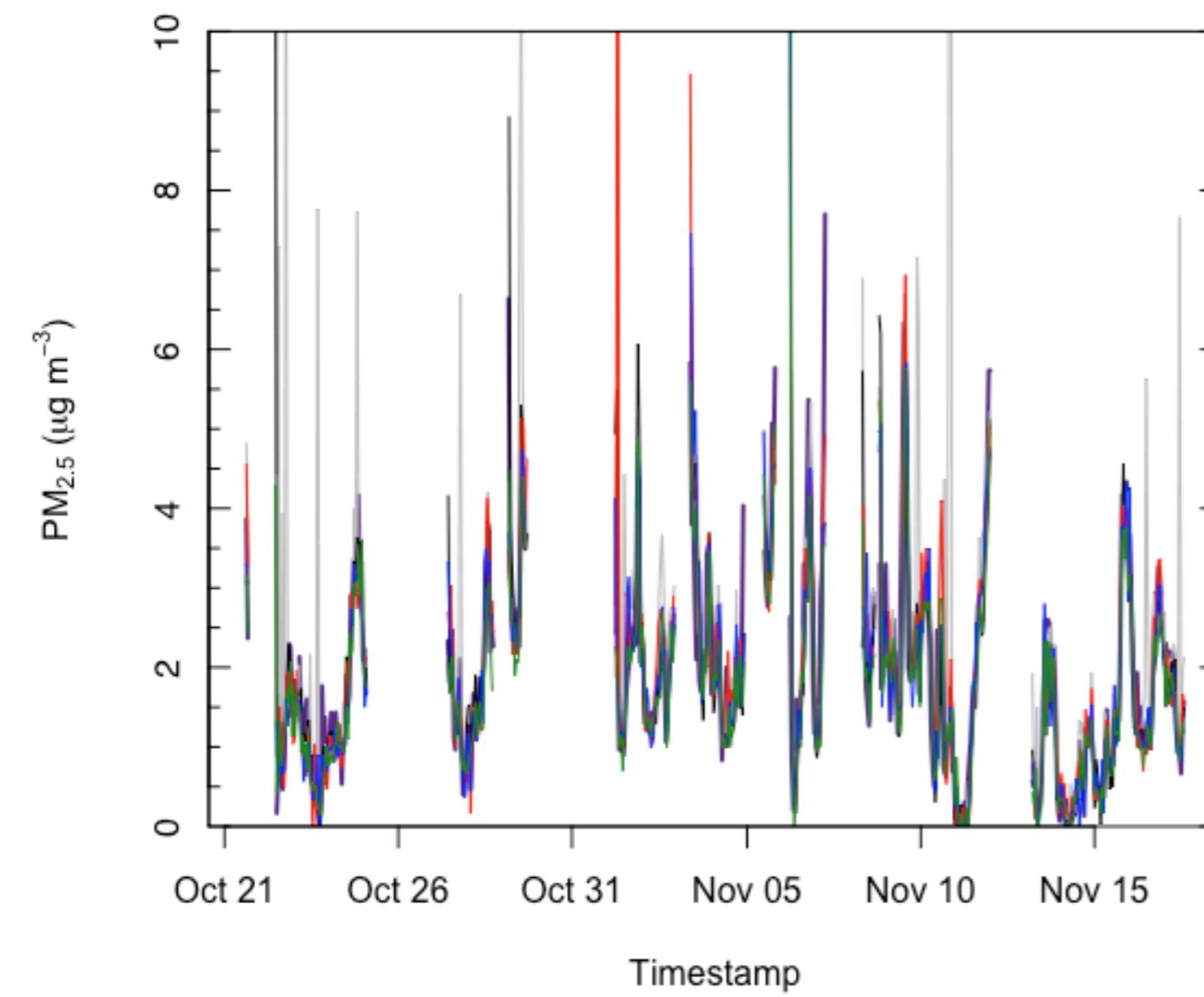
wheeCAIR | particulate matter

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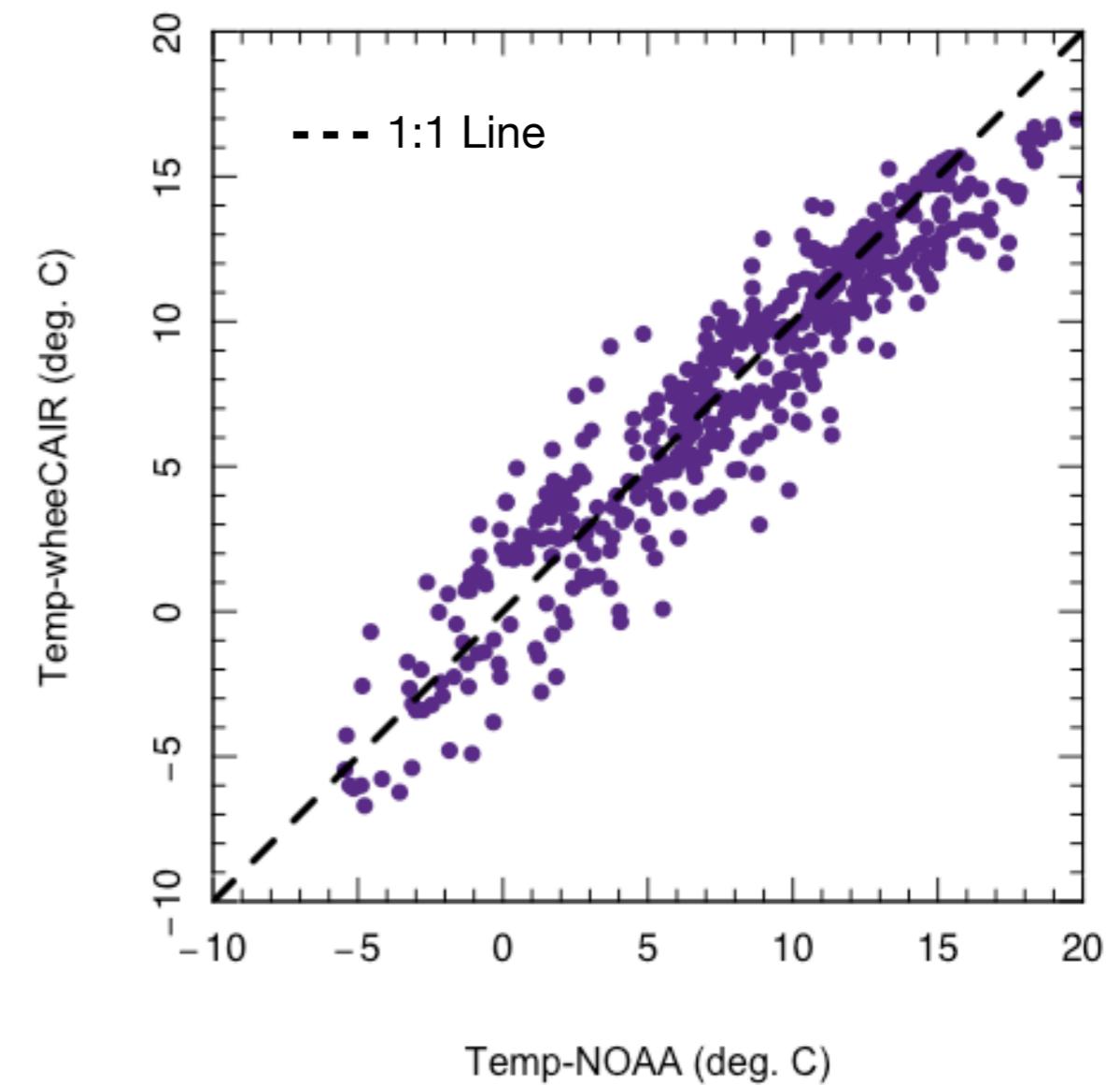
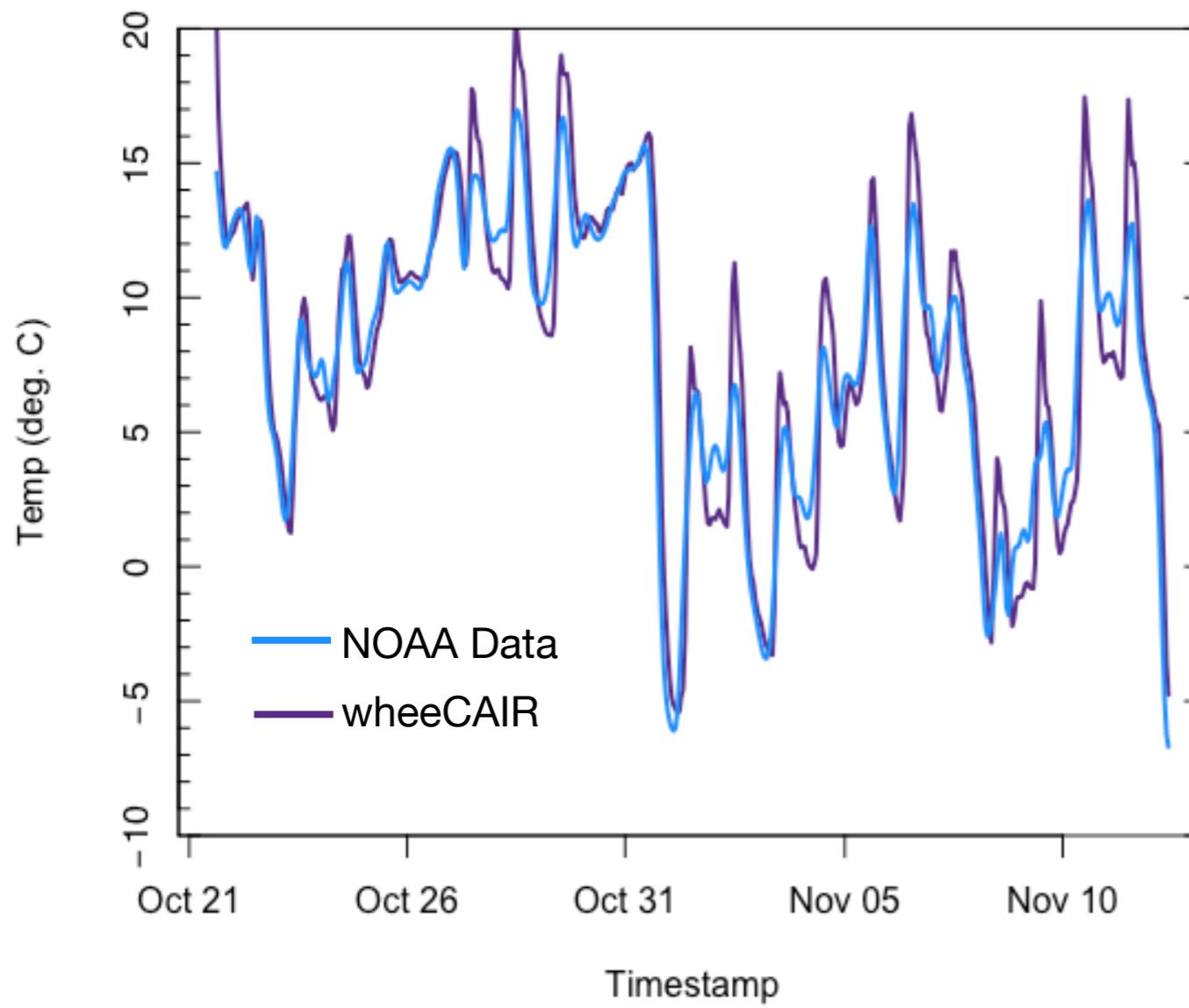
wheeCAIR | particulate matter

PM sensors agree well with each other.



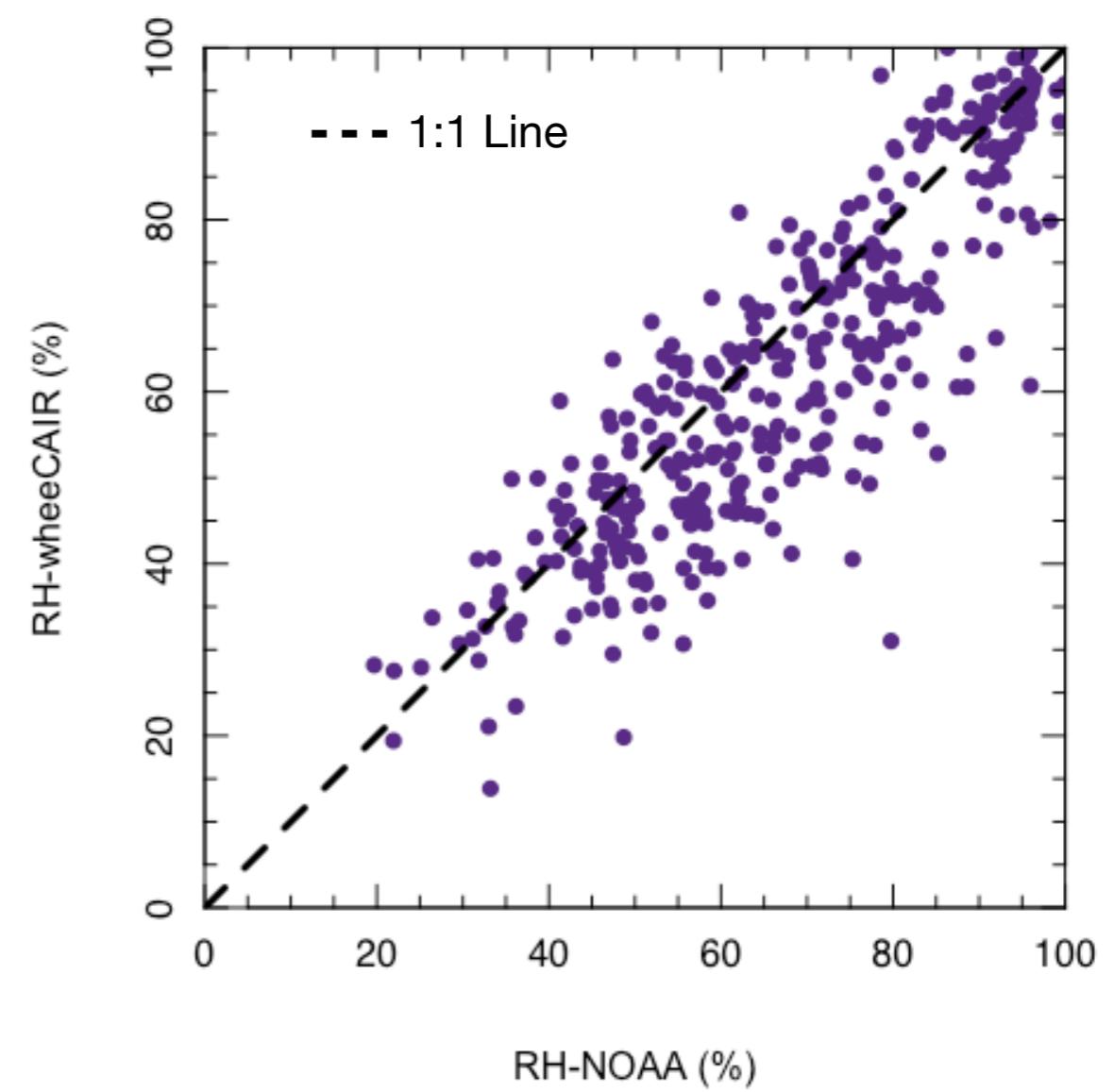
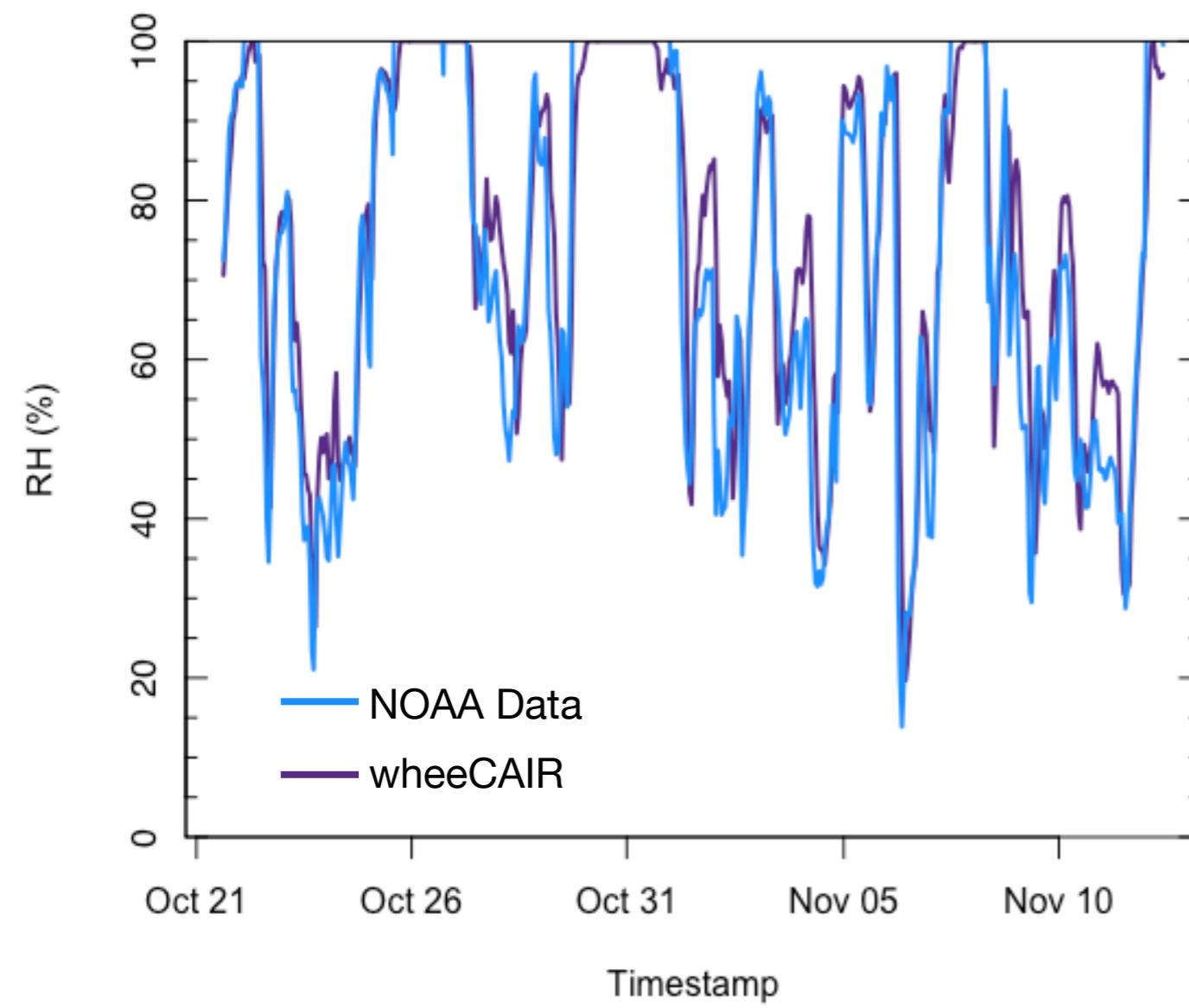
wheeCAIR | temperature

Temperature & humidity data agree well with the NOAA weather station.



wheeCAIR | humidity

Temperature & humidity data agree well with the NOAA weather station.



wheeCAIR | challenges

Plan to co-locate / validate with monitor in Bryson City.

Honeywell

HPM Series

Particulate Matter Sensors

32322550

Issue F

Datasheet



DESCRIPTION

The Honeywell HPM Series Particulate Matter Sensor is a laser-based sensor which detects and counts particles using light scattering. The detection concentration range is 0 $\mu\text{g}/\text{m}^3$ to 1,000 $\mu\text{g}/\text{m}^3$. A laser light source illuminates a particle as it is pulled through the detection chamber. As particles pass through the laser beam, the light reflects off the particles and is recorded on the photo or light detector. The light is then analyzed and converted to an electrical signal to calculate particle concentration. The Honeywell particle sensor provides information on the particle concentration for given particle concentration range.

FEATURES

- Laser-based light scattering particle sensing
- Concentration range: 0 $\mu\text{g}/\text{m}^3$ to 1,000 $\mu\text{g}/\text{m}^3$
- Fully calibrated
- EMC: Heavy industrial level IEC61000
- Response time: <6 s
- Supply current: 80 mA max.
- Output signal: UART (Universal Asynchronous Receiver/Transmitter)
- PM2.5, PM10 output (standard); PM1.0, PM2.5, PM4.0, PM10 output (compact)
- RoHS compliant
- REACH compliant

DIFFERENTIATION

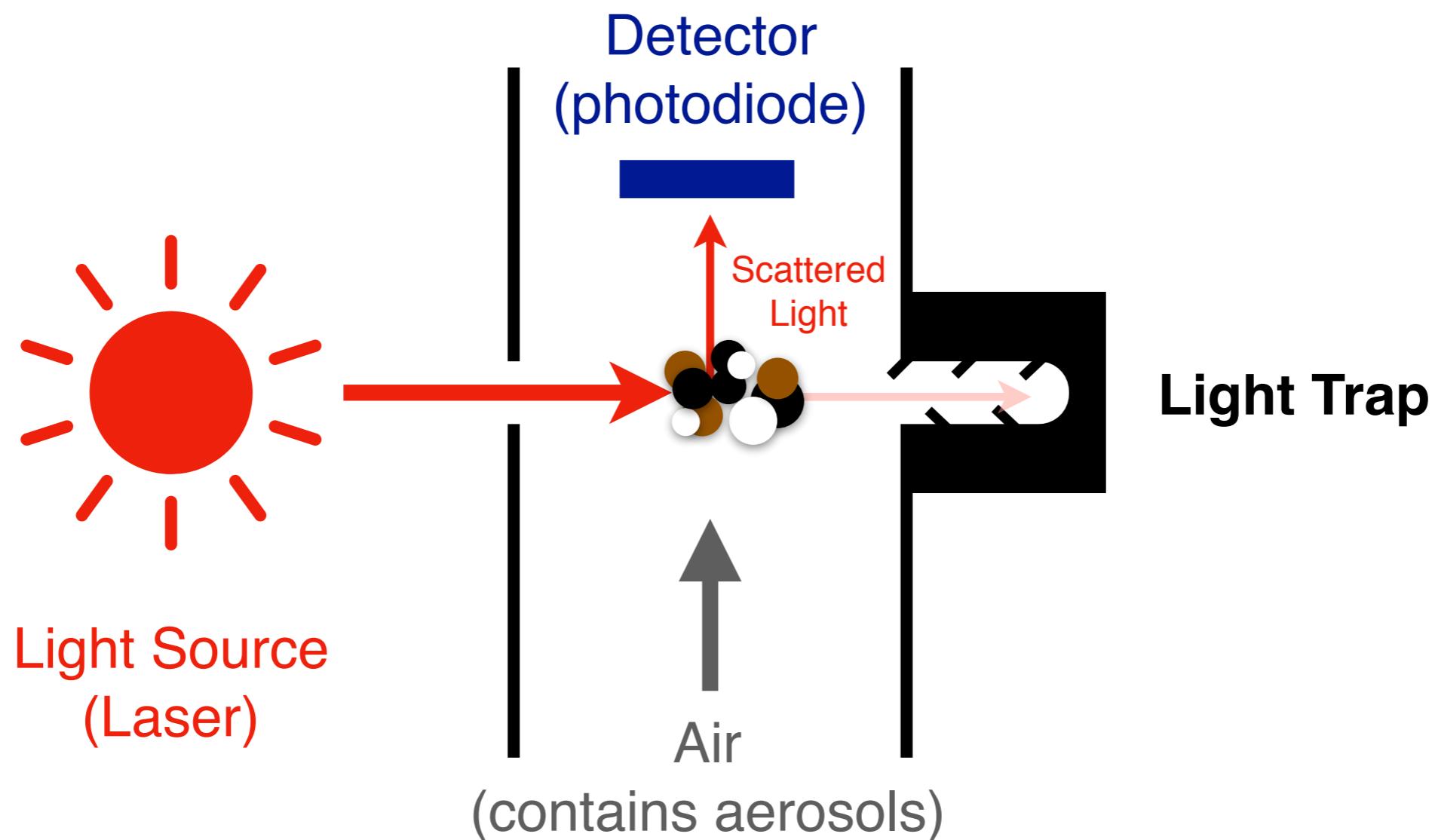
- Long life of 10 years offers a more stable operation for continuous usage
- Proven EMC performance, based on IEC61000 stable operation, ±15% accuracy (PM2.5)

POTENTIAL APPLICATIONS

- HVAC (commercial and residential)
- Indoor air quality monitors
- Handheld air quality monitors
- Air purifiers (commercial and residential)

wheeCAIR | challenges

What knobs can we turn???



thanks!

WCU Department of Chemistry and Physics
2019 CHEM 191 Students

Paul Super and Ronda Wise (National Park Service)
Dr. James Lendemer (New York Botanical Garden)
NC Division of Air Quality



questions?

