Particle and Meteorology Measurements in Sri Lanka using Low-Cost Air Sensors

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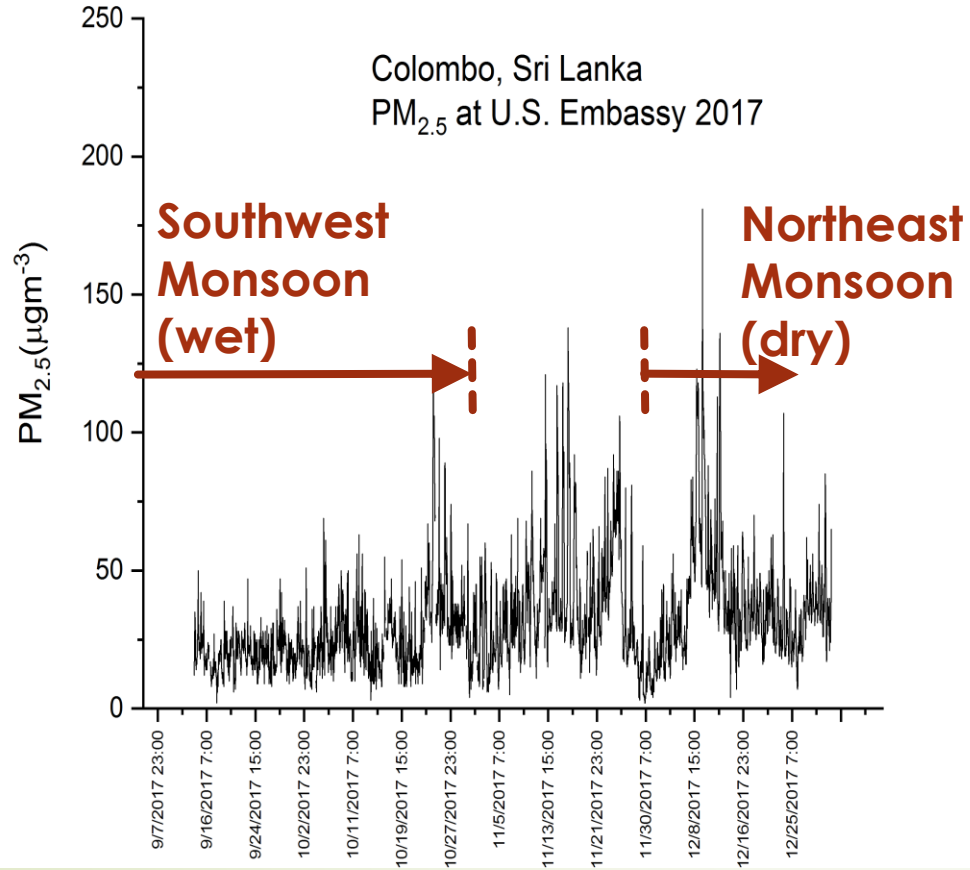
Sri Lanka: Developing Country near Equator

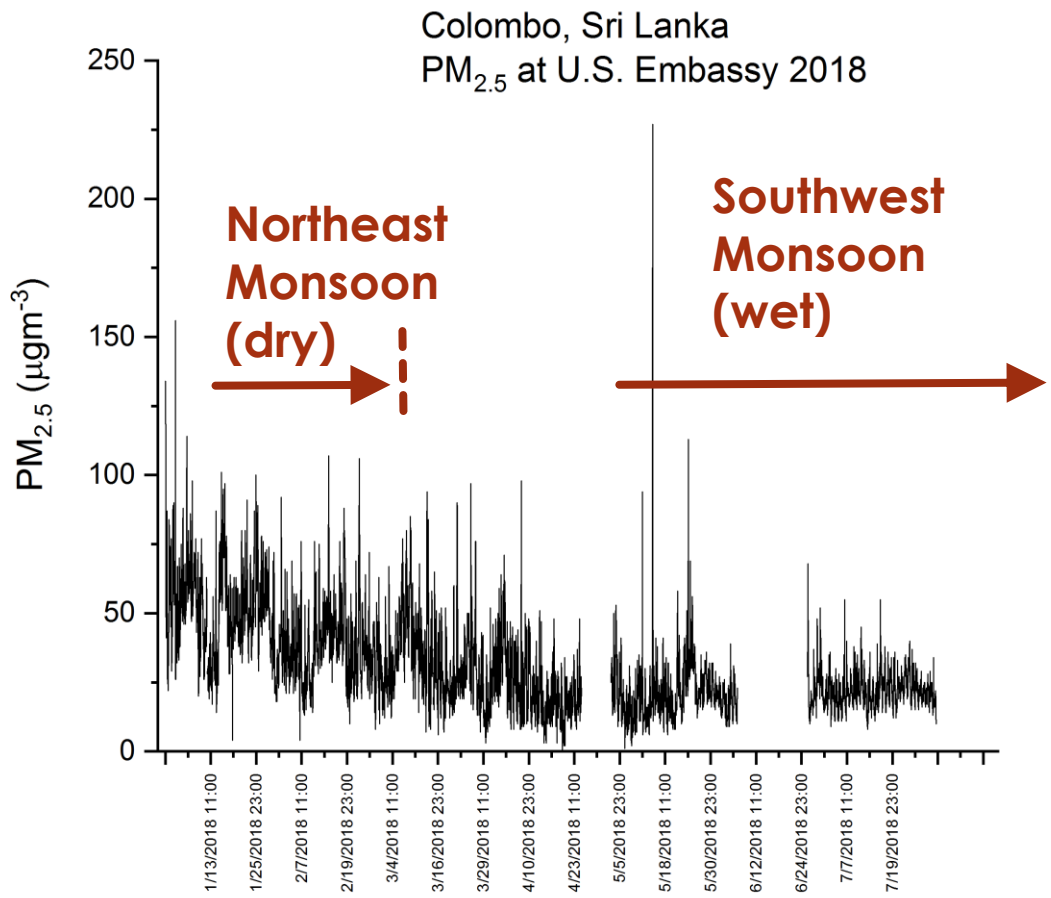
Sri Lanka: Southwest of the Tip of India

~May - September

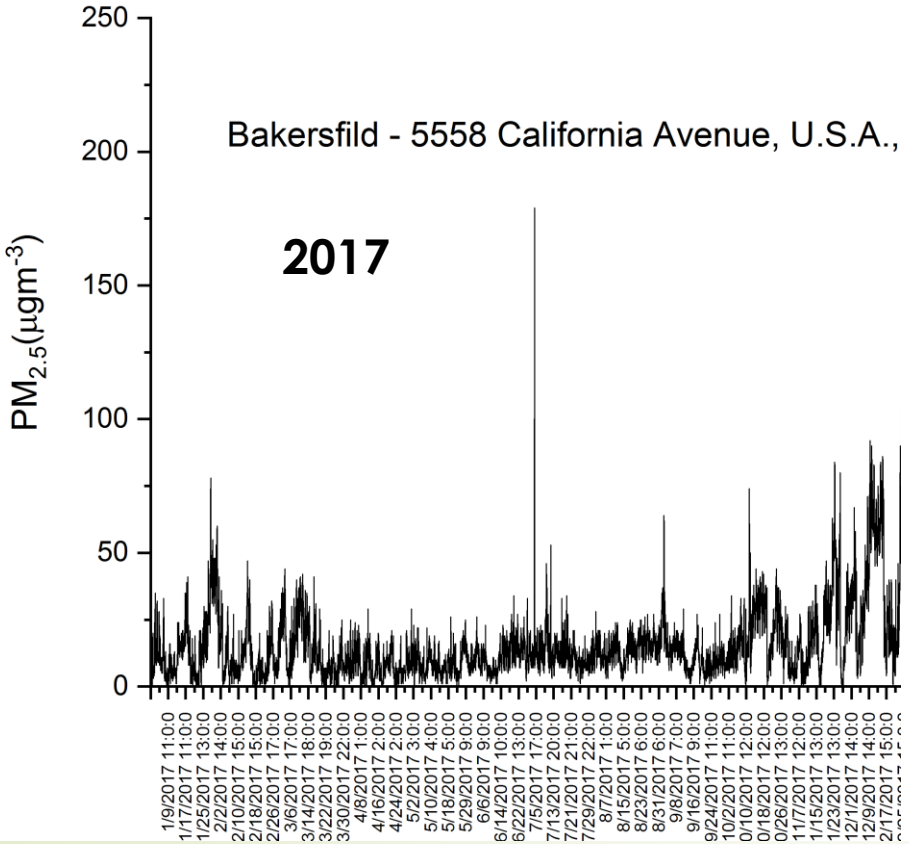
~November - February

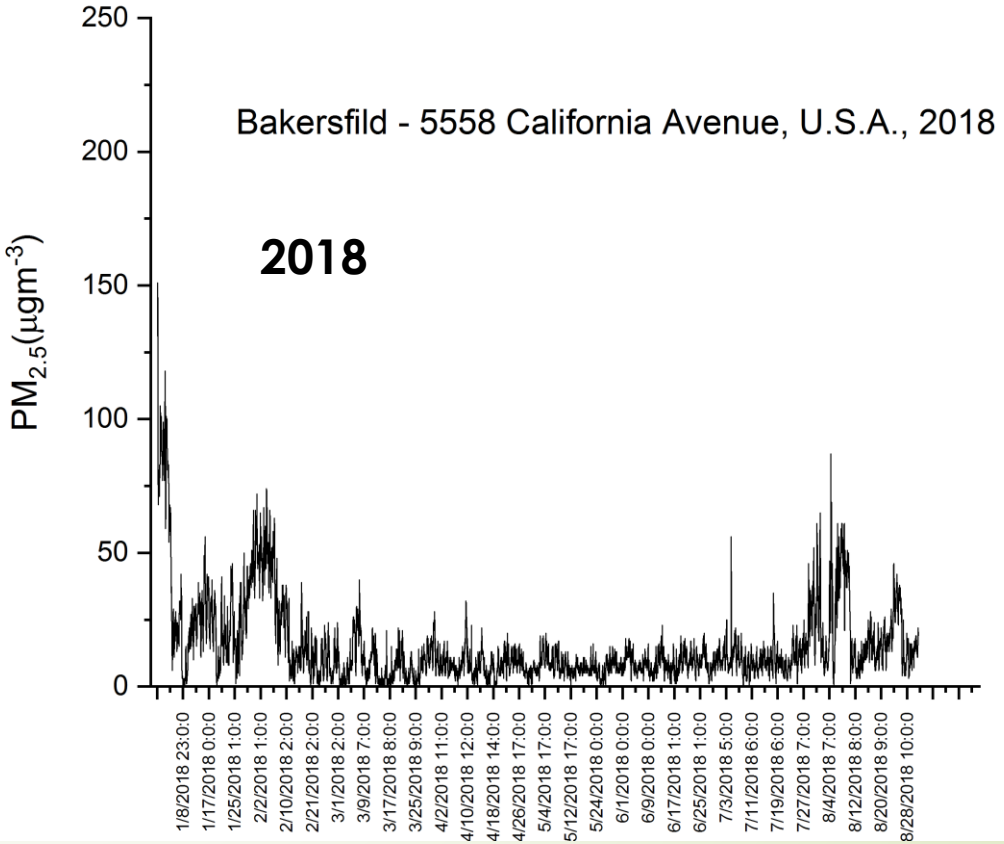
$PM_{2.5}$ at U.S. Embassy in Colombo





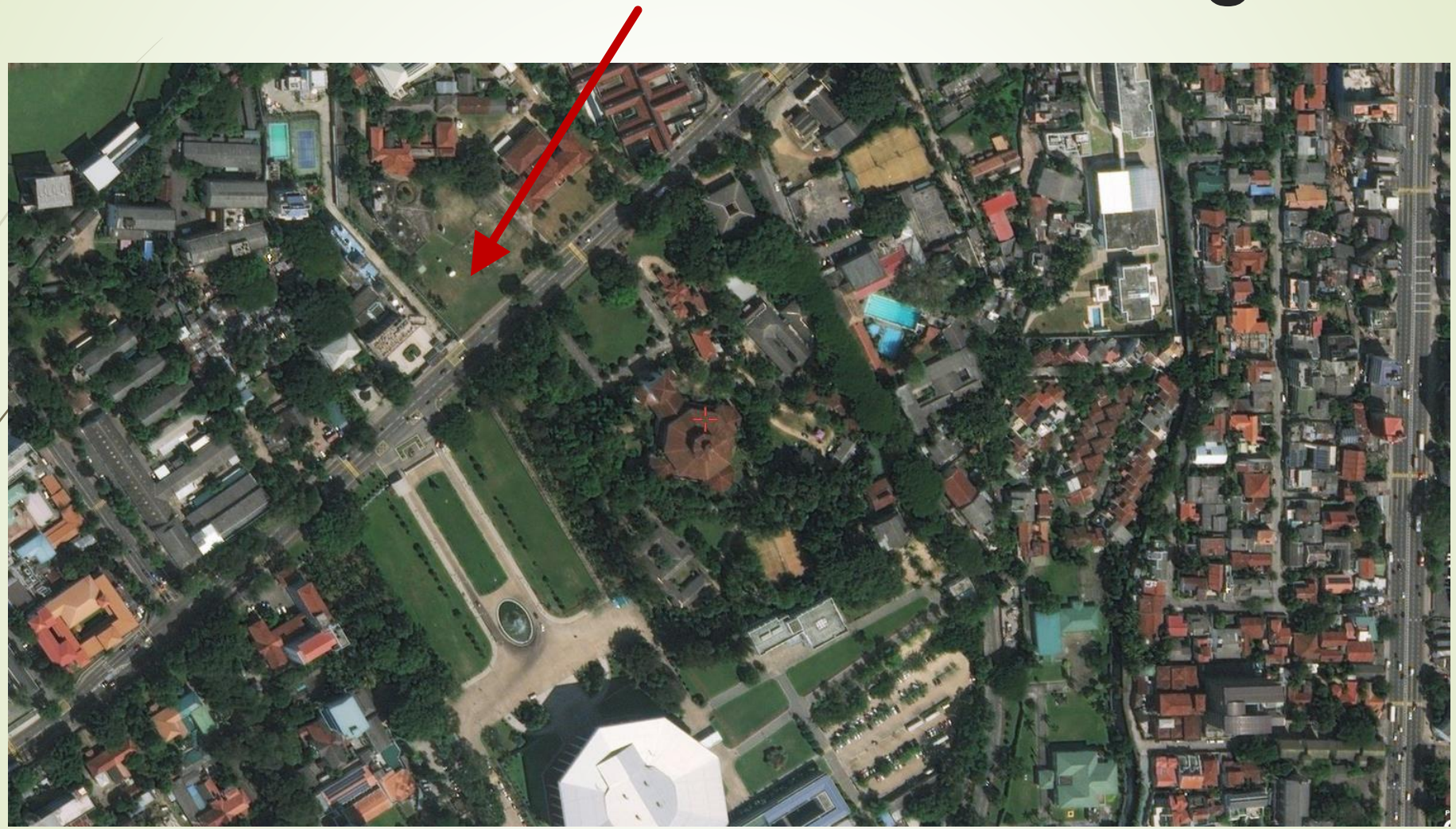
$PM_{2.5}$ in Bakersfield, CA, U.S.A.





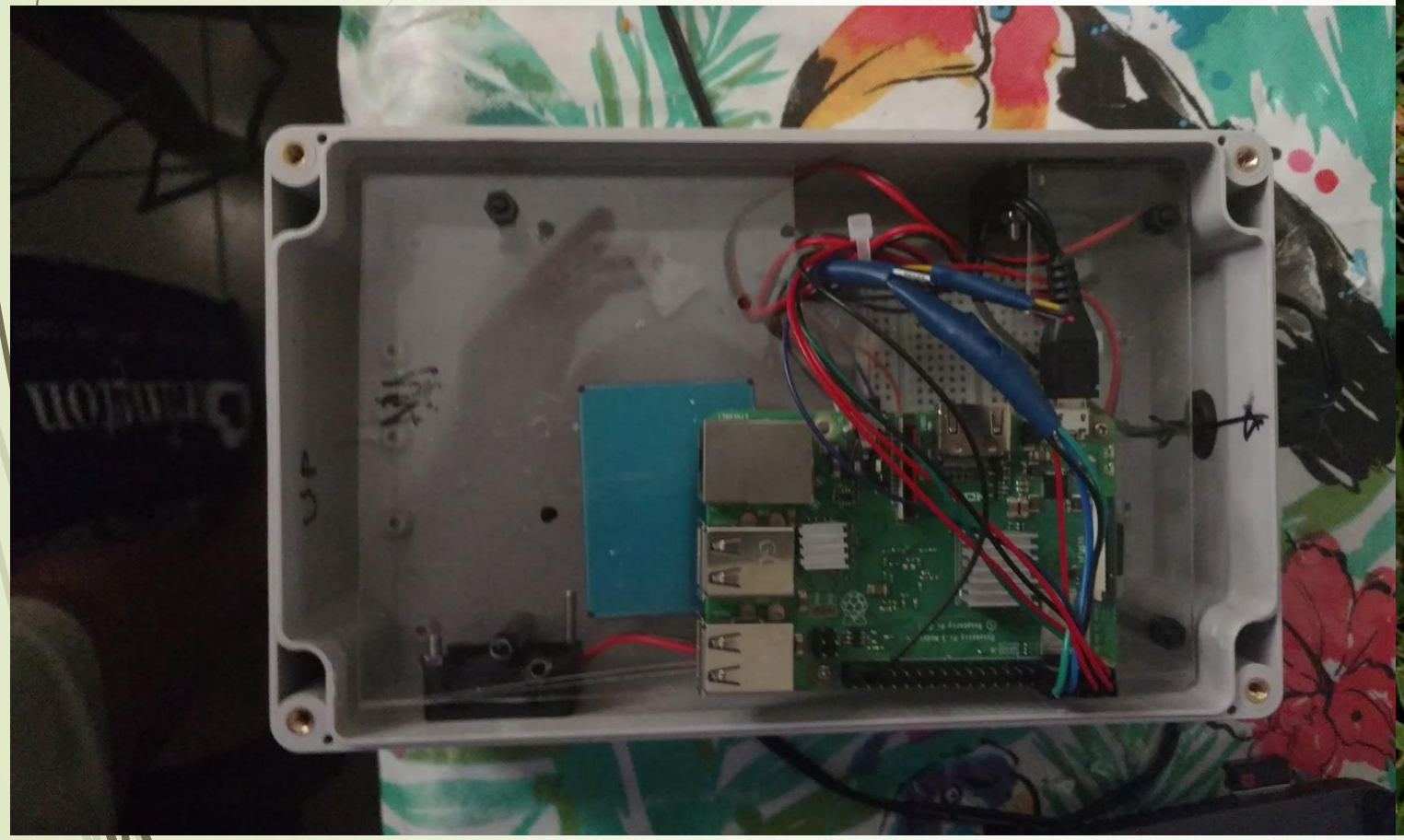
Back to greater Colombo Area

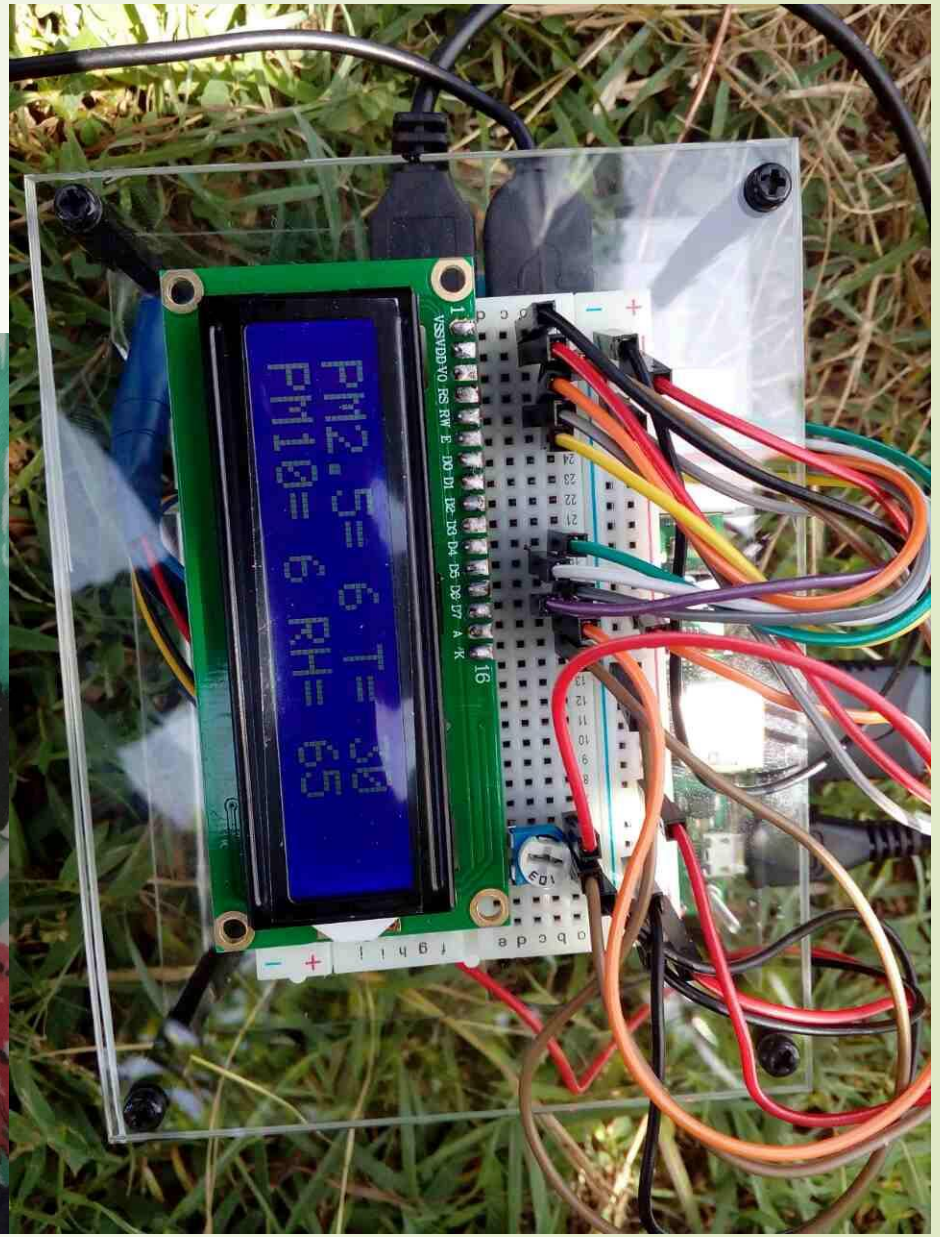
Location of the Sensor Package



Specific Location

Sensor Packages





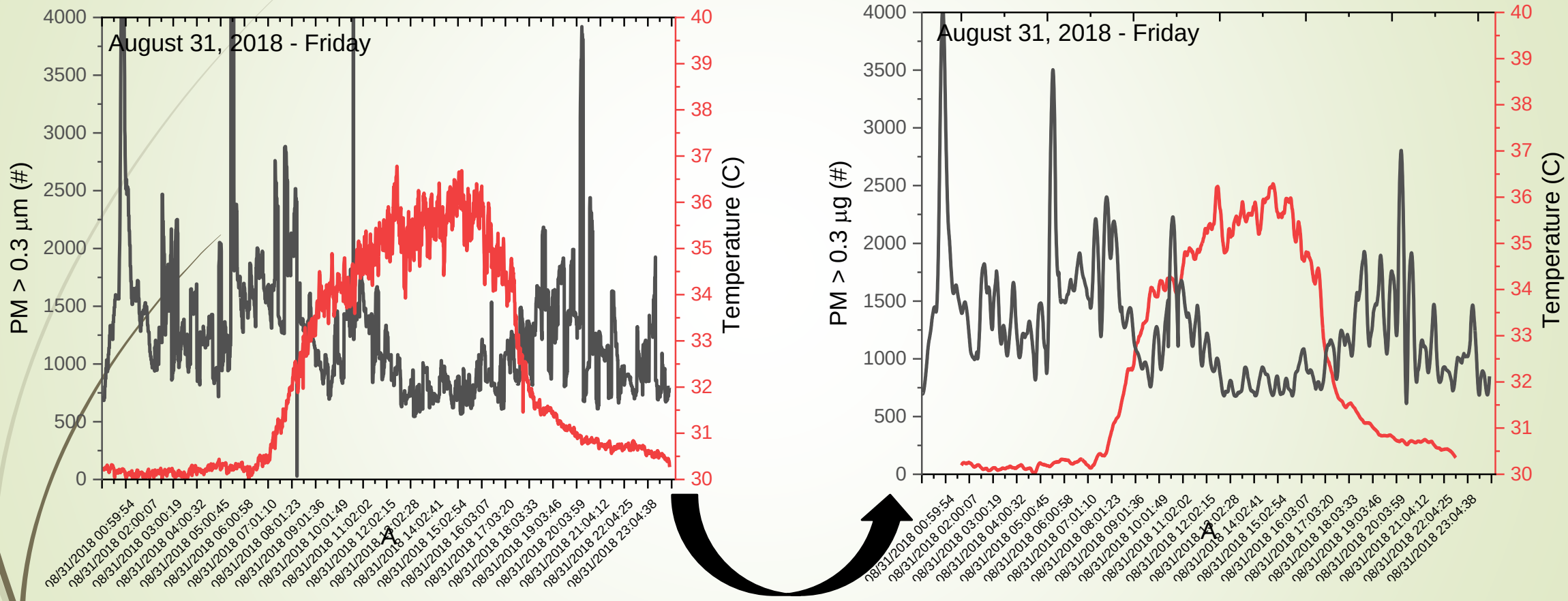
Justification of Components - I

- Raspberry Pi:
  - A functional computer with Wi-Fi built in. Easy to program with Python.
  - Arduino could be more expensive with Wi-Fi shield and less flexible (one code at a time)
  - Production packages could use ESP-12 or ESP-32
- BMP280:
  - Measures Barometric Pressure (P) and Relative Humidity (RH). The board temperature (T) is used to correct P and RH and good indicator of ambient T
  - Well tested and fully supported software (firmware)
  - Production packages could use BMP680 which, in addition to P, RH, and T, has Volatile Organic Compounds (VOCs) – not fully understood

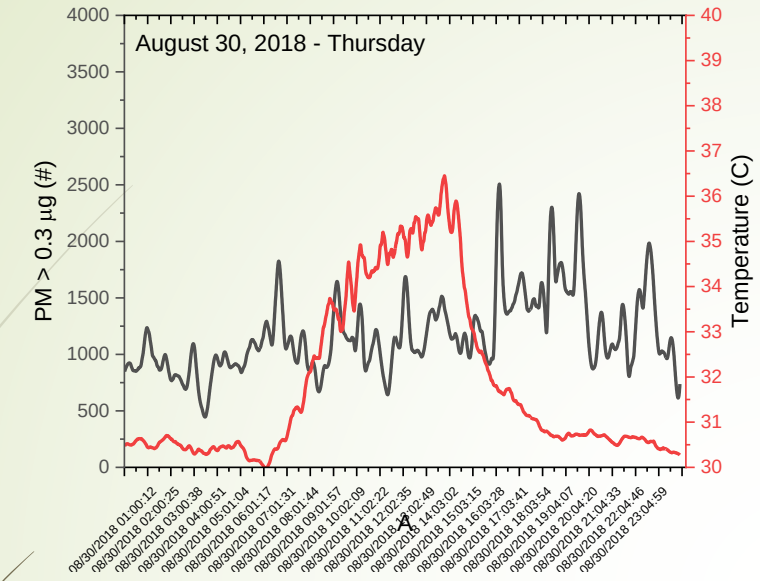
Justification of Components - 2

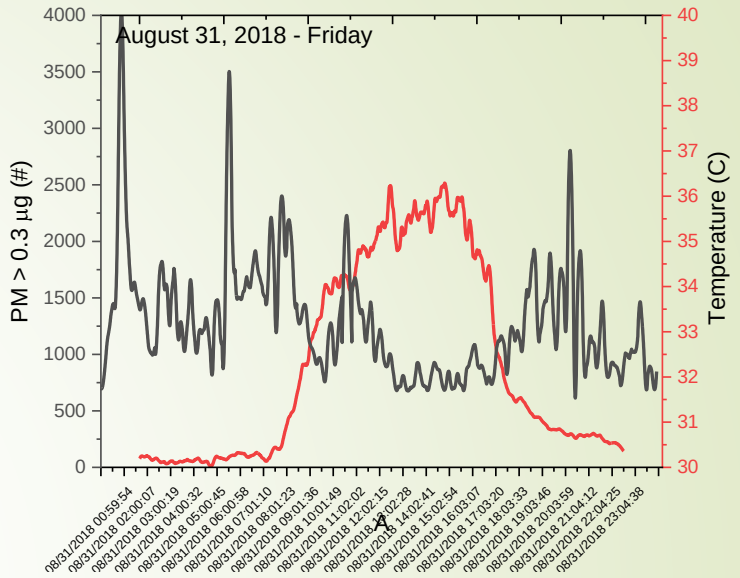
- PMS7003:
  - Particle counter with six size cutoffs (0.3, 0.5, 1.0, 1.5, 2.5, and 10 μm) and three mass cutoffs ($PM_{1.0}$, $PM_{2.5}$, and PM_{10}) – conversion proprietary
  - Latest of the PMS series and comparable to PMS5003
  - PMS5003 used in Purple Air which is endorsed by Weather Underground
- Additional Sensors:
  - Ozone (O_3), Oxides of Nitrogen (NO and NO_2), Oxides of Carbon (CO and CO_2), Sulfur Dioxide (SO_2), …….
- Additional Peripherals:
  - Real-time Clock (done), LCD screen (done), wireless Wi-Fi (done), GPS unit (for mobile applications), …….

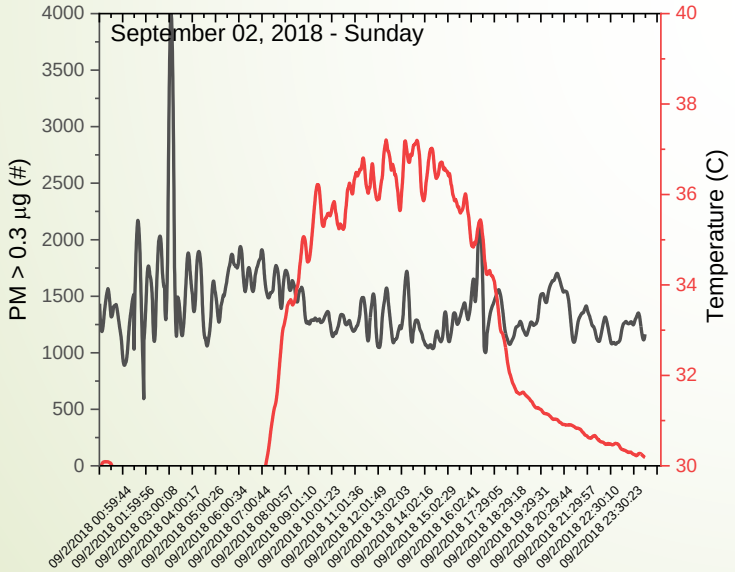
Preliminary Results

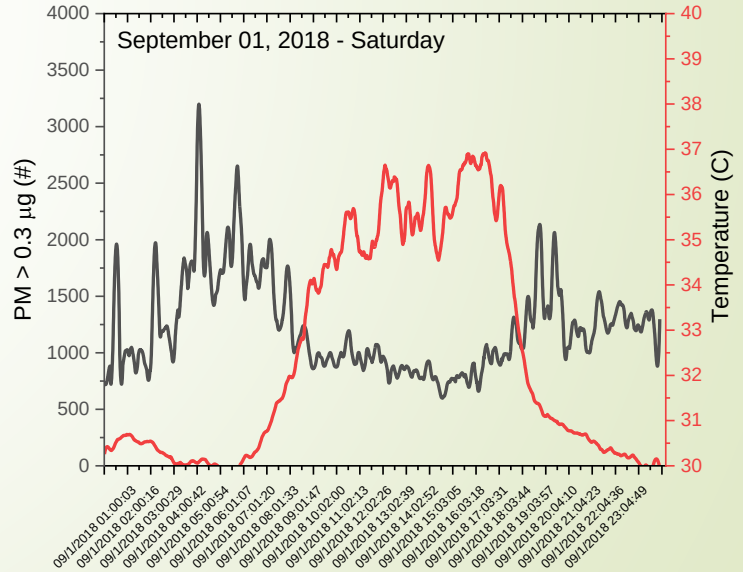


Zavitzky–Golay 50-point smoothing


August 30, 2018 - Thursday
PM > 0.3 µg (#)
Temperature (C)


August 31, 2018 - Friday
PM > 0.3 µg (#)
Temperature (C)


September 02, 2018 - Sunday
PM > 0.3 µg (#)
Temperature (C)


September 01, 2018 - Saturday
PM > 0.3 µg (#)
Temperature (C)

Building a Network of Sensor Packages

- Benefits:
  - Better than nothing!
  - Supplements the current measurement campaign
  - Use as a STEM (Science, Technology, Engineering, and Mathematics) activity in schools – Youth Education
- Challenges:
  - Funding – each package costs ~$100-1000 (depending on sensors)
  - Lack of regulatory/research-grade instruments (co-location)
  - Wi-Fi/LAN not widespread – wireless routers, LGN2 (Lanka Government Network), and Government job training centers (Vidhatha Resource Centers), and local schools with Wi-Fi may be reasonable sites
  - Data warehousing and analytics (depends on the network size)
  - Use of non-regulatory data in policy formation

Thank you for your attention!

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Questions?