MCCHD
United States Environmental Protection Agency
School of Public & Community Health Sciences
University of Montana

November 3, 2019

Research Project Update:

$PM_{2.5}$ Measurements Inside and Outside of Buildings in Missoula, MT During Summer 2019

Outline

- **Project goals**
- **Approach**
- **Preliminary Results**

Wildfires, smoke and exposure

Broad research questions that MCCHD, EPA Office of Research and Development, and UM School of Public & Community Health Sciences are interested to explore:

- What interventions are effective for reducing wildland fire smoke exposures and risks?
- How is public health impacted by different levels and durations of exposures?
- What science is available to support recommendations for communities to develop clean air spaces in larger buildings (e.g., schools, community centers)?
- How effective are portable air cleaners (PACs) during smoke events?
- Are people in community clean air spaces or who have PACs in their homes reducing their exposure/risks to $PM_{2.5}$?
- What can we accomplish with the quickly approaching fire season and how can we transfer results to other smoke impacted communities?

Summer 2019 field study research objectives

1) Conduct measurements of air pollution indoors and outdoors to characterize the concentration variability during wildfire smoke events.

2) Improve understanding of the different drivers of indoor concentrations during wildfire smoke events, including door/window opening, air handling system operation, use of portable air cleaners, and filter maintenance status.

Primary locations for monitoring to be ***commercial buildings or community buildings that are anticipated to have high indoor occupancy during wildfire episodes*** *(e.g., fitness centers, hotels, senior centers).*

Approach

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- New technology has been developed recently that allows for indicative measurements of $PM_{2.5}$ using very small sensors, which can collect a data point every 2 minutes while operating.

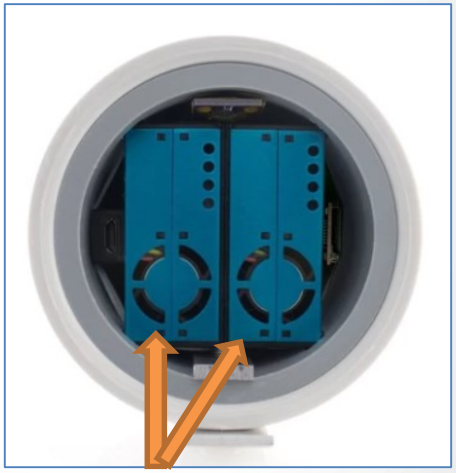
- Research has shown that these sensors typically track the ups and downs of $PM_{2.5}$ well when compared with regulatory-grade monitors, but need correction to give accurate values.

- For this project, a PurpleAir sensor that recorded data to internal memory was utilized (PA-II-SD model sensor).

PA-II-SD relies on an optical detection approach. Particles are pulled into the sensor through a fan, then pass through a light source. Their size and number are then detected based on particles scattering light.

QA /QC

- Sensors were located with regulatory-grade reference monitors at the USFS Fire Lab to evaluate their accuracy and develop correction equation; Boyd Park location was used for collocation of two sensors.
  - USFS reference: Teledyne T640
  - Boyd Park reference: MetOne BAM 1020
- The data from the two identical PM sensors inside the device were used for assessment on data quality.
- 5 of 45 sensors were returned to manufacturer after initial assessment.

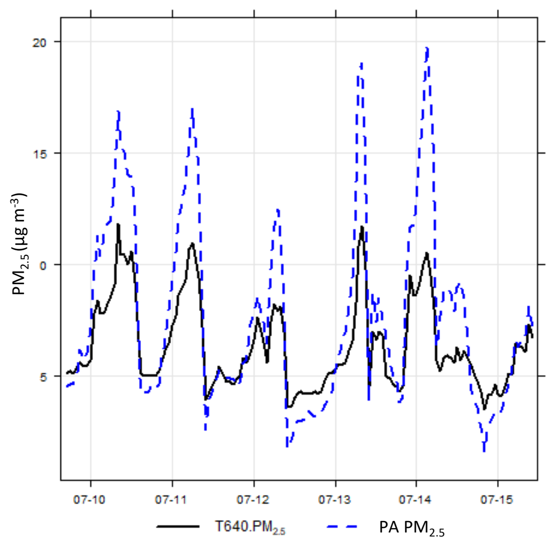


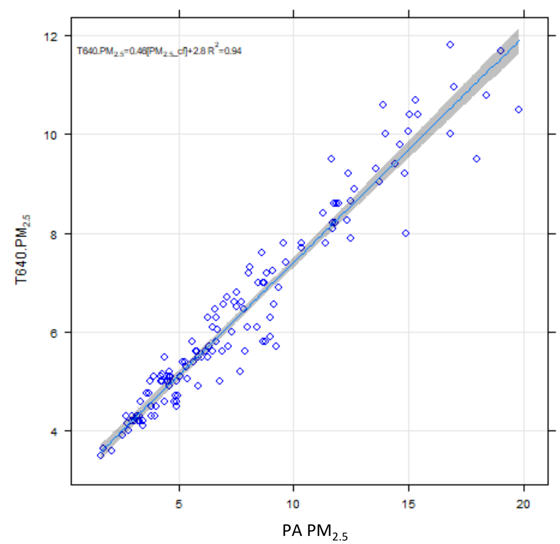
Two identical PM sensors inside the sensor device ("channel a" and "channel b")

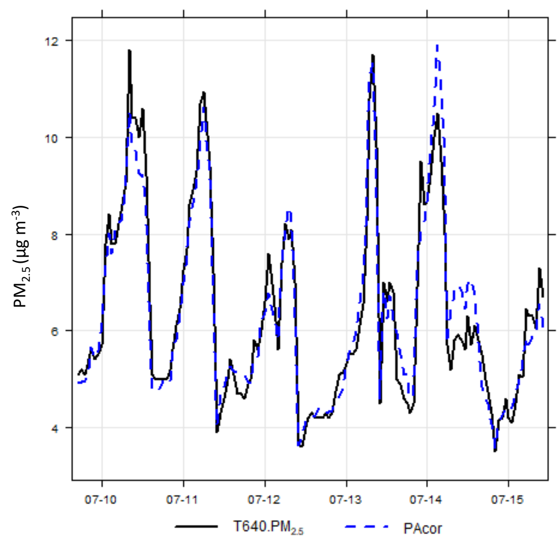
QA /QC

Linear regression of sensor vs. reference

Application of the linear regression to correct the sensor data







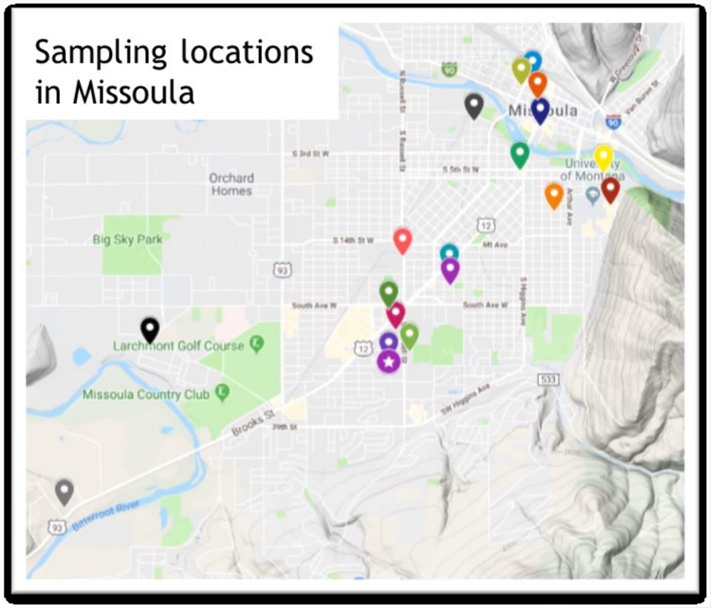
- Prior to correction, sensor was 33.7% off from reference concentrations
- After correction, sensor was within 5.7% of reference monitor
- Very high correlation between sensors and reference – mean Pearson's *r* of 0.96

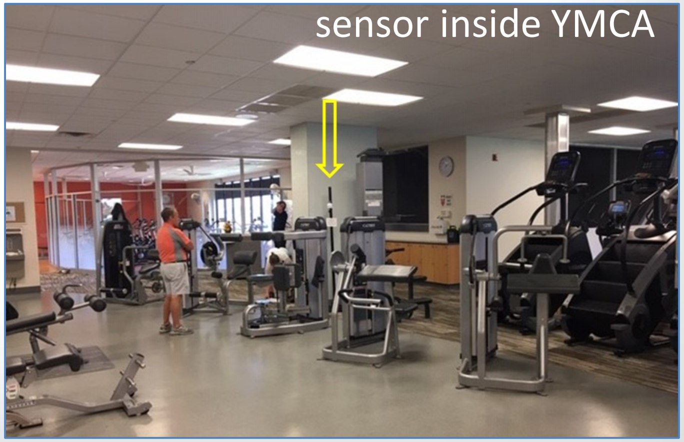
Sampling study

- Sensors were placed indoors and outdoors in buildings throughout Missoula.

- Building selection factors included:
  - Diversity of air handling systems
  - Low likelihood of indoor PM emissions
  - Interest in participation by building owners

- Siting of sensors within the buildings used these criteria:
  - Ease of access by MCCHD staff
  - Access to land power
  - Representing “well-mixed conditions” – avoiding being near doorways/windows; air handling system exhaust, etc.
  - Goal of indoor and outdoor sensor per location if feasible





Sampling summary

- Sensor deployment
  - Total # buildings: 18
  - Sensor: 36 (16 outdoor, 20 indoor)

- Sampling period –July 18 to Sept 16, 2019 (with sensor/reference collocation before and after)
  - Different start/stop times per building due to field logistics
  - Major wildfire smoke event did not occur; minor prescribed fire impact on a few days

- Data records (2 min data, 36 sensors): >1 million $PM_{2.5}$ observations over the study period for the entire set of sensors

- Buildings ranged from natural ventilation using windows and fans (e.g., St. Francis) to HVAC systems with MERV 8 filters (many buildings) to more complex systems (e.g., 1 building with MERV 8 + Activated Charcoal + MERV 14)

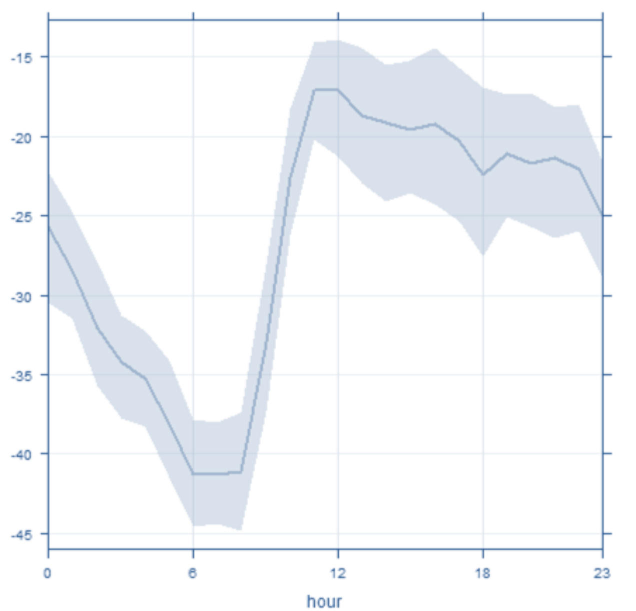
Example results: AT&T

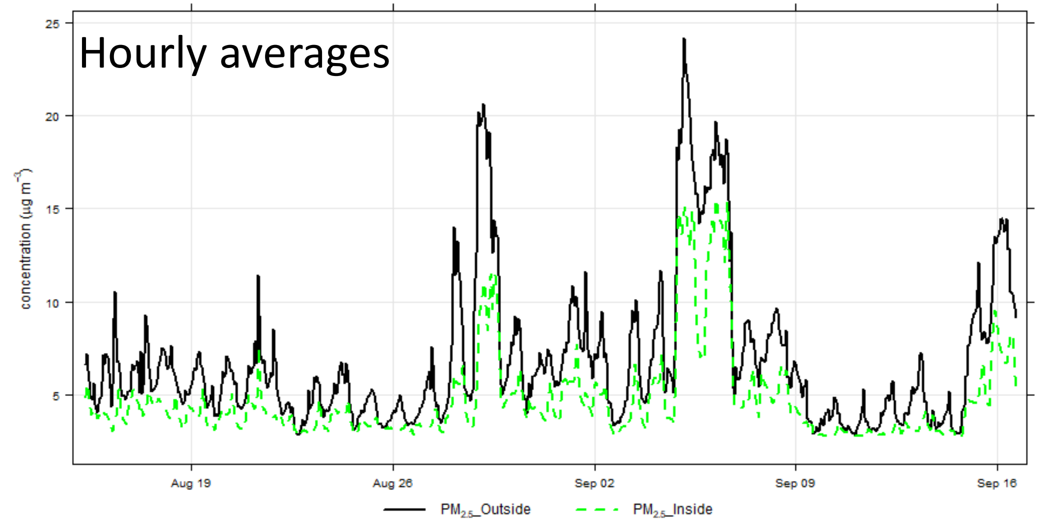
Sensor readings for $PM_{2.5}$ inside was 26.5% lower than outside.

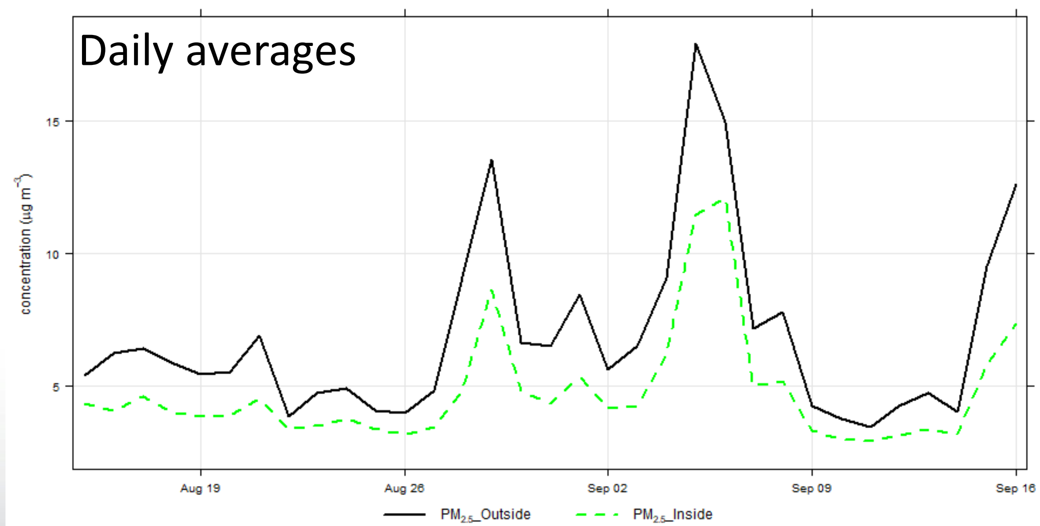
Diurnal fluctuation evident in inside/outside ratio of $PM_{2.5}$

Sensor inside vs. outside

% difference. Inside vs outside







Example results: YMCA

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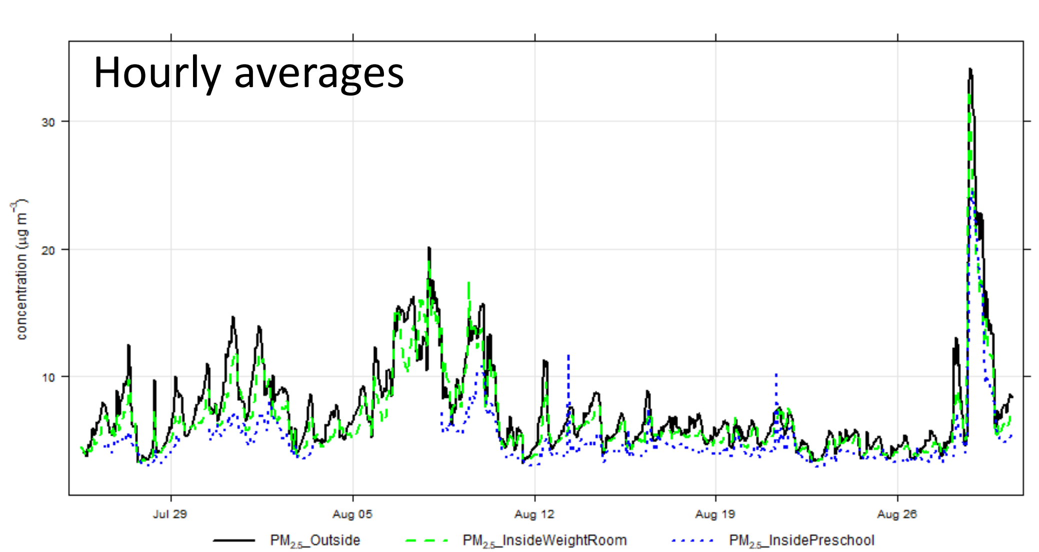
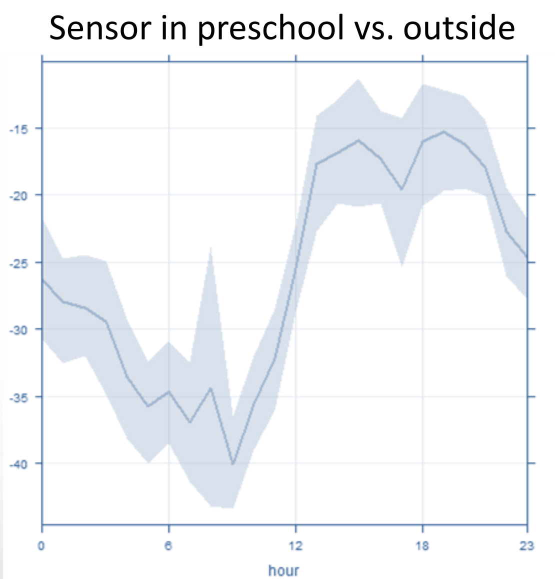
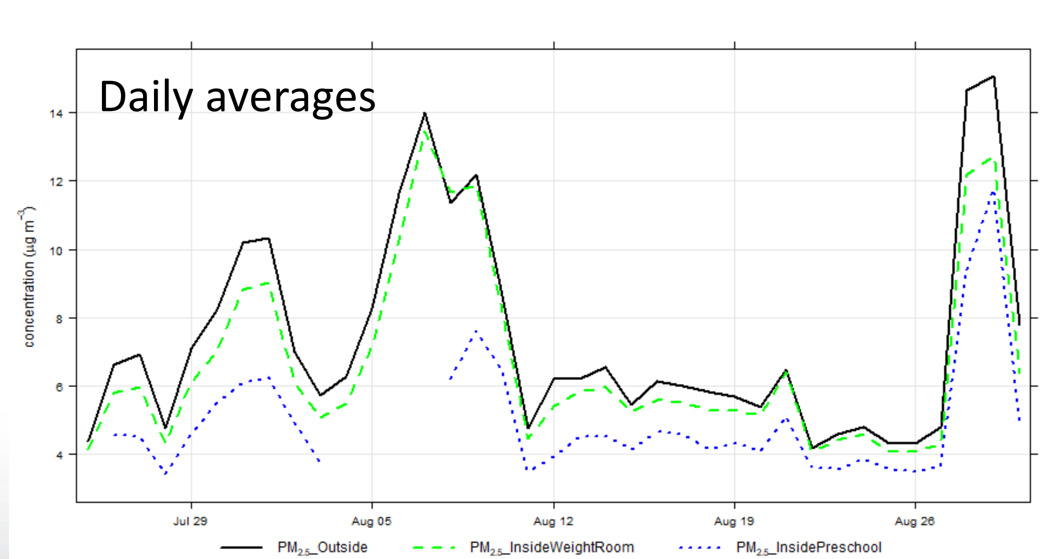
Sensor readings for $PM_{2.5}$ inside preschool were 25.8% lower, weight room was 7.6% lower, than outside on average.

Diurnal fluctuation evident in inside/outside ratio of $PM_{2.5}$



% difference. Inside vs outside





Example results: UM Rec Center

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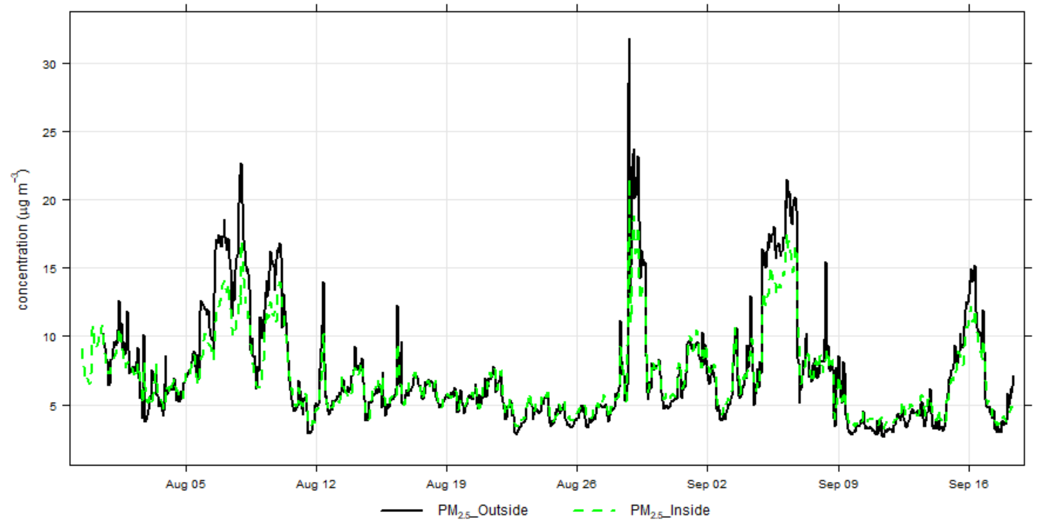
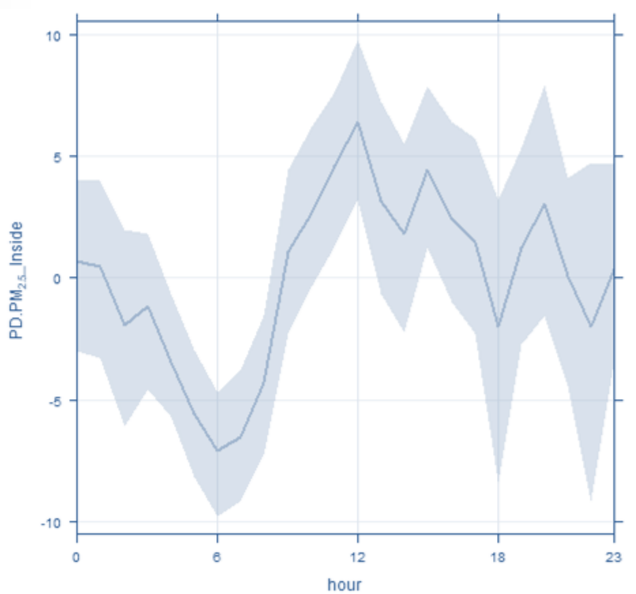
Sensor readings for $PM_{2.5}$ inside were 1.5% lower than outside.

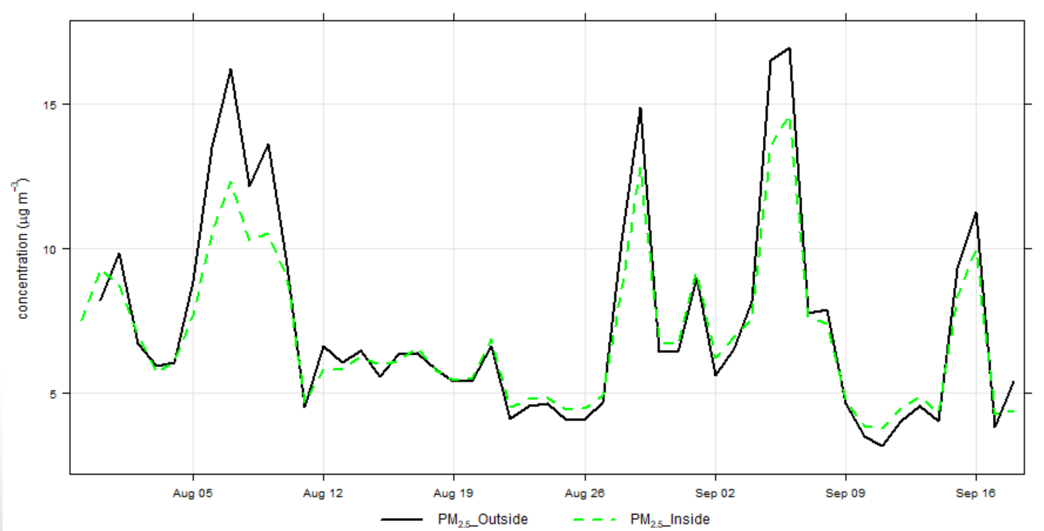
Diurnally variable inside/outside ratio of $PM_{2.5}$, sometimes above and sometimes below outside sensor



Sensor inside vs. outside



% difference. Inside vs outside



Example results: Fort Missoula

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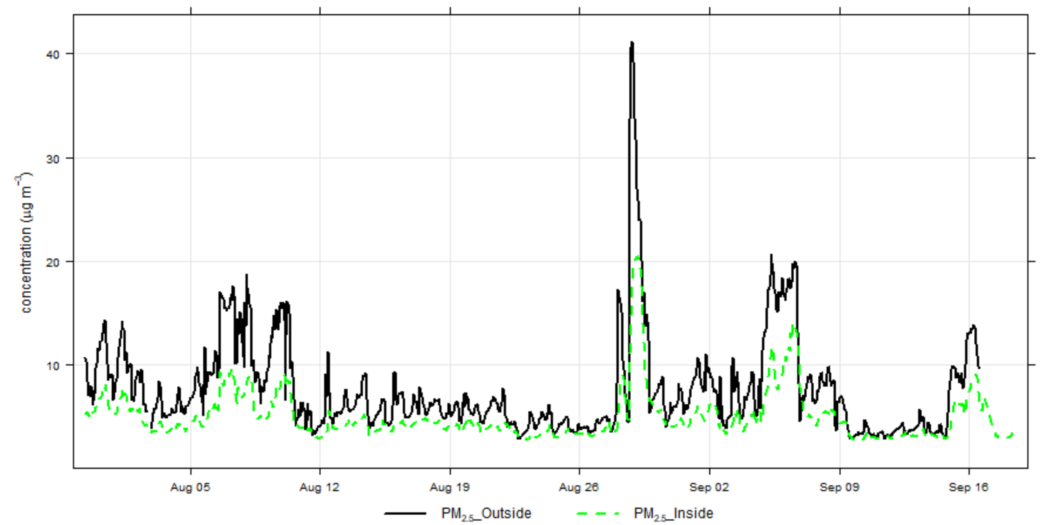
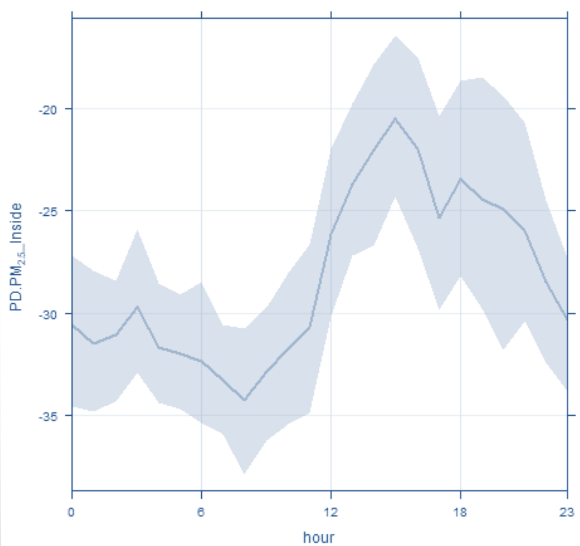
Sensor readings for $PM_{2.5}$ inside were 28.3% lower than outside.

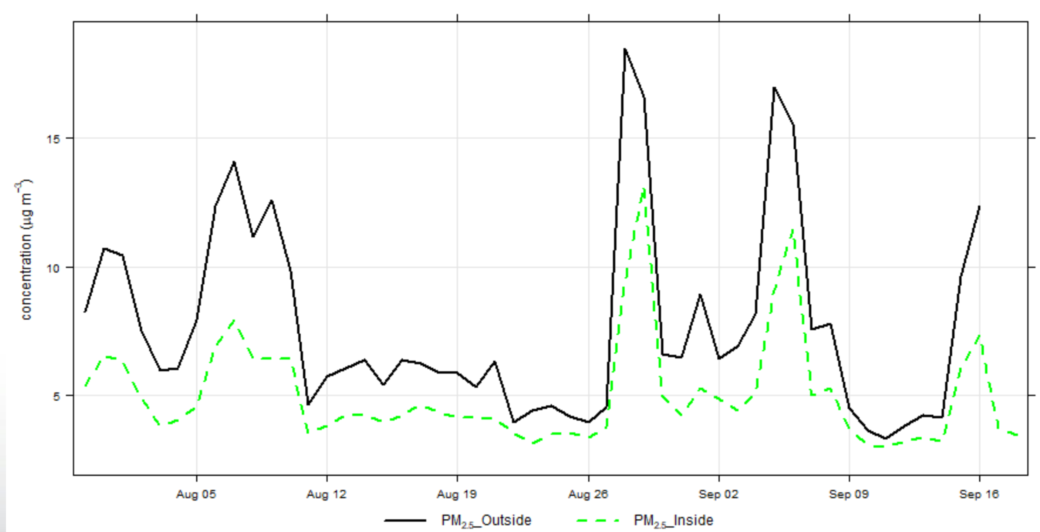
Diurnal fluctuation evident in inside/outside ratio of $PM_{2.5}$



Sensor inside vs. outside

% difference. Inside vs outside





Looking across outdoor network

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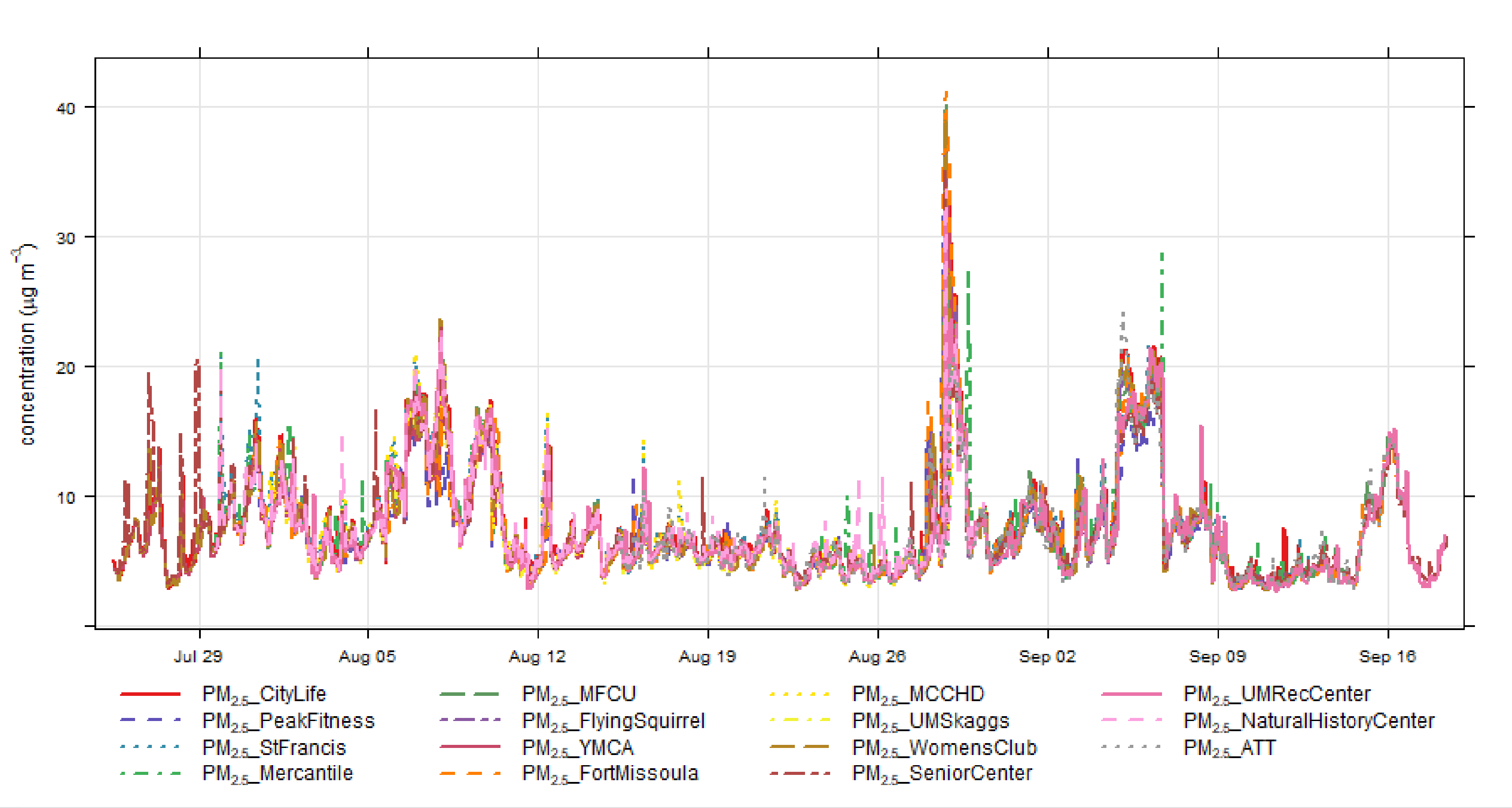
Hourly concentrations across the sensor network look very similar overall; but there are occasional variation likely due to local emissions or spatial variability in transported smoke (e.g., prescribed fire events)



Next steps

- Data analysis is underway

- Presentation of results to local stakeholders via webinar expected in December-January timeframe and slides available for sharing.

- Partner project in Hoopa, California underway, utilizing the same sensors for indoor/outdoor buildings under wildfire smoke events and other biomass emissions (e.g., outdoor burning, residential wood burning).

- Planning summer 2020 field study in Montana building upon knowledge gained from the summer 2019 field pilot.