Advancing Personal Air Pollution Exposure for Pregnancy Studies Using Air Sensors
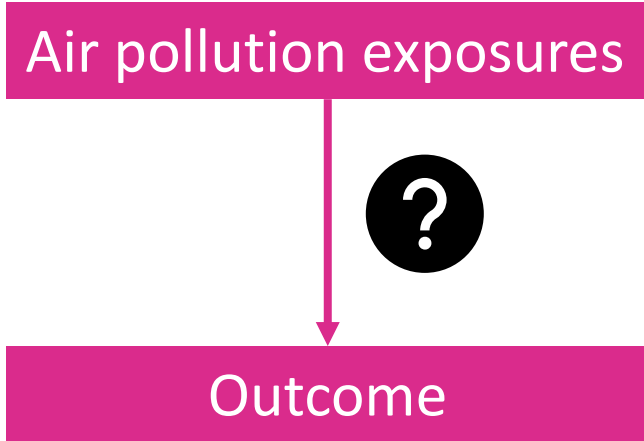
Yisi Liu, PhD

Air Sensor International Conference

May 12th, 2022
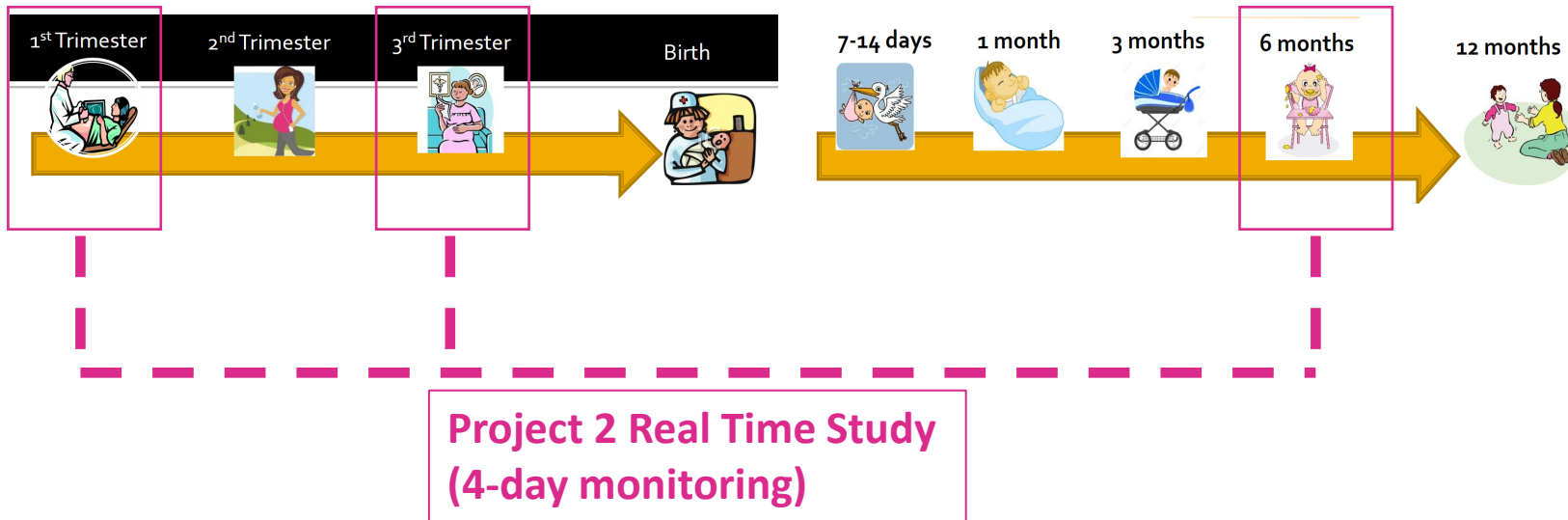
Background

Air pollution exposures

?

Outcome

Ambient

In transit

Indoor

Personal

Research Questions

- How different is personal vs. ambient $PM_{2.5}$ exposure for pregnant women?

- How does built environment impact personal $PM_{2.5}$ exposure ?

- Does built environment modify the relationship between personal and ambient $PM_{2.5}$ exposure?

P2 Real-time Study

| 1st Trimester | 2nd Trimester | 3rd Trimester | Birth | | 7-14 days | 1 month | 3 months | 6 months | 12 months |

Project 2 Real Time Study (4-day monitoring)

RTI microPEM

madresGPS app

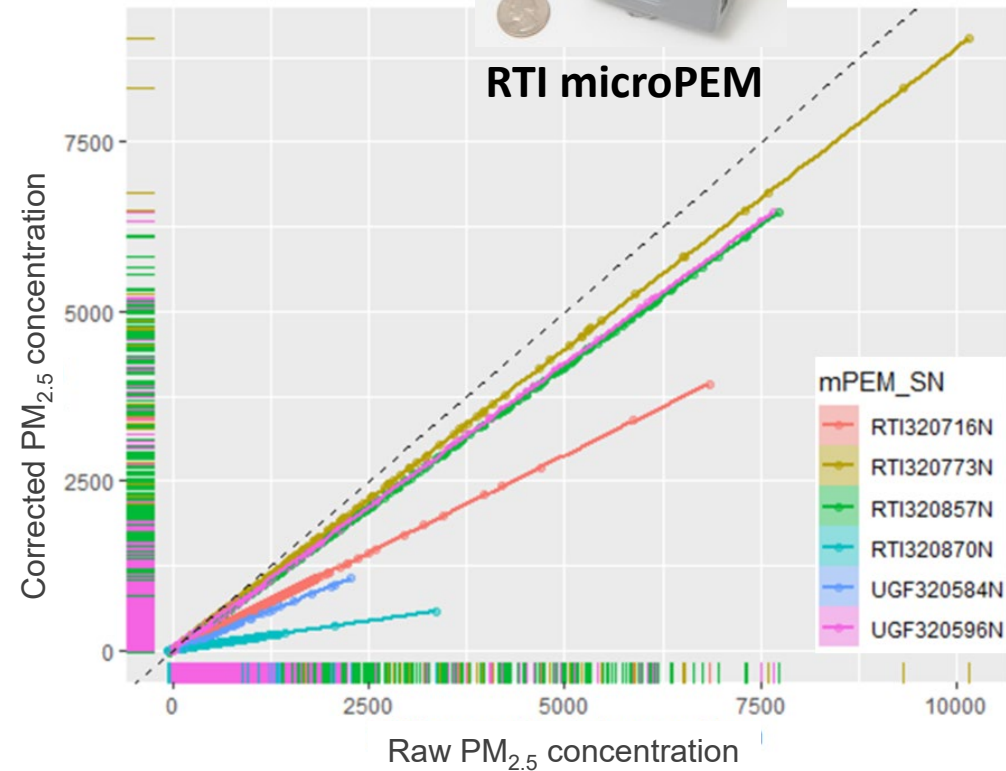# PM$_{2.5}$ exposures

Personal PM$_{2.5}$ Exposure

- Real-time nephelometry: minute-level mass concentrations

- Integrated filter collection: gold-standard measurement

- Post-correction: mixed effect models
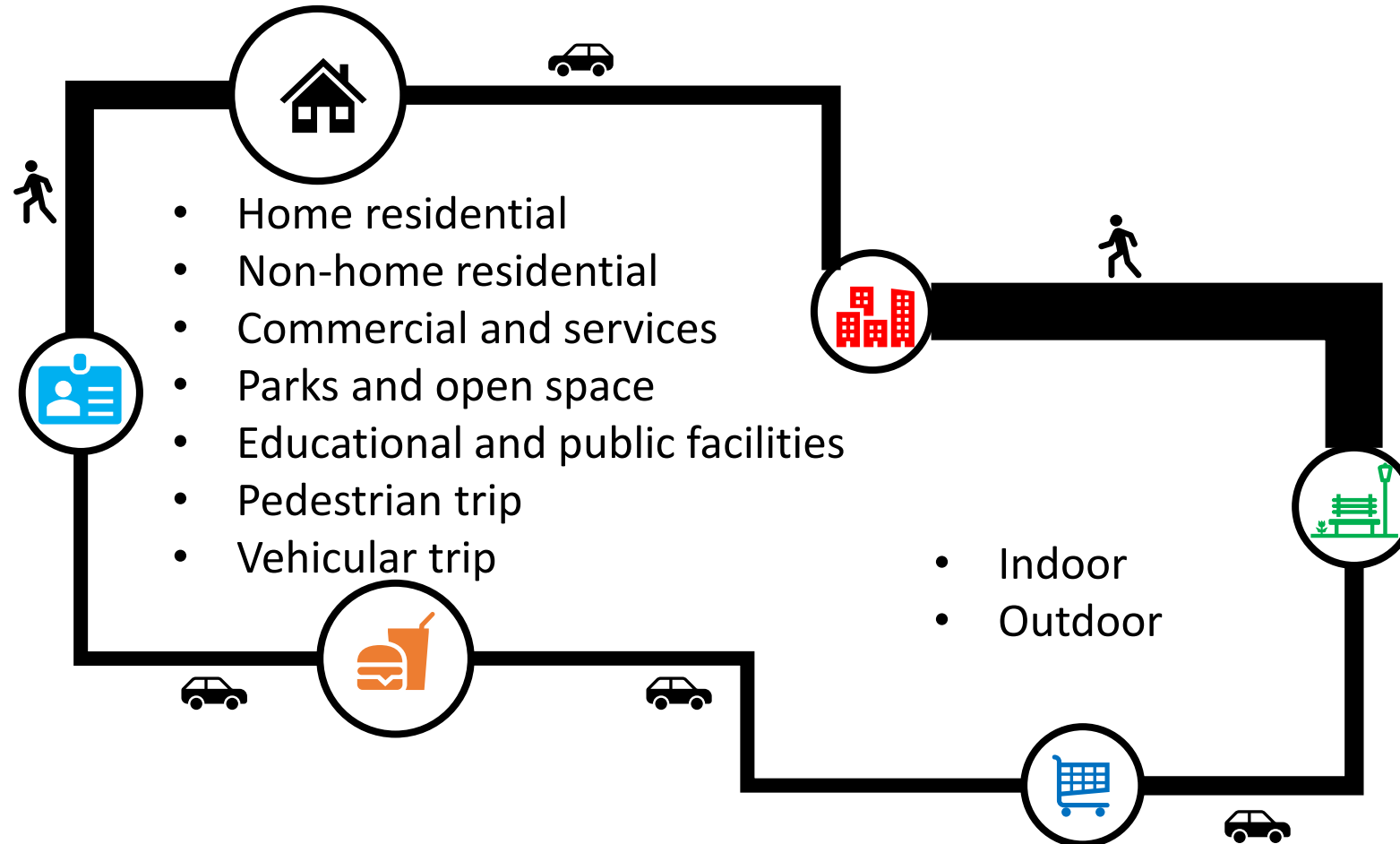
Outdoor PM$_{2.5}$ Exposure

- Home residential

- Inverse distance weighted interpolation



RTI microPEM

Contexts and Microenvironments

- Home residential
- Non-home residential
- Commercial and services
- Parks and open space
- Educational and public facilities
- Pedestrian trip
- Vehicular trip

- Indoor
- Outdoor

Li Yi, PhD

Time-activity and daily mobility patterns during pregnancy and early postpartum – evidence from the MADRES cohort

Li Yi [a], Yan Xu [a], Sandrah P. Eckel [b], Sydney O'Connor [b], Jane Cabison [b], Marisela Rosales [b], Daniel Chu [b], Thomas A. Chavez [b], Mark Johnson [b], Tyler B. Mason [b], Theresa M. Bastain [b], Carrie V. Breton [b], Genevieve F. Dunton [b, c], John P. Wilson [a, b, d], Rima Habre [a, b]
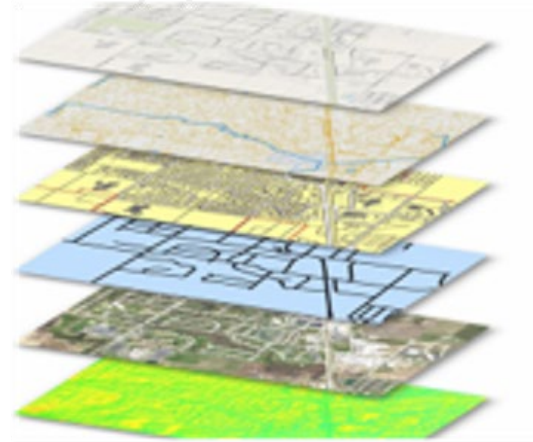
Built Environment Characteristics

Kernel density activity space
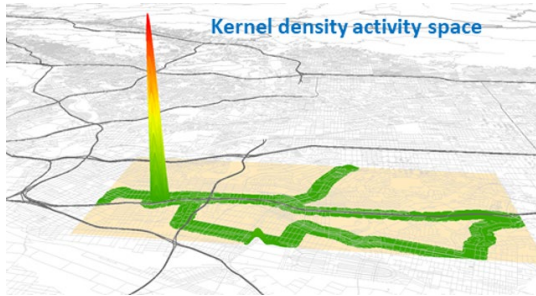
Time-weighted locations

GIS Layers

- Aerial and street greenness
- Park and public transit access
- Street connectivity and walkability
(Based on EPA EnviroAtlas)

Li Yi, PhD

Participants

63

Pregnant women

All Hispanic
Average age: 28.6
53.2% low income
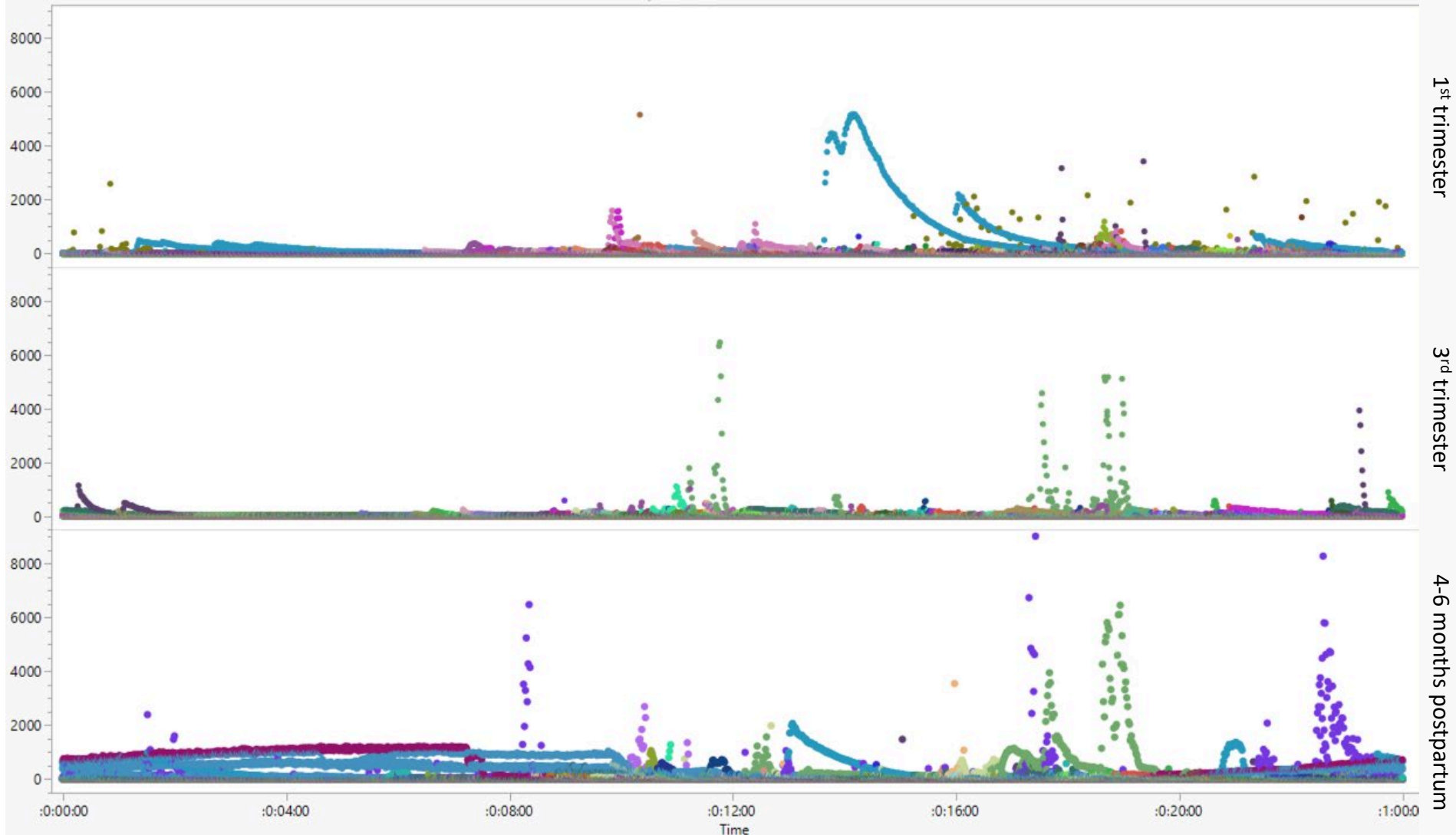33.9% < high school
72.6% obese/overweight before pregnancy

618

Person-days

~
1million

Minute-level data

Personal PM$_{2.5}$ Exposures

1st trimester
333,744 min
15.1 (70.1) μg/m^3

3rd trimester
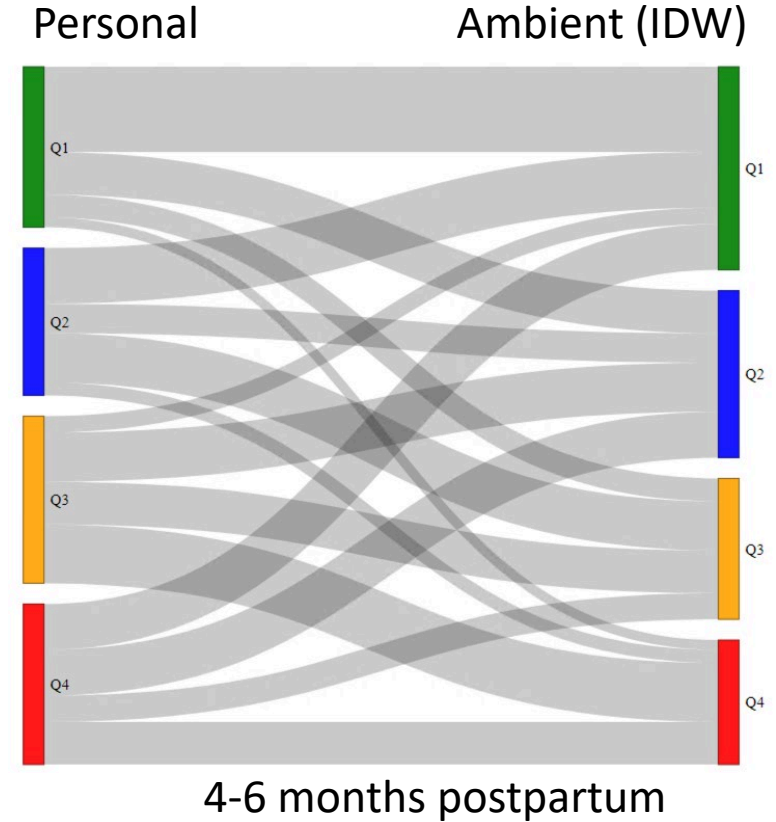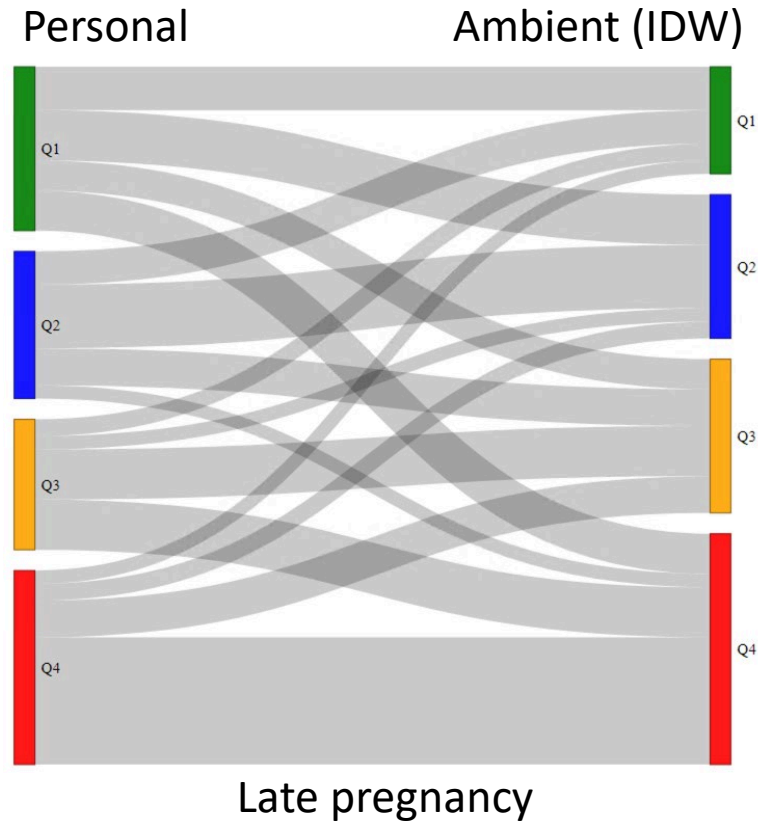263,793 min
15.1 (49.5) μg/m^3

4-6 months postpartum
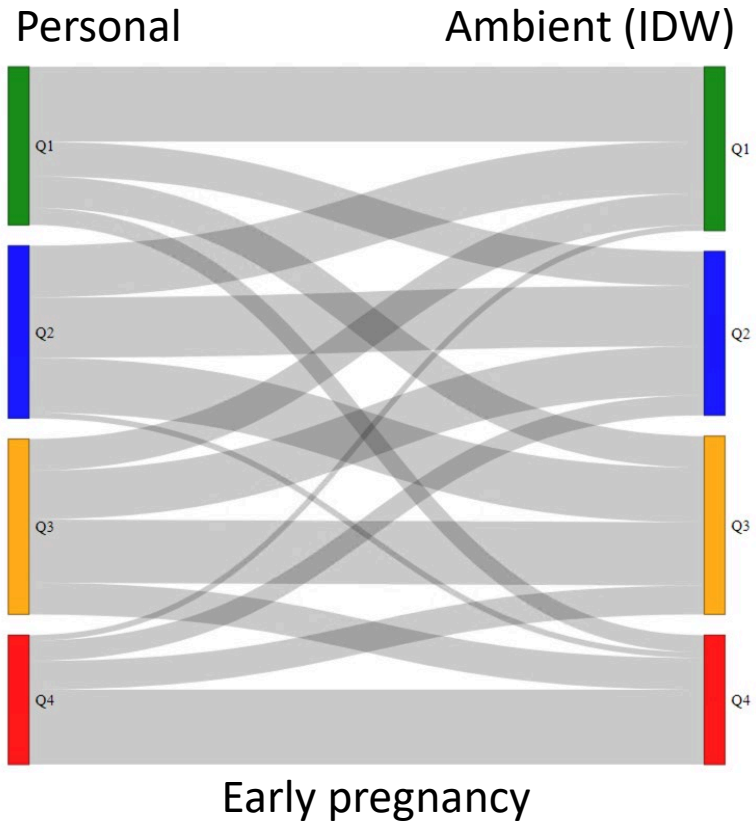276,529 min
26.8 (119.8) μg/m^3

Personal vs. Ambient PM$_{2.5}$ Concentrations

The mean and standard deviation of PM$_{2.5}$ exposure

Visit	Personal PM$_{2.5}$ (μg/m^3)	Ambient PM$_{2.5}$ (μg/m^3)
1st trimester	16.1 (21.1)	11.0 (4.4)
3rd trimester	15.0 (8.7)	13.2 (6.2)
4-6 months postpartum	26.7 (64.3)	10.1 (4.7)

Exposure Misclassification—Daily Averages

Early pregnancy

Late pregnancy

4-6 months postpartum

Exposure Misclassification—Daily Averages

Personal   Ambient (IDW)   Personal   Ambient (IDW)

Q1   Q2   Q3   Q4

Wildfire_10,000 acres (Yes)   Wildfire_10,000 acres (No)
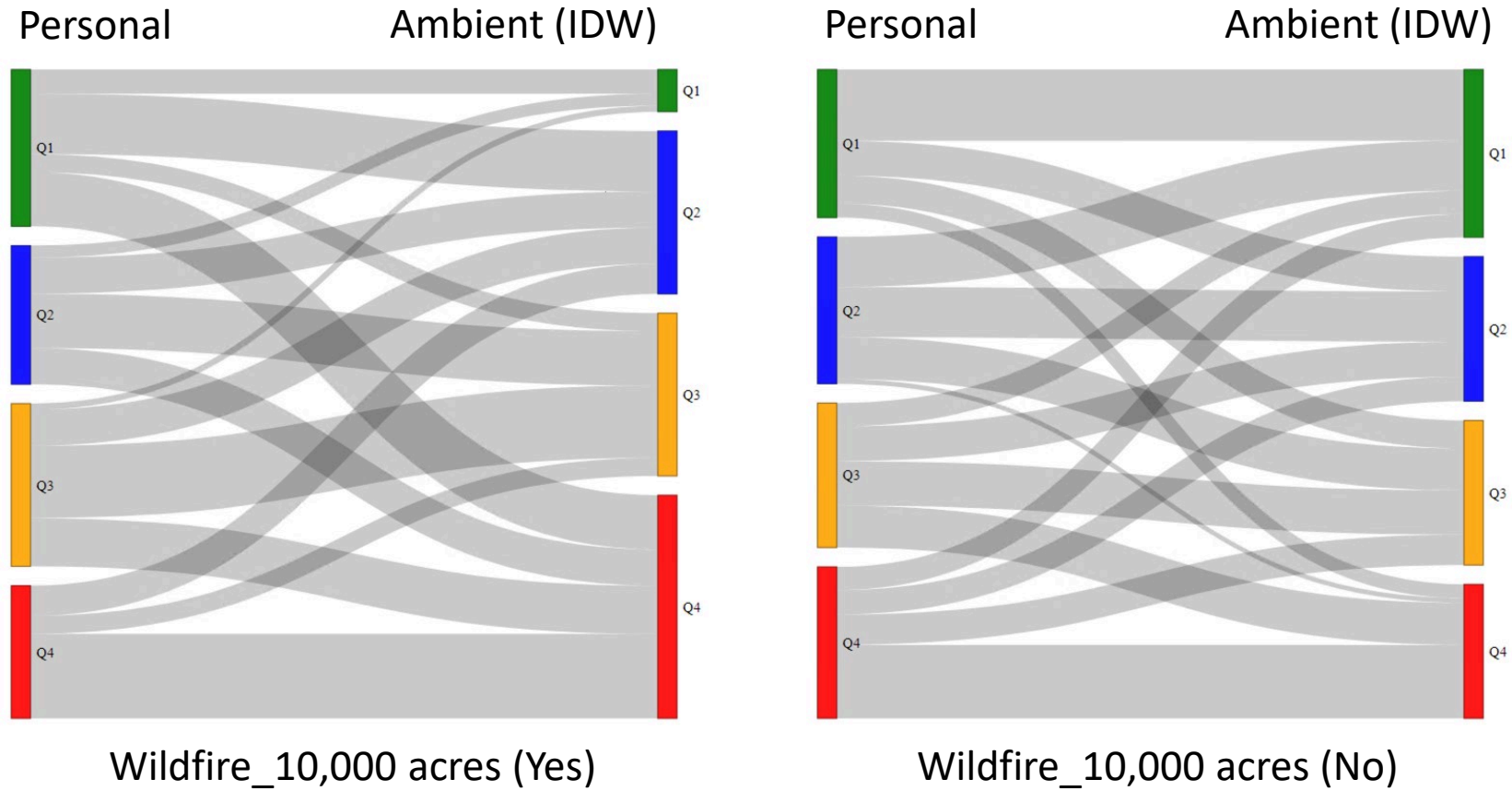
Time-Activity & Mobility Patterns

23% Visits to Commercial and Service Locations
- Decreased at postpartum or had at least one child
- Increased if employed

16.7 Hours
At Home

2% Visits to Parks and Open Space
- Increased during weekends

25% Walking Trips
- Top origins and destinations include home/commercial

75% Vehicular Trips
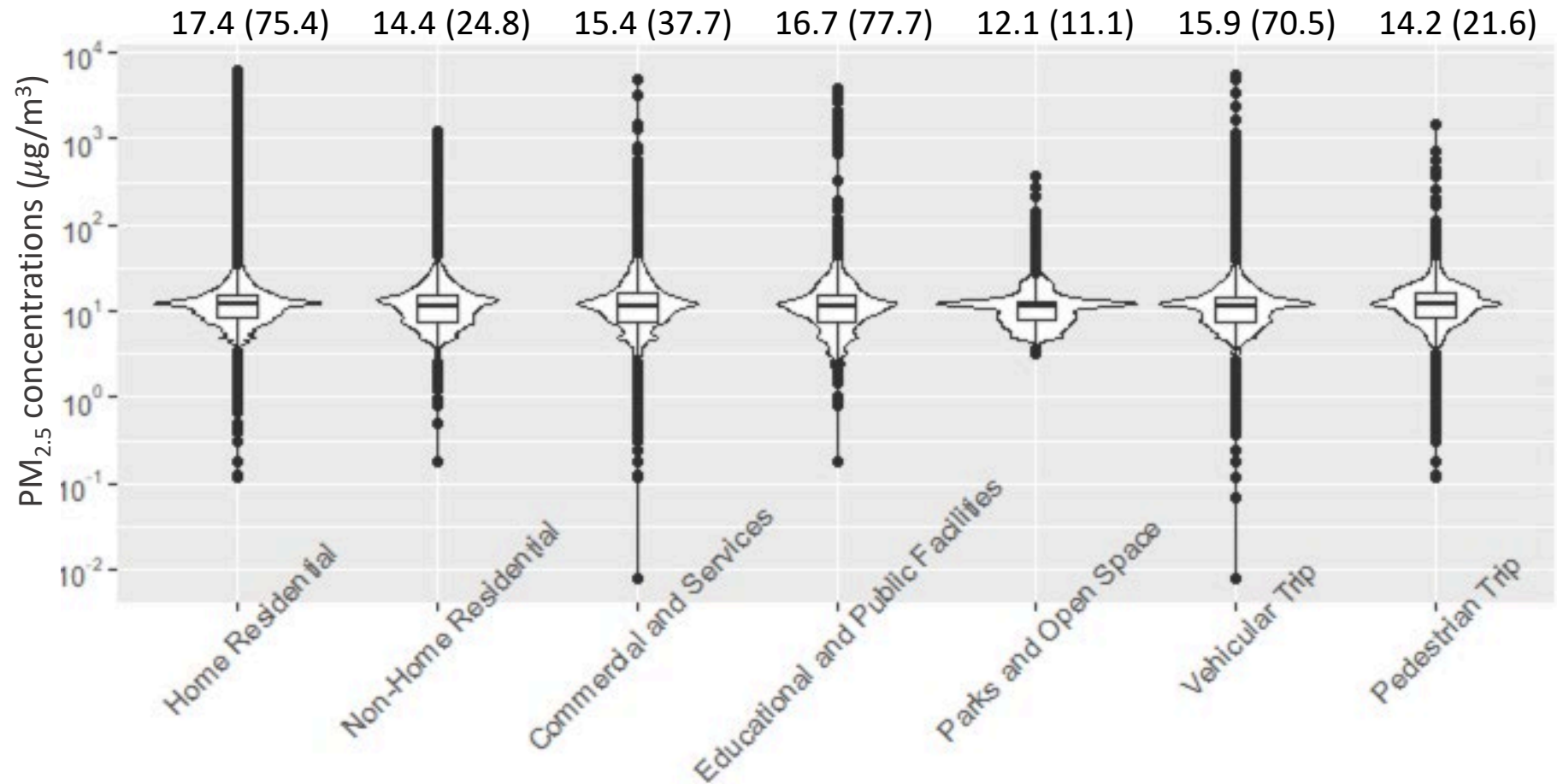- Decreased at postpartum & weekend days
- Increased if higher education attainments
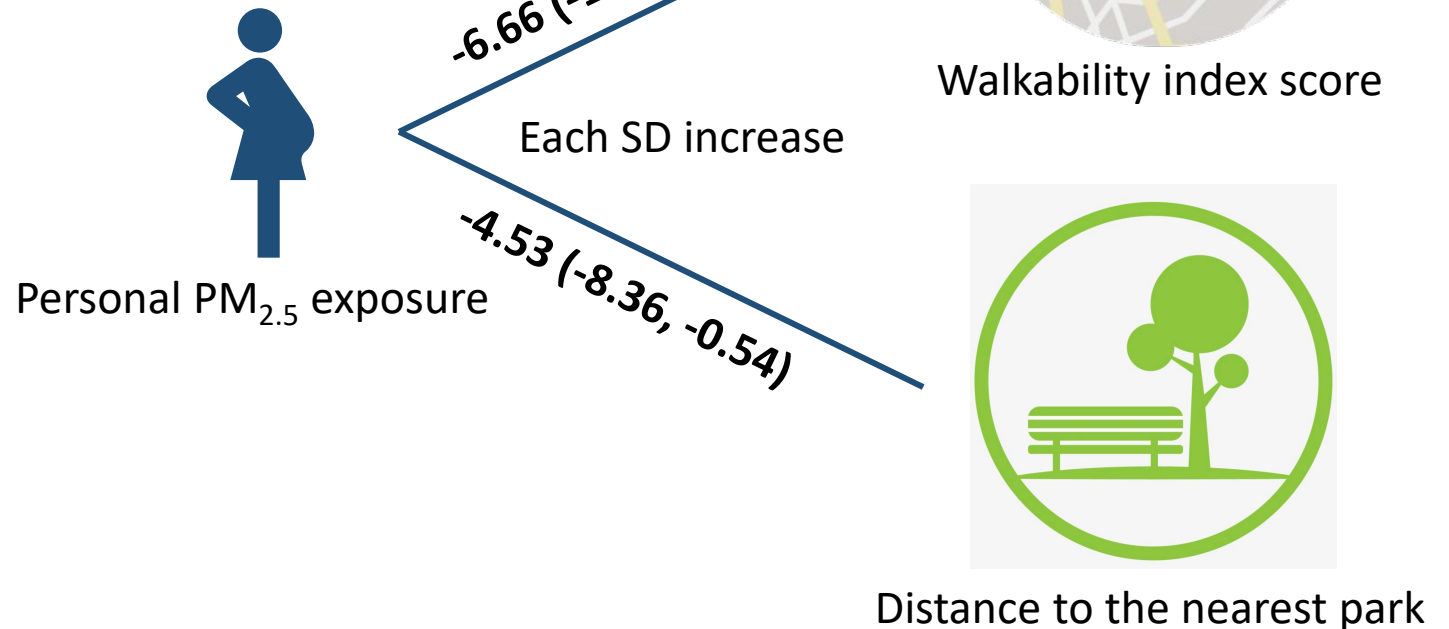
Li Yi, PhD

Personal PM$_{2.5}$ by Contexts

Personal PM$_{2.5}$ & Built Environment in Activity-Space

Linear mixed effect model

Daily Personal PM$_{2.5}$ exposure ~ Built environment in activity-space +

visit, weekend, wildfire days, temperature + (1|ID)

-6.66 (-11.48, -1.45)

Each SD increase

Walkability index score

Personal PM$_{2.5}$ exposure

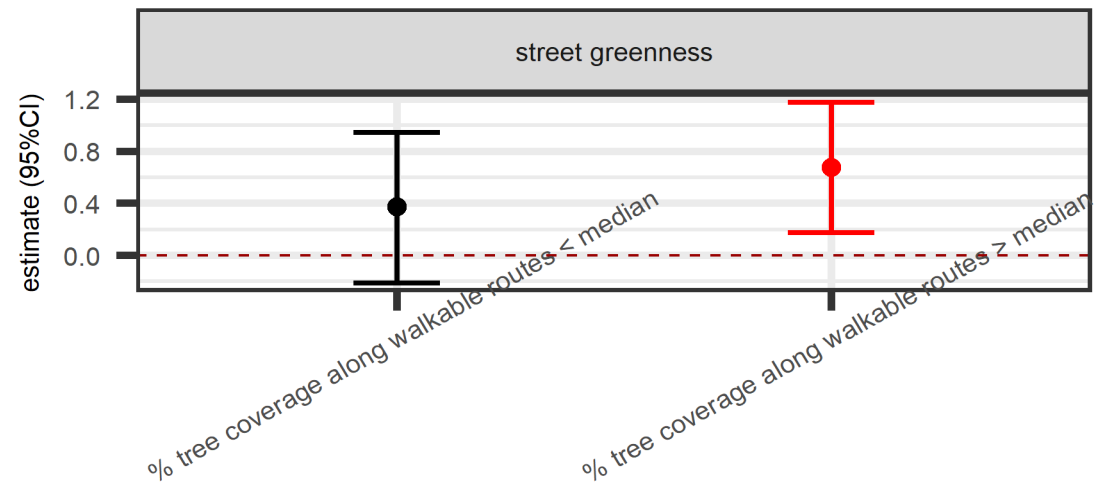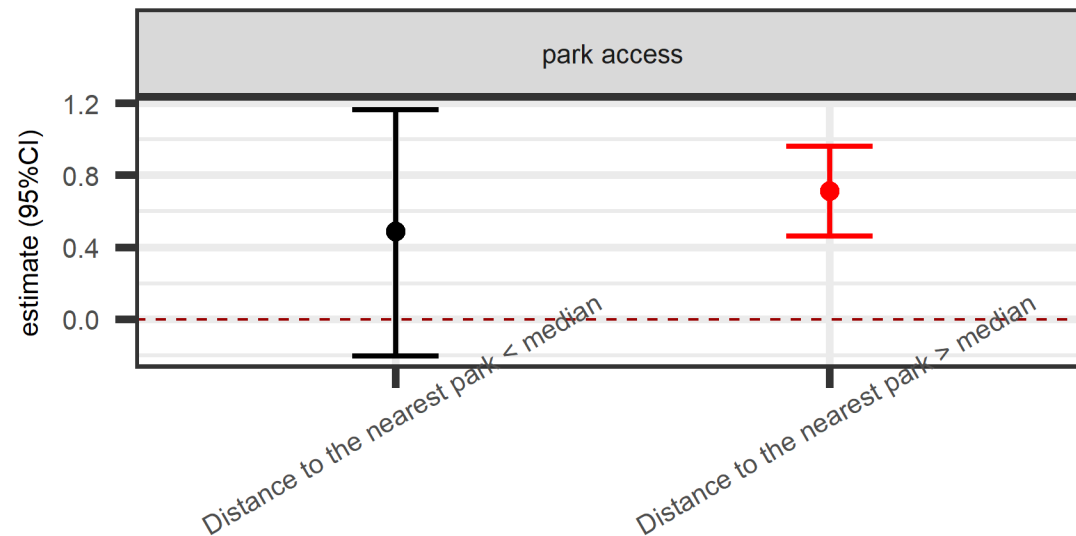-4.53 (-8.36, -0.54)
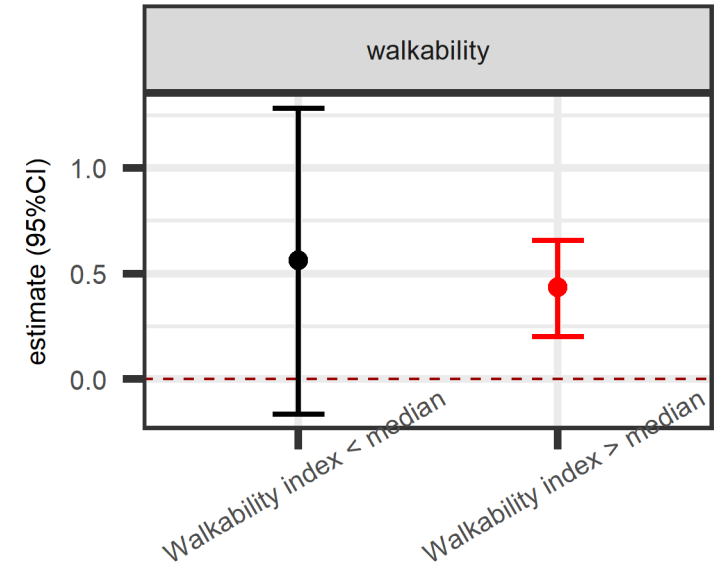
Distance to the nearest park

Exposure Differences & Built Environment in Activity-Space

Linear mixed effect model
Stratified by built environment characteristics

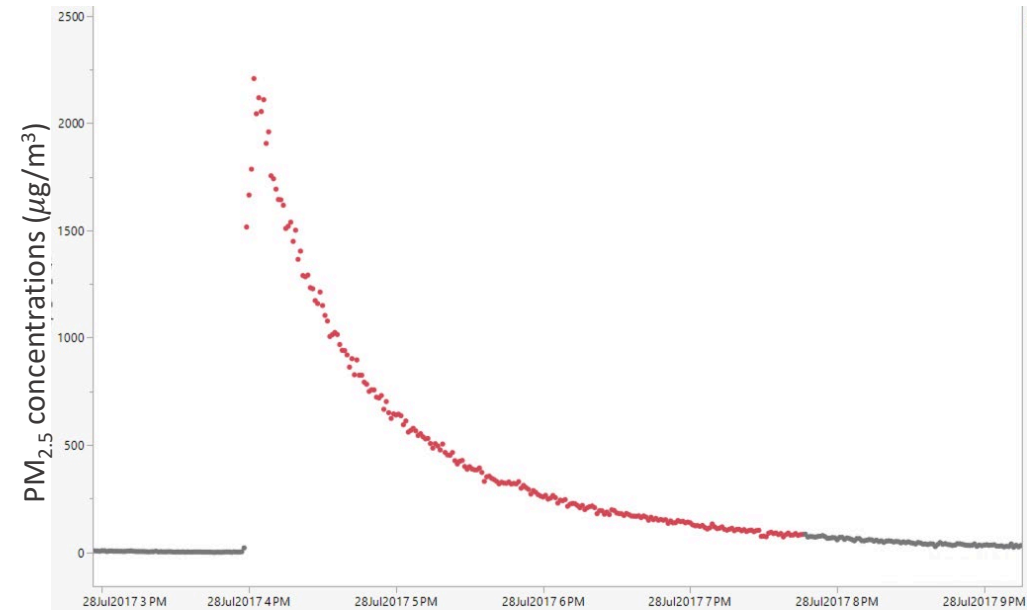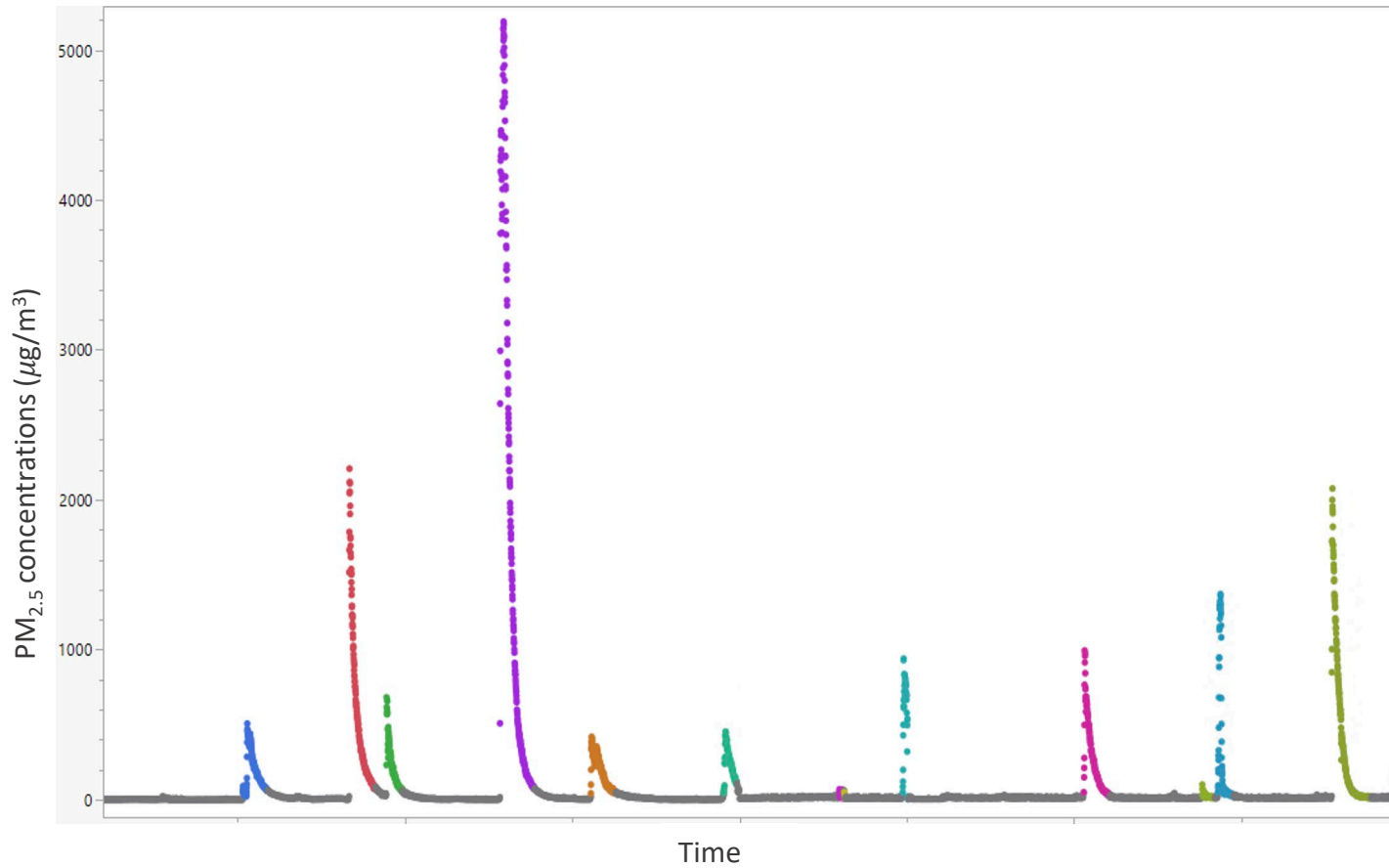Daily Personal PM$_{2.5}$ exposure ~ Ambient PM$_{2.5}$ exposure +
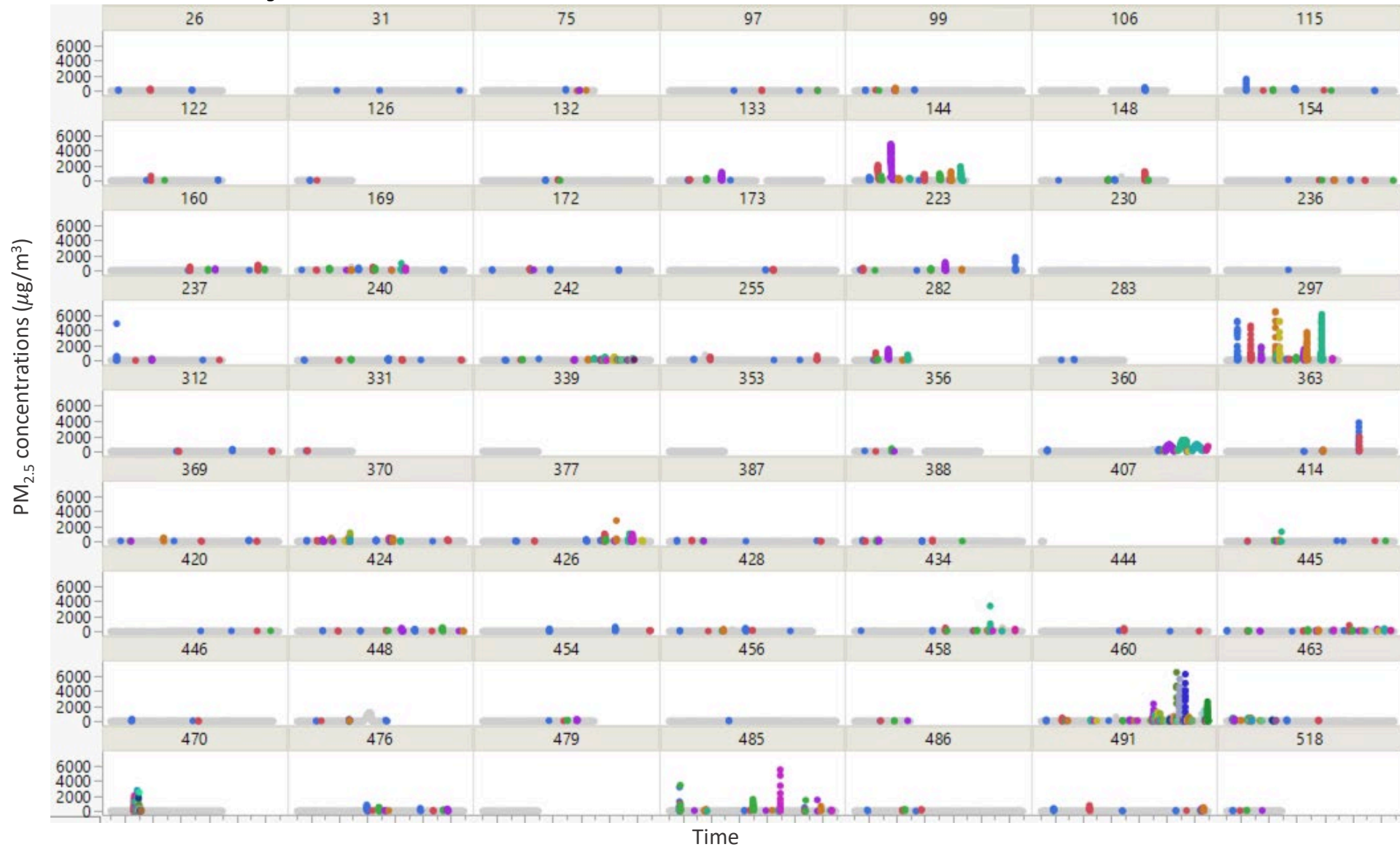
visit, weekend, wildfire days, temperature + (1|ID)

Primary Combustion Peaks

Primary Combustion Peaks

490 peaks in total

0-33 peaks in each person-visit

Conclusion and Next Steps

- Personal $PM_{2.5}$ exposures levels are generally higher and more variable than the ambient $PM_{2.5}$ concentrations estimated at home.

- Built environment characteristics in activity-space impact the total personal $PM_{2.5}$ exposures.

- Built environment characteristics in activity-space may modify the relationship between personal and ambient $PM_{2.5}$ exposures.

- Look into sub-daily variations of total personal $PM_{2.5}$ exposures.

- Analyze a specific source of personal air pollution exposure (i.e., primary combustion peaks) from real-time personal exposure data.