Air Pollution Exposures in Rural and Urban Solid Fuel-Using Households in Sub-Saharan Africa

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Department of Civil, Construction, and Environmental Engineering
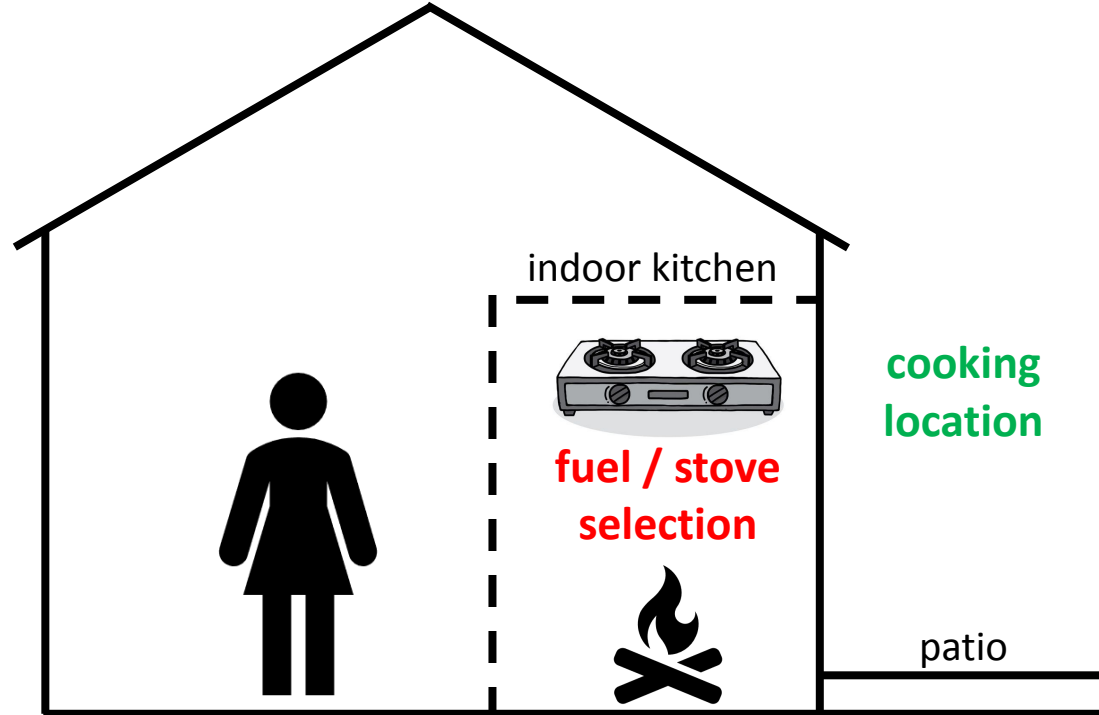North Carolina State University, Raleigh, NC

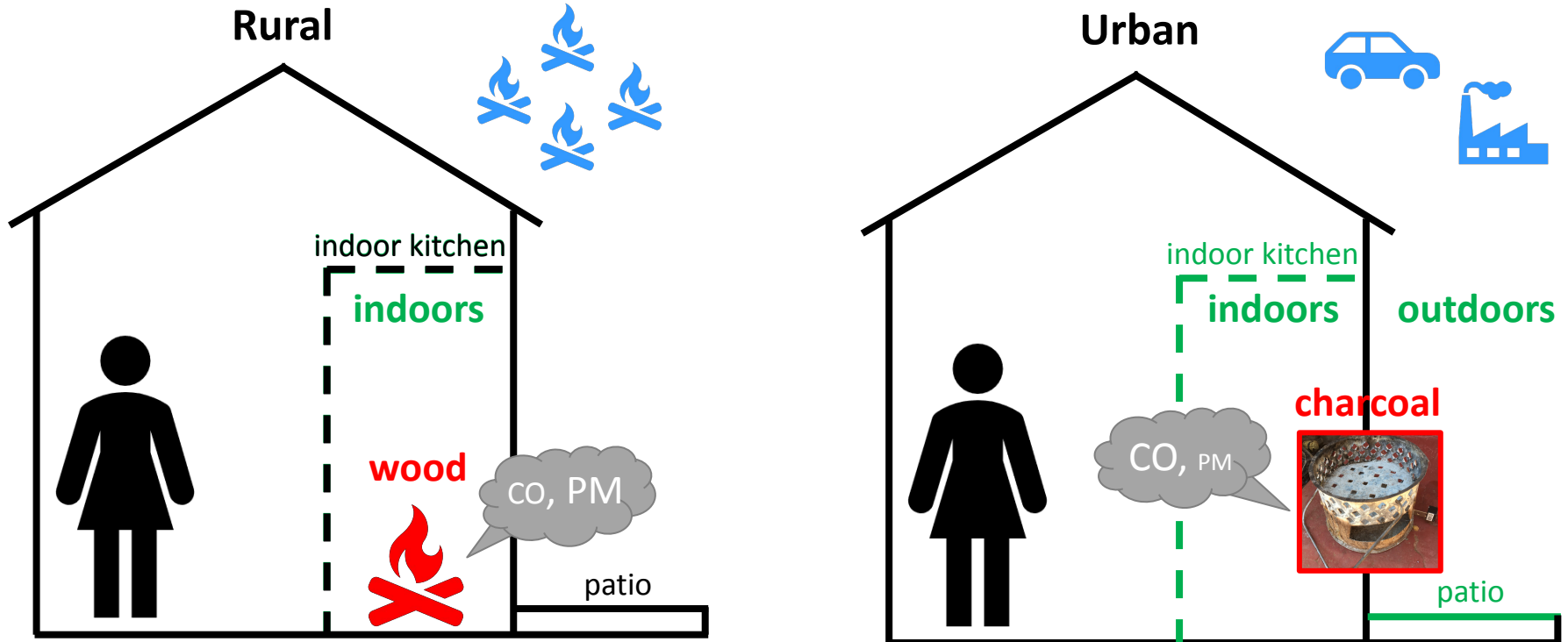# Reliance on Biomass Fuel in Sub-Saharan Africa

What influences personal exposure?

sources outside home

indoor kitchen

cooking location

fuel / stove selection

season

patio

3

What influences personal exposure?

Objective

Investigate the drivers of exposure in different settings.

- *Stove use will drive exposure.*
    - *Wood = higher PM, charcoal = higher CO* ✔
    - *"Clean" = lower exposures* ✘

- *Seasonality was an important confounding factor.*

Participating Locations

Total CO: 4,321

Total PM: 994

Rwanda

Urban

2015-2020

CO=3,322   PM = 655

Zambia

Urban

2019, 2021

CO = 754   PM = 99

Malawi

Rural   **Urban**

2013   2014

CO=100   CO=145

PM=92   PM=148

Personal Exposure 🧍   Ambient Monitoring 🏢

Carbon Monoxide (CO): Lascar USB Logger

Particulate Matter (PM$_{2.5}$):

PM$_{2.5}$: Purple Air (2021 Zambia)

SKC PEM

RTI MicroPEM
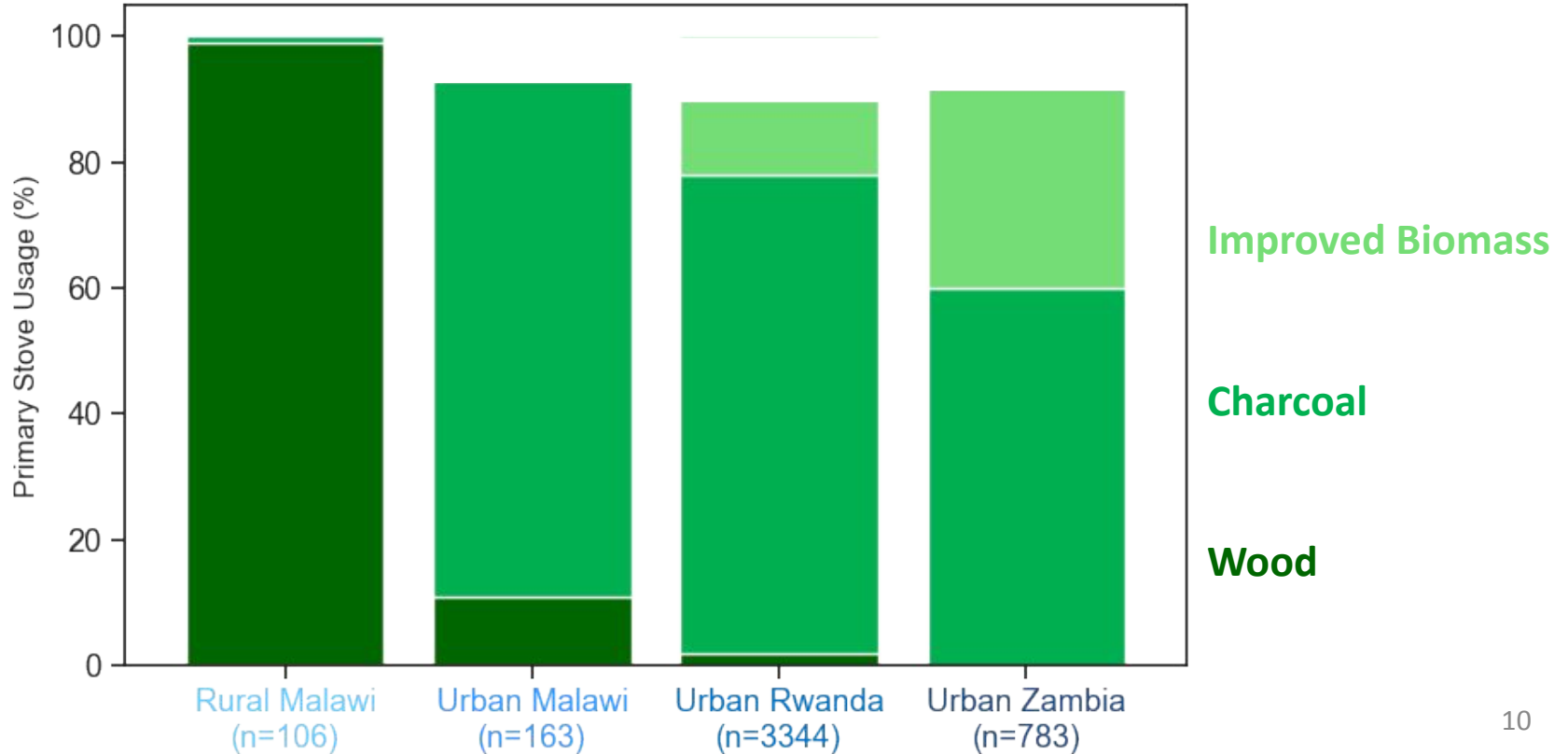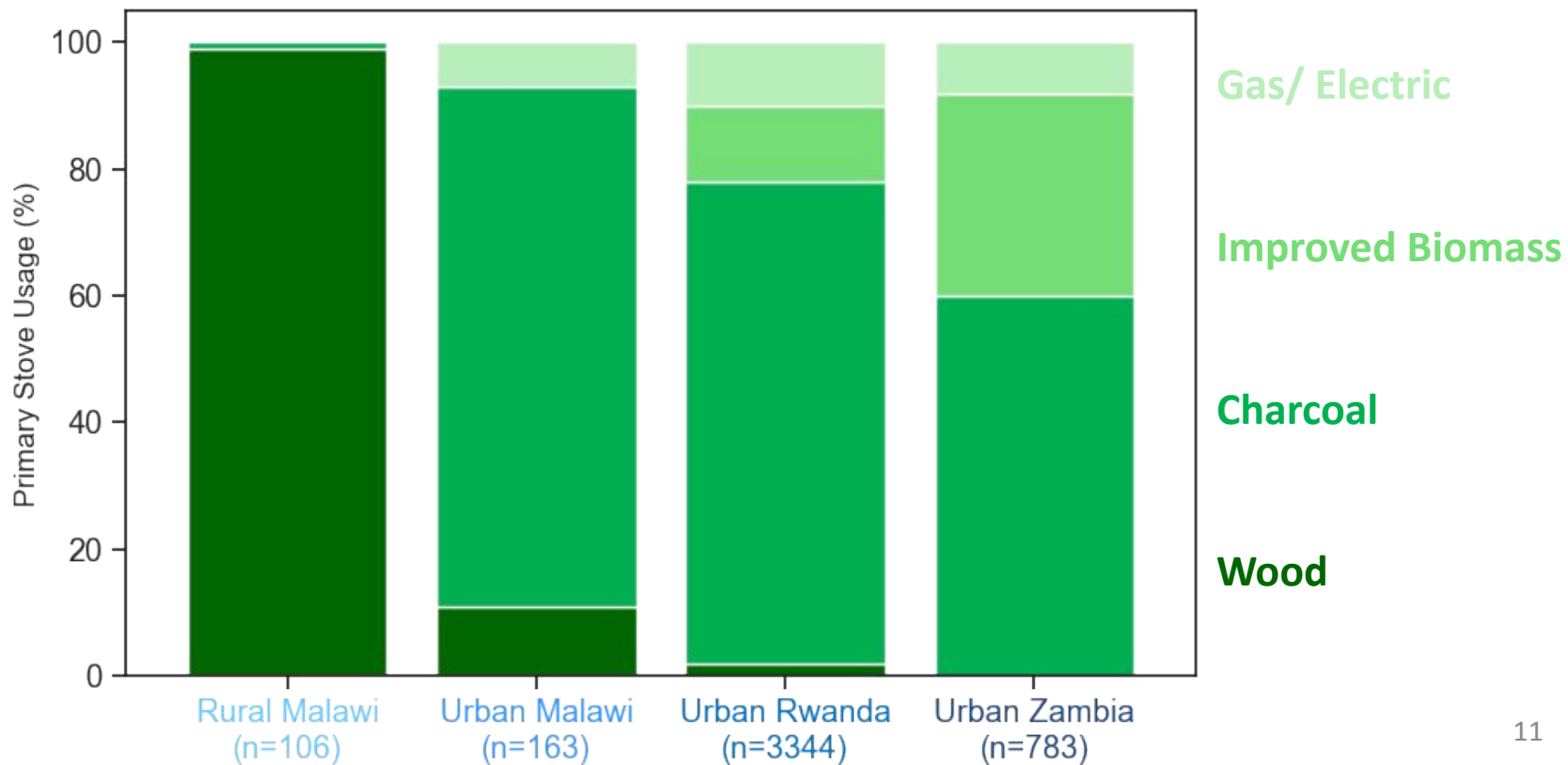
Atmotube
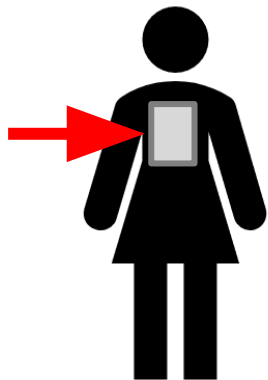
Worn by primary cook for 24 hours in "breathing zone"
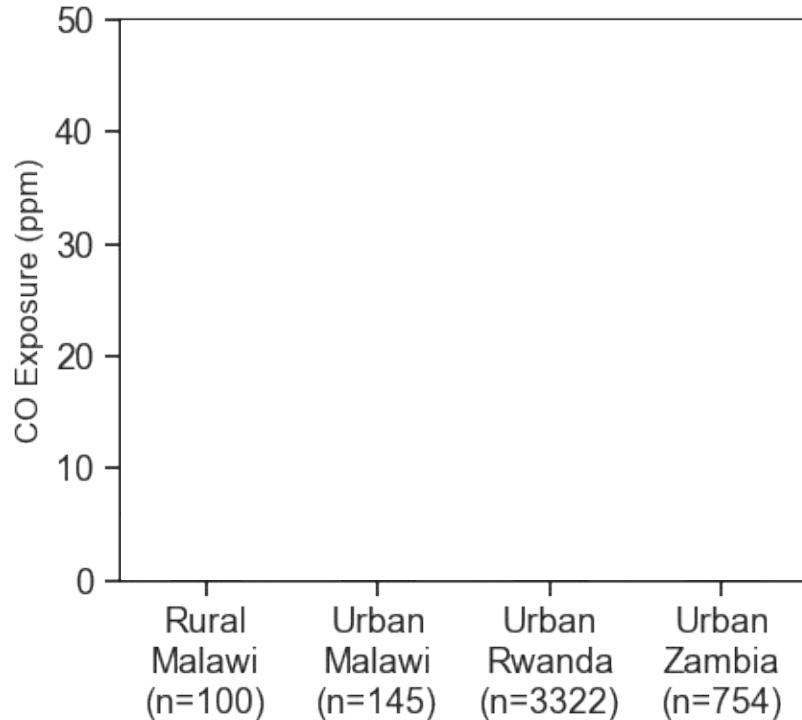
Stove Use by Setting
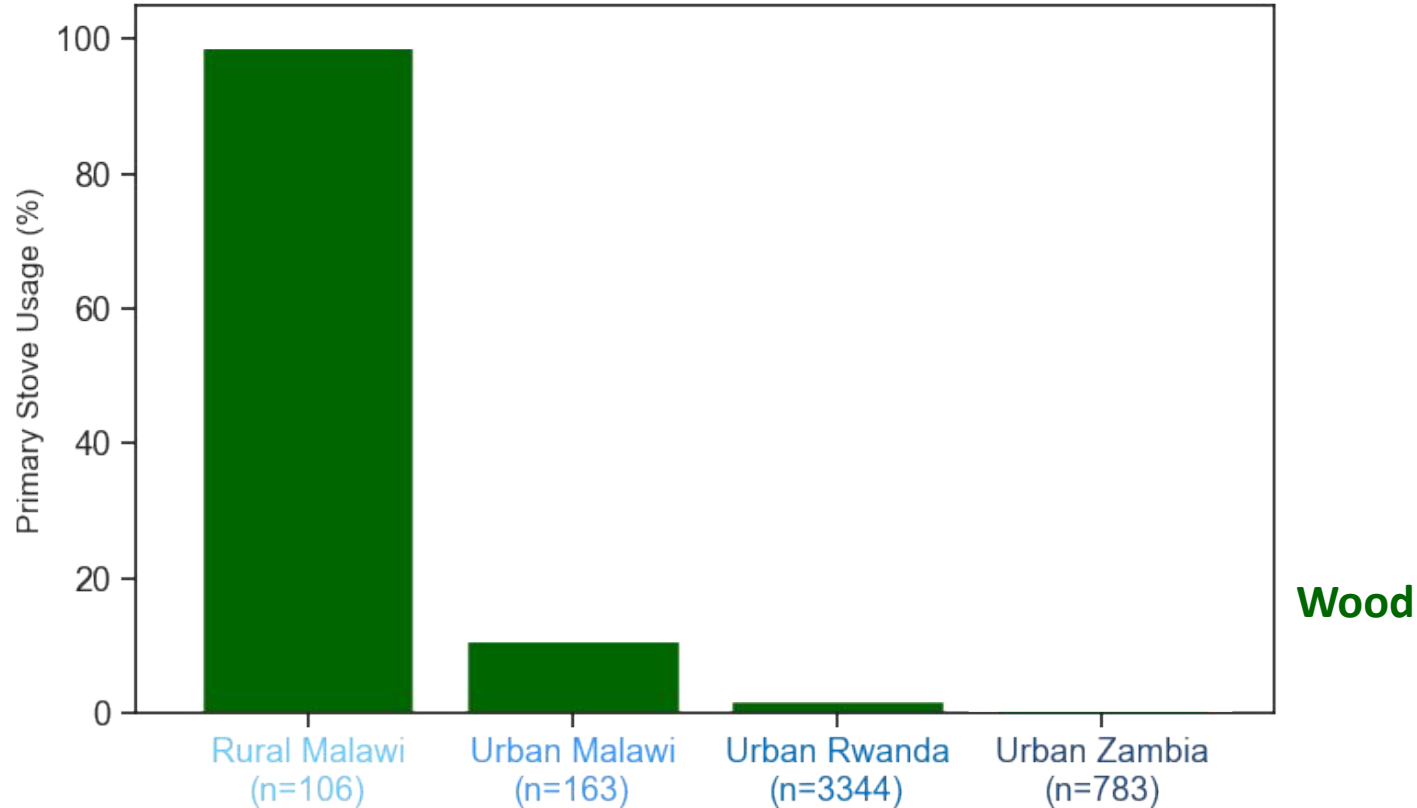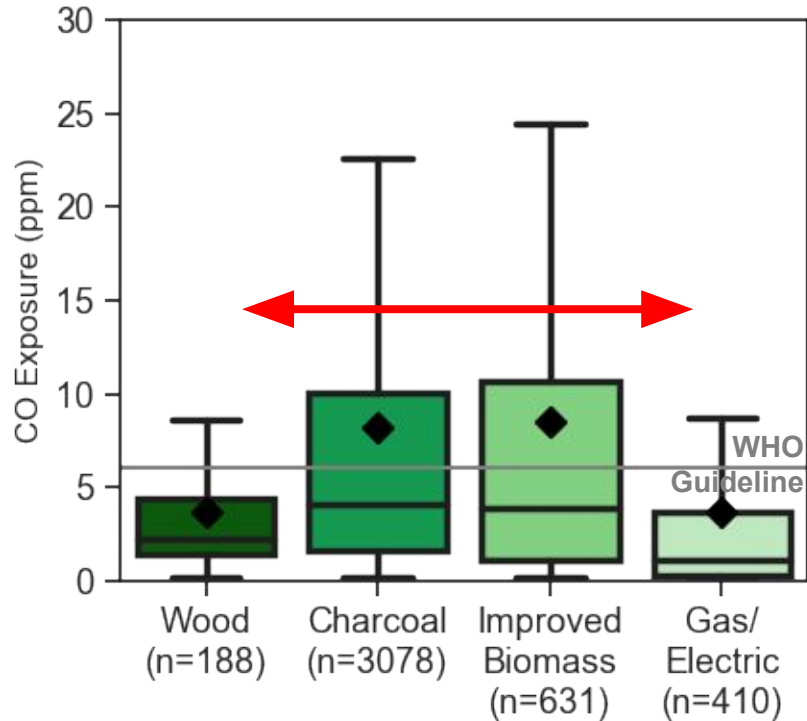
Stove Use by Setting
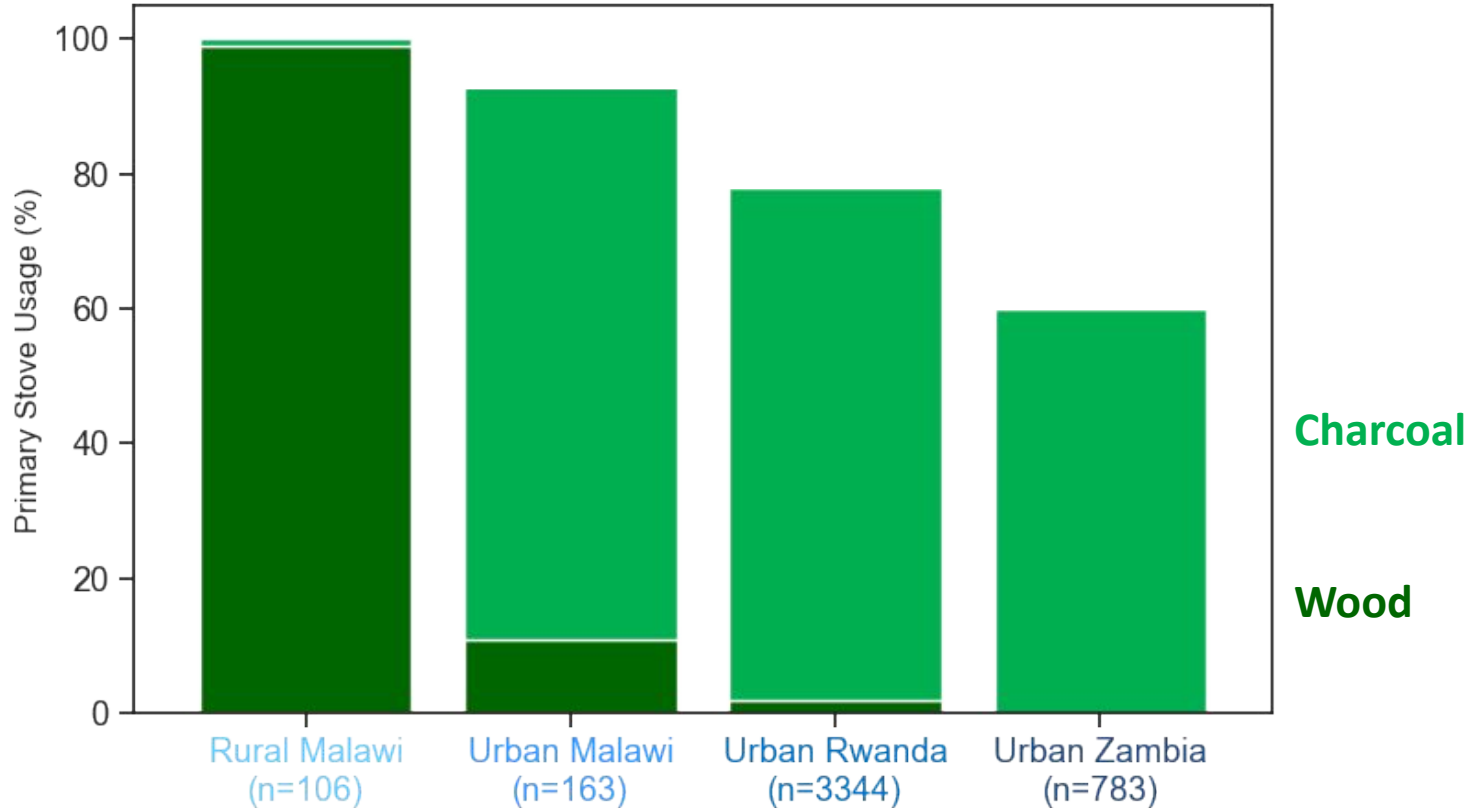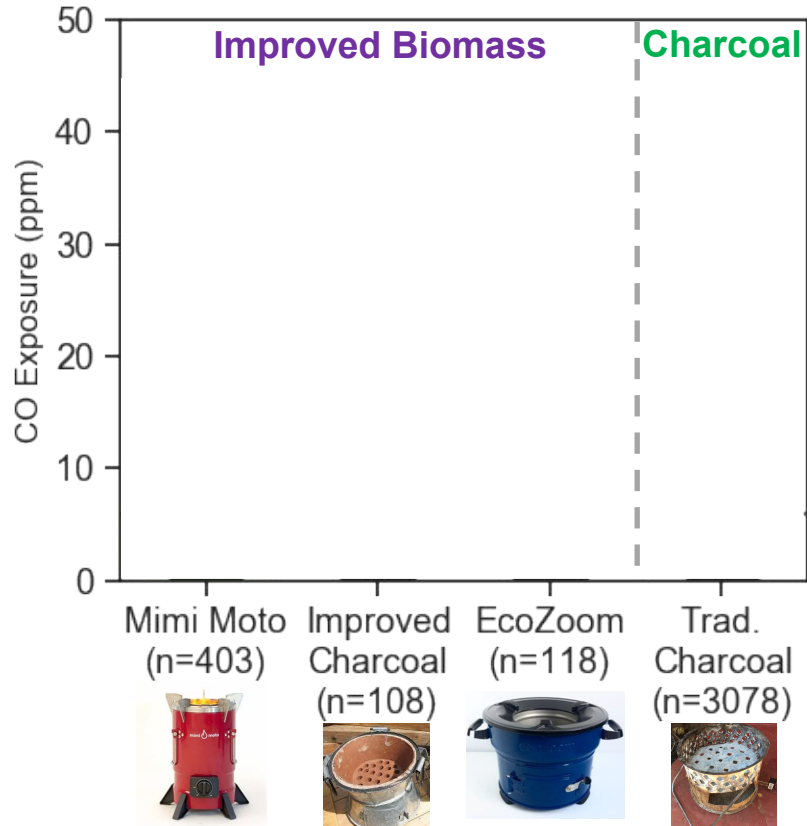
Stove Use by Setting

Stove Use by Setting

CO exposure increases and PM$_{2.5}$ decreases with increasing urbanicity

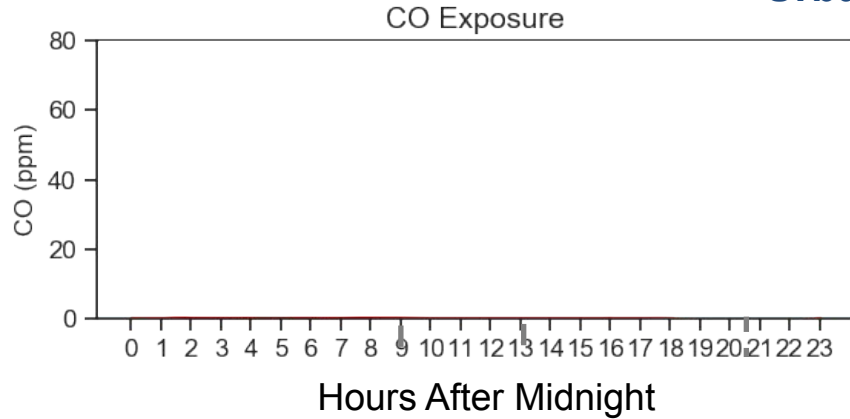# Charcoal and improved biomass stove users experience similar CO

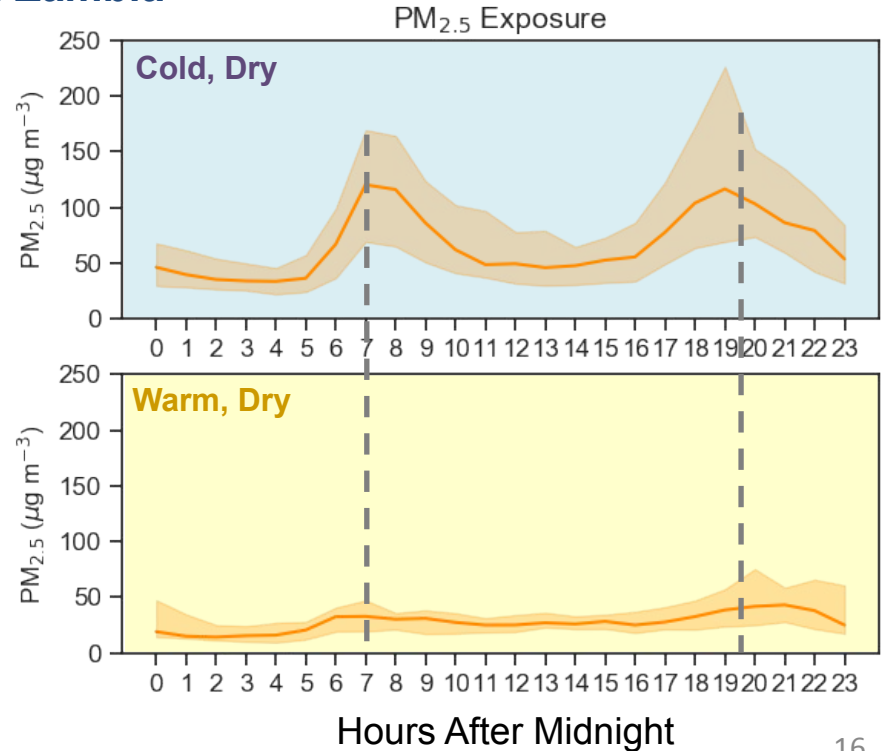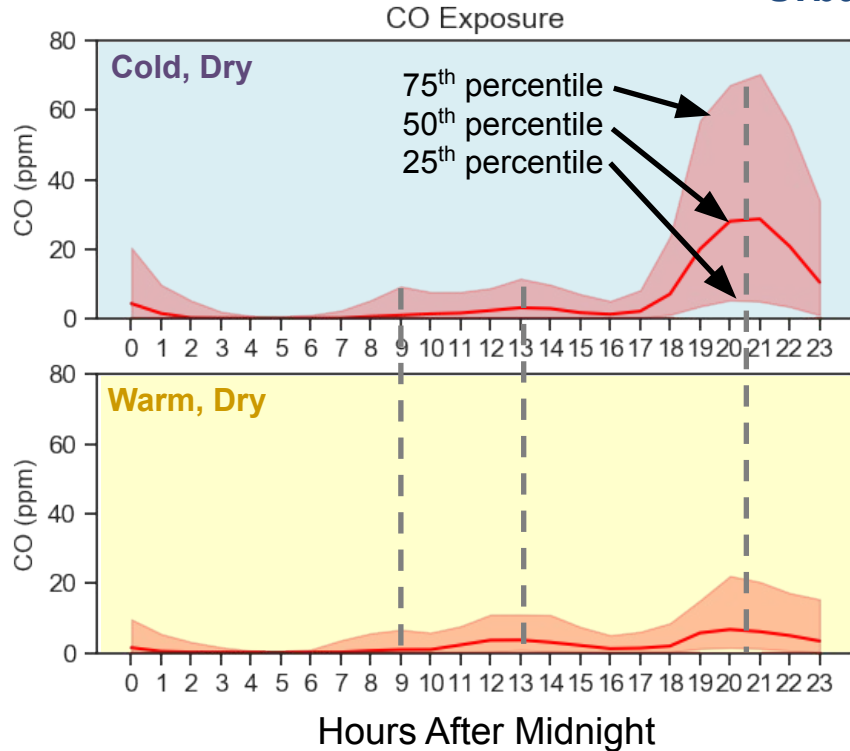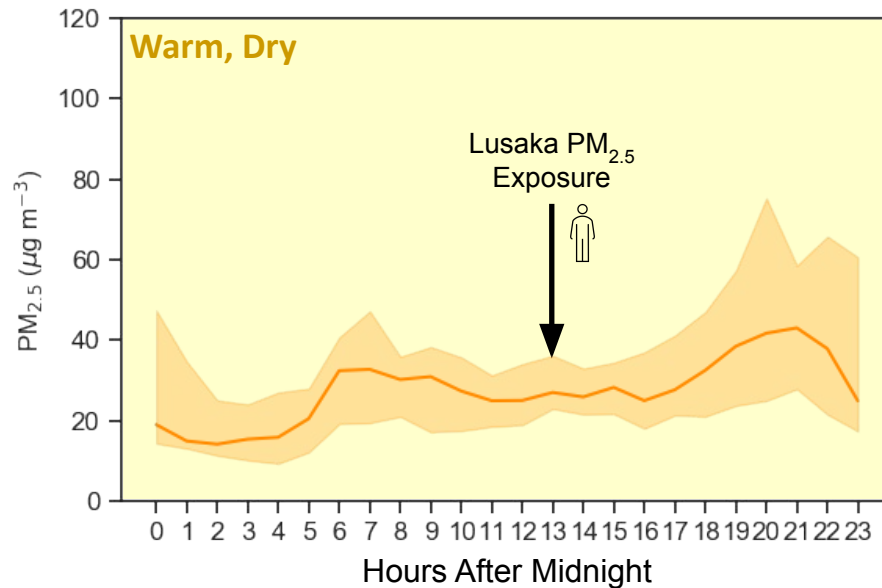# Pellet stove had lowest CO of improved biomass but similar PM$_{2.5}$

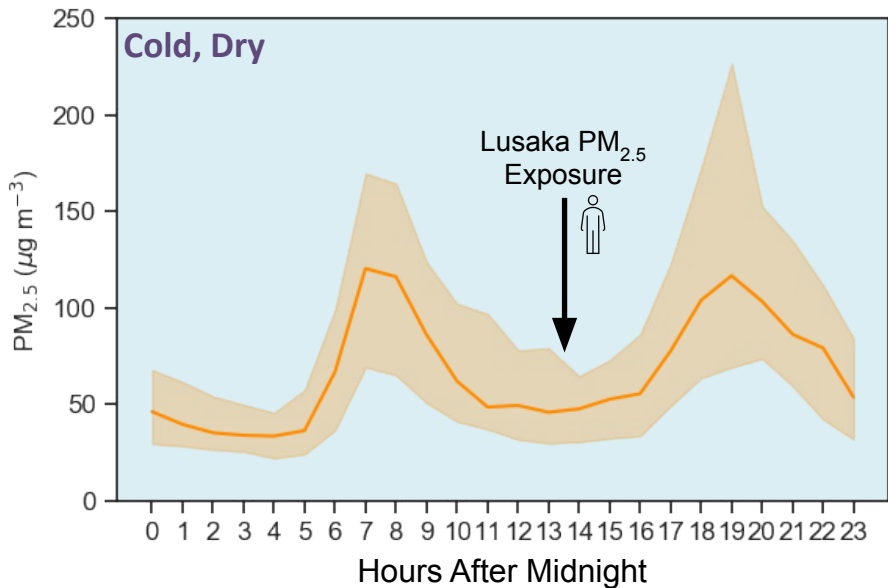# Zambia personal exposure 50% lower in warm season

Urban Zambia

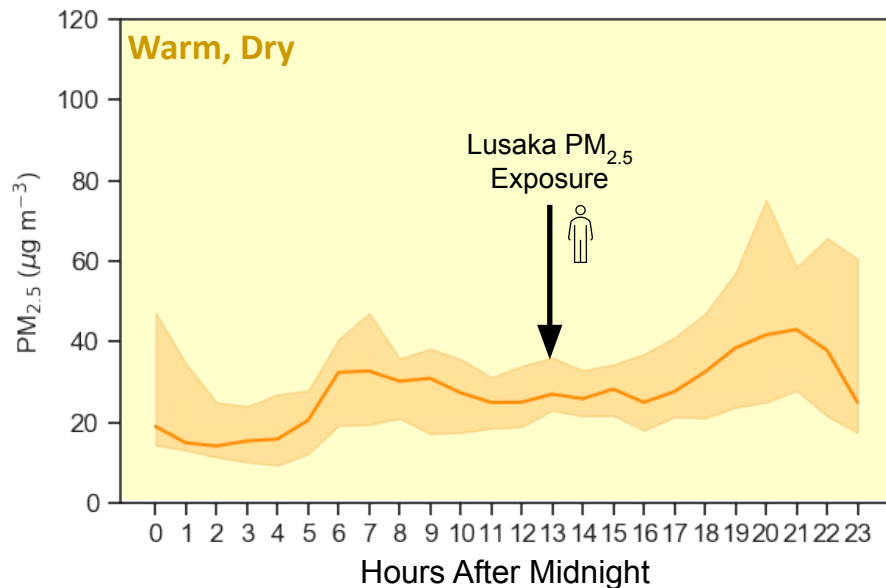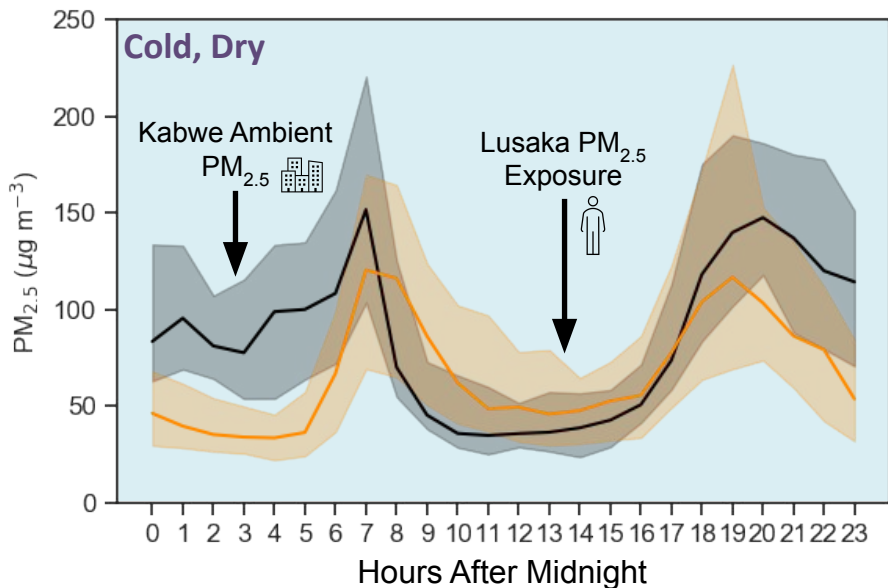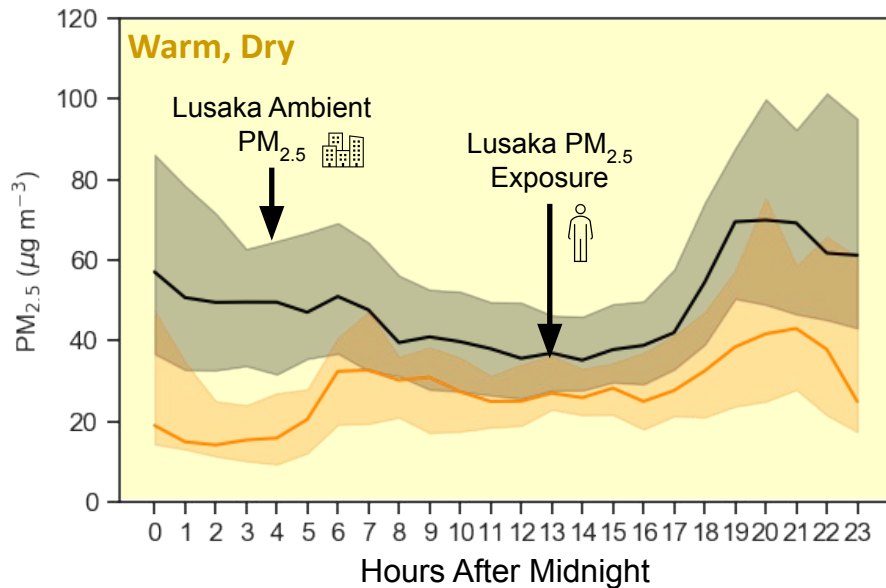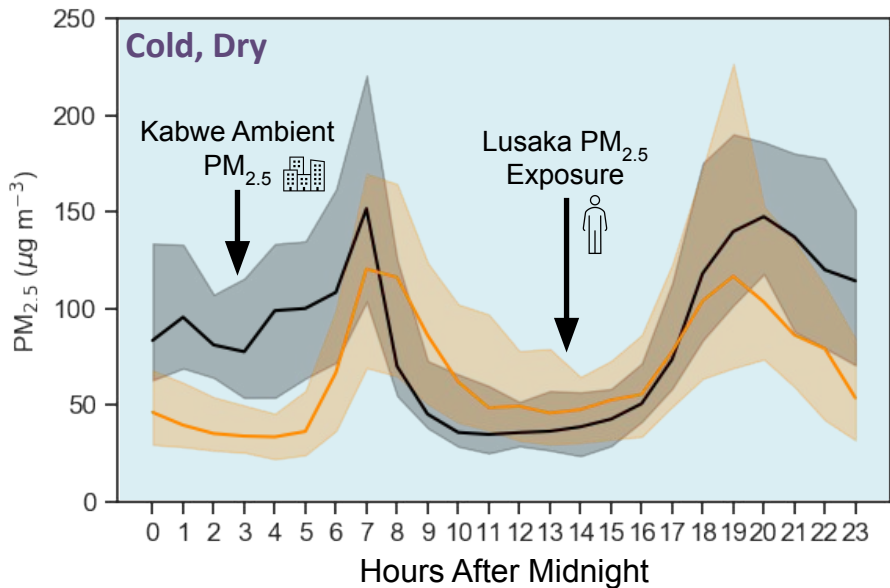# Zambia personal exposure 50% lower in warm season

Daily PM$_{2.5}$ exposure trend consistent with ambient PM$_{2.5}$

Urban Zambia

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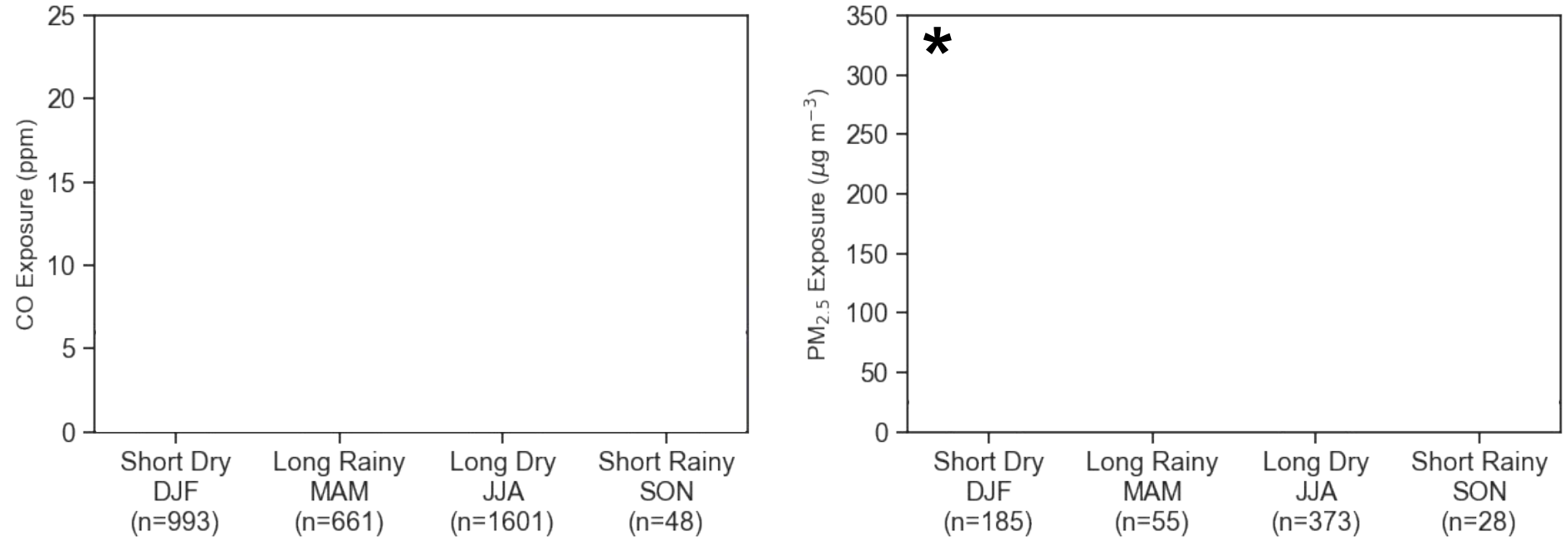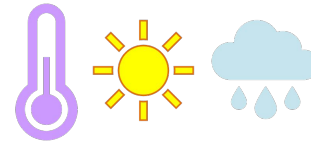
Urban Zambia

Daily PM$_{2.5}$ exposure trend consistent with ambient PM$_{2.5}$

Urban Zambia

Rwanda PM$_{2.5}$ exposure significantly different between seasons

Urban Rwanda

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Conclusions

wood PM$_{2.5}$ **charcoal** CO

- Wood = higher PM, charcoal = higher CO

- Some "clean" stoves had lower CO exposures

- For urban households, regional PM impacted exposure, even for "clean" stoves

- Seasonality had large impact