

#### INTRODUCTION

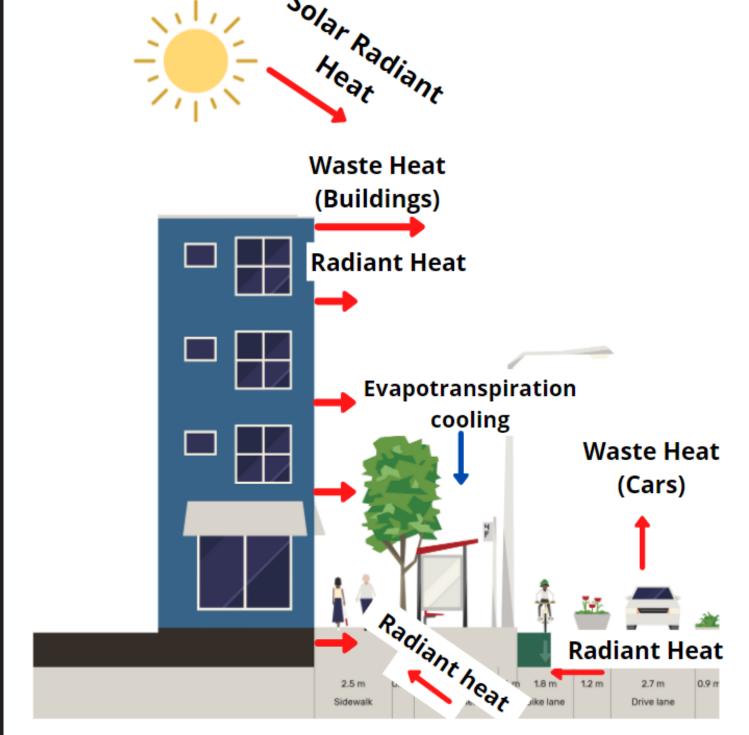
> The average frequency of heat waves in the U.S. has increased from two heat waves per year in the 1960s to six heat waves per year in the 2010s.

> Personal micro-climate heat risk, evaluated through measurements of ambient air temperature and wet bulb globe temperature (WBGT), is vital to pedestrian comfort.

> WBGT expands on the concept of ambient air temperature. It incorporates wind speed, ambient air temperature, humidity, and solar radiant heat to approximate thermal comfort. It is the standard measurement of heat in occupation uses.

> How much heat do vehicles themselves emit and how may it affect pedestrian thermal comfort?

#### > This study aims to better understand micro-climate heat risk and the effects of vehicles on personal heat exposure.



Solar Radiant Heat: Reaches the earth from the sun

Waste Heat: Heat released to the environment as a result of energy use for human activities. Also known as anthropogenic heat.

Can create a 1°C to 4°C warming of near-surface air temperatures

Waste Heat (Buildings): Heat emissions from a building happen throughout the vertical height of the building, but most occur wherever the HVAC equipment is, typically the roof Waste Heat (Cars): Vehicles emit heat into the air at a pedestrian level. Radiant Heat: Natural and man-made structures absorb and store heat energy. Any time the temperature of the material exceeds that of the ambient air, energy is being

released and increasing the ambient temperature. This release is less noticeable early in the day. However, once the sun sets, the stored energy being released is very noticeable. Urban Heat Island (UHI): Describes the up to 10 degrees F difference between rural and urban conditions. The release of radiant heat at night contributes to substandard cooling **Radiant Heat** overnight and the overall UHI effect.

#### QUICK FACTS ABOUT HEAT

> Heat planning is relatively new and 60% of heat planning research was published within the last 5 years.

> Ambient air temperatures near major roadways are the warmest in the area due to the impervious nature of roads and the building and waste heat emissions.

> Waste heat from human activities such as vehicle or air conditioner use can cause a 1.8 °F (1 °C) to 7.2 °F (4 °C) warming in near-surface air temperatures.

> Once temperatures exceed 77 °F (25 °C) pedestrian discomfort increases and once temperatures exceed 82 °F (27.8 °C) there is a significant drop off in cycling.

# THE EFFECT OF VEHICLES ON PERSONAL HEAT EXPOSURE: A PILOT STUDY Ashley Avila<sup>1</sup>, Nicole Iroz-Elardo<sup>2</sup>, Ladd Keith<sup>3</sup>, Kristina M. Currans<sup>4</sup>

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#### METHODS

We collected data using three Kestrel 5400 devices, which measure WBGT, ambient air temperature, solar insolation, wind speed, and humidity.

Davis-Monthan Air Force Base weather station recorded average ambient air temperature measured was **81.4** °F (27.4 °C) Kestrel 5400 recorded average ambient air temperature at the site was 85.4 °F (29.7 °C)

#### STUDY AREA

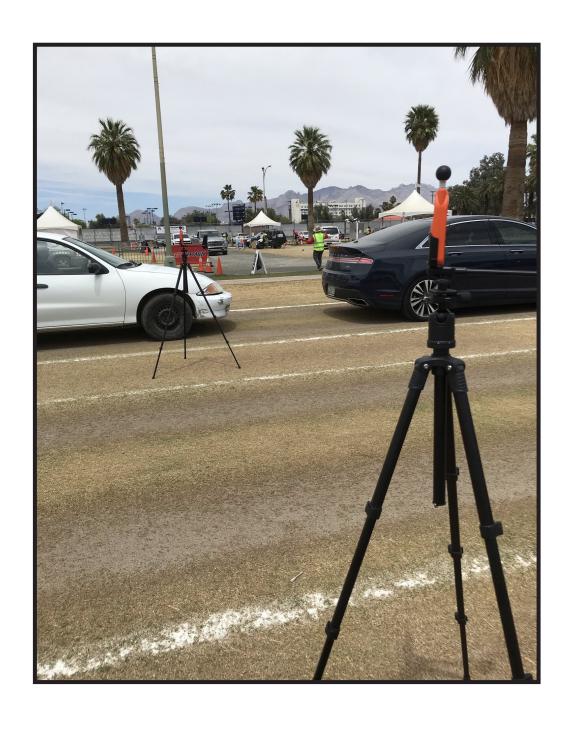
University of Arizona COVID-19 accination Point of Distribution Tucson, Arizona semi-arid, desert vironment

aracterized by low humidity and bove average temperatures

#### TIME LINE

collected data at the University of ona COVID-19 drive-thru vaccinatio of Distribution (POD) in Tucson, Arizona on April 24, 2021 from 10 AM to 3

Break Tent Fix-It Tent



Location 1 provides our control

Location 2 and 3 provide our observations among various lanes of traffic.

Map of Site with Kestrel Data Collection Sites and Vehicle Lanes Marked

#### TRAFFIC ENTRY/EXIT

We created a five definitions for the presence or absence of vehicles within a vehicle lane to control for the transition periods.

- > No Vehicles (base case): no vehicles present for at least two minutes
- > Entering: vehicles moving into the waiting lanes
- > Idling: vehicles idling or parked in the waiting lines

> Empty, but recently exited: vehicles are not currently present, but they had been idling in the location less than two minutes prior

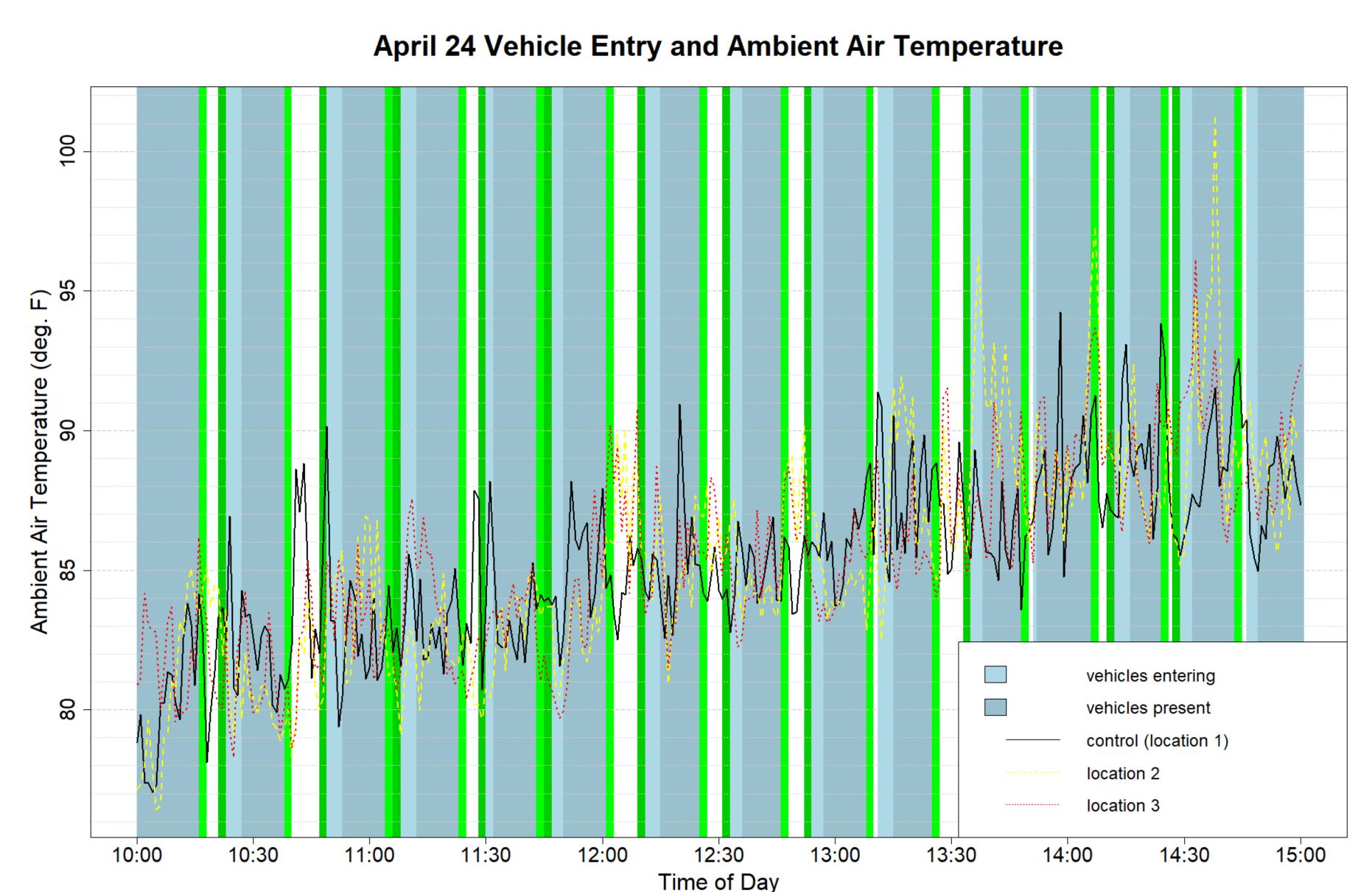
> Entering, but recently empty: vehicles are currently moving into the waiting lanes, but within two minutes prior no vehicles were present

## FINDINGS

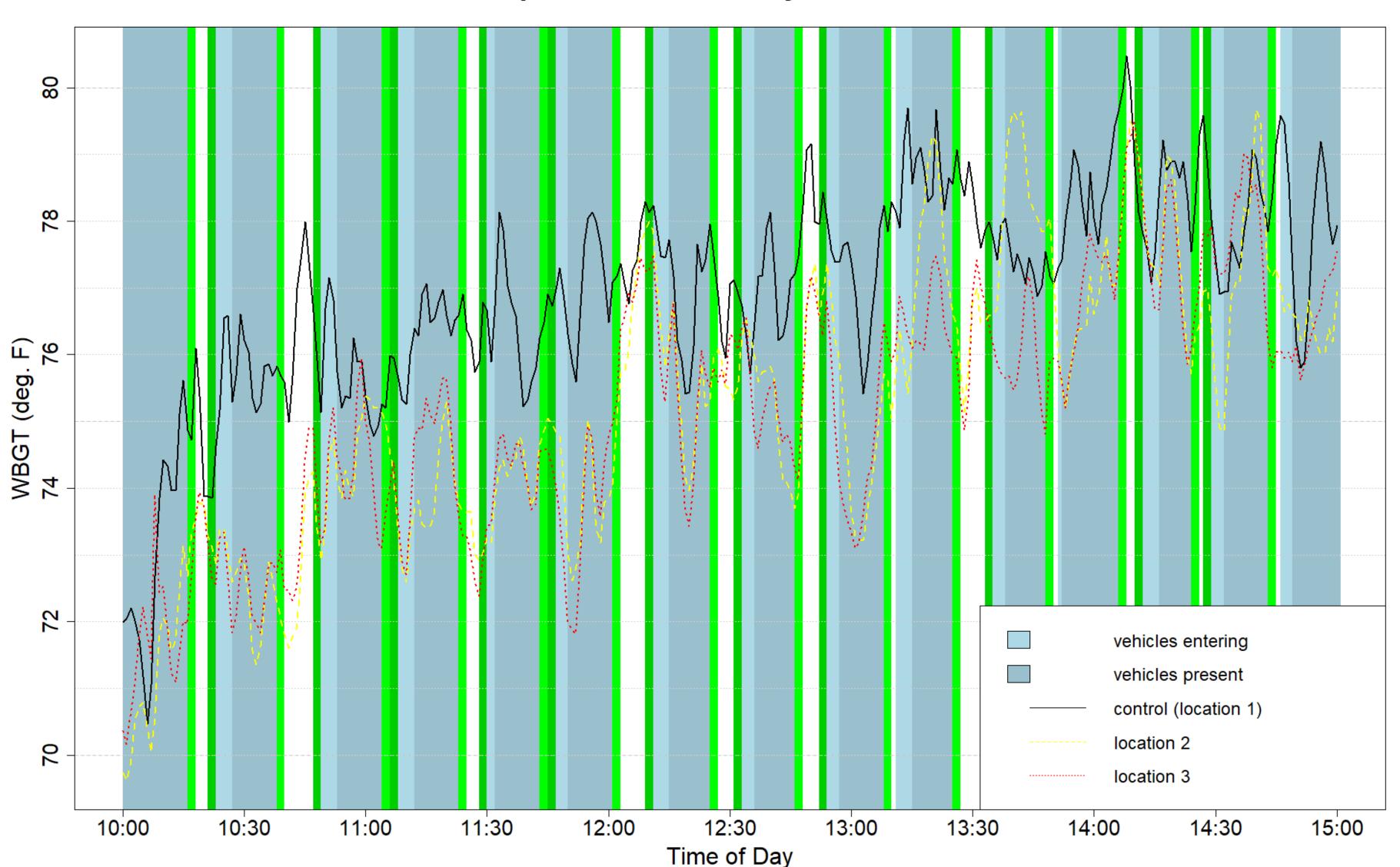
When vehicles are present and idling in lane 1, WBGT reported at Kestrel 1 is an average of 0.46 °F (0.26 °C) higher compared with our base case (p-value < 0.1).

When vehicles are entering (moving, not idling) in lane 1, WBGT reported at Kestrel 1 is an average of 0.6 °F (0.33 °C) higher compared with our base case (p-value < 0.2)

Wind speed was found to be significantly and negatively related to ambient air temperatures. A one-unit increase in wind speed (mile-per-hour) corresponds with approximately 1.5 °F (0.83 °C) to 1.7 °F (0.94 °C) lower ambient air temperatures for Kestrel 1 and Kestrel 2 (p-value < 0.01).



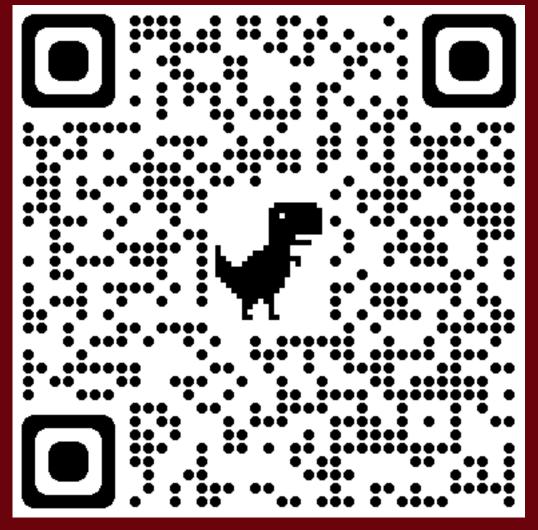




risk



Scan the following QR-code to read the paper:

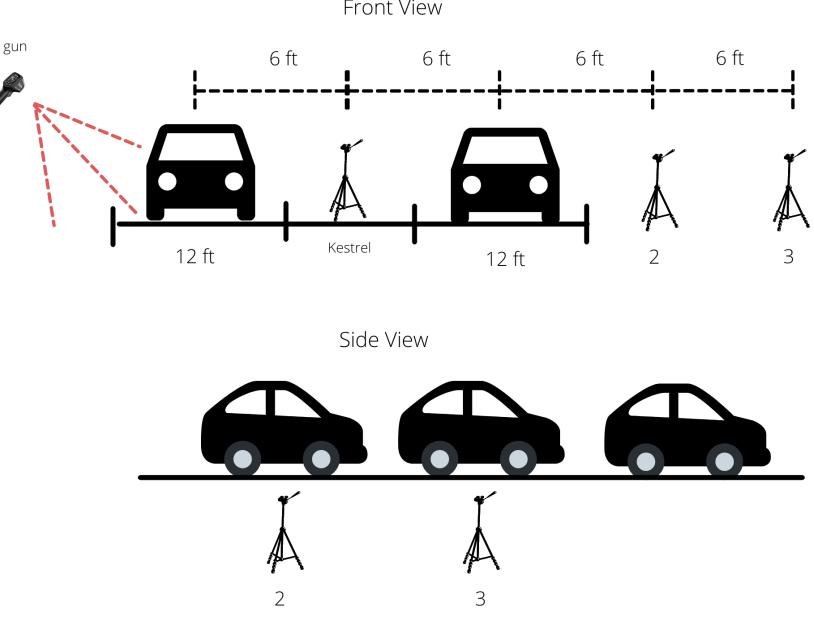


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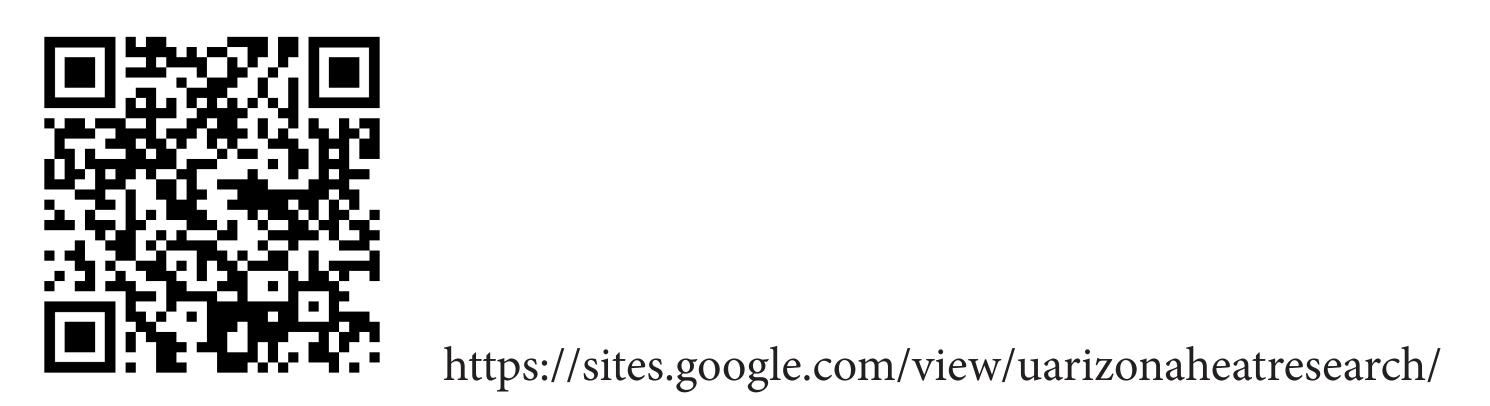
#### DISCUSSION

> Future tests will be conducted to continue teasing out the effect of vehicles on micro-climate heat



> The Healthy Streets Program in the 2021 Infrastructure Bill targets heat along roads. Additional evaluations like this are needed to assure multi-modal comfort.

> Follow UArizona's personal heat exposure efforts and evaluations, including our Cool Corridor Project here:



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