

Southwest Integrated Field Laboratory: Summary for BERAC



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U.S. DEPARTMENT OF
ENERGY

Office of
Science



Motivation



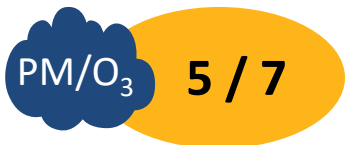
Arizona is fifth for year-over-year population growth in US. Current population is > 7.3M.



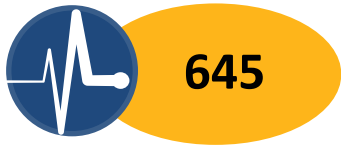
Average summer nighttime low temperature in Phoenix has increased by more than 5 °C over the past 60 years.



Arizona's current drought of 15 years is worst in more than 110 years of official recordkeeping, yet monsoon rains still create seasonal flooding.



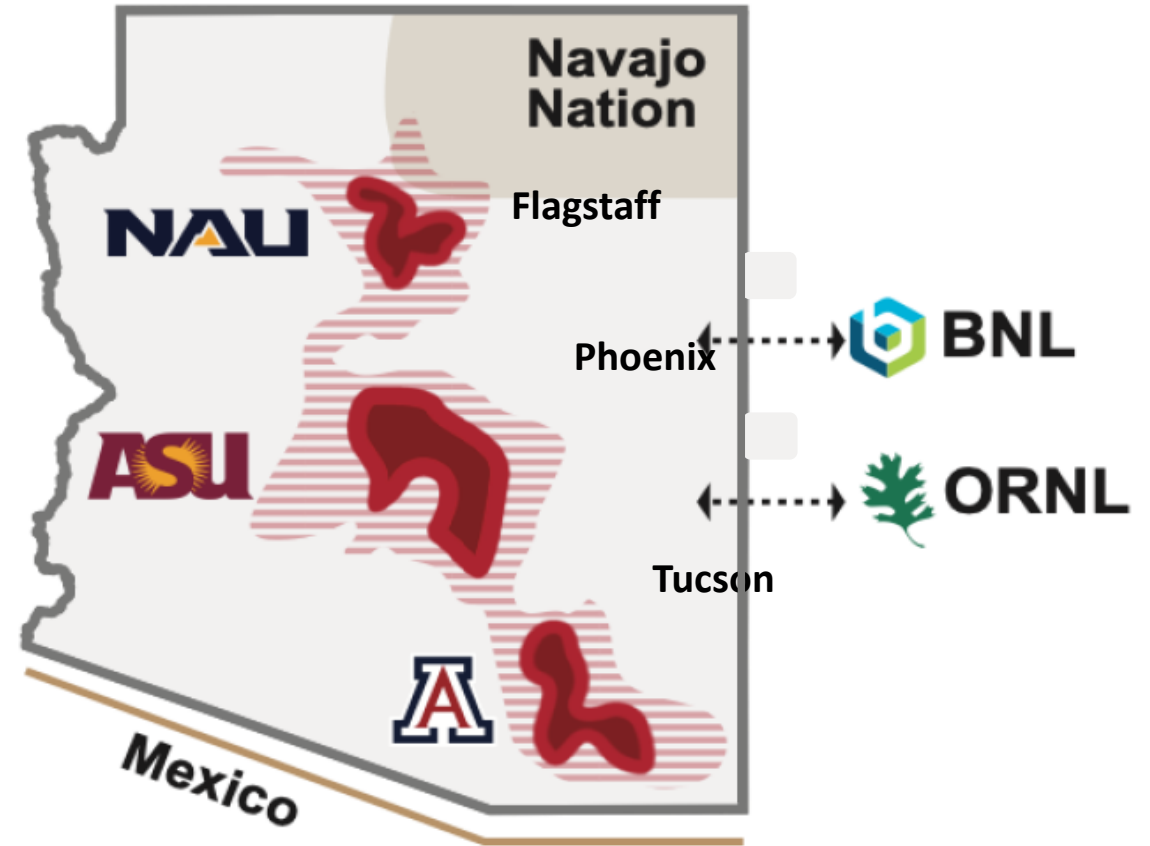
Phoenix has 5th worst ozone pollution and 7th worst year-round PM2.5. Local air pollution is impacted by emissions, temperature, wildfires, and drought.



Heat caused 645 deaths in Maricopa County in 2023, a 52% increase over 2022, continuing a 10-year upward trend.

Purpose and Objectives

We seek to engage stakeholders and provide scientists and decision makers with high-quality, relevant knowledge capable of spurring and guiding responses to environmental challenges related to extreme heat across the state of Arizona.



1. Understanding Environmental Parameters and Drivers

- Gathering historical and current data
- Establishing measurement networks

2. Enabling Opportunities for Change

- Solutions testbeds
- Model/prediction infrastructure

3. Informing the Decision-Making Process

- Engaging the public and local governments
- Providing tools and resources for effective decision-making

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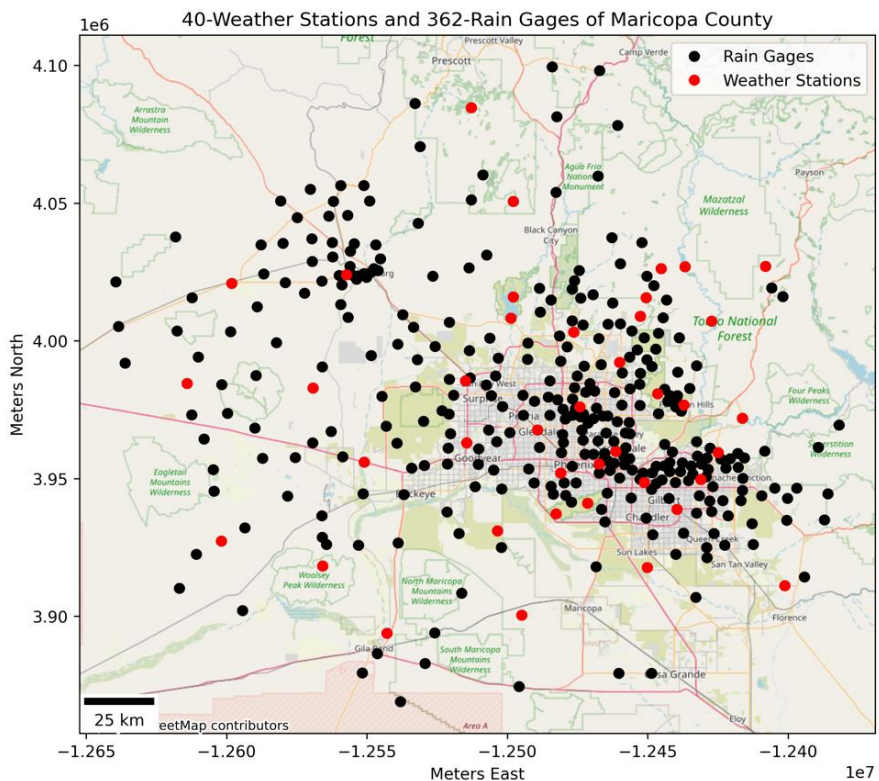
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Data from pre-existing networks and databases

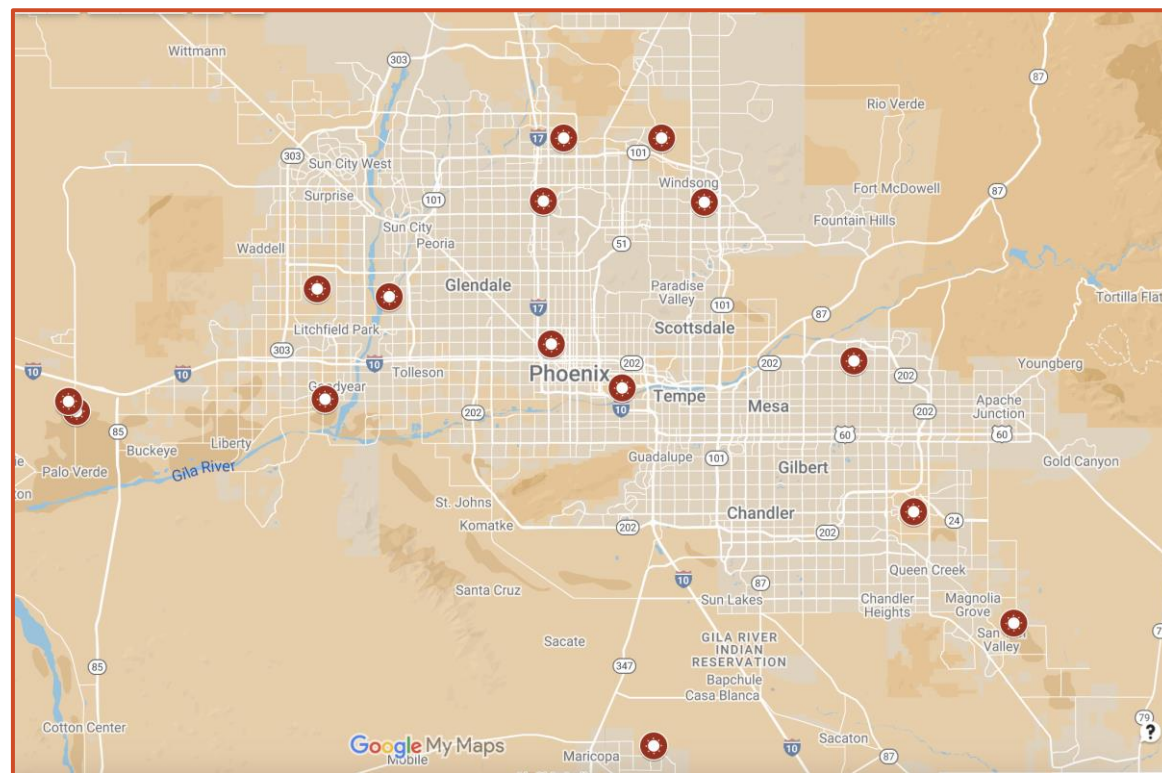
Flood District of Maricopa County

Identified rain gage and weather dataset.
Prepared code to extract this data.



ASOS and AZMET weather station networks

Mapped locations of each station.
Identified areas with sparse coverage.



Data from new measurement networks

12 Weather stations

In neighborhoods rather than airports

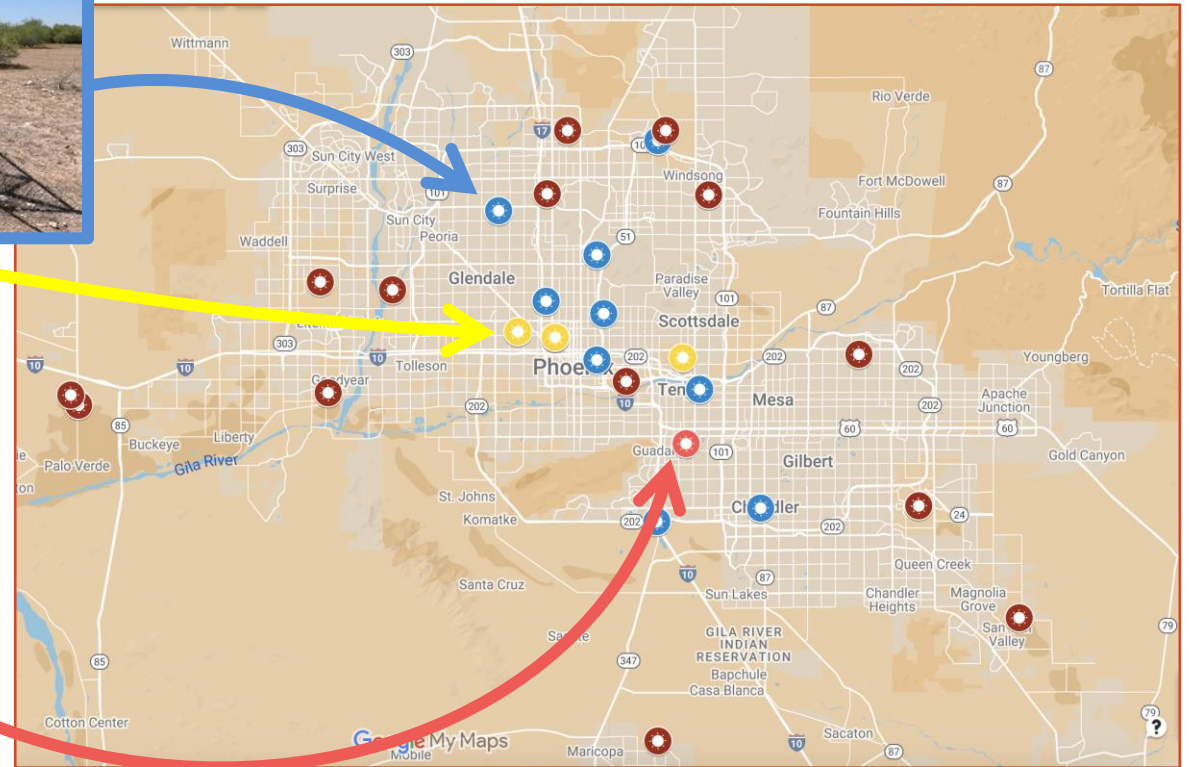
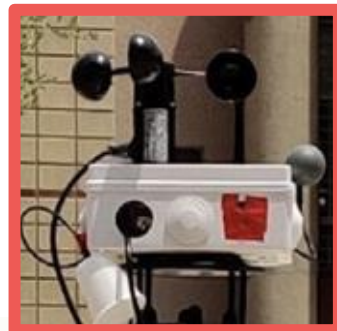


3 Eddy covariance towers *(registered w/Ameriflux)*



3 MaRTiny

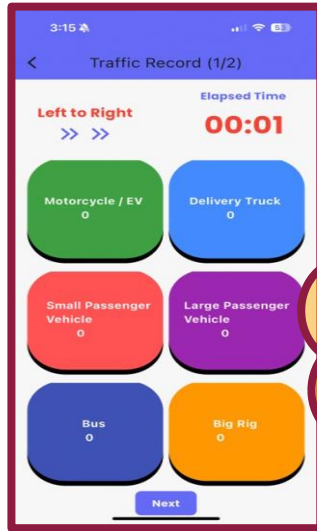
Collects weather data, and counts people in shade & sun



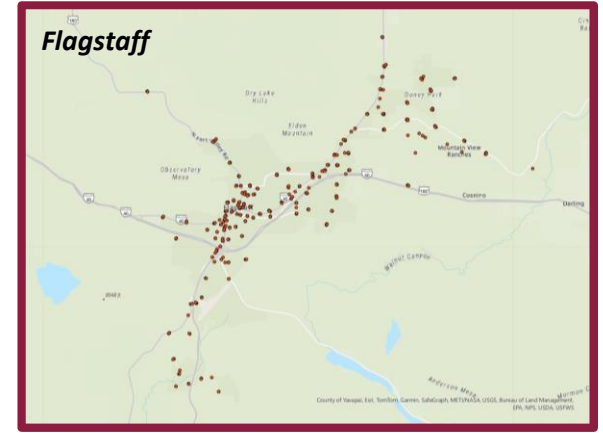
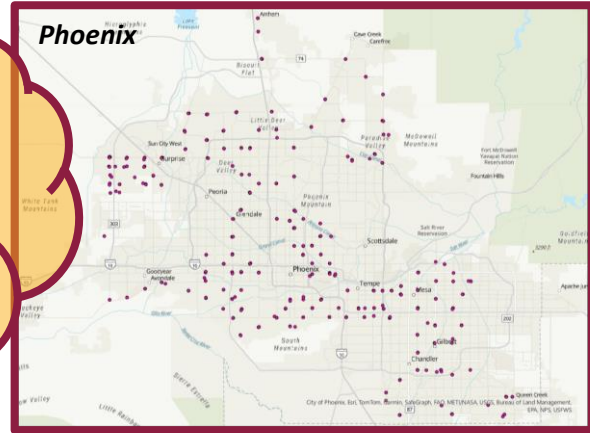
Creating/leveraging apps for use by citizen scientists

Traffic records app

Increase density of traffic data. Related to CO₂, air quality, and anthropogenic heat emissions.

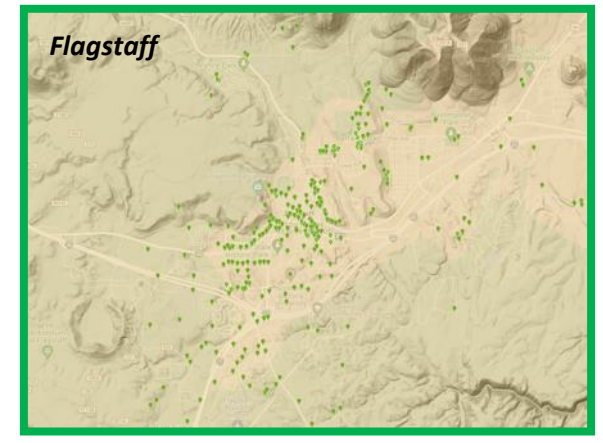
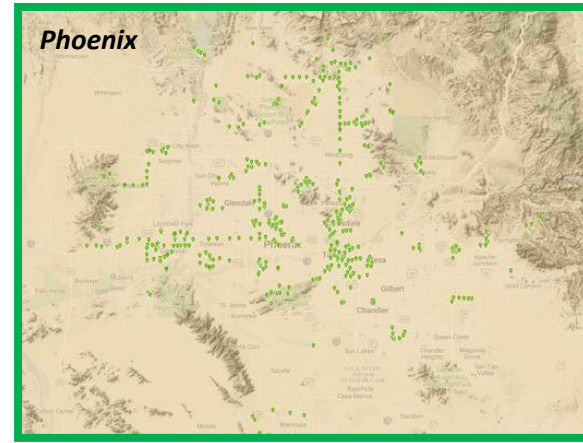
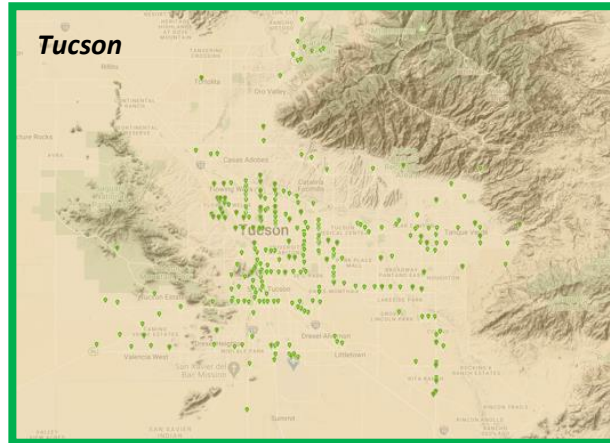


Download "Hestia Traffic" in the App Store to participate in data collection!



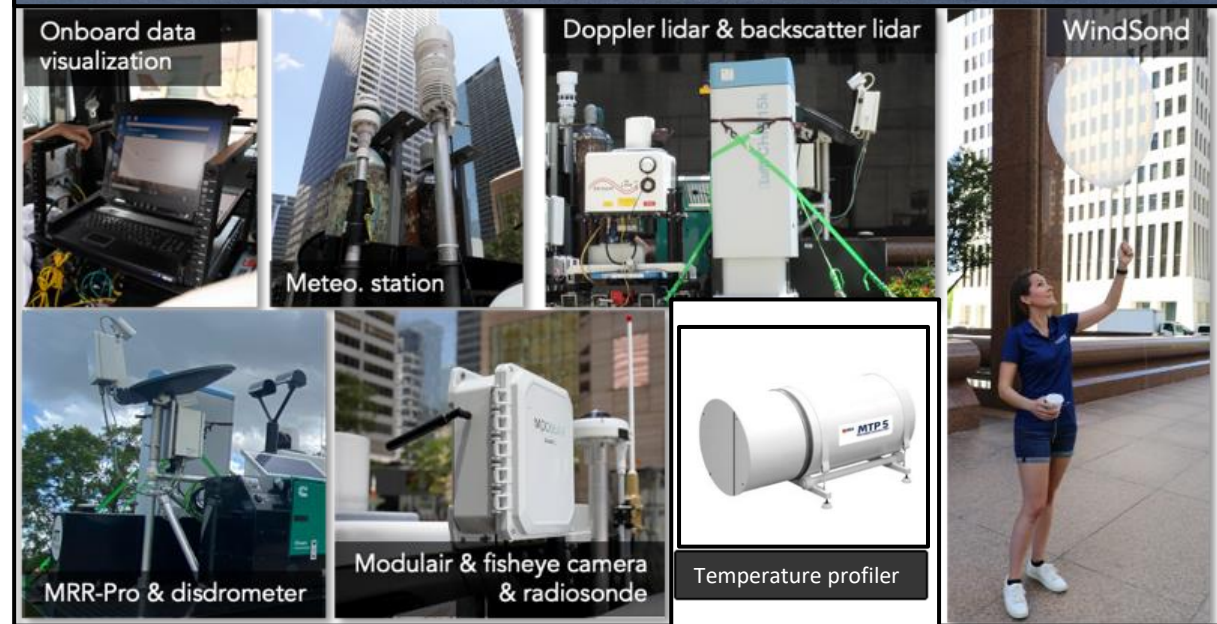
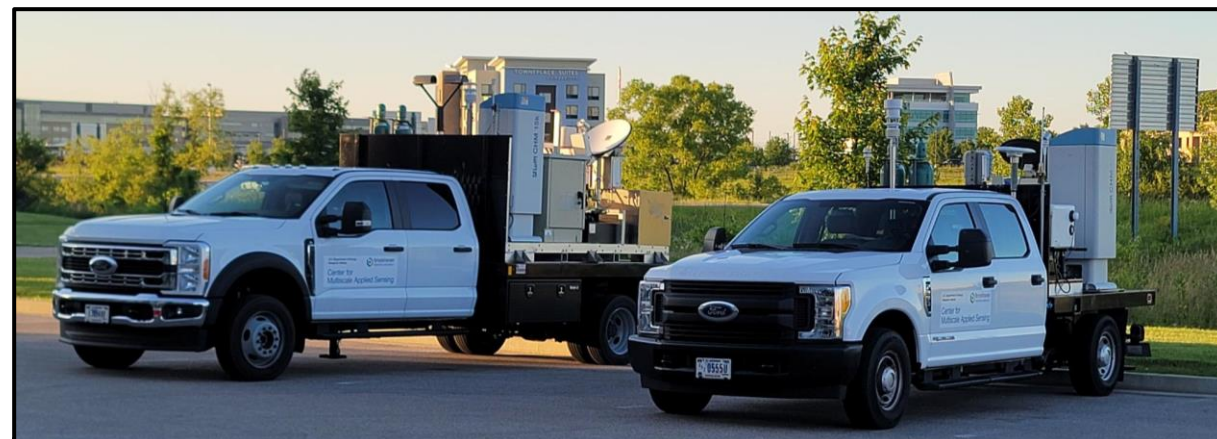
Plant radiocarbon sampling

Monitoring CO₂ emissions through analysis of annual plants.



Summer Intensive Observational Campaigns

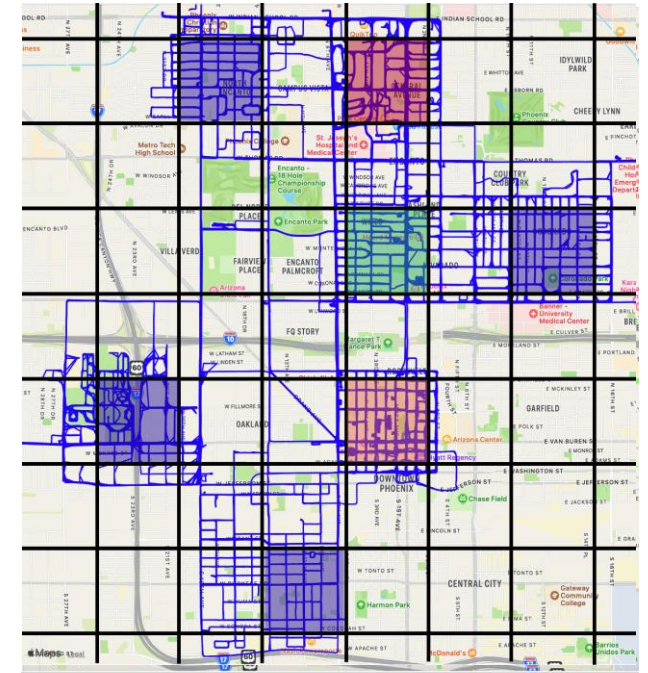
- Supplement fixed measurement infrastructure with traverse measurements using mobile observatories (CMAS) and car-mounted instrument packages
- Intensive measurements in summer (Aug-Sept 2023; June-July 2024)



Summer IOP Research Questions

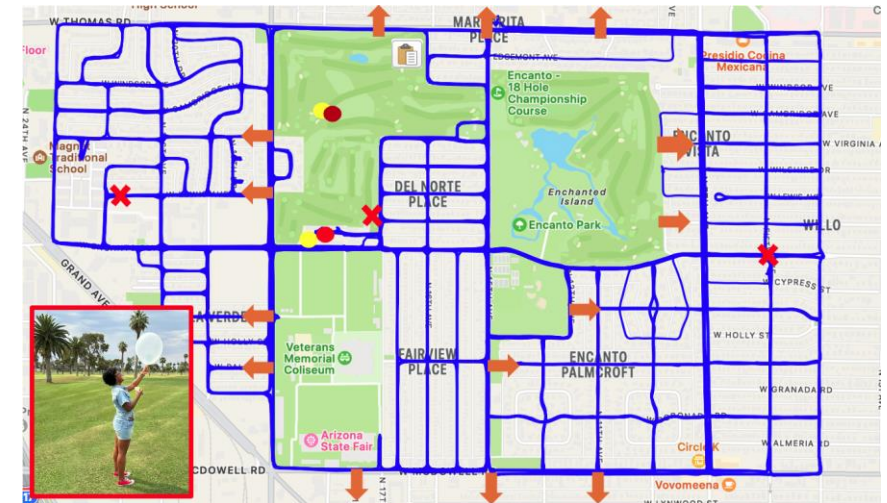
1. Intra neighborhood variability

1. How variable are temperature and air quality in regions of the size of urban climate models grids (1km x 1km)?
2. How well do LST and air temperature correlate (when/where/why)?
3. Does climate variability correlate with building variability?



2. Local and downwind effects of green and blue infrastructure

1. How much can a large green space cool the air and is the effect measurable downwind?
2. How do the cooling effects change with wind speed and direction?

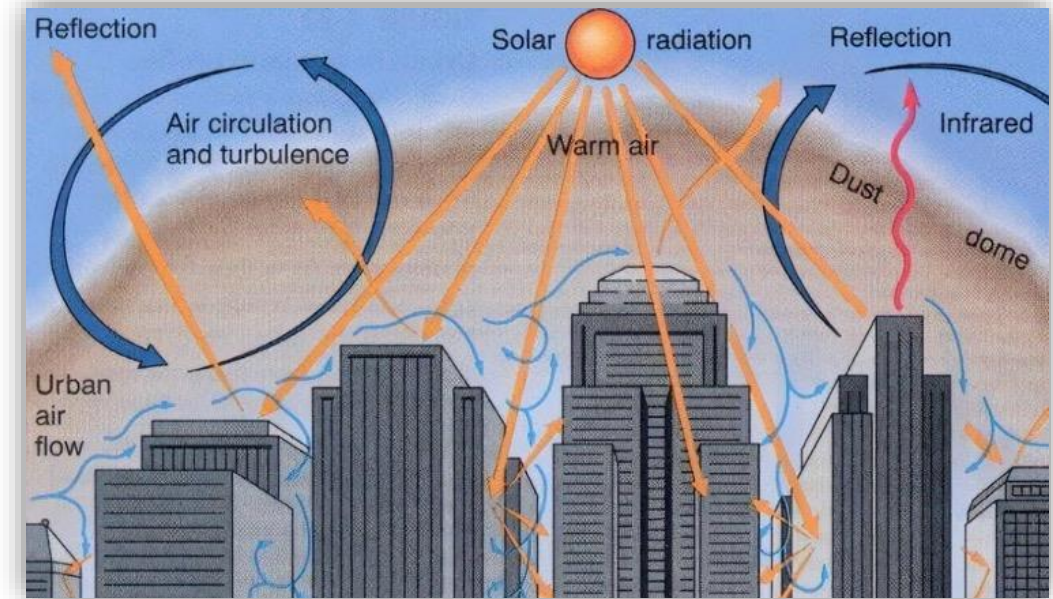


Summer IOP Research Questions

3. What is the structure of Phoenix's lower atmosphere?

- Aerosol/pollution particles
- Temperature and humidity
- Vertical winds

4. Does the lower atmospheric structure vary with distance away from the city center?



Progress to date

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2. Enabling Opportunities for Change

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- Model/prediction infrastructure

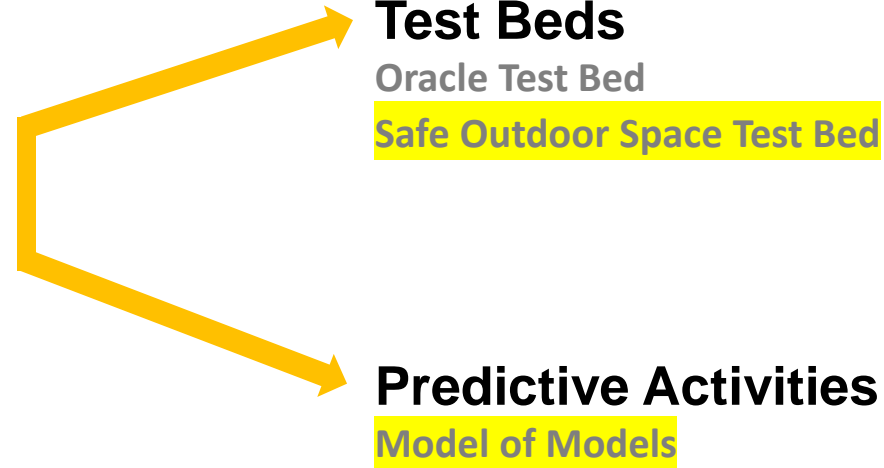
3. Informing the Decision-Making Process

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Test Beds and Predictive Activities

Research Question:

How effective will various solutions be at scale and into the future?



Safe Outdoor Space Test Bed

Site Goals

- Provide a safe outdoor camping option for the unhoused in Phoenix
- Introduce and evaluate cooling solutions including cool roofing films and site vegetation

Data Collection

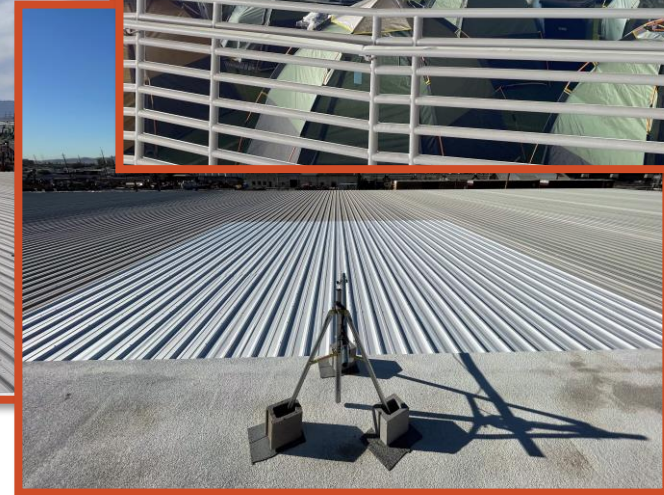
- Reference weather station, surface temperature IR sensors and thermal environment measurements in/around the SOS shelter.



Left: Weather station at SOS site



Below: SOS urban camping for unhoused population



Above and right: SOS roof with 3M Film and installed IR sensor

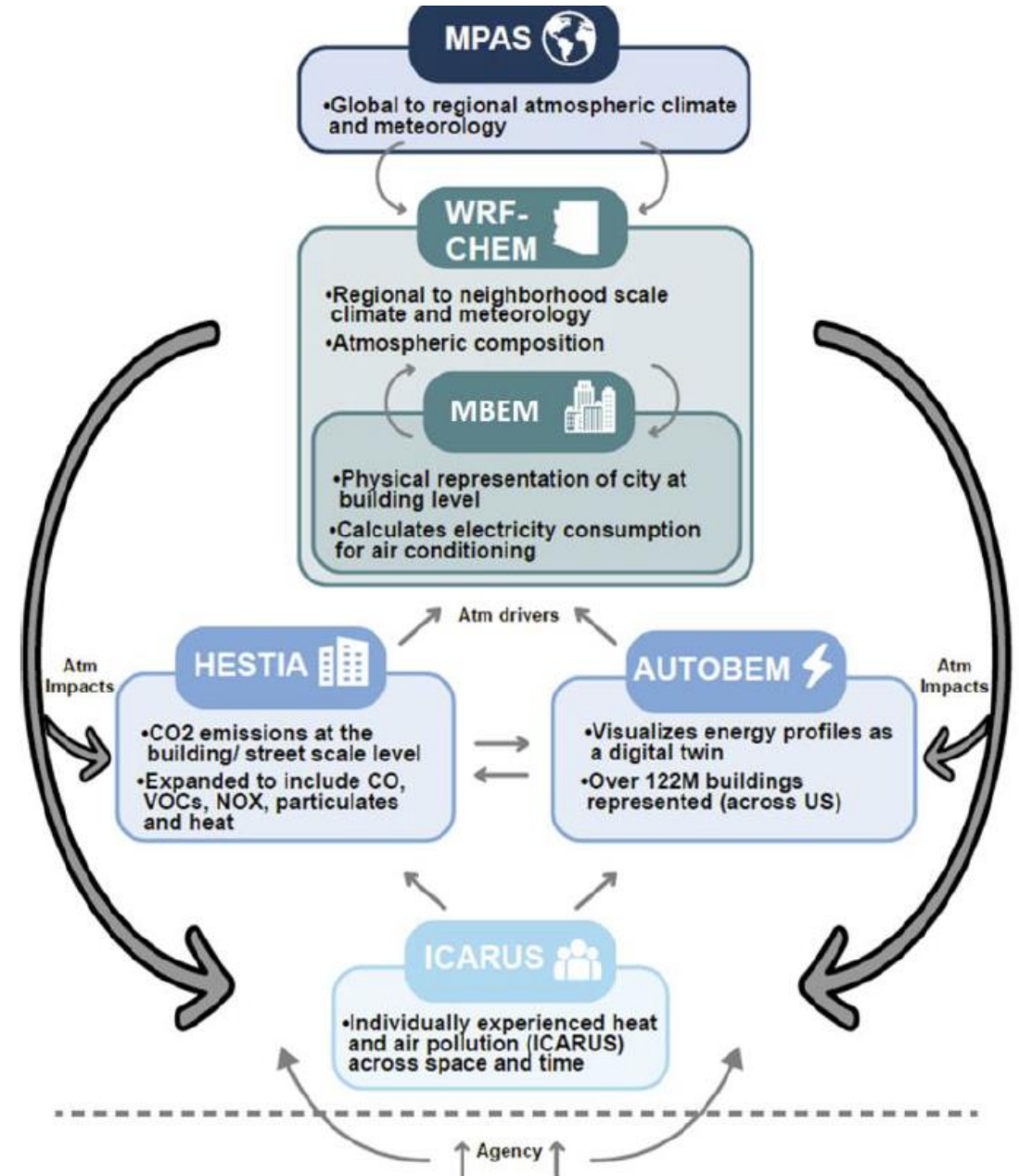
Model of Models (MoM) Overview

Building the diagnostic model

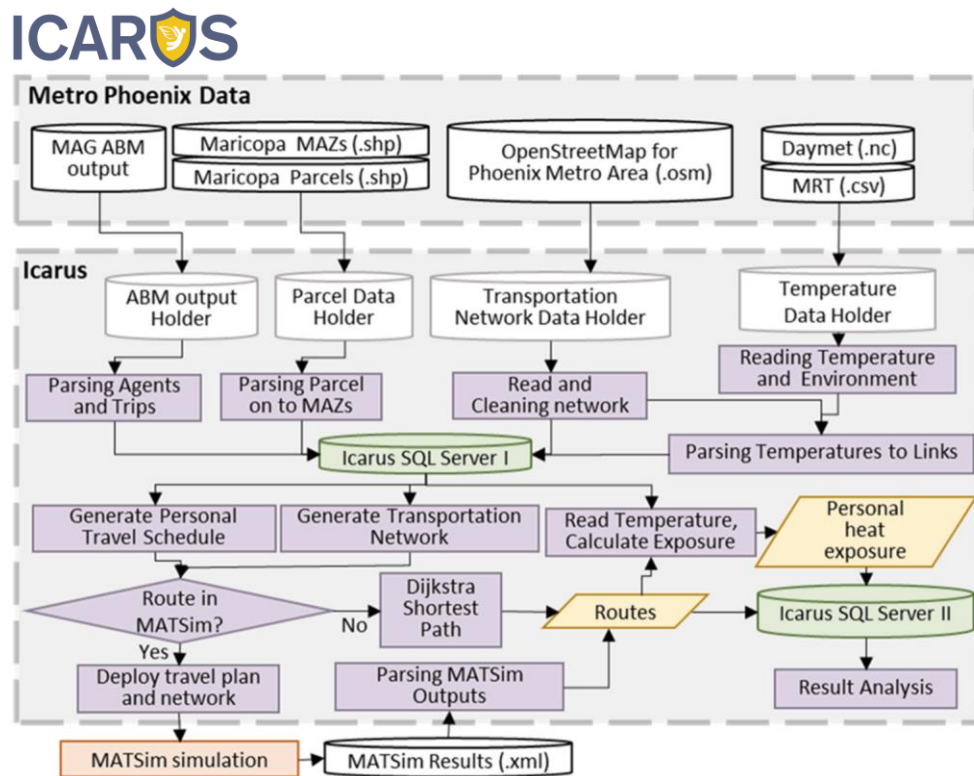
- Coupling global to local
- Coupling humans to technology
- Coupling drivers to atmosphere
- Coupling atmospheric impact to humans

Building the prognostic model

- Policy choices
- Behavioral change due to impact
- Growth
- Changing climate



Behavior & Exposure

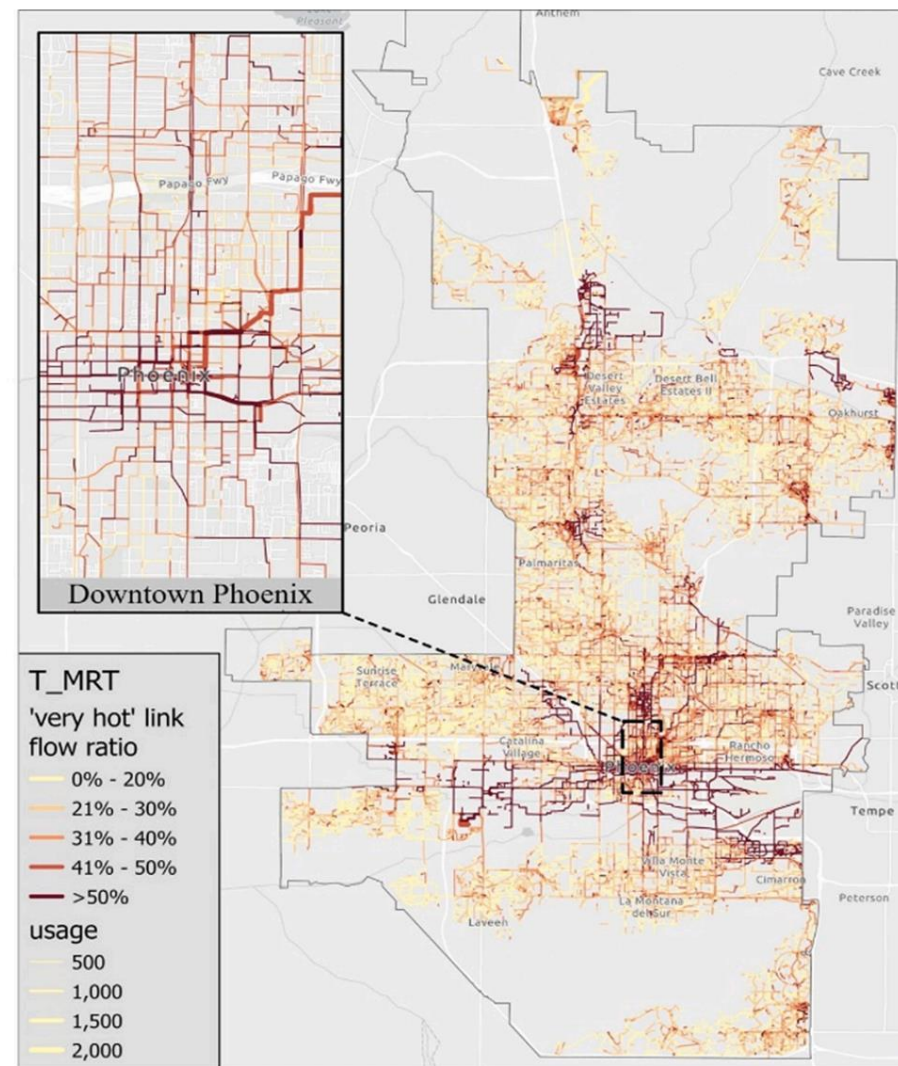


Python Process, Java Process, Processed Data, Server, Files

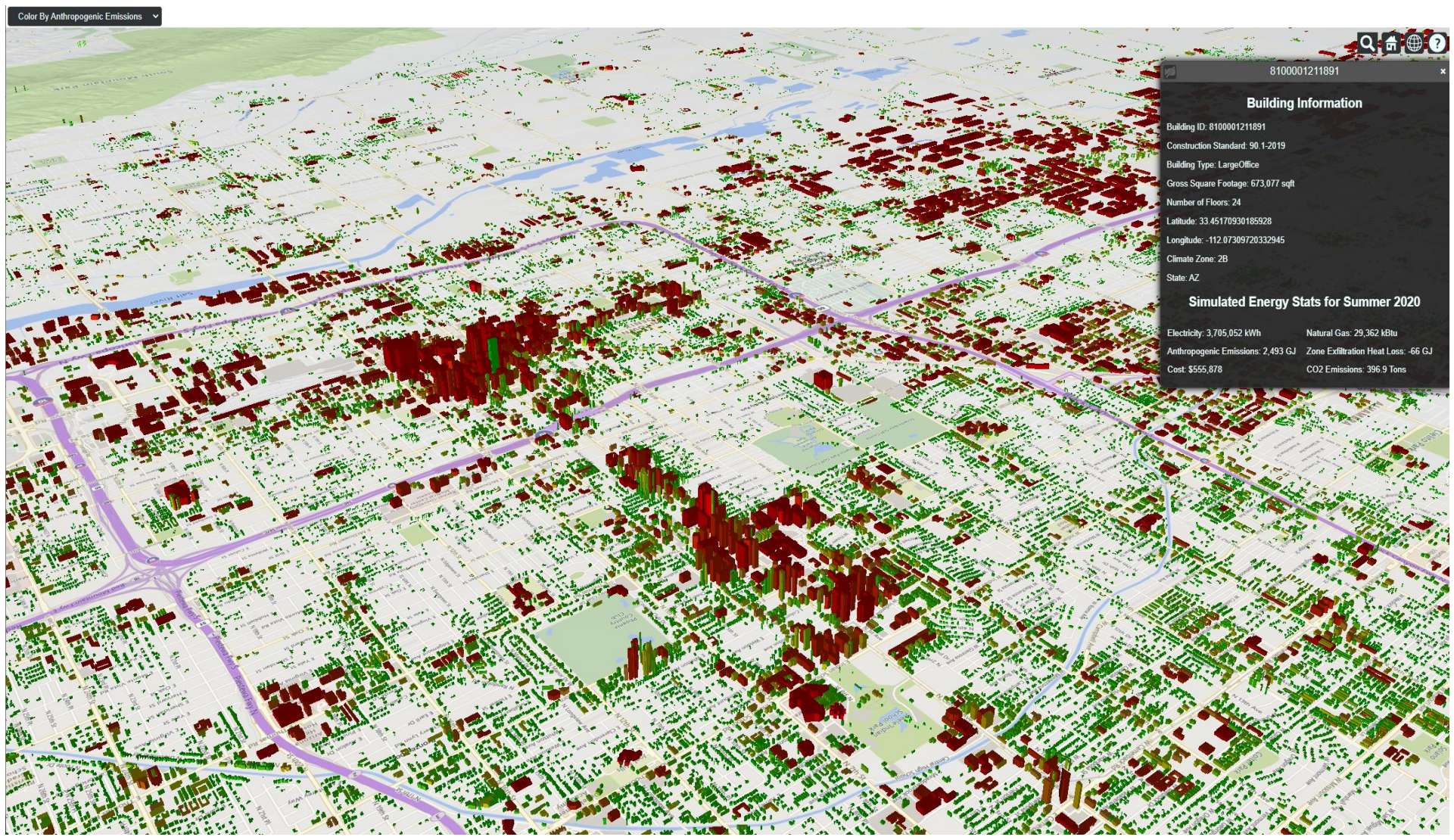
Repurposing Mesoscale Traffic Models for Insights into Traveler Heat Exposure,

Rui Li, Mikhail Chester, David Hondula, Ariane Middel, Jennifer Vanos, Lance Watkins, *Transportation Research Part D*, 2023, 114(103548), doi: 10.1016/j.trd.2022.103548

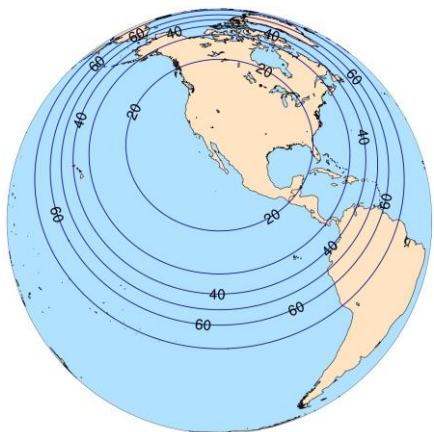
T_{MRT} Very Hot Trips



Neighborhood Morphology and Energy Use Patterns

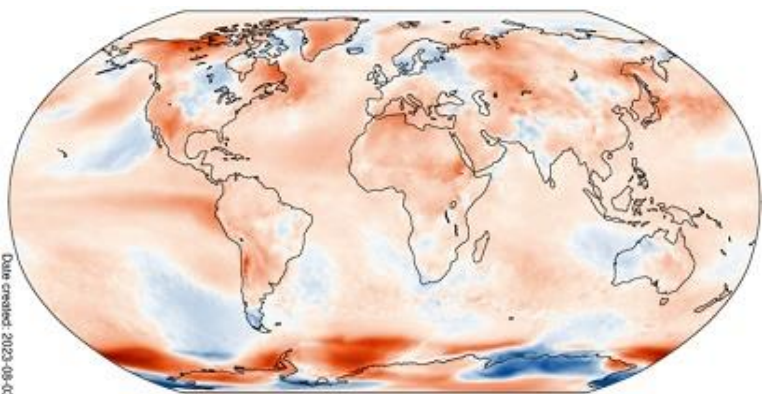


Atmospheric Modeling



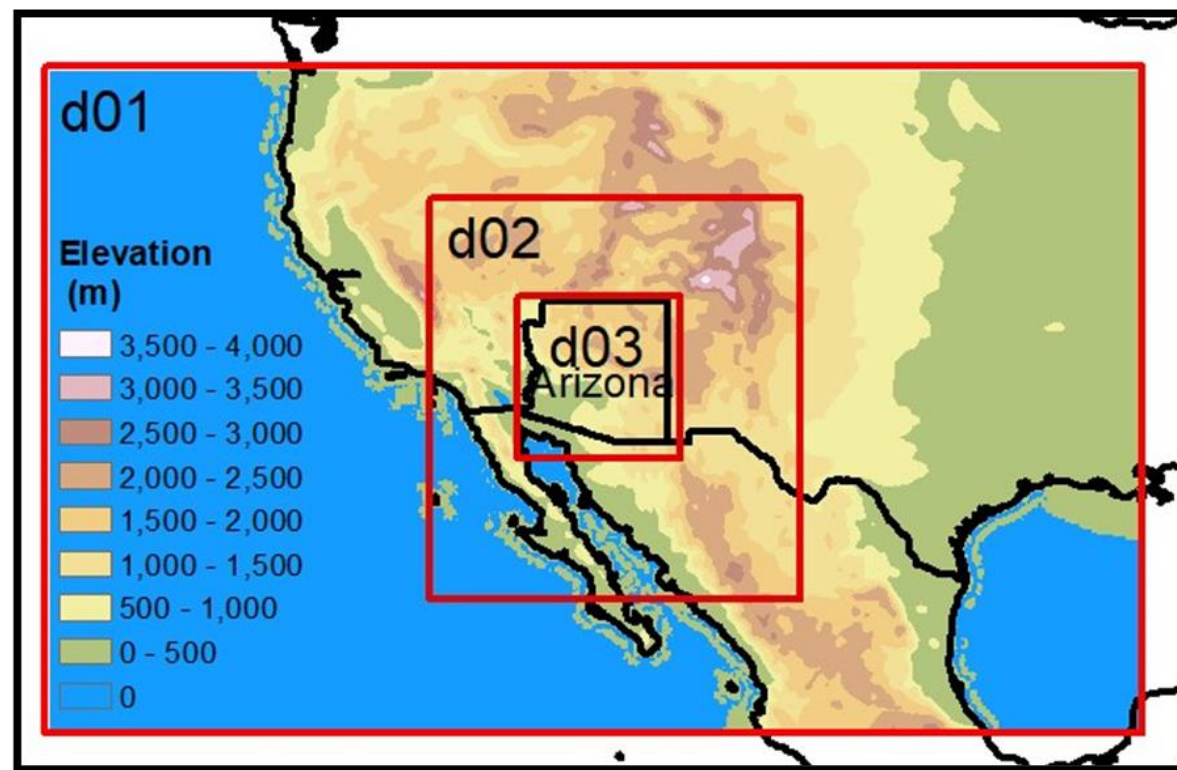
a) **MPAS Mesh Configuration:**
20km grid spacing across SW US.

ICs+LBCs



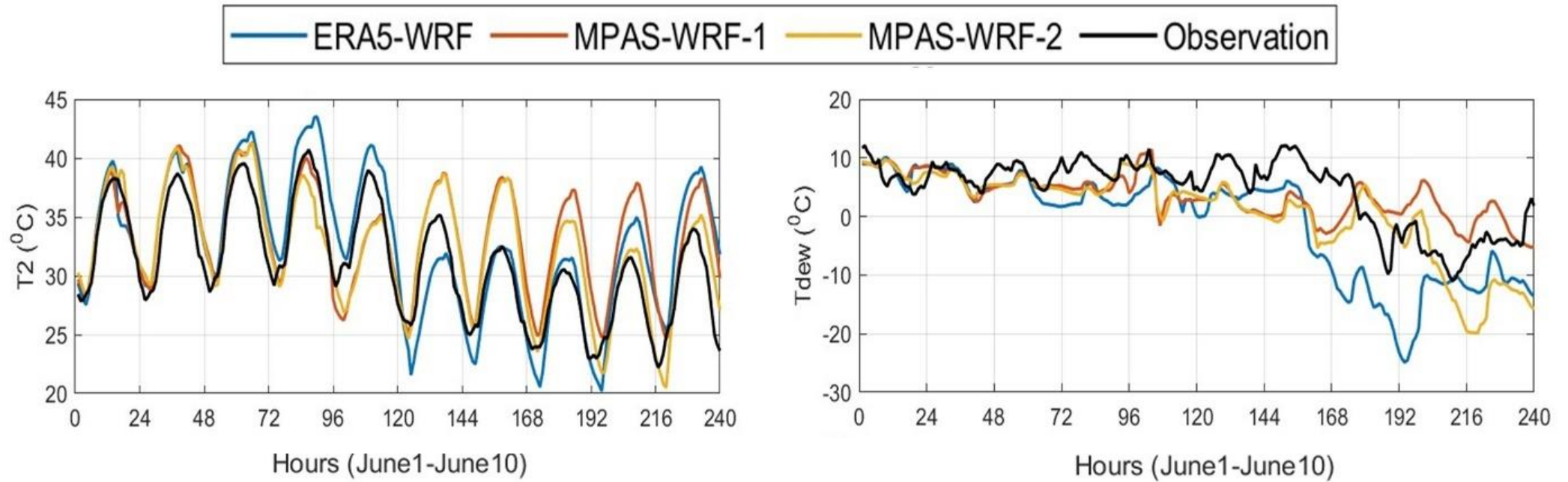
b) **ERA-5** reanalysis at a resolution of 0.25 degrees

ICs+LBCs



c) **WRF Domain:** D01-D02-D03 are 18, 6, 2 km horizontal grid spacing, respectively.

Atmospheric Model Evaluation



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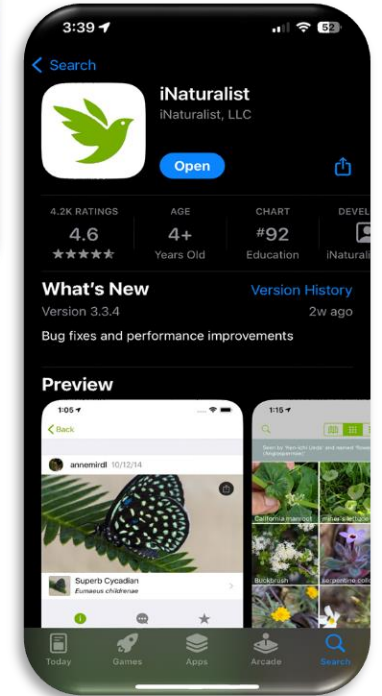
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3. Informing the Decision-Making Process

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Engagement, Dissemination, and Solutions

How can the science of the SW-IFL best inform decision-makers and the public to create a desirable urban environmental future for Arizona?



Engagement: K-12, Student HeatMappers, Fellows

- Household Thermal Security, Tucson
 - Assessed the impact of heat on 40 households through interviews and data collection.
- Traffic CO₂ Emissions App, Flagstaff
 - Support for models that estimate CO₂ emissions and air quality.
- Vacant Land Assessment, Mesa
 - Exploring potential impacts of development on heat and air quality.
- Arizona Project WET educator workshops
 - 4th grade curriculum development



*Above: HeatMappers collecting plant samples.
Left: Traffic app in action.*



Above: Arizona Project WET Water Festival



Below: HeatMappers Team.

Dissemination: Communications

- Summer IOP Media Coverage
 - Community Night with Desert Botanical Garden's Flashlight Night (Jun 22)
 - Media Day, Tucson (Jul 2)
 - OpenDoor Preview (Oct 11)
- SW-IFL Newsletters
- Cross UIFL Seminars
- Extensive news media coverage
- Presentations and publications

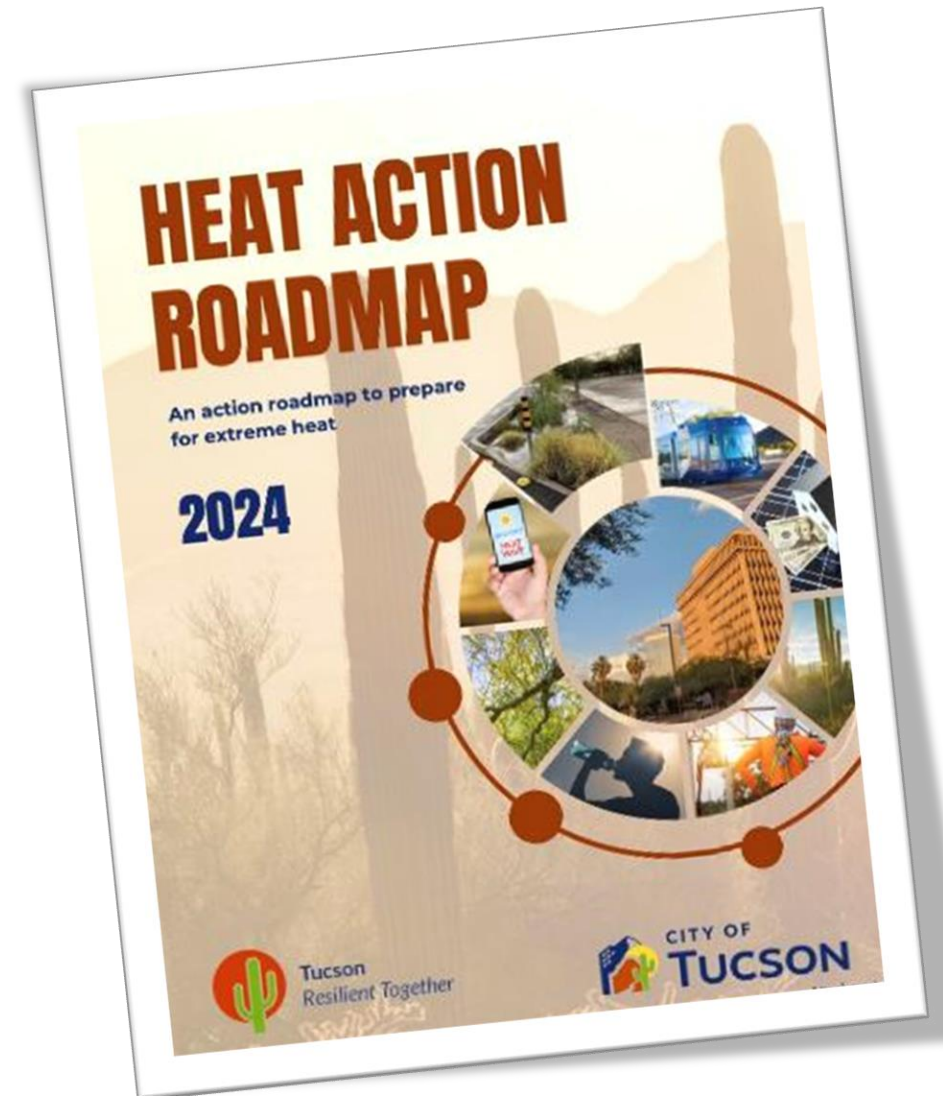


Photos from Community Night with Desert Botanical Garden, OpenDoor Preview, and Media Day.



Solutions & Tools: Planning Discovery

- Plan Evaluation for Heat Resilience Reports
 - Finalized and delivered reports for seven Arizona cities summarizing plan evaluation results
- Pilot Multihazard Planning Evaluation
 - Piloting multihazard plan evaluation pilot with both Pima County and City of Tucson comprehensive plan updates
- City of Tucson Heat Action Roadmap
 - Ladd Keith, Sara Meerow, and Malini Roy served as technical experts for the City of Tucson's Heat Action Roadmap (adopted June 2024)
- Center for Heat Resilient Communities
 - Ladd Keith and Sara Meerow are co-leads of the newly created national NOAA/NIHHIS center (www.heat.gov)



Solutions & Tools: Arizona Heat Exposure Dashboard

- Summary data products
- Filtering capability
- Useful for public, decision-makers, and researchers

