Southwest Integrated Field Laboratory (SW-IFL) Overview

2023 DOE UIFL PI meeting
September 27-28, 2023

Dr. David Sailor, ASU
SW-IFL Director

Motivation

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

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

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

PM/O_3 5 / 7 Phoenix has 5th worst ozone pollution and 7th worst year-round PM2.5. Local air pollution is impacted by emissions, temperature, wild fires, and drought.

425 Heat caused 425 deaths in Maricopa County in 2022, a 25% increase over 2021, continuing a 10-year upward trend.

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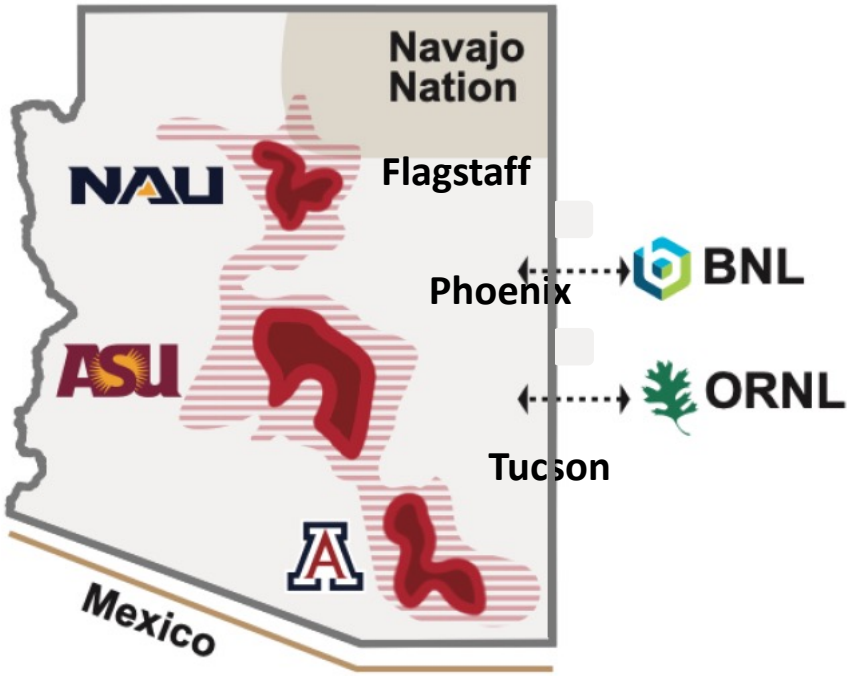
Focus of SW-IFL:

Extreme heat as a key driver of environmental and societal outcomes throughout the urbanizing megaregion from border with Mexico to the Navajo Nation



Modeling

A next-generation predictive system – a Model of Models (MoM) – that transcends scales from individual buildings to the globe

Observations

New surface and vertical profile measurements of atmospheric composition and temperature

Resilient Solutions

Stakeholder engagement to drive environmental and social resilience solutions

Linking Research Questions & Stakeholder Concerns

Research Area 1: ***Spatial variabilities and interactions with micro-environments***

Q1.1: How does heterogeneity of urban surface properties control atmospheric processes?

Q1.2: What are the impacts of extreme heat, air chemistry, and urban hydrology on disadvantaged/underrepresented communities?

Research Area 2: ***Observing and modeling biogeochemical cycling and atmospheric composition***

Q2.1: How do climate and surface/human drivers interact and how do their impacts manifest spatiotemporally across urban environments?

Q2.2: How do the above impacts & trade-offs map to under-represented communities?

Research Area 3: ***Equitable & resilient solutions in heterogeneous urban regions***

Q3.1: How do policy levers, technologies, materials, and landscaping strategies impact the patterns of urban climate and associated societal outcomes, including equity considerations?

Q 3.2: How can the models and findings of the drivers and socioecological impacts of heat and air quality be used to develop support tools so diverse stakeholders can make equitable decisions related to resilience?

What about communities in the north that have less extreme heat, but are less adapted to heat and have less access to AC

→ **add focus on passive survivability of buildings**

We need data on net benefits in order to use taxpayer $ to implement solutions

We need data for people

→ **public-facing dashboard**

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Engagement

- NAU, UA, and ASU are all Hispanic Serving Institutions (HSI)
- Discovery fellows program connects representatives from local organizations with academic partners
- HeatMappers program emphasizes diversity and undergraduate participants (from 26 minority-serving institutions and tribal colleges within region) will engage local youth and community members in citizen science
- Community organization and local population engagement through a Stakeholders Advisory Group

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SW-IFL Research Areas

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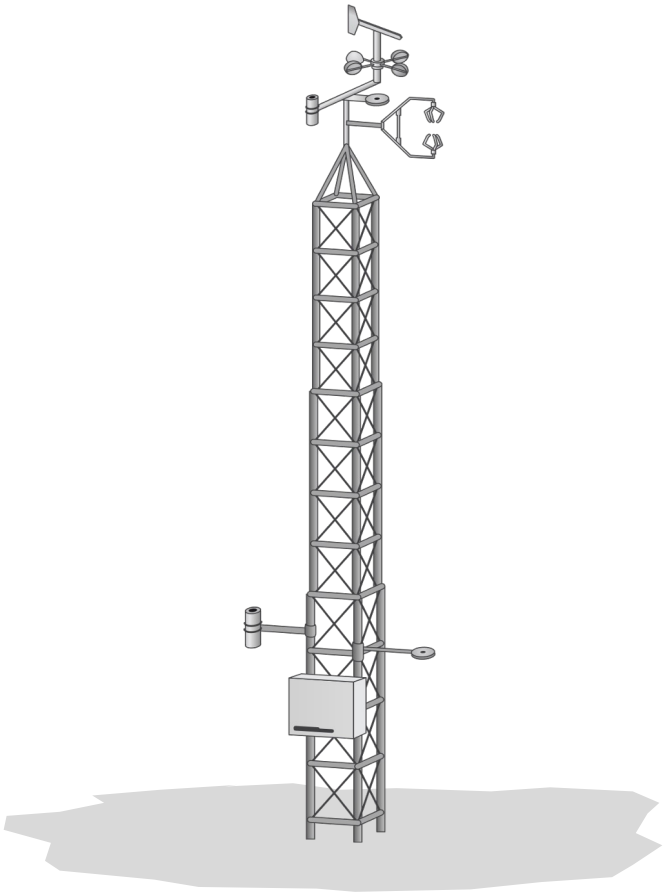
Observations

- Persistent networks of observations supplemented by new networks to fill gaps
- Eddy covariance towers
- Citizen science campaigns with significant K-12 engagement in vulnerable communities
- Intensive Observation Periods (IOPs) each summer



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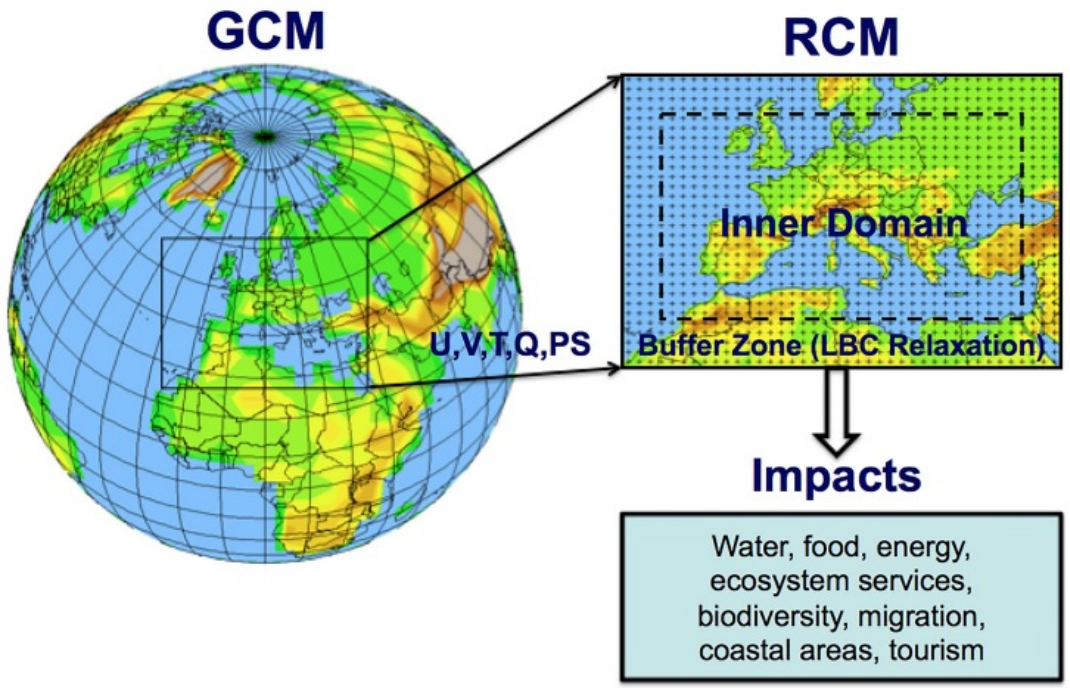
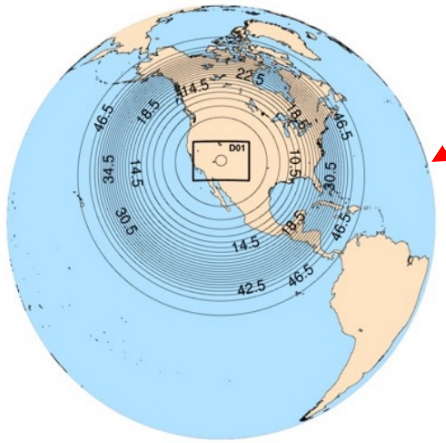
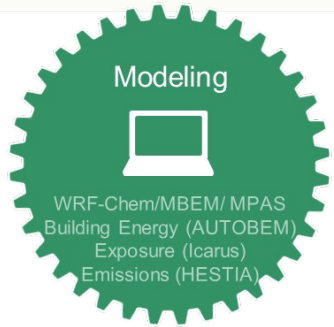
Modeling





Global to local [MPAS-to-WRF]



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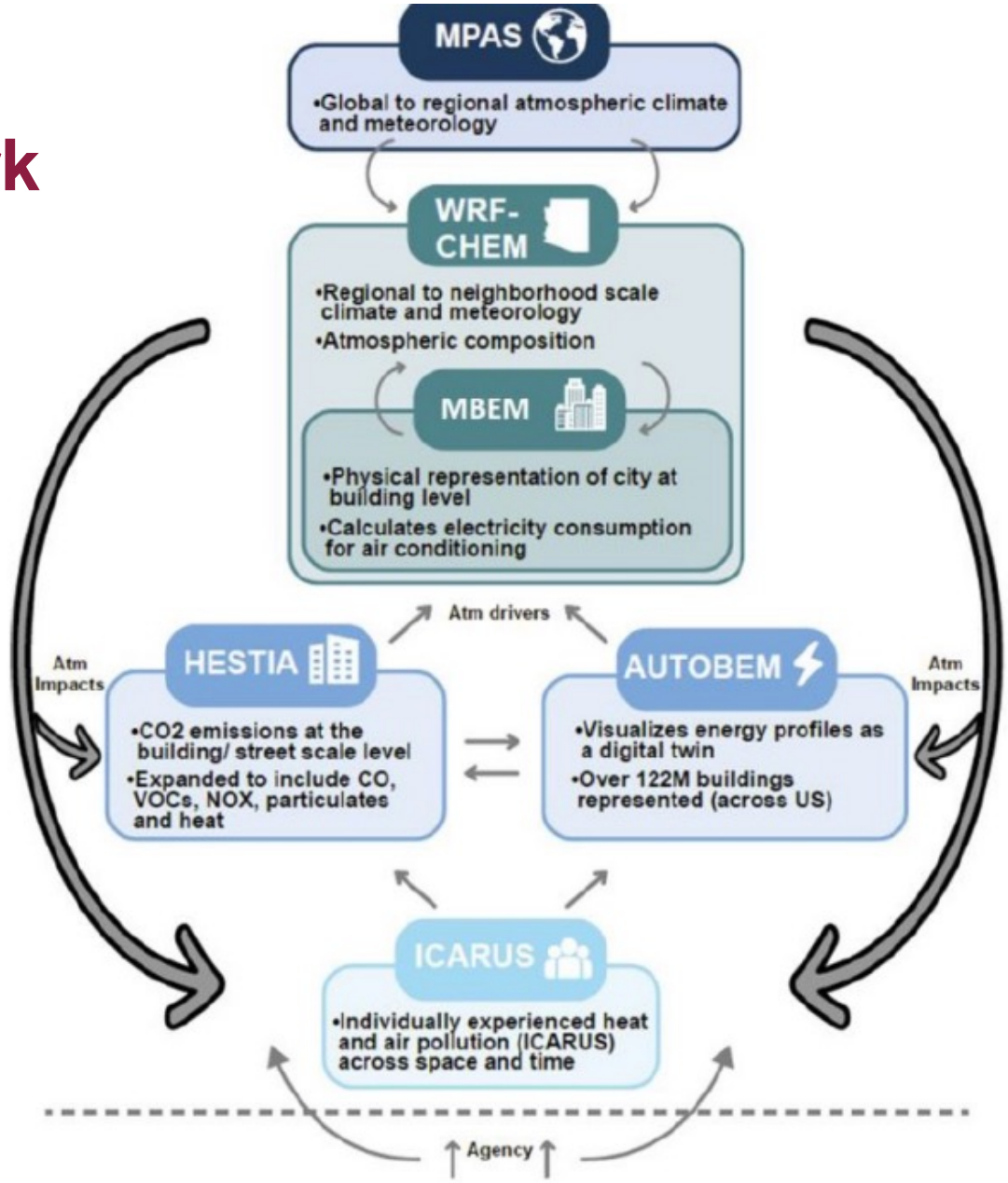
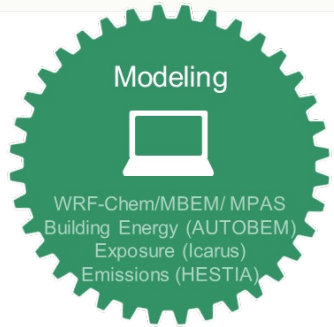
Model of Models (MoM) Framework





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Resilient Solutions

- Stakeholder Advisory Group
  - Build trust through multi-directional engagement
  - Co-development of resilient solutions
- Discovery components
  - Home thermal security
  - Mobility
  - Planning
- Engagement
  - K-12 curricular activities
  - HeatMappers participatory science
  - Discovery fellows (community & university co-design)

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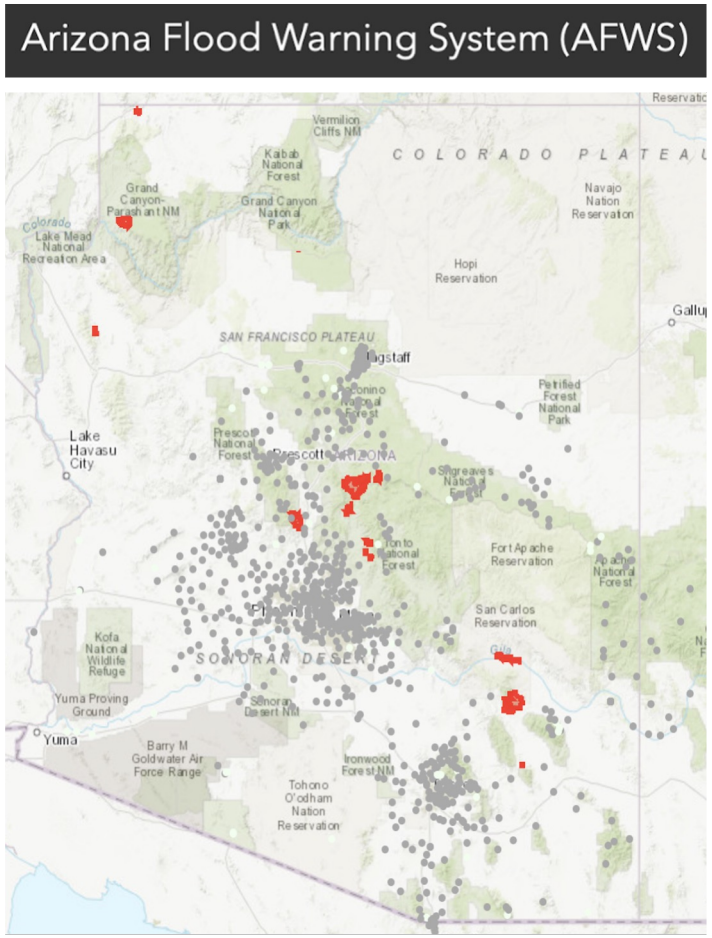
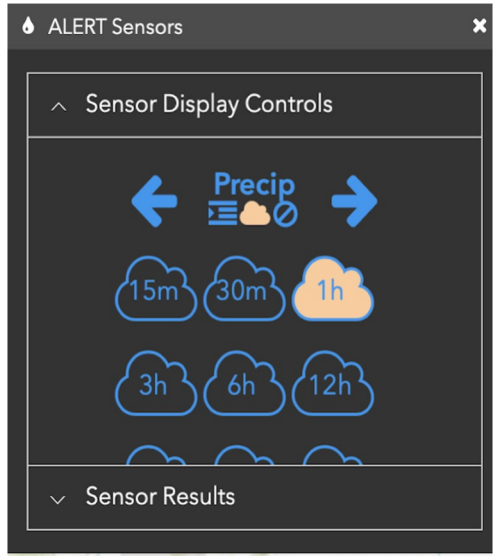
Year 1 Progress

Year 1 Progress: Persistent networks



Integration of Real-time AFWS Observations:

- Multiple Flood Control Districts in Arizona
- High-frequency rainfall, weather and streamflow
- Long-term historical context (10 to 30 years)



Other Observation Platforms:

- AZMET (urban, rural, ag) sites
- ASOS / RAWS / SCAN sites
- Air quality stations
- Water quality sampling sites
- Weather radar
- Long-term (40-year) 1-km gridded products from NOAA

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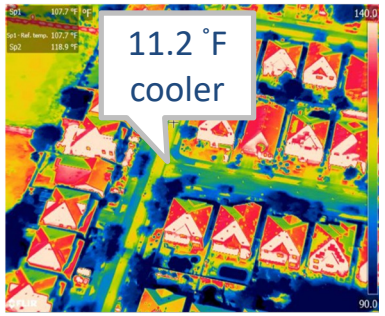
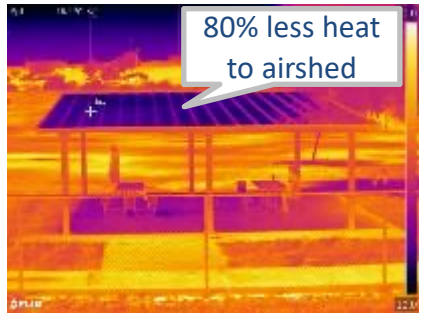
Year 1 Progress: Technology Test beds

- Cool paving
- Role of shade
- Passive radiant cooling materials





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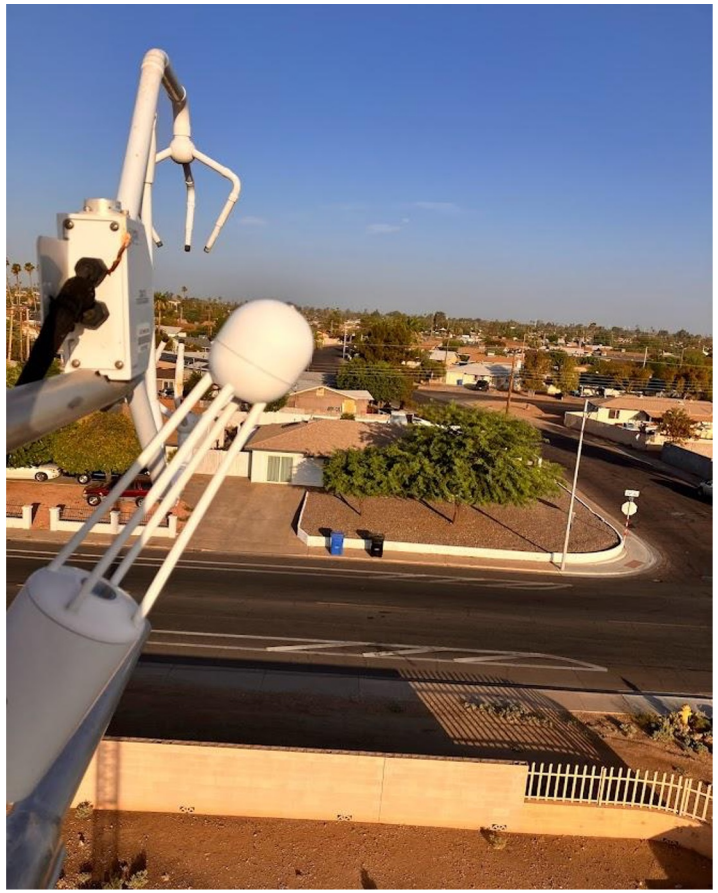
Year 1 Progress: Observations

LOW-RISE RESIDENTIAL



Maryvale, West Phoenix
Processing data from 2010-2021

URBAN/RURAL INTERFACE

Desert Botanical Gardens
Data from 2010-pres. EC installation underway

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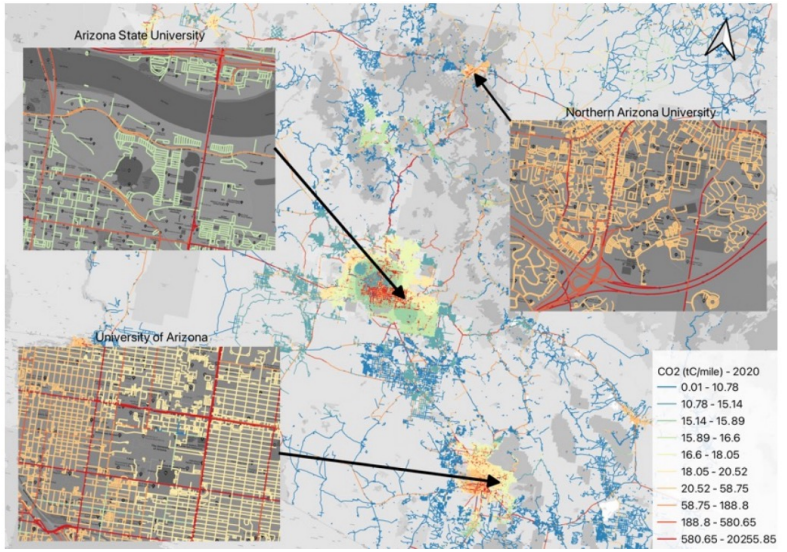
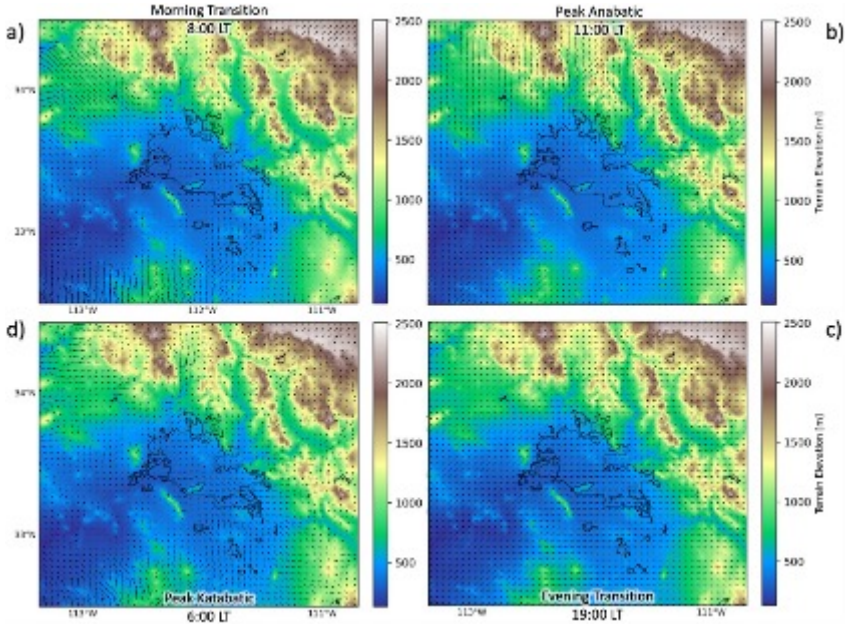
Year 1 Progress: Modeling

- Arizona $FFCO_2$ on-road sector

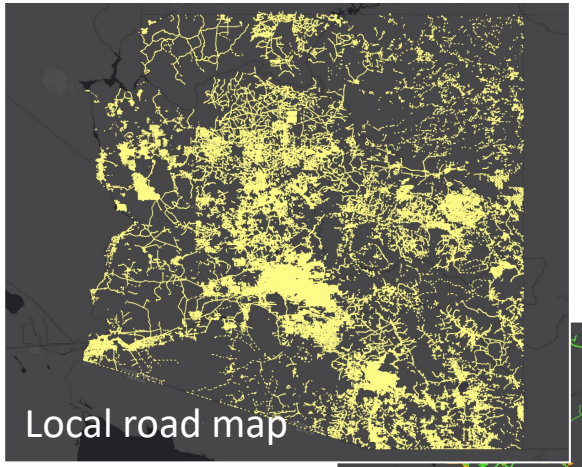


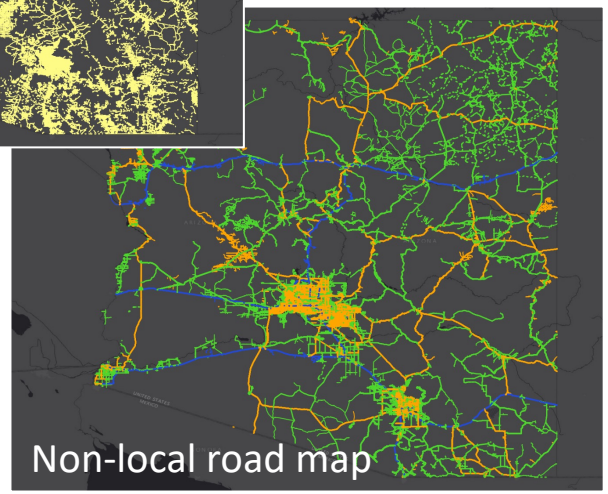
- Model coupling and initial testing of high-res modeling (PHX)

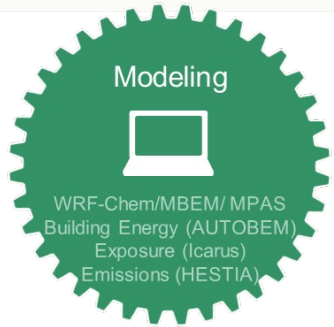


Year 1 Progress: Modeling

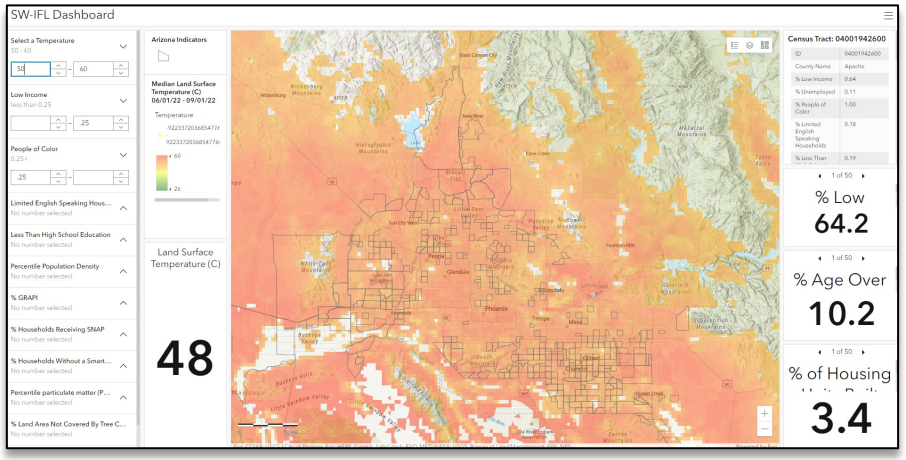
- Completed road base map as a core element of on-road modeling work (heat/AQ/GHG)







- Completed beta version of statewide GIS Dashboard
  - Users can filter by multiple demographic and environmental conditions, including SW-IFL derived data products



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Year 1 Progress: K-12 Activities

- K-12 Teacher Workshops
- Connecting teachers and their curriculum to the SW-IFL research:
  - Air quality and air quality sensors
  - School garden landscape performance
  - Plant carbon citizen science
  - Environmental justice and technology
- Establishing instrumentation networks in data deserts

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Year 1 Progress: Community Test beds

- Two initial community test beds have been selected to consolidate, synergize, and de-silo SW-IFL activities
  - Jackson Street in Phoenix
  - Oracle Road in Tucson

Jackson Street (above) and Oracle Road (below)

- Centered on real-world, localized areas where concepts, strategies, and approaches can be assessed with respect to the effectiveness of proposed solutions

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Plans for Year 2

Plans for Year 2

- Discovery Fellows
  - Collaboration between community experts and research scholars
  - 10-month collaboration to co-design and implement case studies
- HeatMappers
  - Teams of undergraduates will undertake 6-week participatory research activities across SW-IFL institutions
  - Students will be trained and guided to contribute to data observations, measurements, and validation of models, and interpretation of results
  - Program emphasizes diversity and participants will engage local youth and community members in citizen science participatory action

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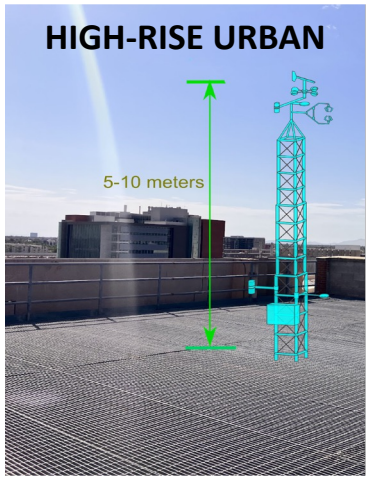
Plans for Year 2:

- Expand eddy covariance network
- Launch summer IOP
  - Instrumented trucks, vehicle traverses, towers, mini radiosonde balloon releases, weather and AQ networks
  - At test bed sites, collocated with towers, and in high-rise urban areas
  - Winds, mixing layer, temperature, humidity, urban aerosols, cloud formation
- Citizen science campaigns
  - Radiocarbon plant sampling to determine CO_2 sources



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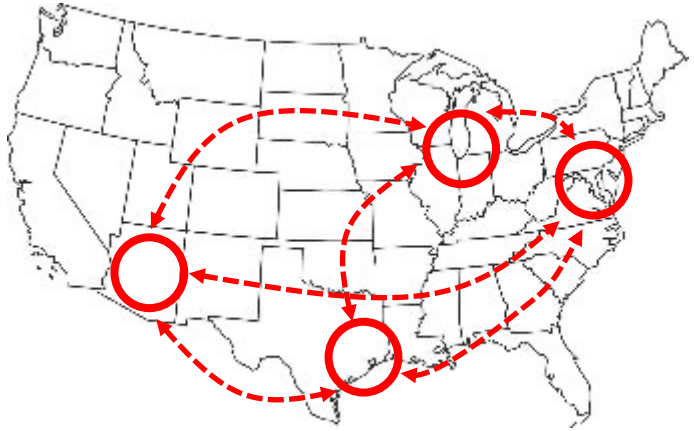
Cross-IFL Collaboration Opportunities

- Additional and unique measurements for IOP campaigns. Sharing of capabilities
- Standardization of, and intercomparison across, modeling and observational approaches
- Data standardization and sharing
- Leveraging knowledge across UIFL domains, communities, geographies, and climates
- K-12 curricular activities, approaches, curricula
- Developing complementary efforts and proposals to build on the UIFL foundation



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Thanks to the entire SW-IFL team!

All-hands SW-IFL meeting, September 11-12 2023