Improving CO_2 and anthropogenic heat from the onroad sector through the citizen science deployment of a phone-based traffic app

UHI workshop

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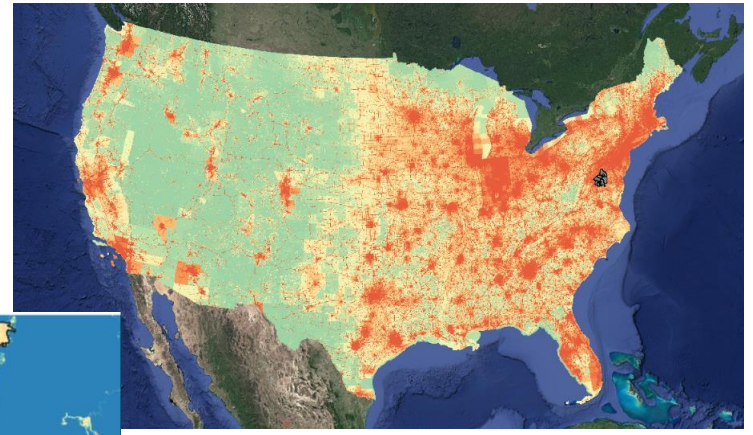
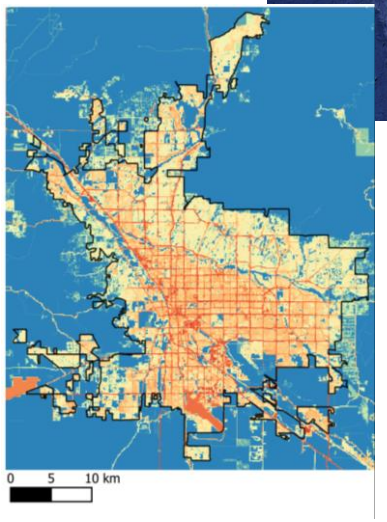
Gurney lab's work: Vulcan and Hestia Projects

Develop and provide emissions estimates due to human/industrial activities with spatial and temporal details

- CO_2 from fossil fuel combustion and cement production (CO_2 from fossil fuel: $FFCO_2$)
  - By sector (Onroad, railroad, commercial buildings, etc)
  - By fuel type (Coal, natural gas, oil)
  - At hourly time-step
  - At road segment and building scales
- CO_2 from electricity consumption
  - By end-users (residential, commercial, etc)
  - By jurisdiction (e.g., census tract, blocks)
- Criteria air pollutants
- Anthropogenic heat

Vulcan: U.S. emissions product





Hestia: city-level emissions product (example for Tucson)

Annual emissions (2017-2022) at the native resolutions (points/lines/polygons) for AZ

Spatial/temporal downscaling

County tax assessor data	**Traffic volume data from ADOT/MPOs**
Local building infrastructure data	Local road network data

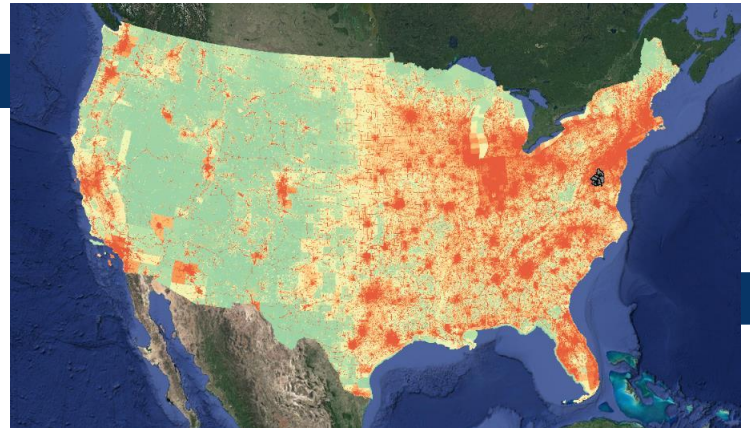
Create native resolution products

Extract data for urban domains (e.g., Phoenix, Tucson, and Flagstaff)

Create gridded products

Gridding at 100m resolutions by sectors

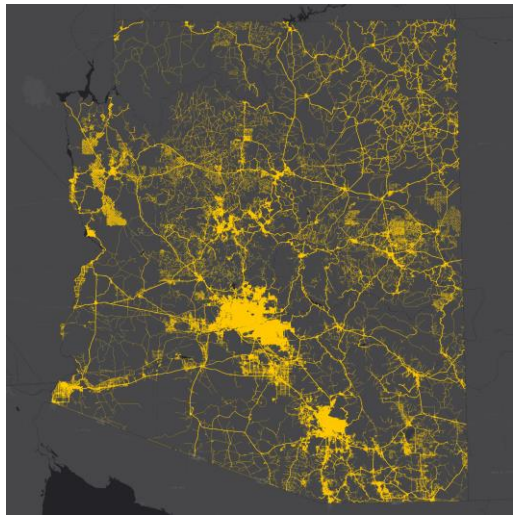
Vulcan project U.S. $FFCO_2$ emission product



Arizona self-reported inventory (AZ SRI)

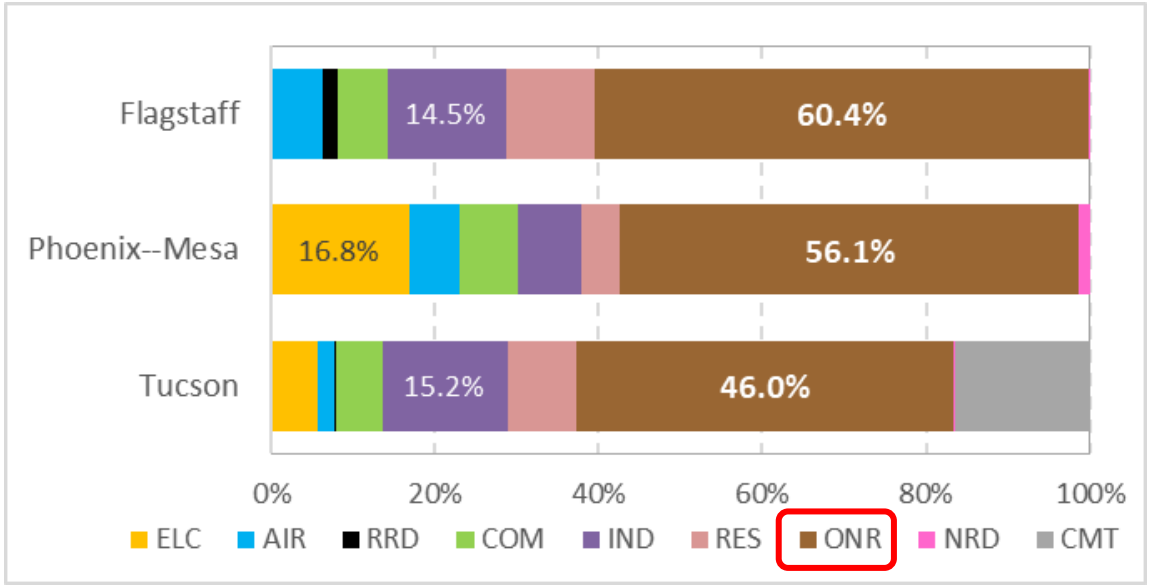
County-level annual summary outputs for Arizona

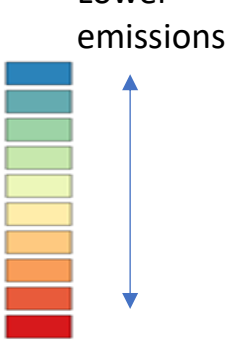
Hestia-SWIFL native resolution product



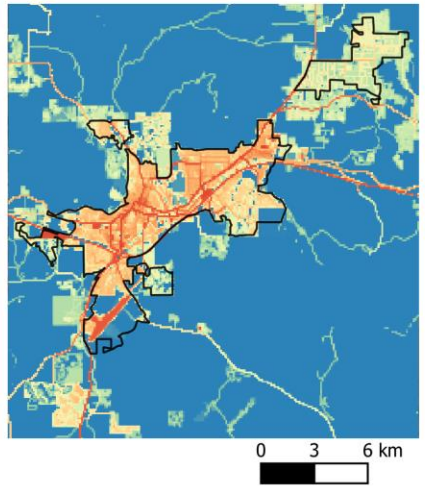
Segment-level annual onroad emission data is available at ESS-DIVE for the entire state of Arizona for 2017-2022!! (https://data.ess-dive.lbl.gov/datasets/doi:10.15485/2335384)

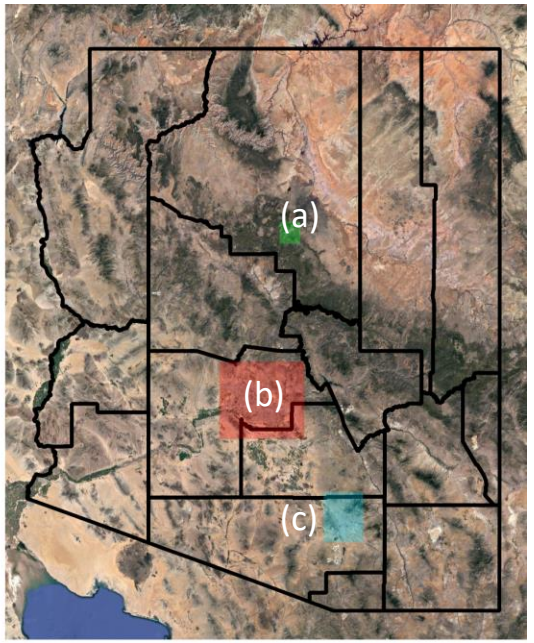
2021 $FFCO_2$ emissions for the three urban domains in Arizona



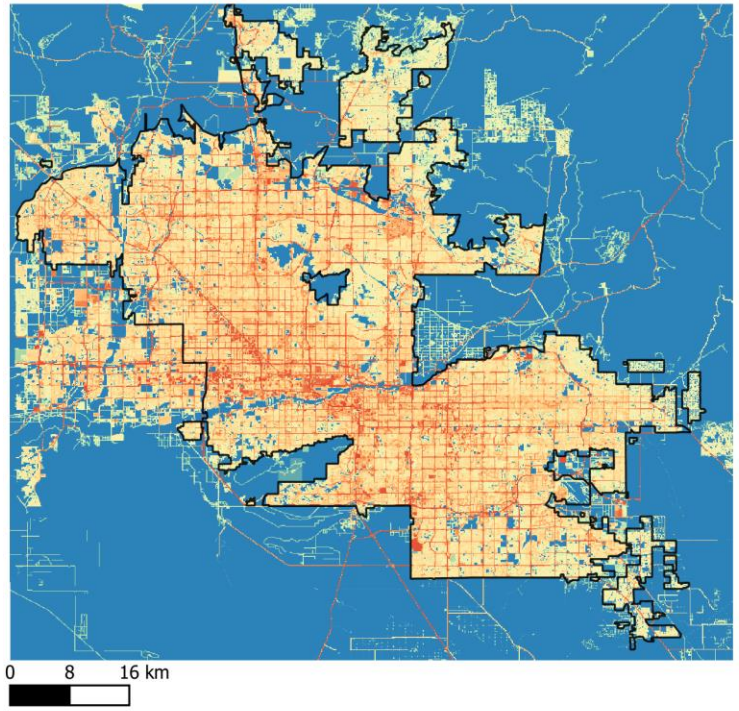


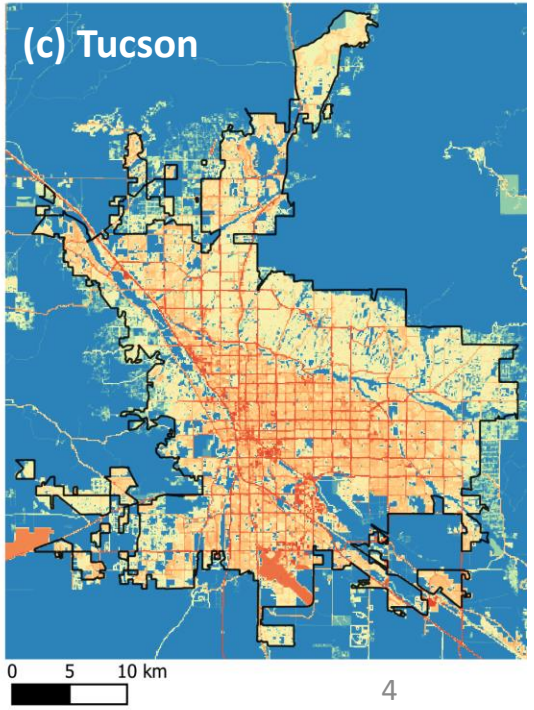
(a) Flagstaff





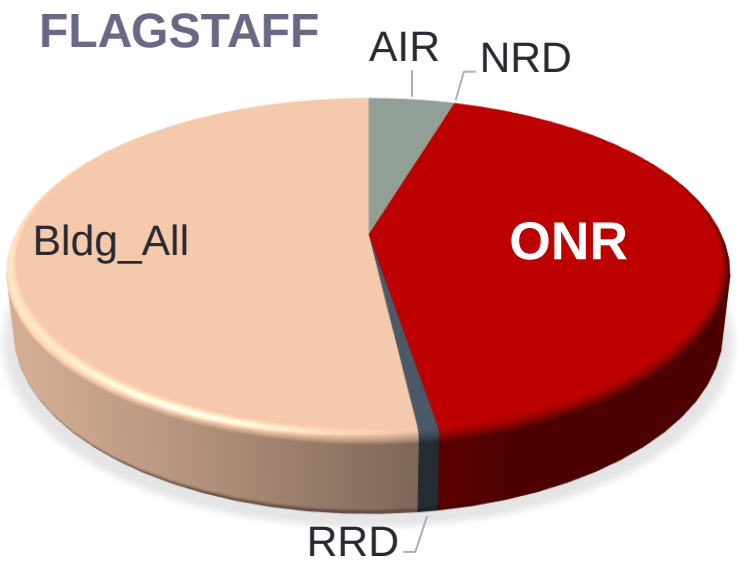
(b) Phoenix

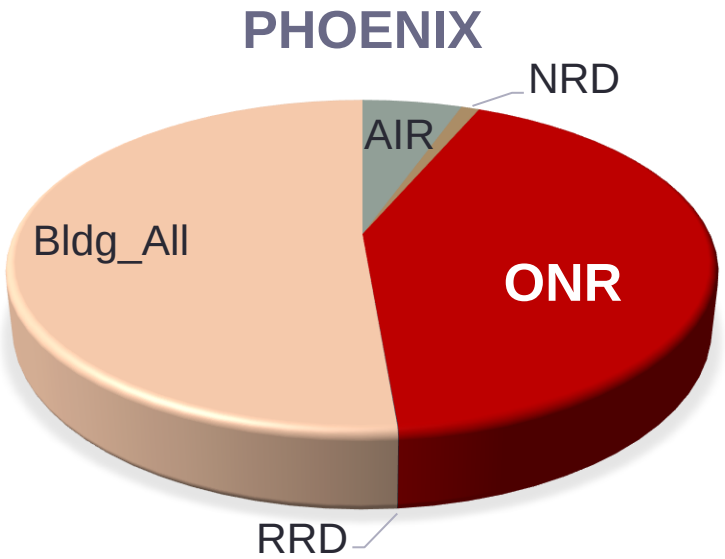


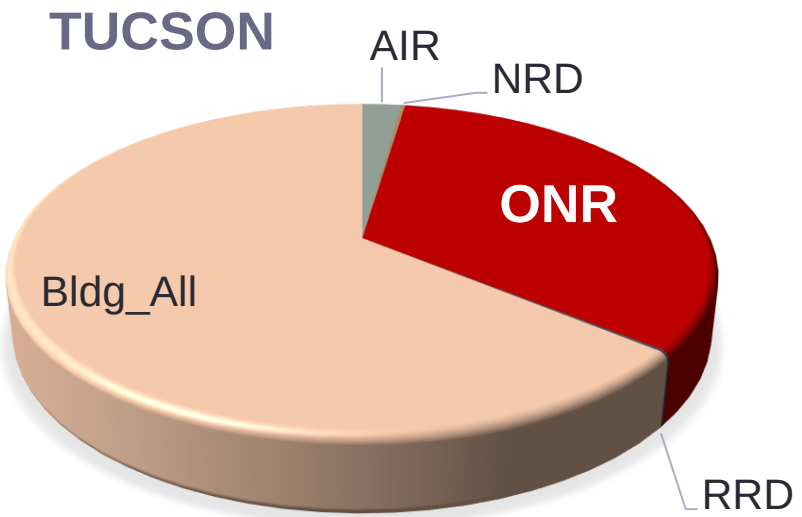


Anthropogenic heat (heat from fuel combustion)

- Anthropogenic heat from Onroad sector (ONR) is the 2nd largest source.

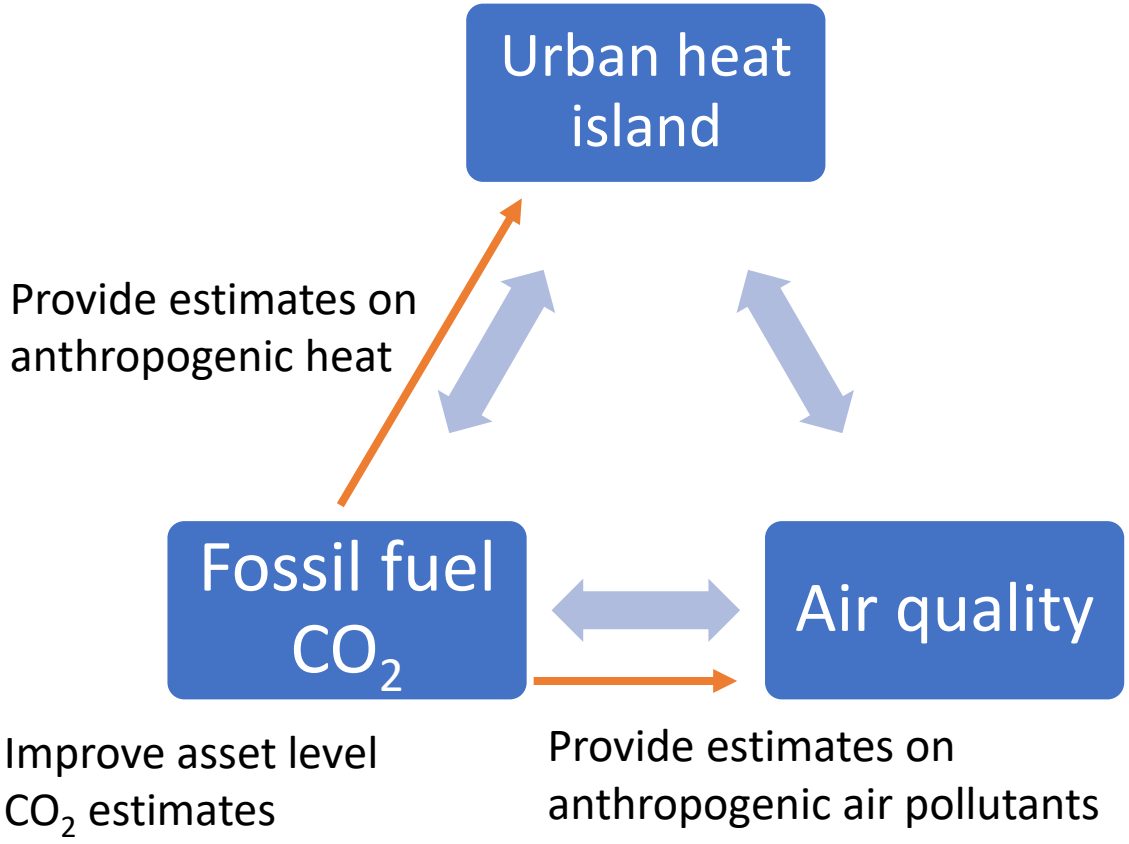






Fossil fuel CO_2, air quality, and urban heat island

- Urban heat island, air quality, and fossil fuel CO_2 emissions are all important to urban policymaking
  - The co-benefits and tradeoffs are poorly understood
- Fossil fuel CO_2 is unique
  - Is already produced at high granularity
  - Is more observable than the other two



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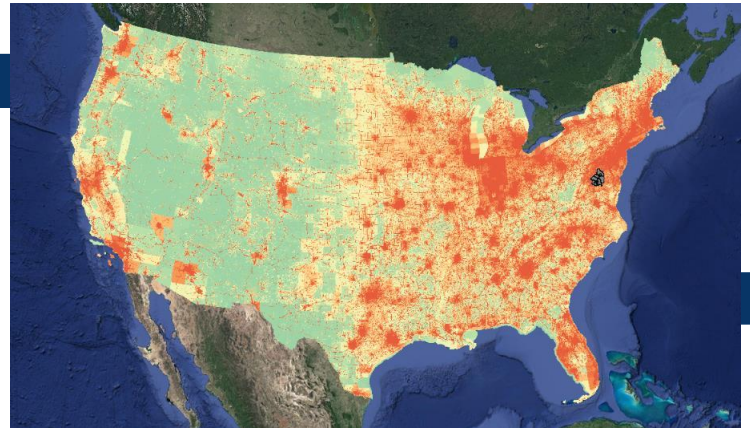

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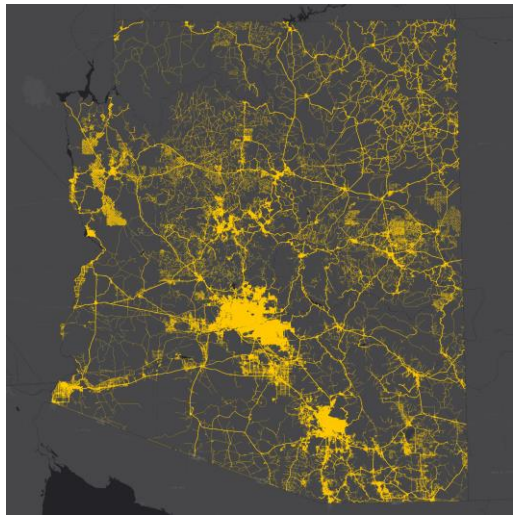


Upcoming improvements

- Onroad downscaling using Traffic App data (e.g., fleet distribution)
- Energy Use Intensity adjustments
- Scope 2 emission estimates
- Emissions scenario development
- Constrain emissions using plant ^{14}C radiocarbon data

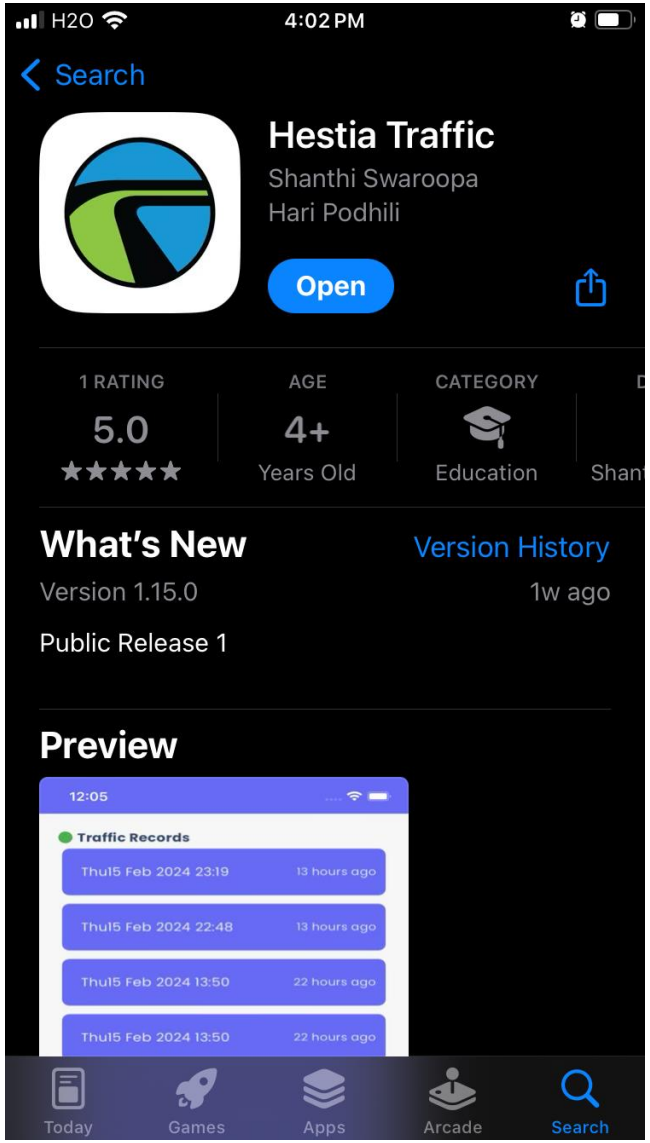
Motivation: Traffic counting using a phone-based App

- We aim to improve our estimates of onroad fossil fuel CO_2 ($FFCO_2$) emissions in Arizona (emphasis on the three cities)

- One of the weaknesses in generating accurate, spatially granular, onroad $FFCO_2$ and anthropogenic heat emissions is the characterization of the "fleet" on a given section of roadway (e.g., how many trucks versus small vehicles) at a particular time
  - Currently we only have vehicle type distribution at the county scale (from DMV vehicle registration)

- An iPhone/Android device app "Hestia Traffic" allows citizen scientists to collect fleet information and share it with us at Northern Arizona University
  - Observed fleet distribution at a sample of road segments can make a big difference in our CO_2 accuracy!

Hestia Traffic App



- Developed by NAU MS student Shanthi (Hari)
- A user-friendly app designed to:

1) increase density of traffic fleet data
2) empower citizens by contributing to climate change solutions.

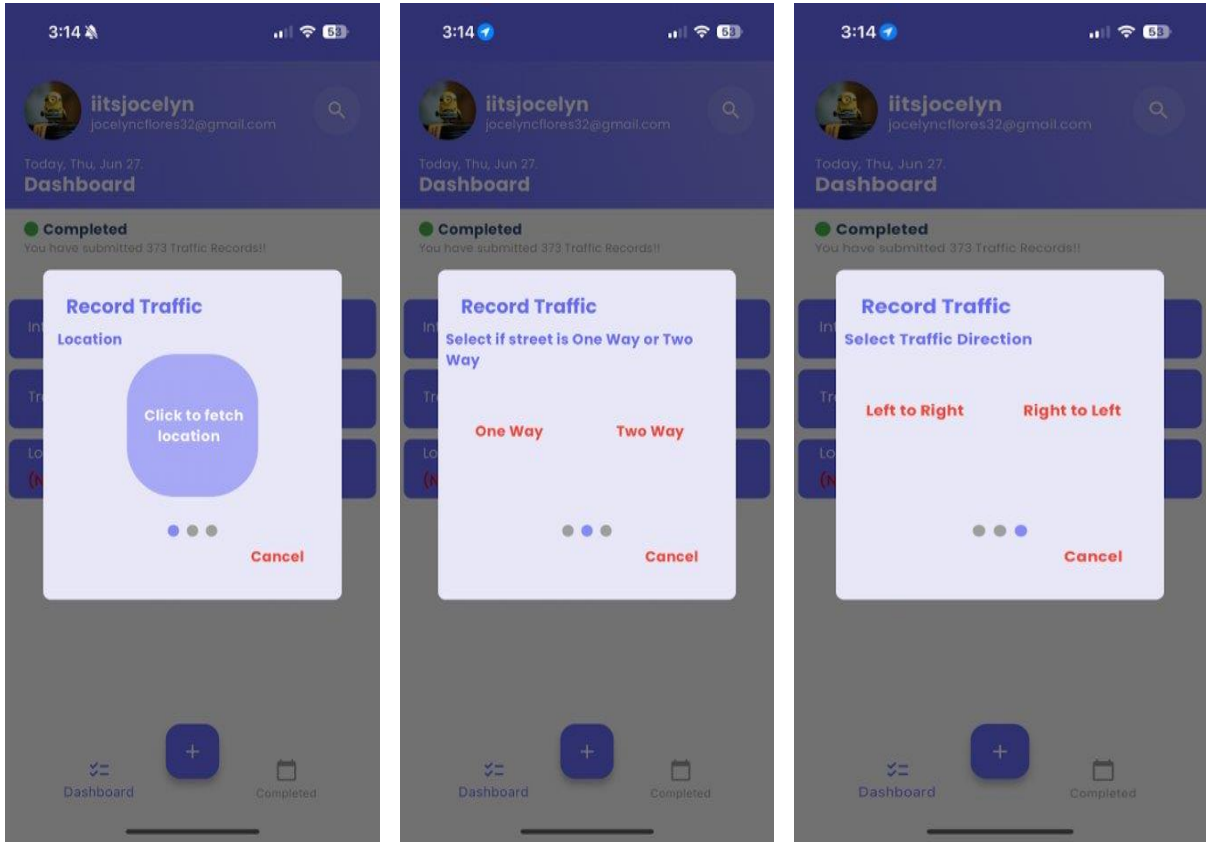
- Available on Apple store (Android version is coming soon!)

- Requirements:
  - Create a user account (free!)
  - Internet connections (WiFi or Cell) to fetch locations
  - Set correct time zone (in your case, Arizona time)

For iPhone (available on App store)

For Android (need test subjects)

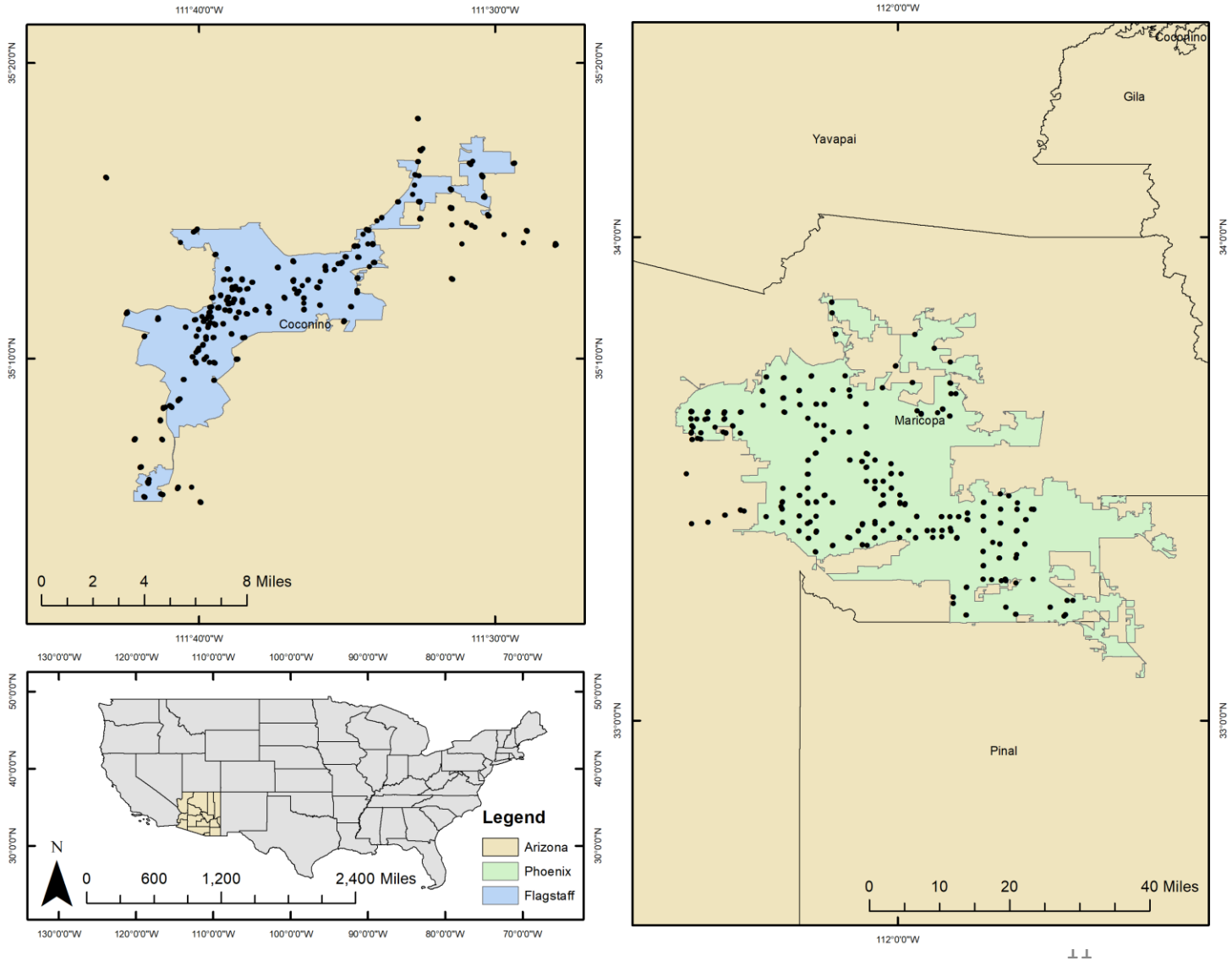
Hestia Traffic App



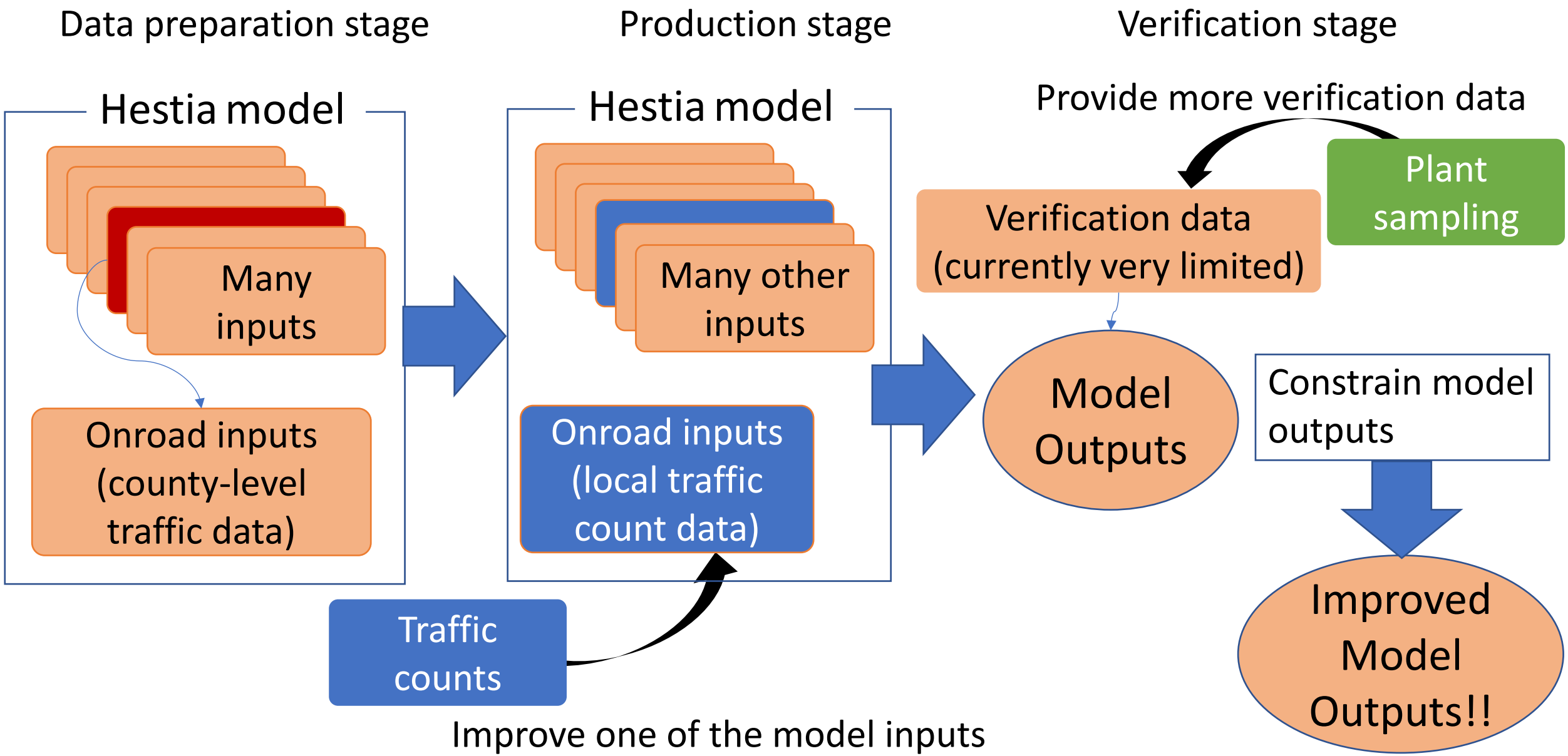
Need observations in Tucson!

Collect **vehicle counts data:**

- By six vehicle categories
  - Passenger cars, trucks, buses, etc.
- At different day-of-week
  - Weekend vs. weekday
  - Monday vs. Friday
- At different time-of-day
  - Morning/afternoon rush hours
  - Evening traffic
- At various locations
  - Busy roads (e.g. state routes)
  - Residential roads



How citizen scientists collaborate with us?



We need your inputs!

< Challenges >

- How to propagate this app to wide communities?
- How to do outreach effectively?
- How to communicate with users to improve the app?
- How to assure data quality?