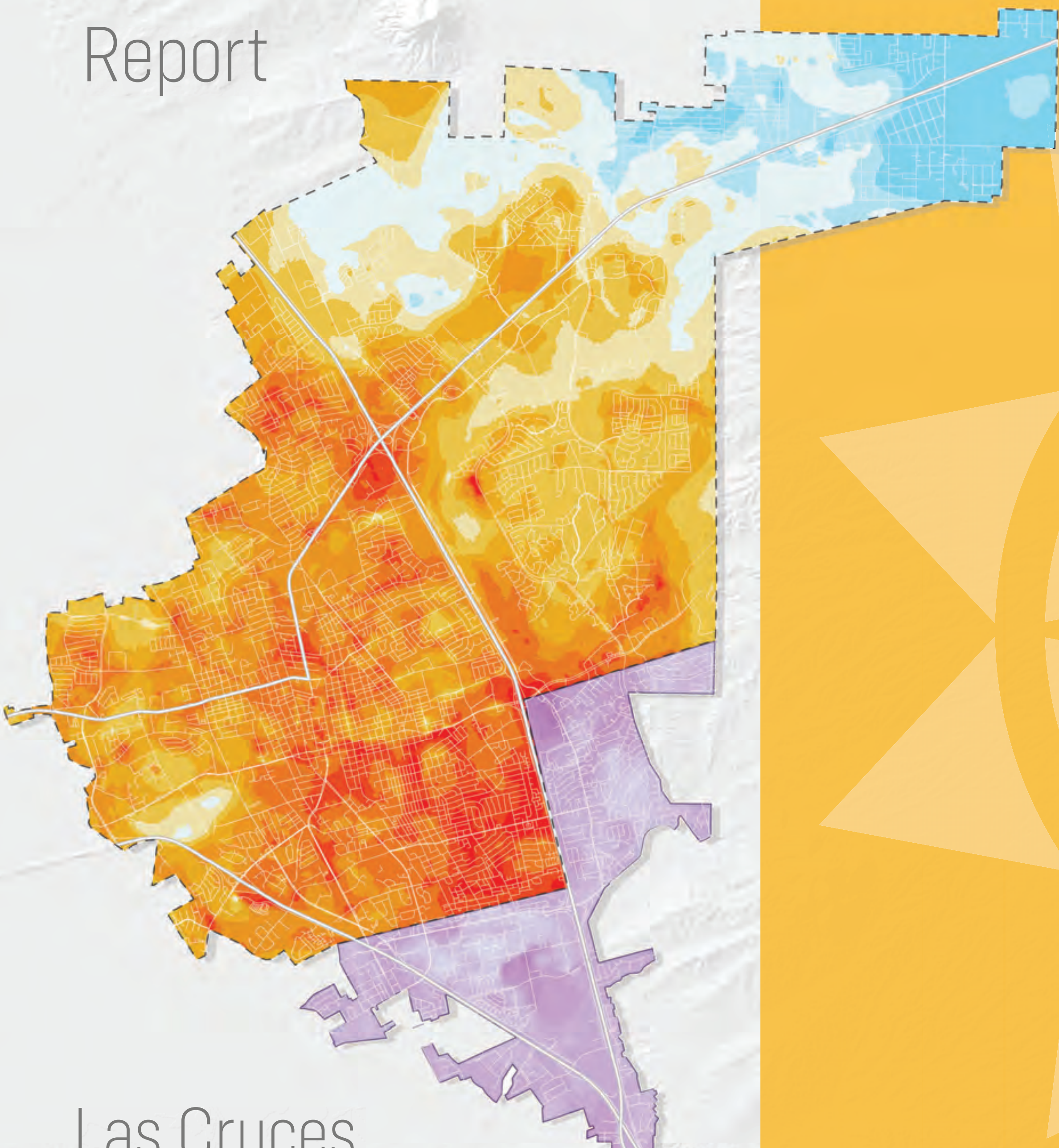
Heat Watch
Report



Las Cruces,
New Mexico

CAPA
strategies

CAPA strategies

Heat Watch

The CAPA Heat Watch program, equipment, and all related procedures referenced herein are developed through a decade of research and testing with support from national agencies and several universities. Most importantly, these include our partners at the National Integrated Heat Health Information System, the National Oceanic and Atmospheric Administration's (NOAA's) Climate Program Office, and National Weather Service, including local weather forecast offices at each of the campaign sites, The Science Museum of Virginia, and U.S. Forest Service (USDA). Past support has come from Portland State University, the Climate Resilience Fund, and the National Science Foundation. We are deeply grateful to these organizations for their continuing support.

CPO Climate Program Office

NIHHIS National Integrated Heat Health Information System

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

This report was prepared by CAPA Strategies, LLC
Summer 2020

Organ Mountains by Jack Pumphrey

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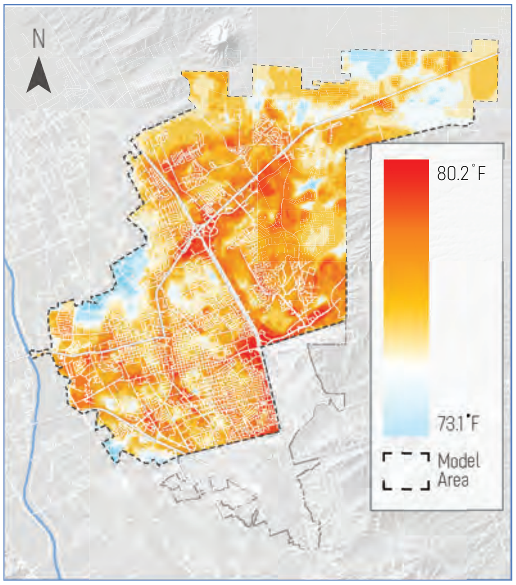
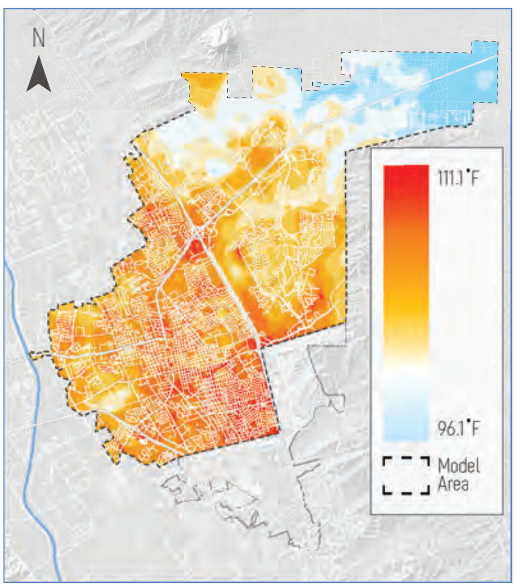
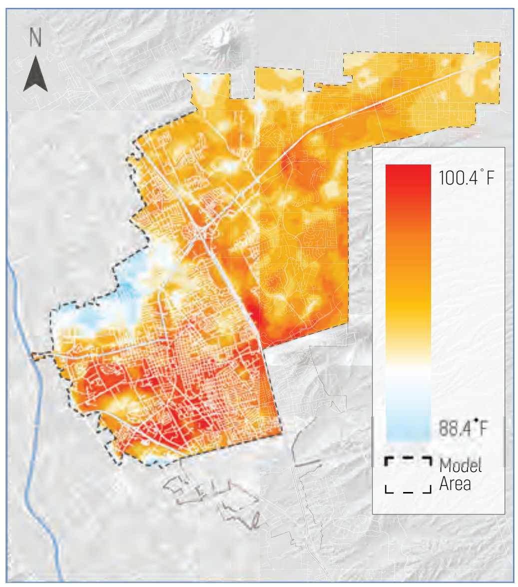


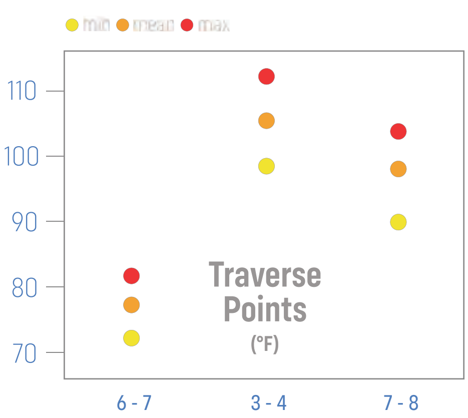
Major thanks to all of the participants and organizers of the Urban Heat Watch program in Las Cruces, New Mexico. After months of collaboration and coordination, local organizers and volunteers collected thousands of temperature and humidity data points in the morning, afternoon, and evening of a long, hot campaign day on July 10th, 2020.

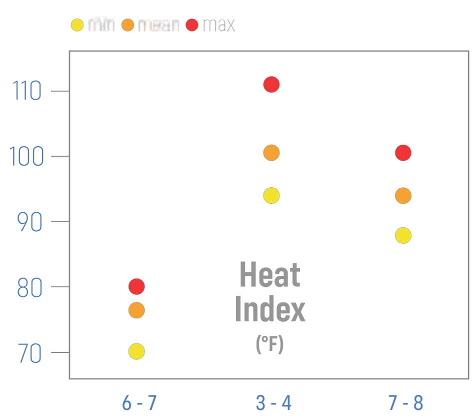
Afternoon Area-Wide Predictions (3 - 4 pm)



Evening Area-Wide Predictions (7 - 8 pm)







Summary represents data collected by car-mounted sensors. For bike-mounted sensor information, see Bike Section.

Study Date

7/10/20

11
Volunteers

5
Study Areas

38,807
Measurements

112.3°
Max Heat Index

14.1°
Heat Differential

Heat Watch

Learn more about the background and goals of each Heat Watch 2020 campaign city at https://nihhis.cpo.noaa.gov/Urban-Heat-Island-Mapping/Campaign-Cities.

Purpose & Aims

We know that climate-induced weather events have the most profound impact on those who have the least access to financial resources, historically underserved communities, and those struggling with additional health conditions. Infrastructure is also at risk, which can further compromise a region's capacity to provide essential cooling resources.

CAPA Strategies offers an unparalleled approach to center communities and infrastructure facing the greatest threat from the impact of increasing intensity, duration, and frequency of extreme heat. This report summarizes the results of a field campaign that occurred on July 10th, and with it we have three aims:

1. Provide high resolution descriptions of the distribution of temperature and humidity (heat index) across an urban area;
2. Engage local communities and create lasting partnerships to better understand and address the inequitable threat of extreme heat;
3. Bridge innovations in sensor technology, spatial analytics, and community climate action to better understand the relationships between urban microclimates, infrastructure, ecosystems, and human well-being.

With a coordinated data-collection campaign over several periods on a hot summer day, the resulting data provide snapshots in time of how urban heat varies across neighborhoods and how local landscape features affect temperature and humidity.

Campaign Process

CAPA Strategies has developed the Heat Watch campaign process over several iterations, with methods well established through peer-reviewed publications[1], testing, and refinement.

The current campaign model requires leadership by local organizers, who engage community groups, new and existing partner organizations, and the media in generating a dialog about effective solutions for understanding and addressing extreme heat.

CAPA provides training, equipment, and support to the recruited community groups as they endeavor to collect primary temperature and humidity data across a metropolitan region.

The seven main steps of the campaign process are summarized to the right. An overview of the analytical modeling methodology is presented later in this report and described at full length in peer-reviewed publications.

[1] The most relevant and recent publications to the Heat Watch campaign process include:

Shandas, V., Voelkel, J., Williams, J., & Hoffman, J., (2019). Integrating Satellite and Ground Measurements for Predicting Locations of Extreme Urban Heat. Climate, 7(1), 5. https://doi.org/10.3390/cli7010005

Voelkel, J., & Shandas, V. (2017). Towards Systematic Prediction of Urban Heat Islands: Grounding Measurements, Assessing Modeling Techniques. Climate, 5(2), 41. https://doi.org/10.3390/cli5020041

1. Set Goals

Campaign organizers determine the extent of their mapping effort, prioritizing areas experiencing environmental and social justice inequities. CAPA then divides this study area into sub-areas ("polygons"), each containing a diverse set of land uses and land covers.

2. Establish

Organizers recruit volunteers, often via non-profits, universities, municipal staff, youth groups, friends, family, and peers. Meanwhile, CAPA designs the data collection routes by incorporating important points of interest such as schools, parks, and community centers.

3. Prepare

Volunteers attend an online training session to learn the why and how of the project, their roles as data collectors, and to share their personal interest in the project. Participants sign a liability and safety waiver, and organizers assign teams to each polygon and route.

4. Activate

With the help of local forecasters, organizers identify a high-heat, clear day (or as near to one as possible) and coordinate with their volunteer teams. Once confirmed, CAPA ships the sensor equipment and bumper magnets to be distributed to campaign participants.

5. Execute

Volunteer teams conduct the heat campaign by driving and/or bicycling sensor equipment along pre-planned traverse routes at coordinated hour intervals. Each second the sensors collect a measurement of ambient temperature, humidity, longitude, latitude, speed and course.

6. Analyze

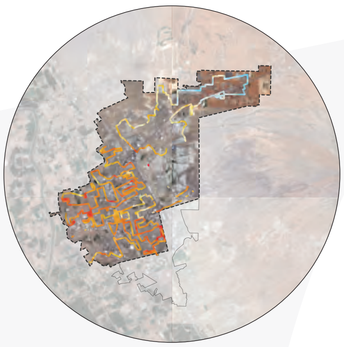
Organizers collect and return the equipment, and CAPA analysts begin cleaning the data, as described in the Mapping Method section below, and utilize machine learning algorithms to create predictive area-wide models of temperature and heat index for each traverse.

7. Implement

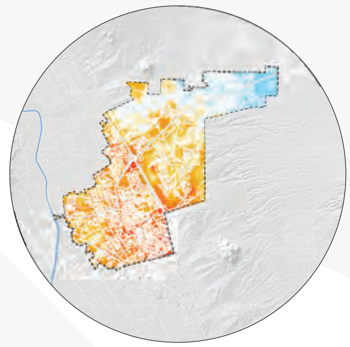
Campaign organizers and participants review the Heat Watch outputs (datasets, maps, and report), and campaign teams meet with CAPA to discuss the results and next steps for addressing the distribution of extreme heat in their community.

About The Maps

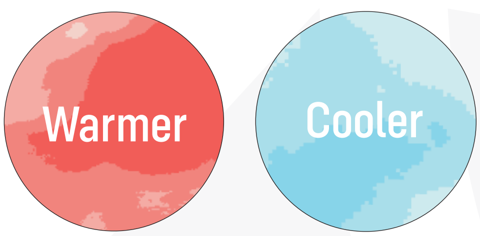
The following sections present map images from the Heat Watch campaign and modeling process. Two sets of maps comprise the final results from the campaign process, and they include:



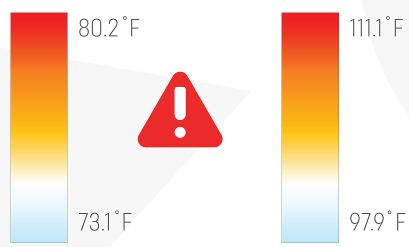
Point temperatures collected in each traverse period, filtered to usable data.



Area-wide heat maps, displaying either the modeled temperature or heat index across the entire study area at each traverse period.



The data are classified by natural breaks in order to clearly illustrate the variation between warmer (red) and cooler (blue) areas across the map.



Note that the scales are different between the traverse point and area-wide maps due to the predictive modeling process.

How does your own experience with heat in these areas align with the map?

Find your home, place of work, or favorite park on the maps and compare the heat throughout the day to your personal experience.

What about the landscape (trees, concrete buildings, riverside walkway) do you think might be influencing the heat in this area?

Initial Observations

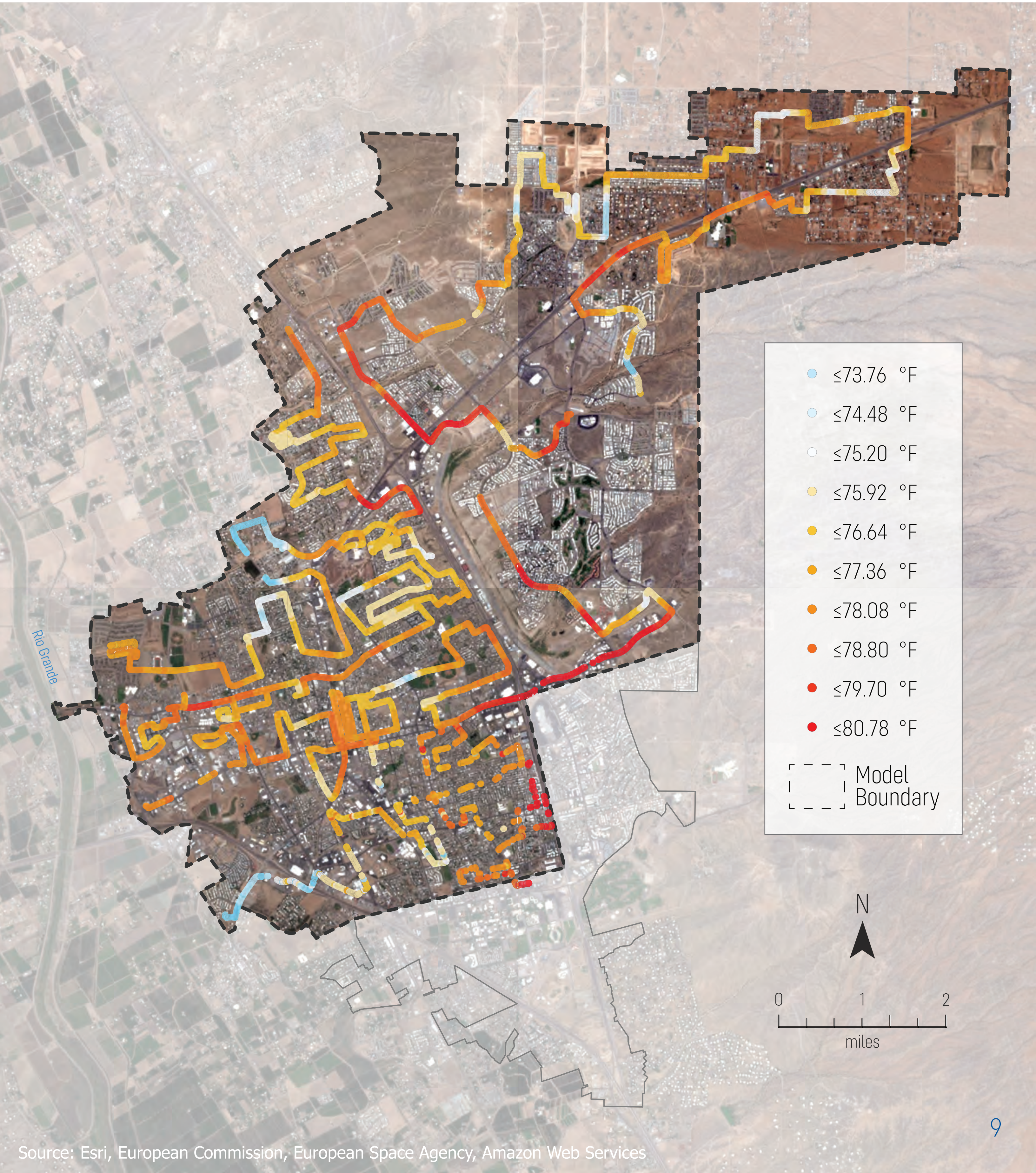
The distribution of heat across a region often varies by qualities of the land and its use. Here are several observations of how this phenomenon may be occurring in your region.

Homogeneous residential streets full of concrete and little shade can create "hot spots" within neighborhoods.

Shade trees along the sidewalk and right-of-way, such as near Hermosa Heights Elementary School and Park, may create a "cool spot" within a neighborhood.

Areas with many parking lots, such as these near downtown, feature low albedo materials that absorb and retain the sun's heat throughout the day.

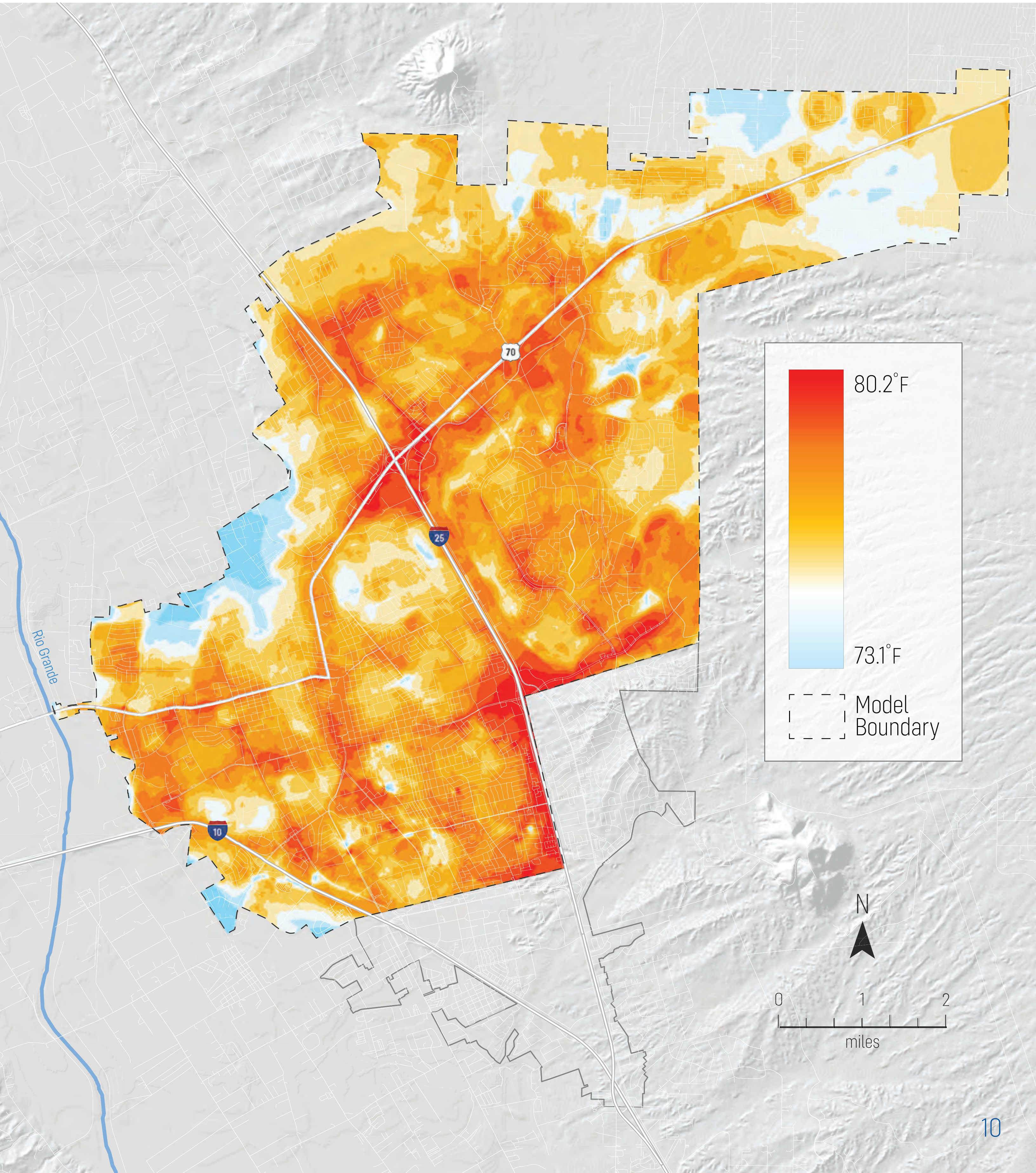
Morning Traverse Points
(6 - 7 am)



Source: Esri, European Commission, European Space Agency, Amazon Web Services

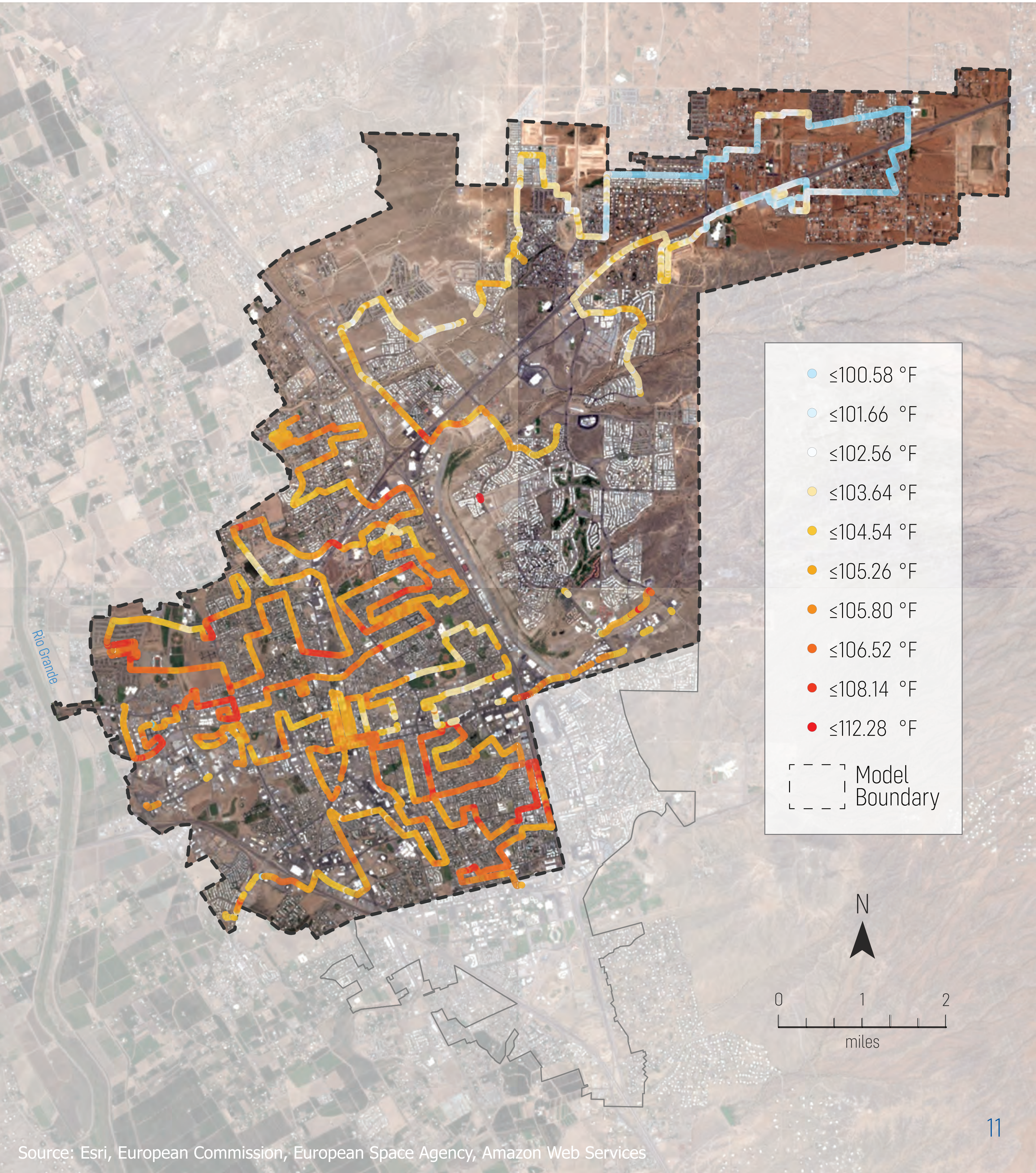
Morning Area-Wide Predictions

Heat Index (6 - 7 am)



Afternoon Traverse Points

(3 - 4 pm)

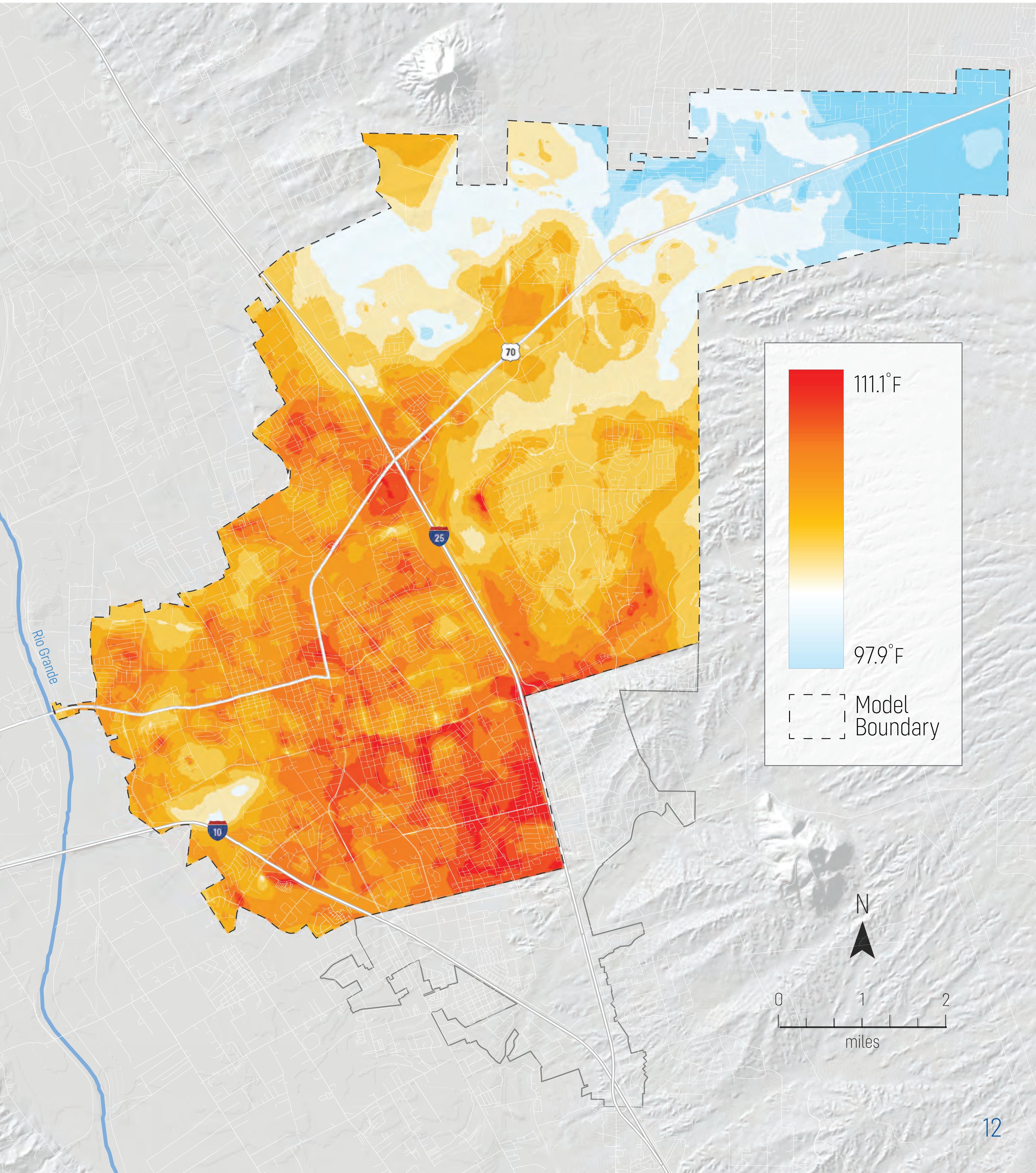


Source: Esri, European Commission, European Space Agency, Amazon Web Services

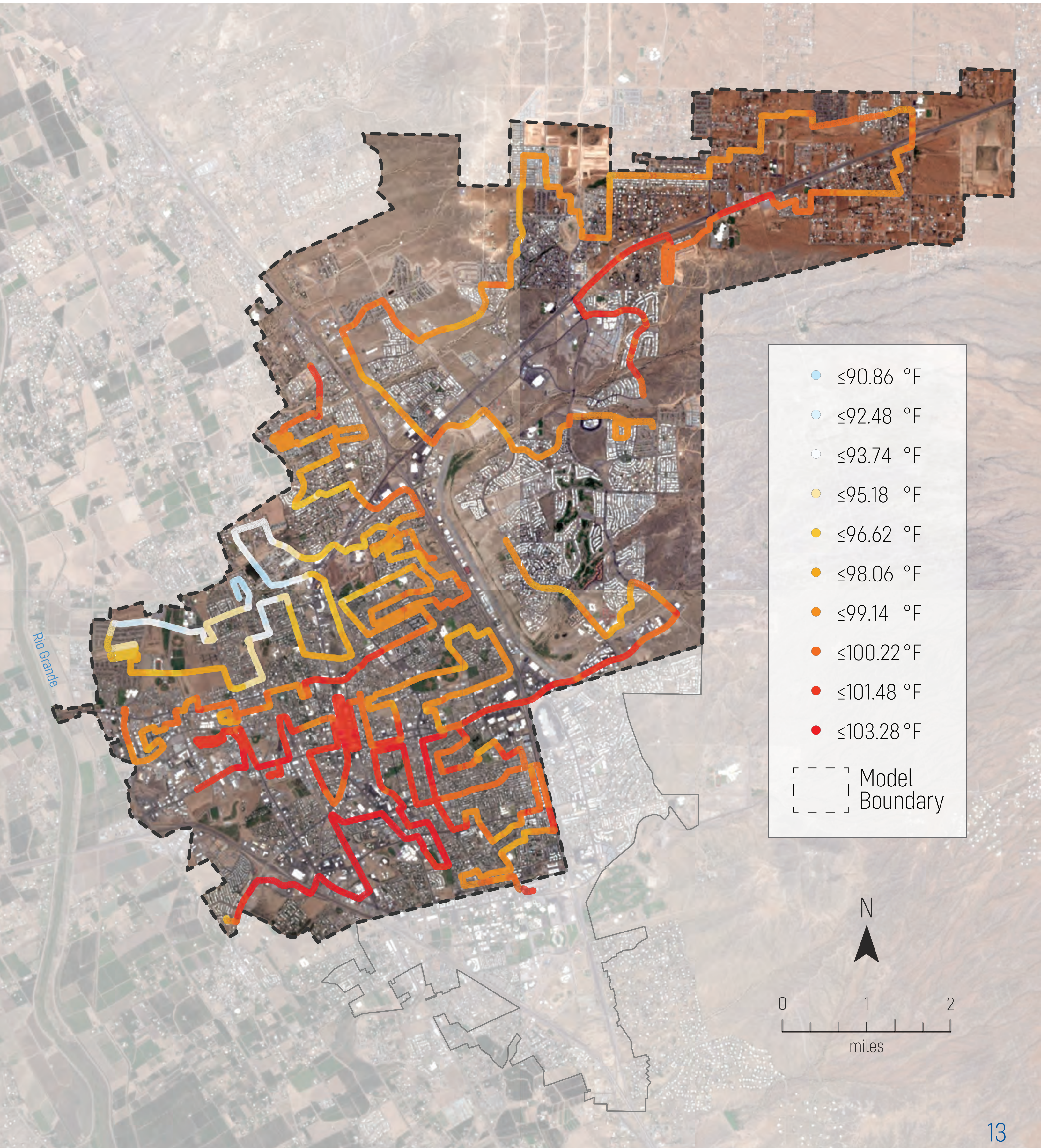
Afternoon Area-Wide Predictions

Heat Index (3 - 4 pm)

Heat Watch



Evening Traverse Points
(7 - 8 pm)

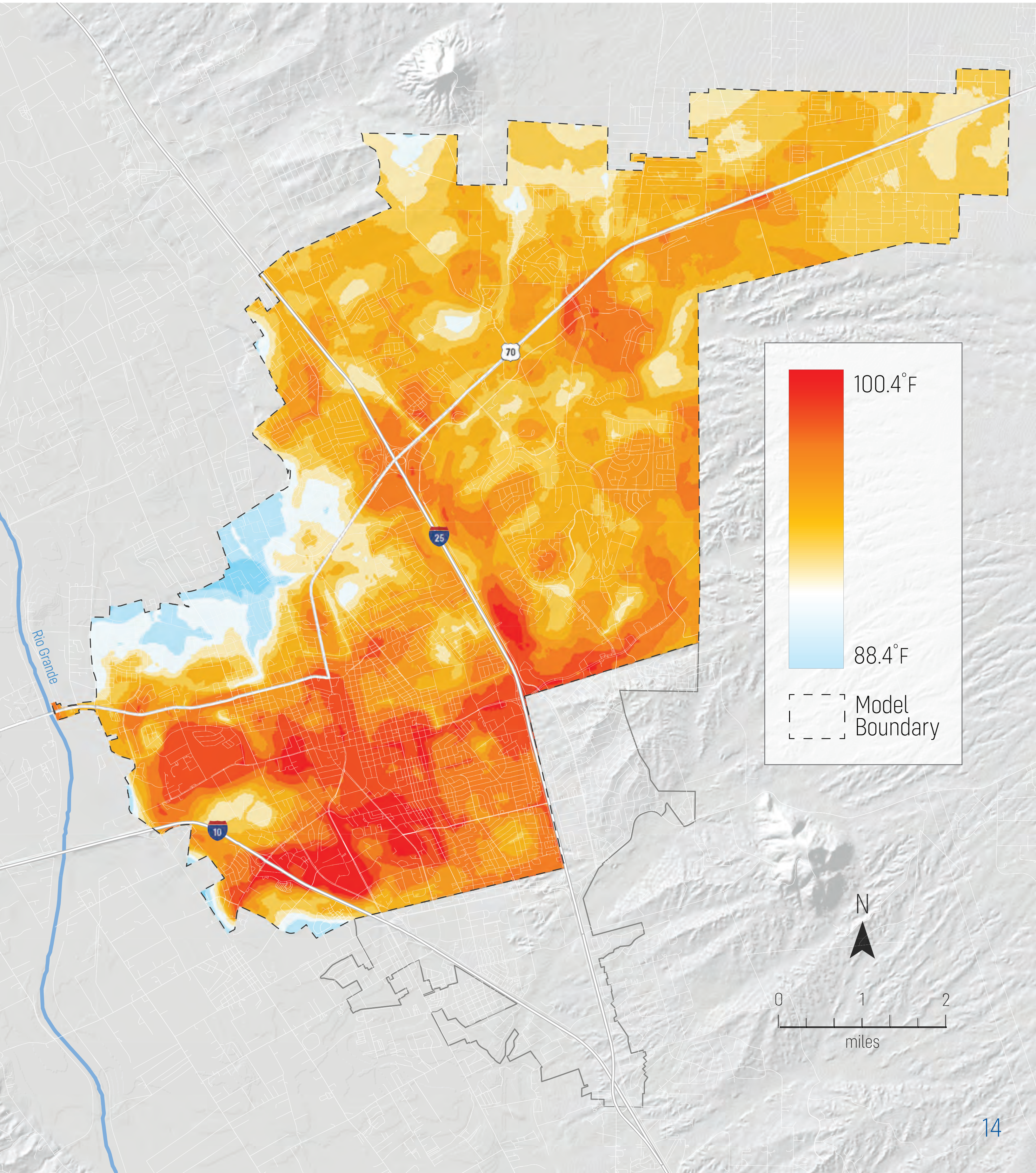


Source: Esri, European Commission, European Space Agency, Amazon Web Services

Evening Area-Wide Predictions

Heat Index (7 - 8 pm)

Heat Watch



Bike Summary

Thank you to the Heat Watch bicyclists, who rode to collect valuable temperature and humidity measurements on a very hot day! Bikes are an innovative and growing component of CAPA's Heat Watch campaigns.

Much like the car equipment, data collected on bikes describe relative differences between warmer and cooler locations; however, unlike the cars, they are collected at different speeds and relative distances from the ground.

As such, we do not suggest directly comparing data collected and models from the bike with those collected by car. We provide these bike models as seperate maps with the darker-shaded traverse points and areas reflecting warmer locations, and the lighter-shaded traverse points and areas as cooler.

Study Date

7/10/20

2
Volunteers

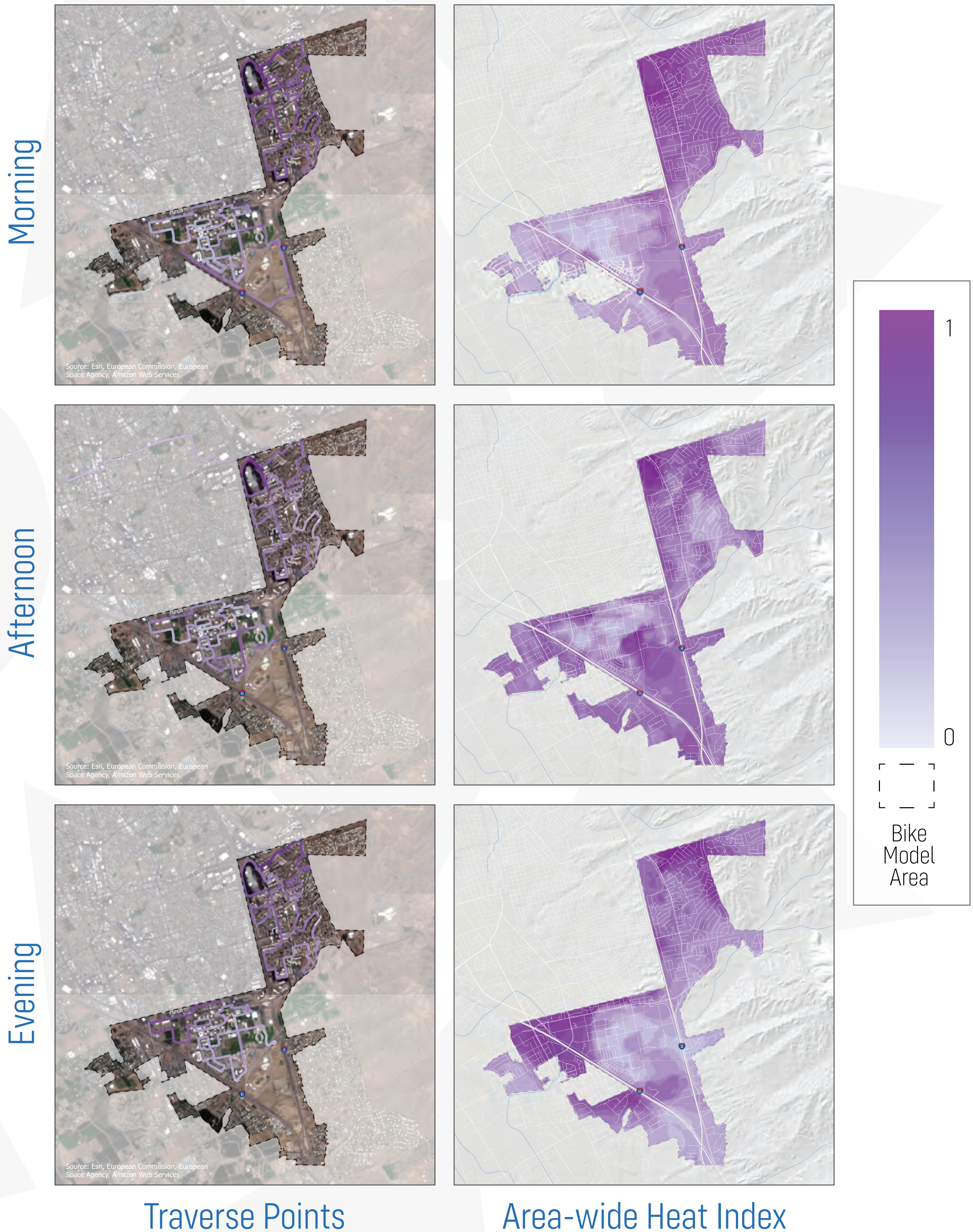
2
Routes

17,481
Measurements

Heat Watch

Learn more about the background and goals of each Heat Watch 2020 campaign city at https://nihhis.cpo.noaa.gov/Urban-Heat-Island-Mapping/Campaign-Cities.

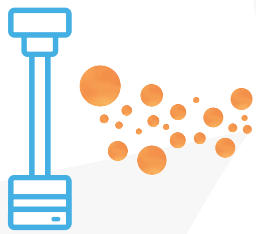
Bike Traverse Points & Area-Wide Predictions



Mapping Method

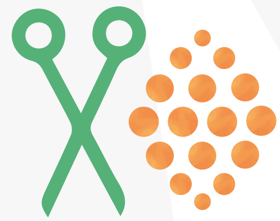
Heat Watch

1 Download & Filter



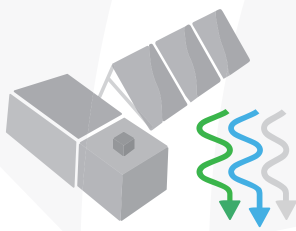
Download raw heat data from sensor SD cards

Compare data with field notes and debrief interview

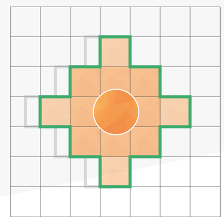


Trim data to proper time window, speed, and study area

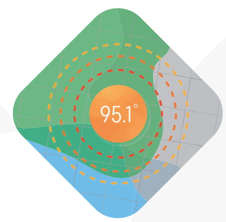
2 Integrate & Analyze



Download multi-band land cover rasters from Sentinel-2 satellite

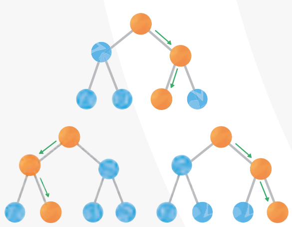


Transform land cover rasters using a moving window analysis

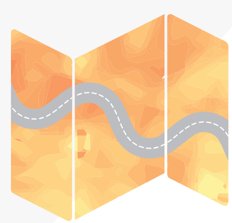


Calculate statistics of each land cover band across multiple radii

3 Predict & Validate



Combine heat and land cover data in Machine Learning model



Create predictive raster surface models of each period

Perform cross validation using 70:30 holdout method

The most relevant and recent publications include:

Shandas, V., Voelkel, J., Williams, J., & Hoffman, J., (2019). Integrating Satellite and Ground Measurements for Predicting Locations of Extreme Urban Heat. Climate, 7(1), 5. https://doi.org/10.3390/cli7010005

Voelkel, J., & Shandas, V. (2017). Towards Systematic Prediction of Urban Heat Islands: Grounding Measurements, Assessing Modeling Techniques. Climate, 5(2), 41. https://doi.org/10.3390/cli5020041

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Source: Heat Watch Las Cruces participant

Accuracy Assessment*			
Primary		Bike	
Traverse	R-Squared	Traverse	R-Squared
6 - 7 am	0.91	6 - 7 am	0.99
3 - 4 pm	0.96	3 - 4 pm	0.98
7 - 8 pm	0.99	7 - 8 pm	0.99

Field Data

Like all field campaigns, the collection of temperature and humidity data requires carefully following provided instructions. In the event that user error is introduced during the data collection process, outputs may be compromised in quality. While our team has a developed a multi-stage process for assessing and reviewing the datasets, some errors cannot be identified or detected, and therefore can inadvertently compromise the results. Some examples of such outputs may include temperature predictions that do not match expectations for an associated landcover (e.g. a forested area showing relatively warmer temperatures). We suggest interpreting the results in that context.

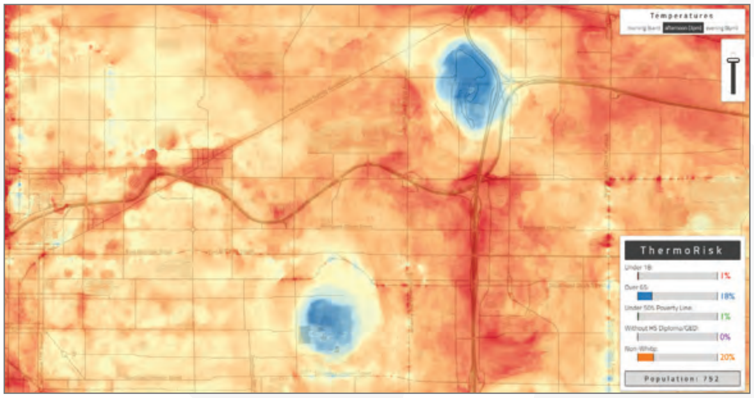
Prediction Areas

The traverse points used to generate the areas wide maps do not cover every square of the studied area. Due to the large number of data collected, however, our predictive models support the extension of prediction to places beyond the traversed areas. We suggest caution when interpreting area wide values that extend far beyond the traversed areas

*Accuracy Assessment: To assess the strength of our predictive temperature models, we used a 70:30 "holdout cross-validation method," which consists of predicting 30% of the data with the remaining 70%, selected randomly. An 'Adjusted R-Squared' value of 1.0 is perfect predictability, and 0 is total lack of prediction. Additional information on this technique can be found at the following reference: Voelkel, J., and V Shandas, 2017. Towards Systematic Prediction of Urban Heat Islands: Grounding measurements, assessing modeling techniques. Climate 5(2): 41.

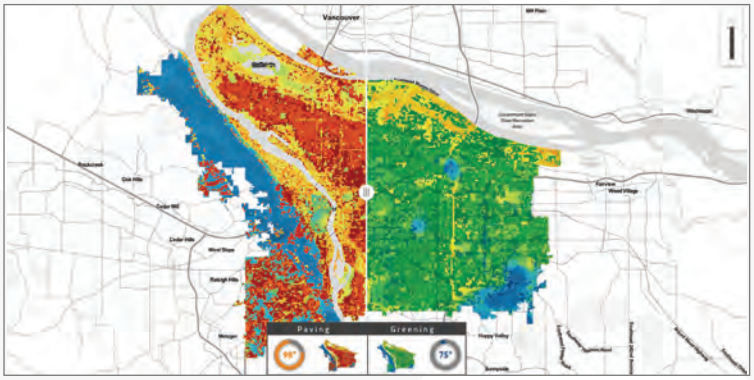
Next Steps

To further explore how your community's heat distribution affects local populations and infrastructure, we have created a suite of tools that help to organize these variables in user-friendly interfaces.



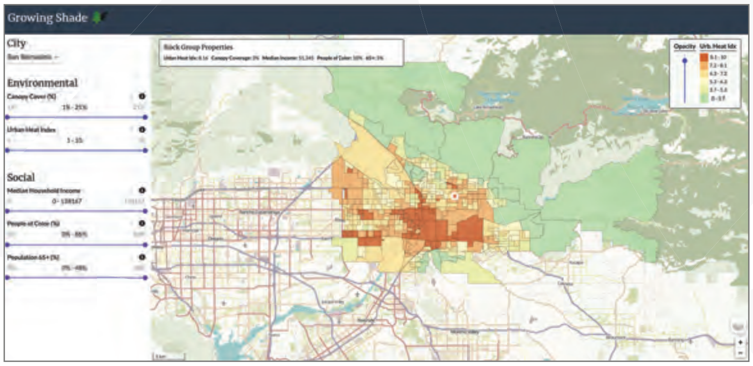
Social Vulnerability

Use Heat Watch data and publicly available demographic information to explore the intersection of urban heat and social vulnerability to better understand the needs of local communities facing the most acute impacts of a warming planet.



Built Environment Scenarios

Using computer models and municipal infrastructure data, this tool shows the effect on heat of changing the built environment. We explore scenarios of increased paving versus greening on heat at the scale of a city block.



Growing Shade

Using publicly available data on sociodemographics and land use, this tool identifies areas where expanding tree canopy would have the most direct benefit to social and environmental conditions.

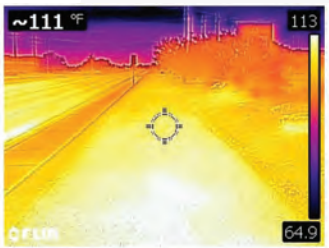
Growing Capacity

Moving beyond data acquisition and decision support tools, CAPA offers resources and services to build and implement climate preparedness strategies. At CAPA we aim to make climate planning as accessible as possible by offering multiple scales of resources to fit your needs and capacity. Explore openly available tools, request place-specific analyses, or engage our team in facilitating outreach and planning processes.

Media

Dave DuBois
@NMClimate

Managed to capture a few intersections and walking paths today during our #UrbanHeatIsland measurement campaign for #CAPAHeatWatch. I sometimes walk on this path. Image from 7 pm on July 10. Air temperature about 101°F. #LasCruces #nmwx #summerheat #health



11:25 PM · Jul 10, 2020

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Heat Watch