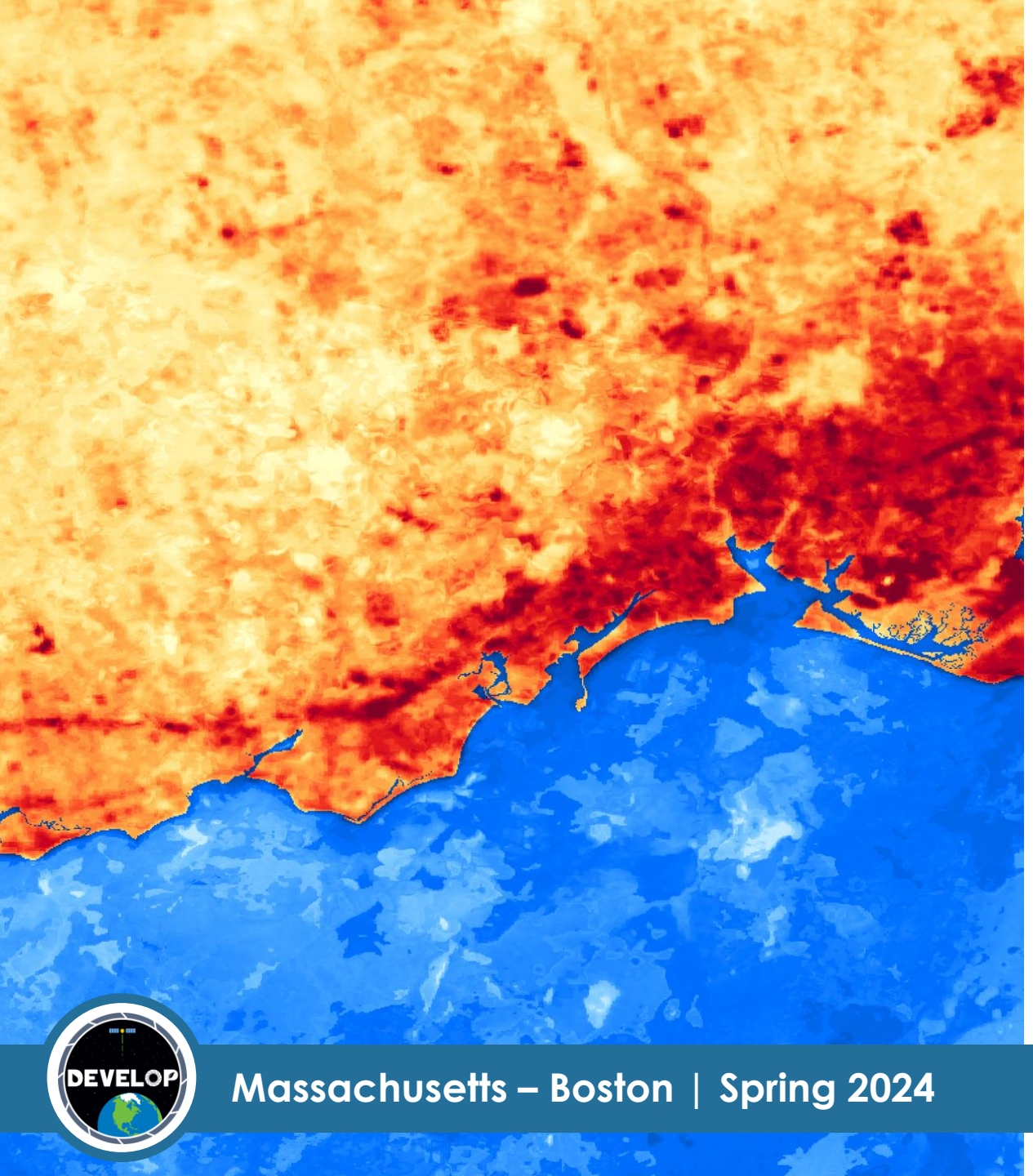


National Aeronautics and Space Administration

BRIDGEPORT URBAN DEVELOPMENT

Leveraging NASA Earth Observations and Sociodemographic Data to Assess Urban Heat Vulnerability and Inform Cool Corridors in Bridgeport, Connecticut

Silas Kirsch

John Hocknell

Maggie Roseto

Char Tomlinson

DEVELOP

Massachusetts – Boston | Spring 2024

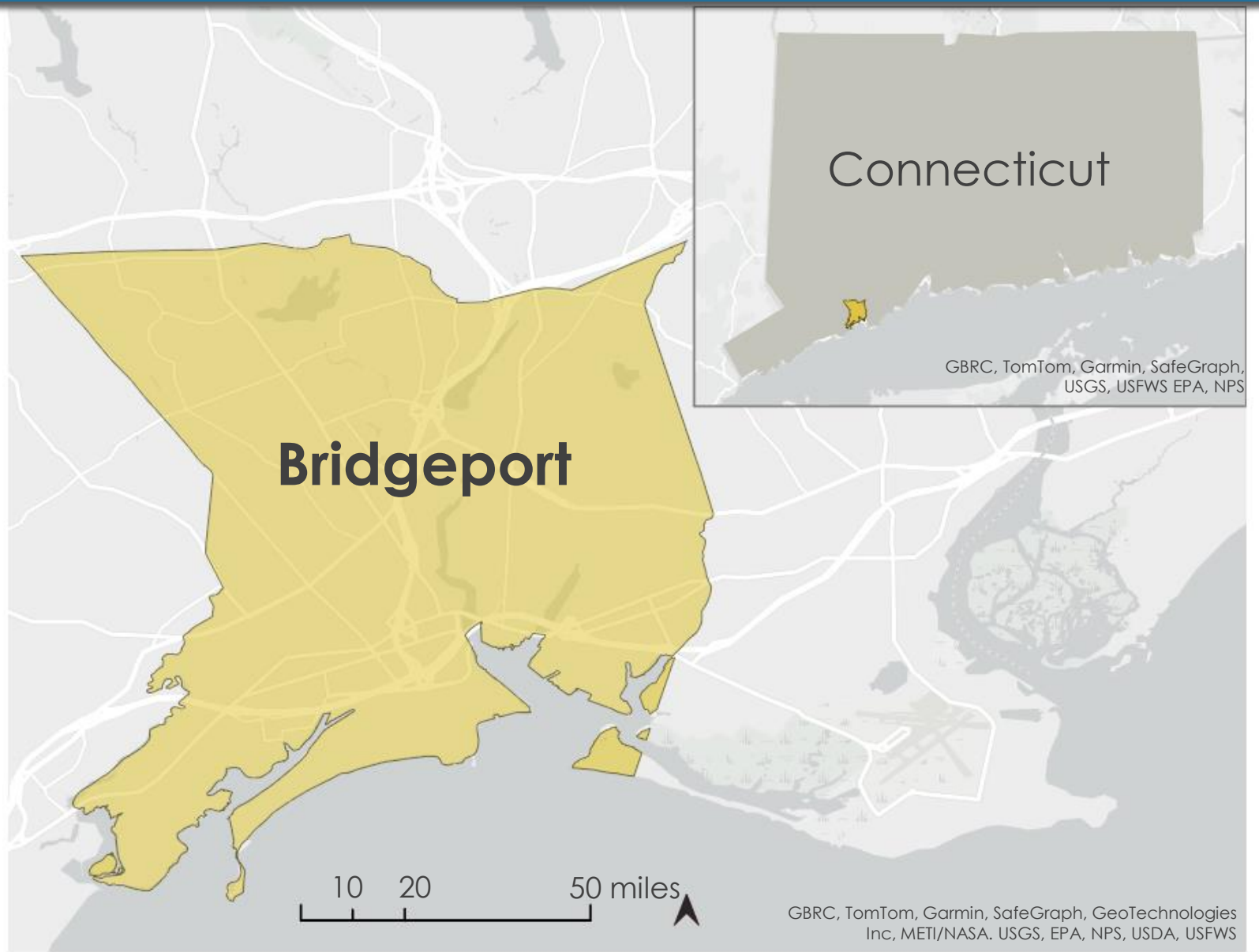
Bridgeport, Connecticut

Study Area

- Located in Fairfield County
- Population: 149K (2022)
- Climate: Humid Subtropical
- Focus on the East Side neighborhood

Study Period

- 2013 - 2023
  - June 01 - September 30



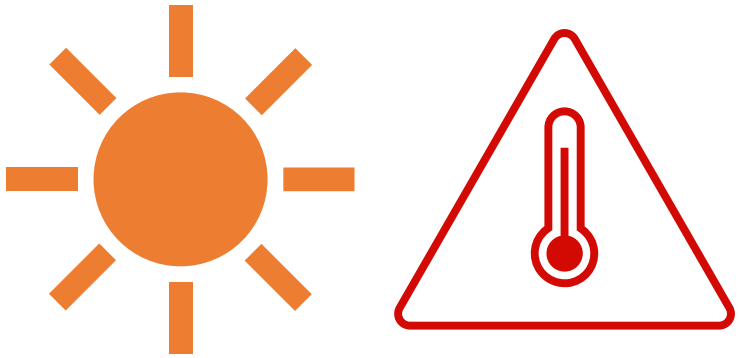
Partner: Groundwork Bridgeport

Mission: promoting civic and youth engagement and the sharing of knowledge to rebuild post-industrial and blighted areas of Bridgeport.

Image Credit: Groundwork Bridgeport

Community Concerns

Urban Heat Intensity



Heat Relief in Public Spaces

Elevated Heat Exposure

Individual Sensitivity

Environmental Injustice in Bridgeport

Redlining

Deindustrialization and Urban Renewal

Inequitable Distribution of Greenspace

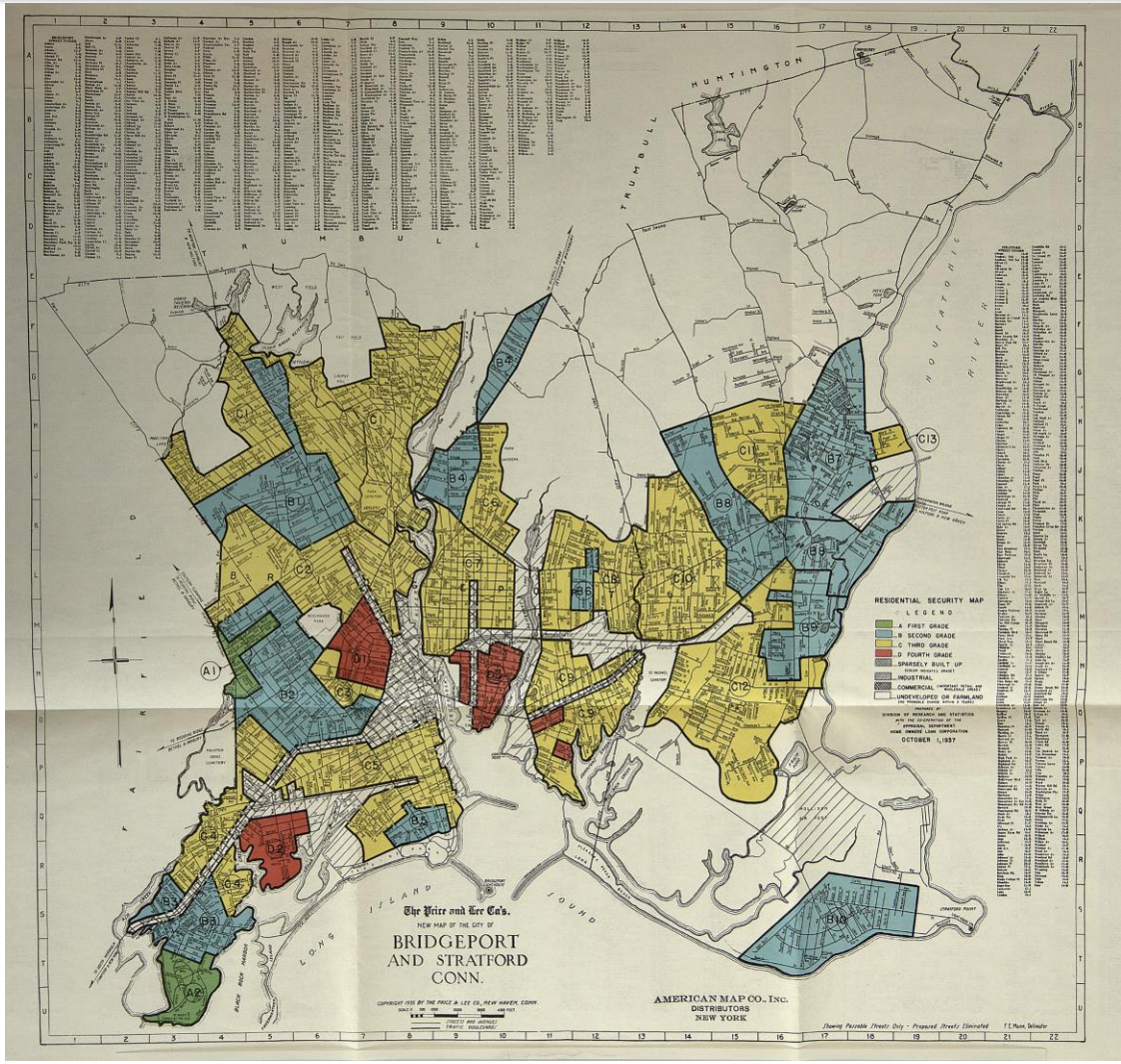
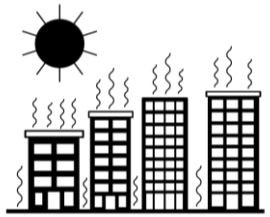


Image Credit: Mapping Inequality

Icons: "City"--Chalwat Kinkaew (The Noun Project), "Industry"--Wartina Anggraeni (The Noun Project), "Sustainable Urban"--Uyun (The Noun Project)

Objectives



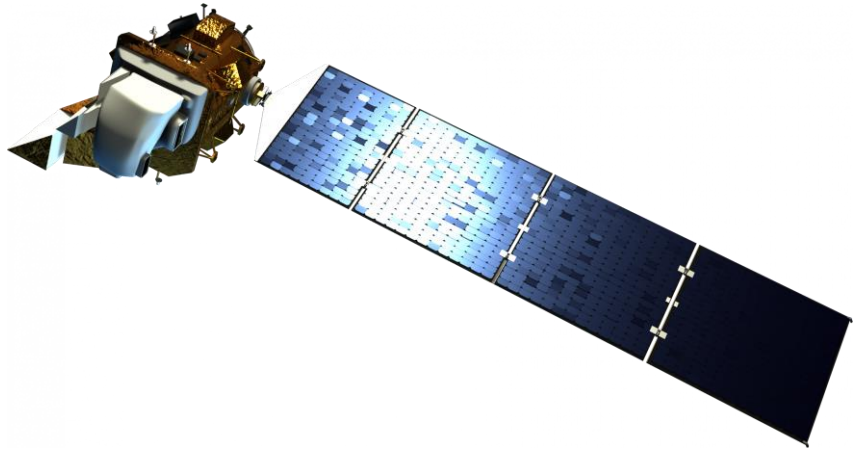
Urban Heat Assessment
Use Earth observations to map urban heat disparities in Bridgeport by analyzing 10-year land surface temperature averages and comparing them to the average temperature in the neighboring city of Fairfield.

Urban Heat Vulnerability
Identify areas where land surface temperature is extremely high and where Bridgeport residents are most vulnerable to the harms of extreme heat, as indicated by health, socioeconomic, and lifestyle factors.

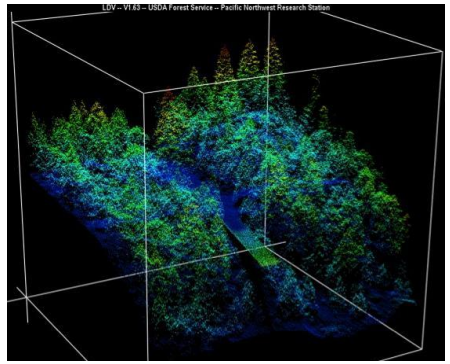
Urban Heat Intervention Model
Locate optimal spots for Groundwork Bridgeport to implement cooling strategies through SOlar and LongWave Environmental Irradiance Geometry (SOLWEIG) modeling.

Icons: "Urban Heat Island"--Softscape (The Noun Project), "Urban Heat Island"--Creative Mania (The Noun Project), "Eco City" -- Softscape (The Noun Project)

Earth Observations



Landsat 8 TIRS

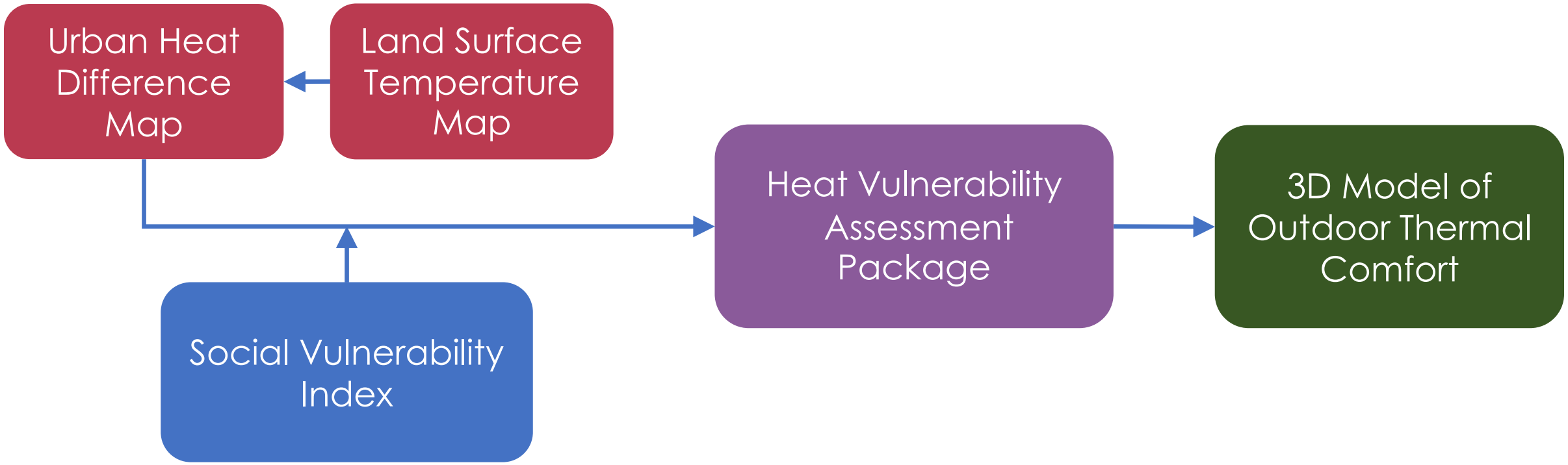


Lidar

Landsat 9 TIRS-2

Image Credit: NASA

Methods


Urban Heat Difference Map
Land Surface Temperature Map
Social Vulnerability Index
Heat Vulnerability Assessment Package
3D Model of Outdoor Thermal Comfort

Urban Heat Assessment

Data Acquisition | Processing | Analysis | Result

Landsat 8 TIRS
Landsat 9 TIRS-2

Clip by Study Area

Cloud Mask & Mosaic

Calculate Median LST for every Pixel

Calculate LST by Census Block Group

Average Land Surface Temperature Map

Calculate Median LST for Reference Area

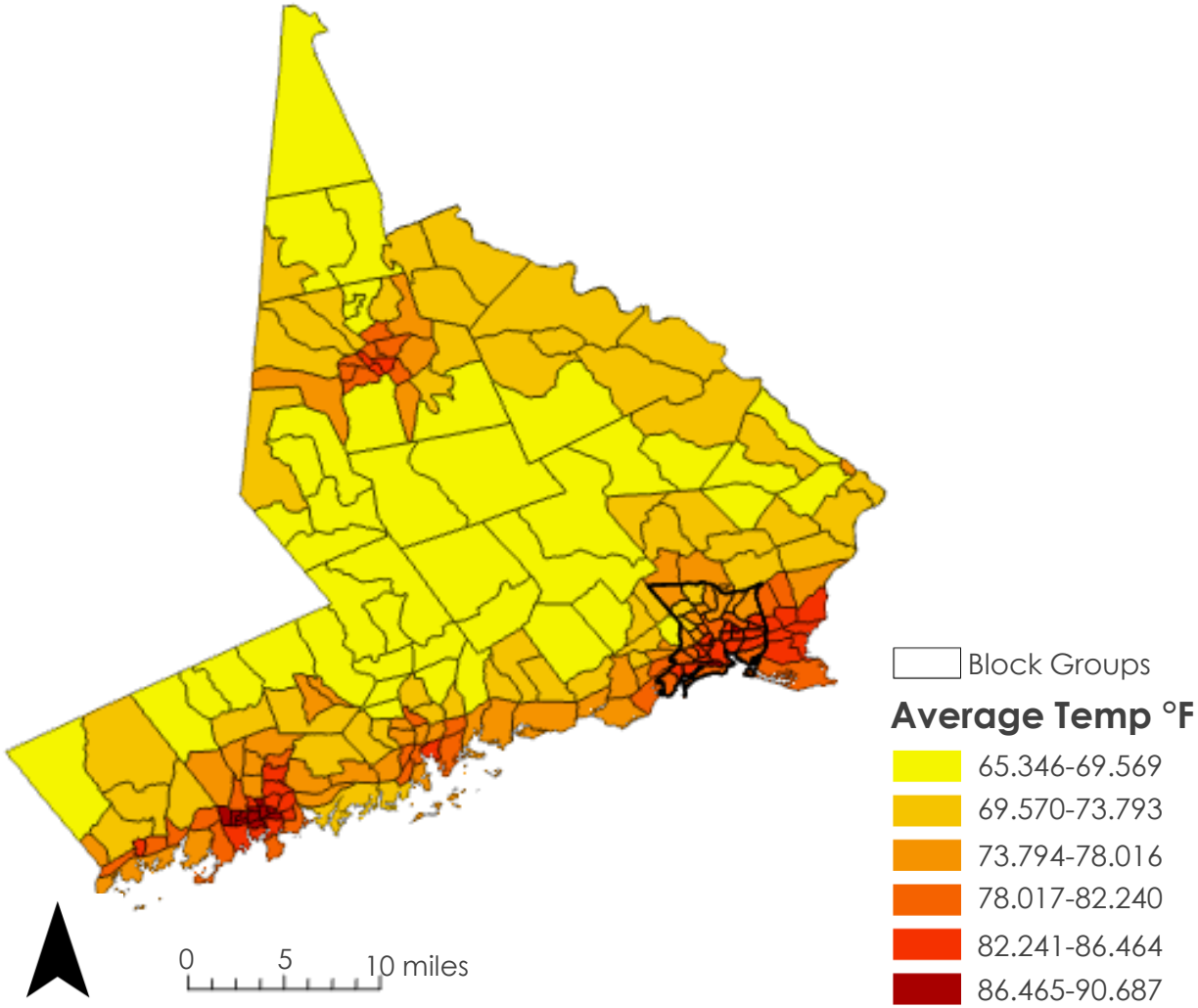
Subtract Reference LST from every Pixel

Urban Heat Difference Image Map

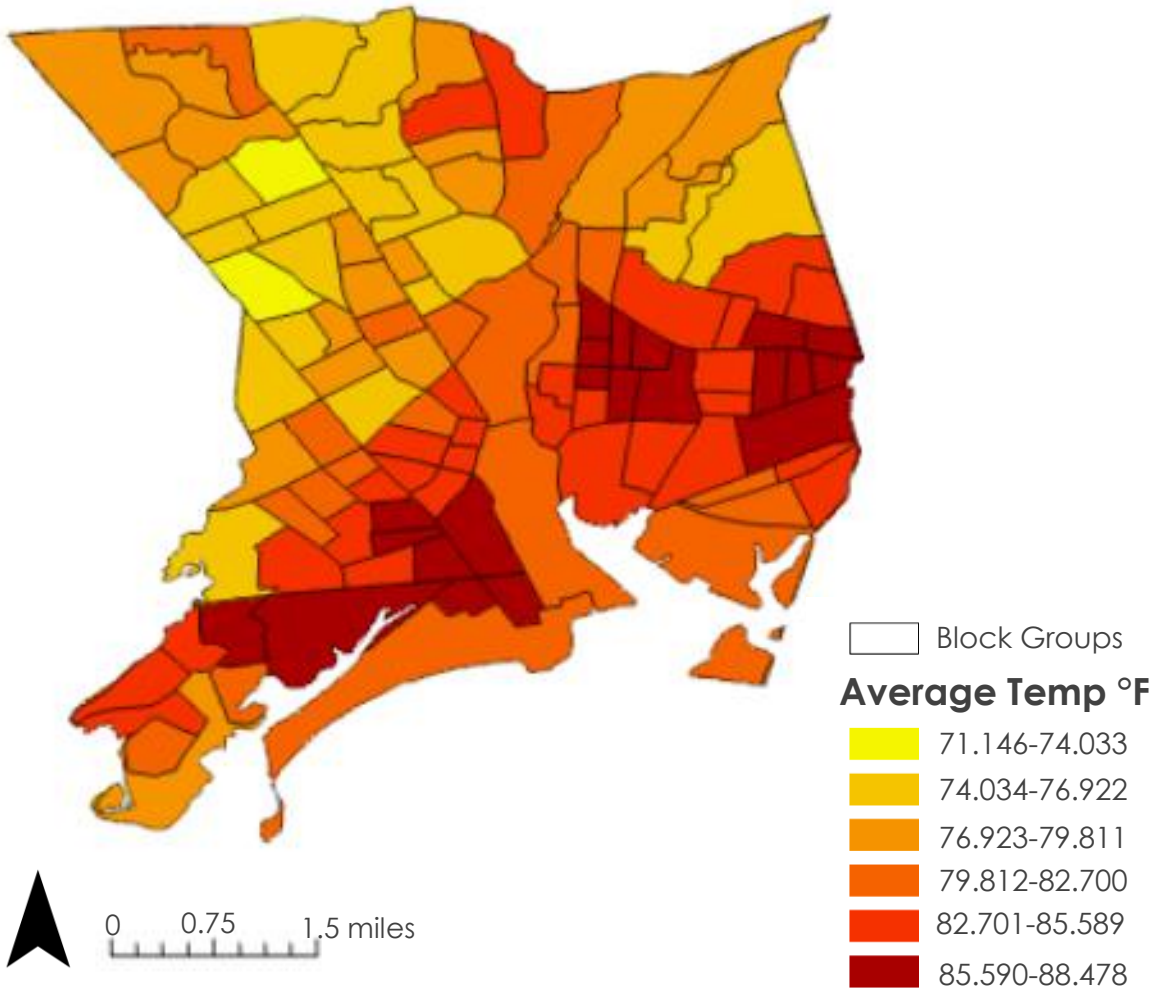
Image Credit: NASA

Land Surface Temperature Results

Temperature Distribution for Fairfield County Block Groups

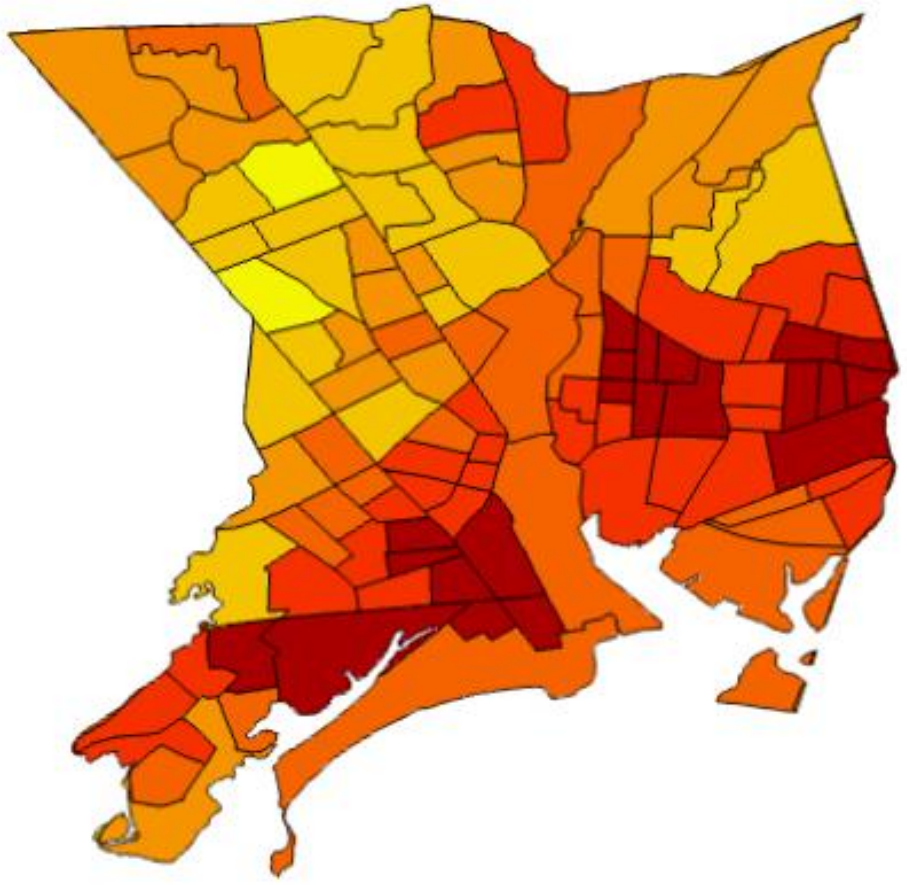


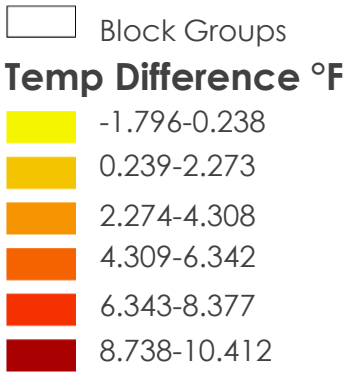
Temperature Distribution for Bridgeport City Block Groups



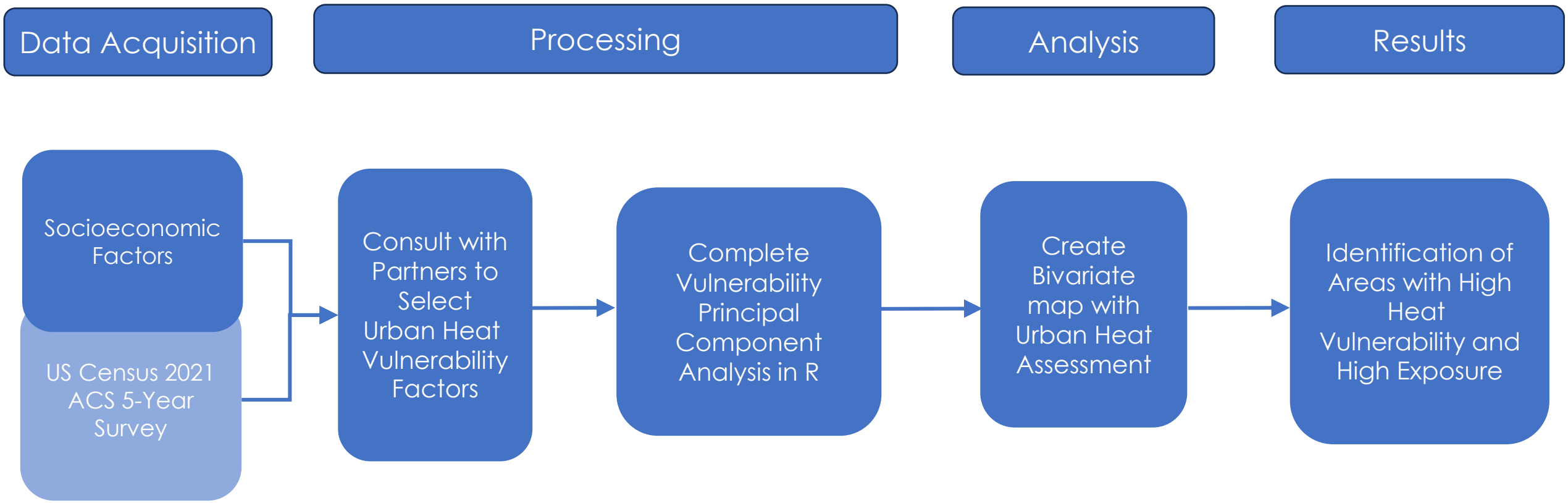
Heat Difference Results

Temperature Difference between Bridgeport and Fairfield City Block Groups



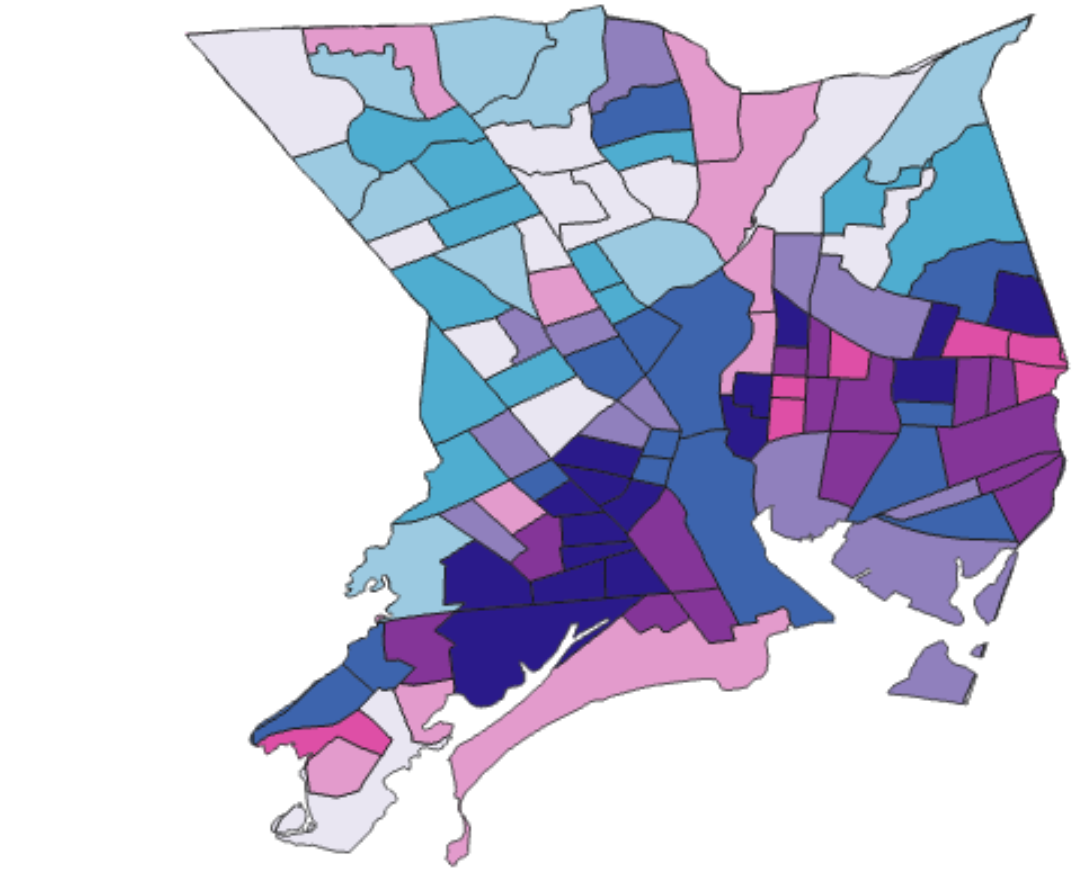


Principal Component Analysis and Social Vulnerability Index

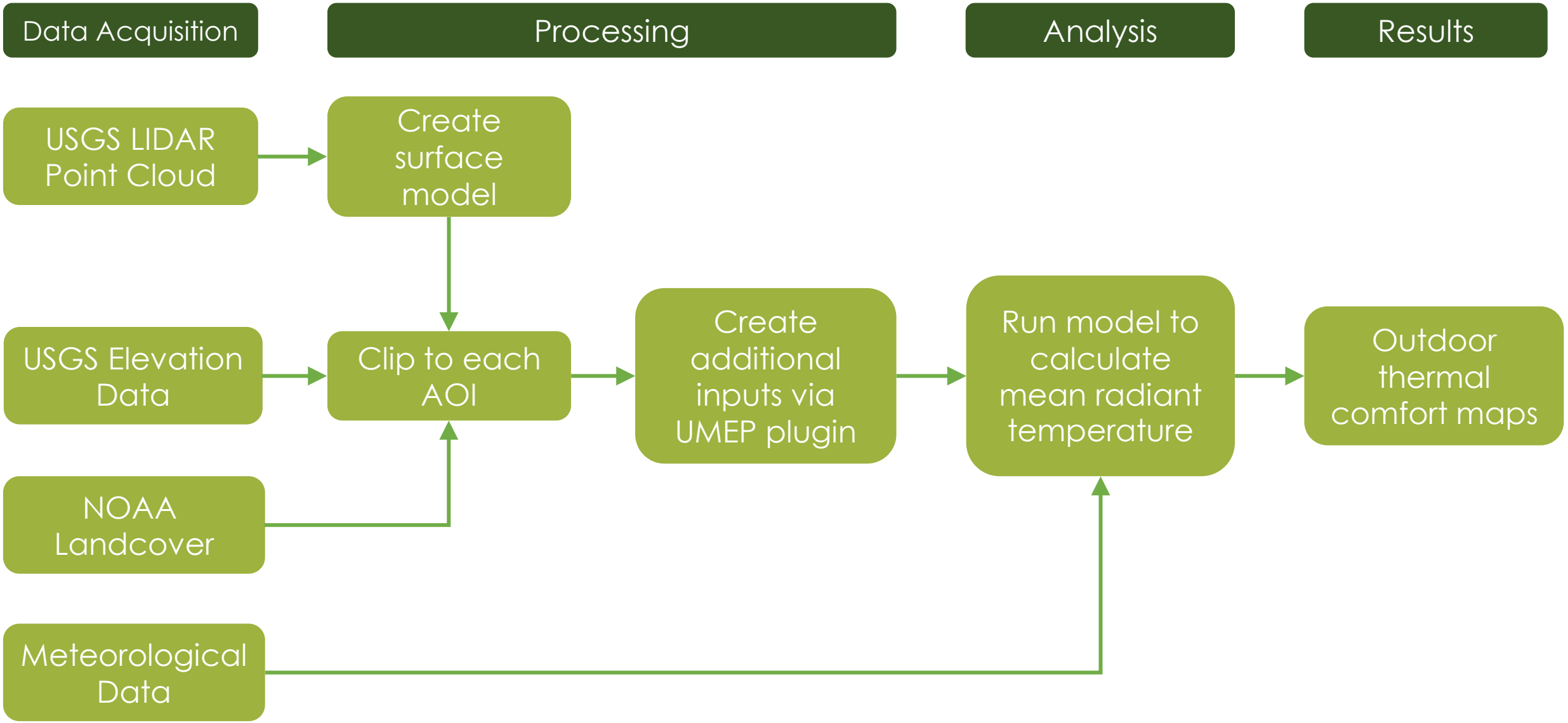


Heat Vulnerability Map

Bivariate Choropleth map of Temperature Distribution and Heat Vulnerability for Bridgeport Block Groups

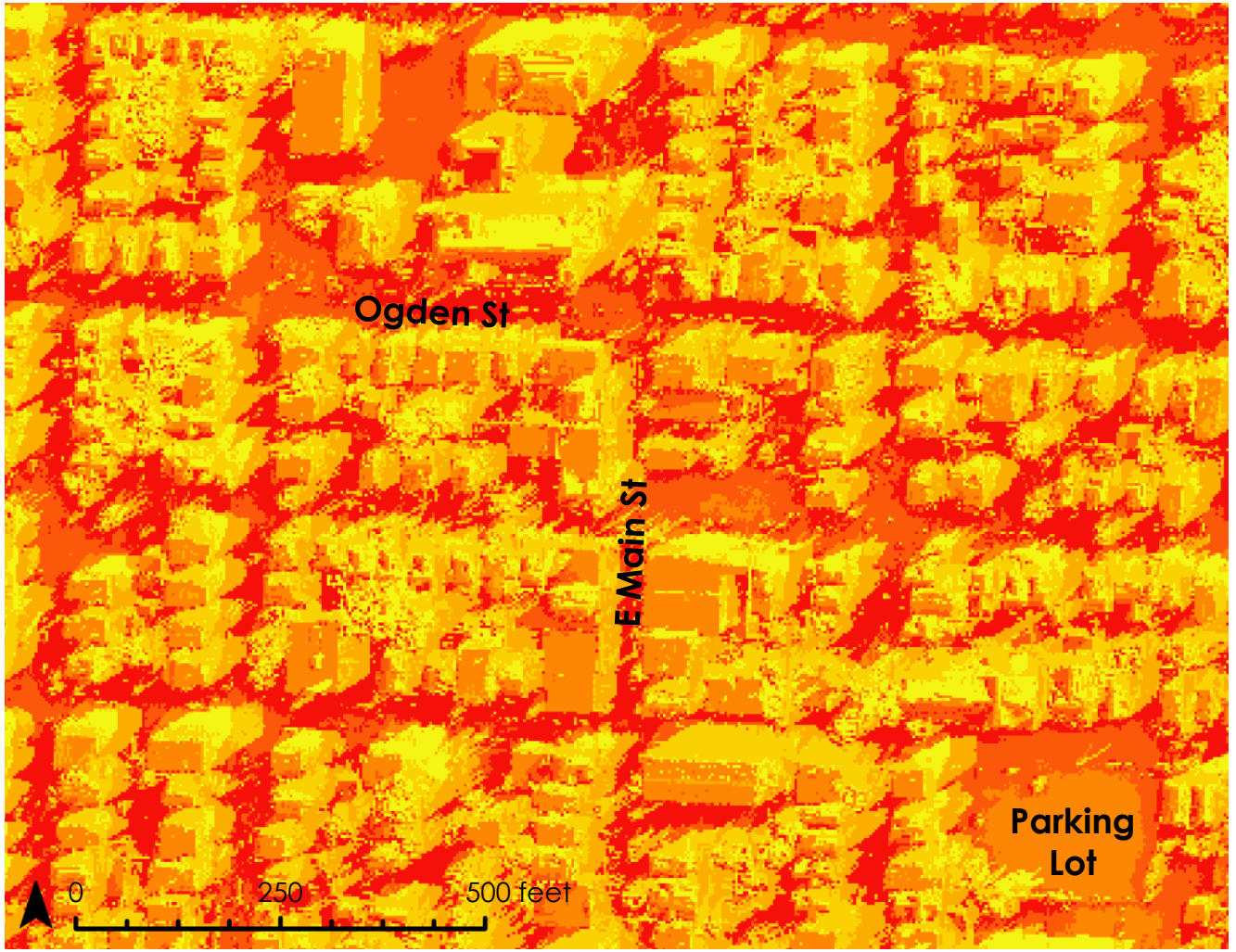


Outdoor Thermal Comfort (SOLWEIG Modeling)

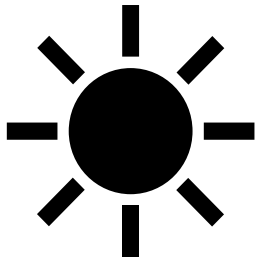


SOLWEIG Output

Mean Radiant Temperature in the East Bridgeport on 07/30/2022 at 14:30

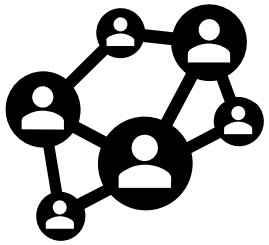


Errors & Uncertainties

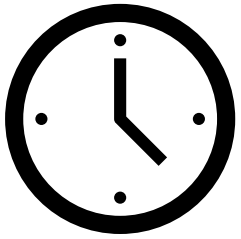


Urban Heat Assessment
Land surface temperature does not account for how heat is felt or experienced

Coarse Landsat temporal resolution (revisit time ~ 16 days)



Social Vulnerability
Could not include all factors relevant to social vulnerability. Social data at block level are desired.
Adapted existing code base



SOLWEIG
Due to availability of data, model inputs are taken from different dates

Highly computer intensive, making it difficult to produce on a large scale

Conclusions

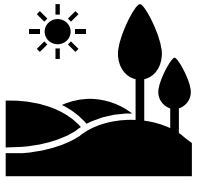
- Bridgeport is about **10 F hotter** than Fairfield City on average during Summer months.
- Socio-demographic and socio-economic factors contribute to higher likelihood of heat related hardships
- Cooling interventions such as adding vegetation could help address heat concerns at high heat vulnerability regions.

Feasibility Assessment

Landsat Earth observations ***can*** be used to identify hot areas

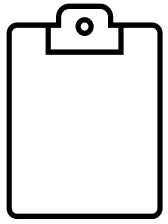
Thermal Comfort Modeling is valuable for determining cooling interventions

Future Recommendations



Modeling **tree canopy** interventions to determine effectiveness in neighborhoods vulnerable to heat

Conducting a multi-purpose study of green infrastructure to **assess cooling and flood relief**



Incorporate more **in-situ temperature data** for social vulnerability

Acknowledgments

We would like to thank our wonderful science advisors and lead:

- Dr. Kenton Ross - NASA Langley Research Center
- Dr. Xia Cai - NASA Langley Research Center
- Madison Arndt – DEVELOP Massachusetts – Boston Lead

We would also like to thank our partners for this project:

- Christina Smith - Groundwork Bridgeport
- Andrei Harwell - Yale Urban Design Lab

This material is based upon work supported by NASA through contract 80LARC23FA024. Any mention of a commercial product, service, or activity in this material does not constitute NASA endorsement. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration and partner organizations.