New Jersey Statewide Temperature Statistical and Machine Learning Analysis

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Introduction

- **Urban heat island (UHI) effect:** urban areas experience more extreme temperatures than less urbanized surroundings.
- The UHI results from reduced green space and increased impervious surfaces in urban areas that absorb more solar radiation, heat up, and elevate local temperatures.
- The UHI can increase energy consumption for cooling, air pollution, and heat related illness and death.
- Disadvantaged communities are disproportionately exposed to the UHI.
- 94% of New Jersey residents live in urban areas and New Jersey's UHIs will be a growing problem with climate change.

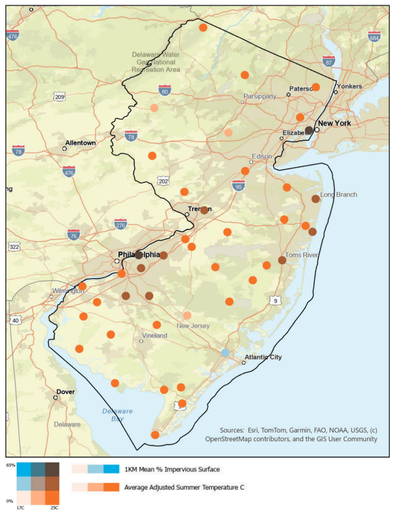
Project Goals

- **Goal 1:** Expand the Community Heat Assessment and Monitoring Program (CHAMP) weather station network in Camden, NJ to address the lack of urban weather data.
- **Goal 2:** Identify and quantify spatial and temporal patterns of temperature variability in New Jersey, focusing on urban heat amplification and underlying mechanisms of the UHI effect.
- **Goal 3:** Share these findings with communities and healthcare providers to enhance resilience and improve understanding of UHI-related health impacts.

Methods

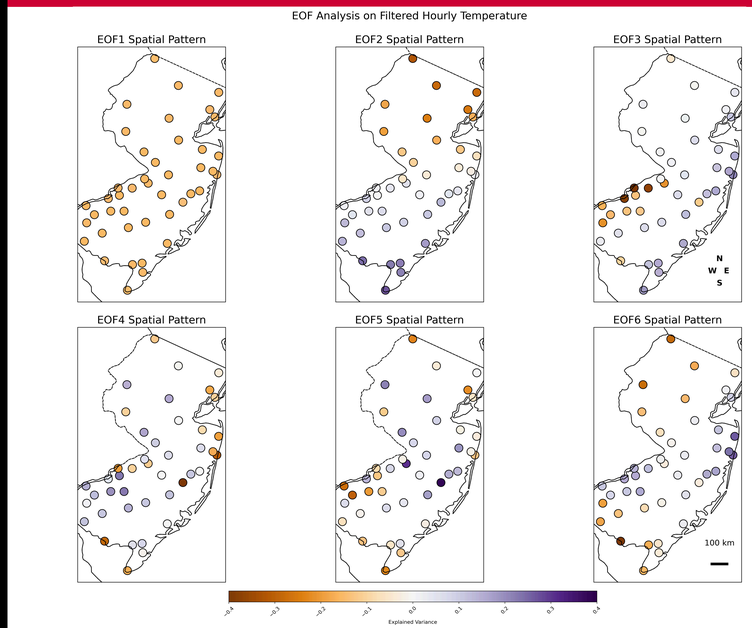
- First, summer hourly average temperatures from 43 New Jersey Mesonet stations (2016–2024) were altitude-corrected and compared with the mean of the surrounding 1 km impervious surface percentage.
- Second, empirical orthogonal function (EOF), K-means clustering, and self-organizing map (SOM) analyses were applied to both station-level temperatures and ERA5 gridded data (2004–2024) to identify temporal patterns across New Jersey.

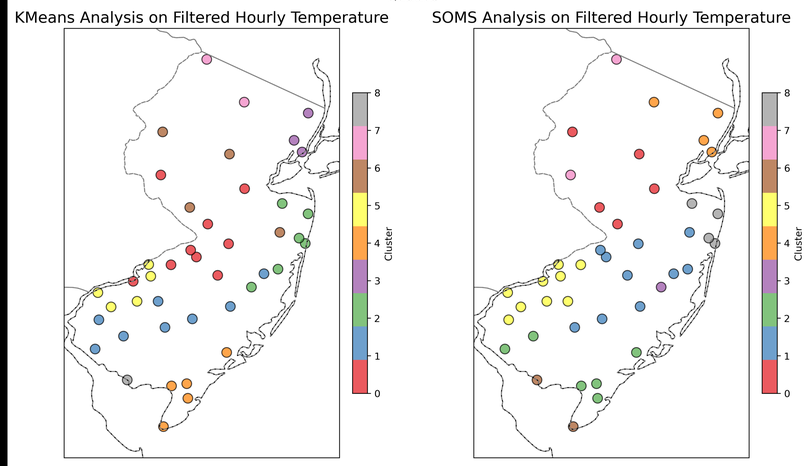
Impervious Surface and Temperature



- 55.4% of New Jersey land use represents impervious surfaces.
- Within a 1km radius Pennsauken, Jersey City, Oceanport, and Toms River had the highest mean of impervious surface with Pennsauken having the highest of 65%.
- Lydhurst, Manfield , Hammonton, and Pennsauken were the warmest stations, with the Pennsauken location displaying the warmest climatology.
- Over the 6-year period, Pennsauken experienced the warmest meteorological summer (June–August), averaging 24.58 °C.
- Mesonet stations do not show clear evidence of an air temperature UHI.

New Jersey State Climatologist Mesonet Station Temperature Analysis





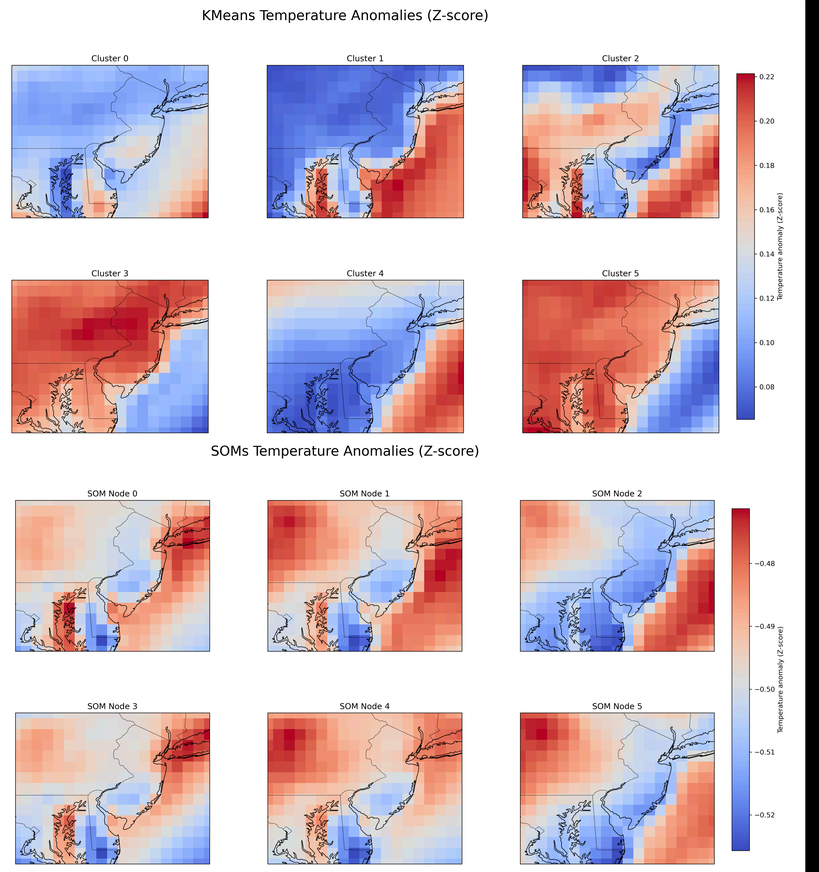
- A coastal signal and latitude signal appears consistently across EOF, KMeans, and SOM analyses.
- Mesonet station coverage weakly represents the UHI signal due to limited placement and density.

Awknowledgements

This project is supported by the Megalopolitan Coastal Transformation Hub.

MACH Megalopolitan Coastal Transformation Hub

ERA 5 Gridded Data Temperature Analysis



- Temporal patterns seen using the ERA 5 data show strong continental warming and seasonal shifts in both the KMeans and SOMS analysis.
- Distinct patterns are seen in KMeans analysis while more gradient detail is seen in the SOMS analysis.
- There is limited UHI signal seen in just hourly temperature data. By increasing the types of variables and region studied, more distinct patterns should be revealed.

Next Steps

- Install more local-scale weather stations in Camden, New Jersey to better represent the UHI and temperature in the urban core.
- Continue statistical and machine learning analysis on gridded data with variables such as geopotential height, 10m wind, humidity, precipitation, and solar radiation to understand how they factor into the formation of urban heat islands.
- Compare different filtering options to identify extreme heat events and urban heat amplification such as looking at just summer seasons or night.
- Compare extreme heat events with local health care information to understand the health impacts of the urban heat island effect.