Characterizing the spatial complexity of the *intra*-Urban Heat ***Islets***

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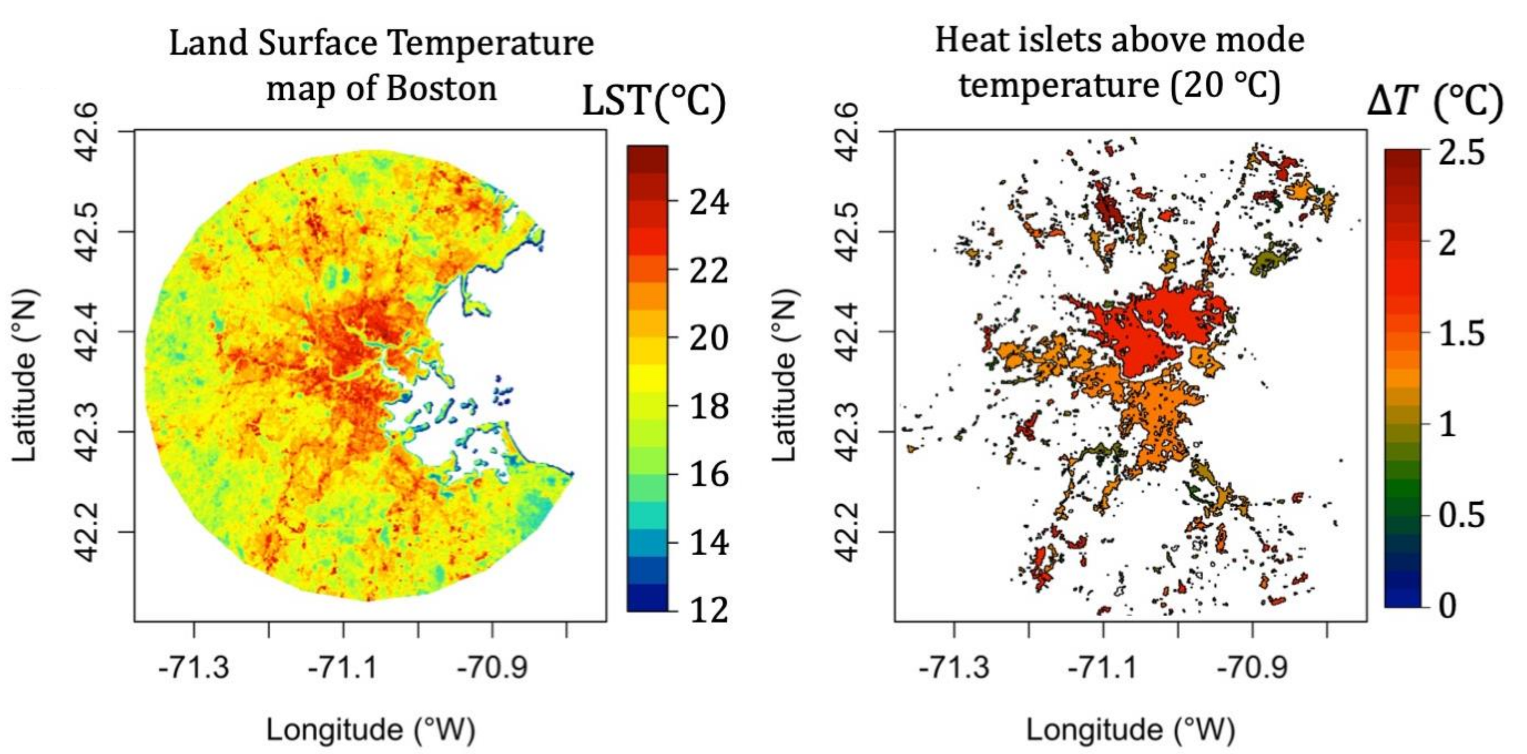
Introduction

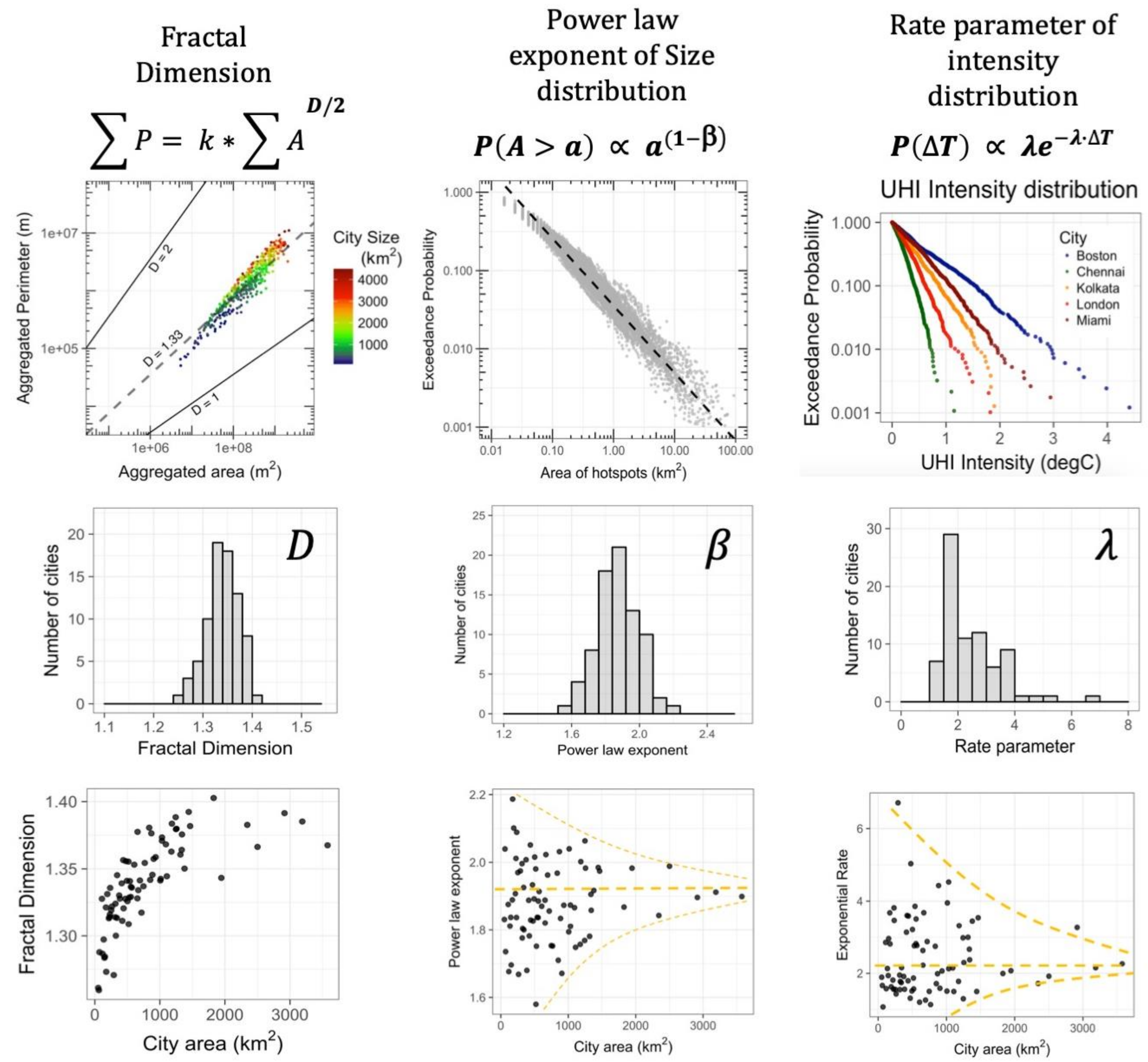
- Variability of the intra-urban temperatures is not well characterized, since the commonly used metrics, such as Urban Heat Island Intensity, do not take account for the spatial heterogeneity of urban Land Cover Land Use.
- Building upon the known fractal properties of Urban Form and Functions, I conceptualize the thermal landscape within cities as a collection of **intra-Urban Fractal Heat *Islets***.
- This provides a framework to quantify the spatial complexity of urban temperatures and enable comparison of cities across the world irrespective of their geographical, climatological, or cultural background.

Methods



- Land Surface Temperatures (LST) for 78 diverse cities across the world were derived for a cloud-free summertime day using Landsat 8 imagery and the geospatial platform of Google Earth Engine.
- Using incremental percentiles of temperature threshold, connected clusters of high heat that emerge within a city are identified.
- Using techniques such as area-perimeter fractal dimension and size distribution of clusters from percolation theory, the fractal topography of heat islets was affirmed.

Summary of Key Findings



- The heat islets have a fractal topography with the area-perimeter fractal dimension (D) of the isothermal lines narrowly distributed for all cities with D = 1.33±0.007.
- In agreement with fractal systems, the size distribution heat islets follow a power law size distribution with mean slope, β = 1.88± 0.26.
- Analogous to UHI Intensity, thermal anomalies (ΔT) for each heat islet is calculated as the difference between mean islet temperature and the thermal threshold. The distribution of islet intensities for all cities is well represented as an exponential distribution.
- Lastly, the metrics converge to the mean as a function of city area indicating the influence of common generative mechanism of thermal spatial organization as cities grow.

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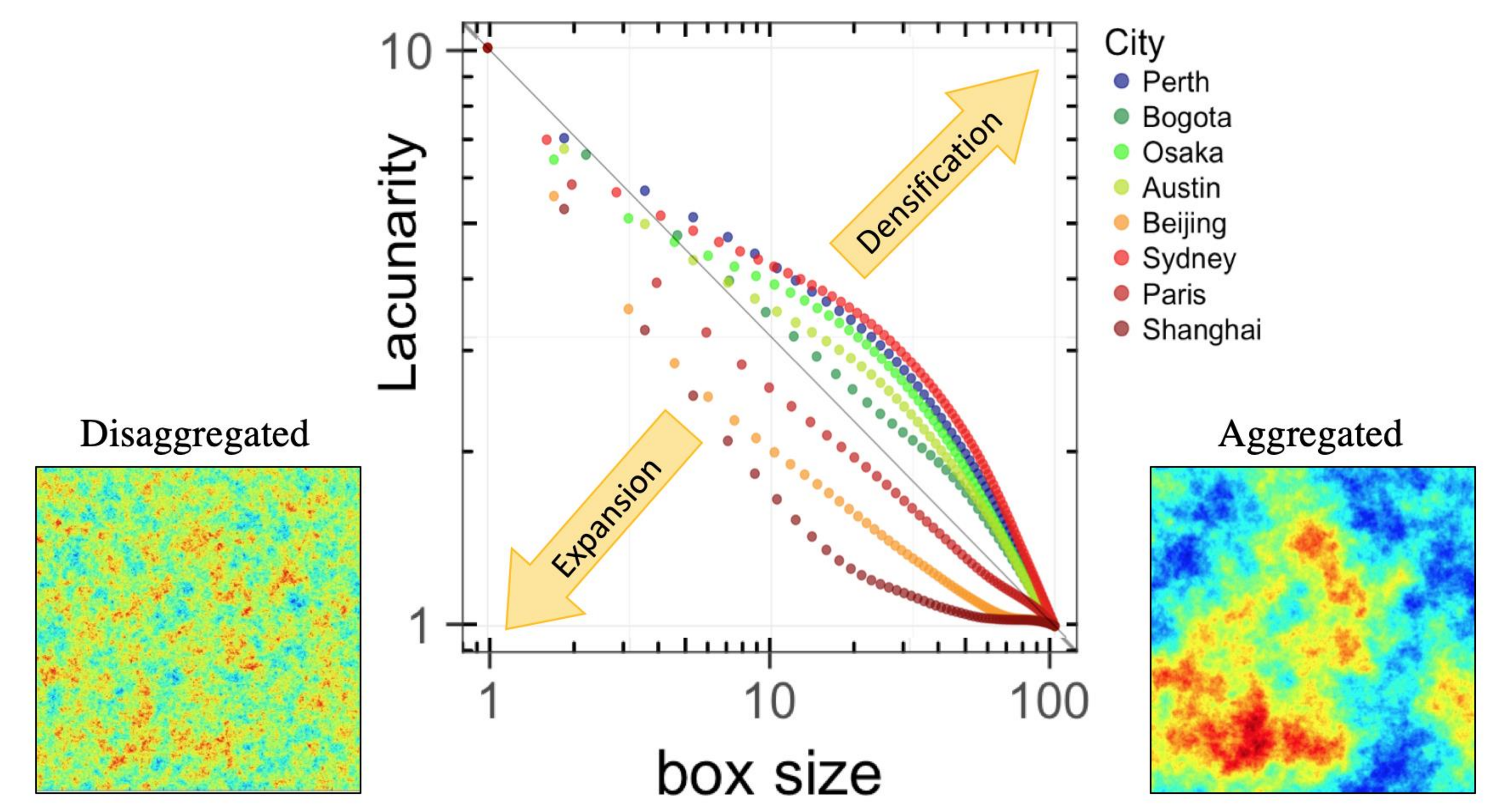
Ongoing Work

Cities grow primarily through expansion and densification. How do these two trajectories impact the spatial organization of heat islets?



Further questions to explore

- How does the spatial organization vary in time, from short term seasonal variability to long term growth trends for a single city?
- How do the heat islets interact with mesoscale extreme events such as heat waves?
- The distribution of population within cities also varies spatially. Given the fractal structure of both heat and population within cities, how does the thermal map overlay on the demographic map of a city?
- Zooming out of the intra-urban thermal landscape, do regional temperature patterns show a similar fractal topography as well?

References

1. Batty, Michael, and Paul A. Longley. *Fractal cities: a geometry of form and function*. Academic press, 1994.
2. Isichenko, Michael B. "Percolation, statistical topography, and transport in random media." *Reviews of modern physics* 64.4 (1992): 961.