

## MOTIVATION

- How does heterogeneity in land surface modulate the correlation between land surface temperatures (LSTs) and local climate zones (LCZs)?
- What are the range of heterogeneities within which, the usefulness of the LCZ representation is high (or low)?
- Heterogeneity exists in the form of LCZ intensity (Say, number of one class divided by total number of classes) as well as in the form of spatial distribution (How are the classes spread?)

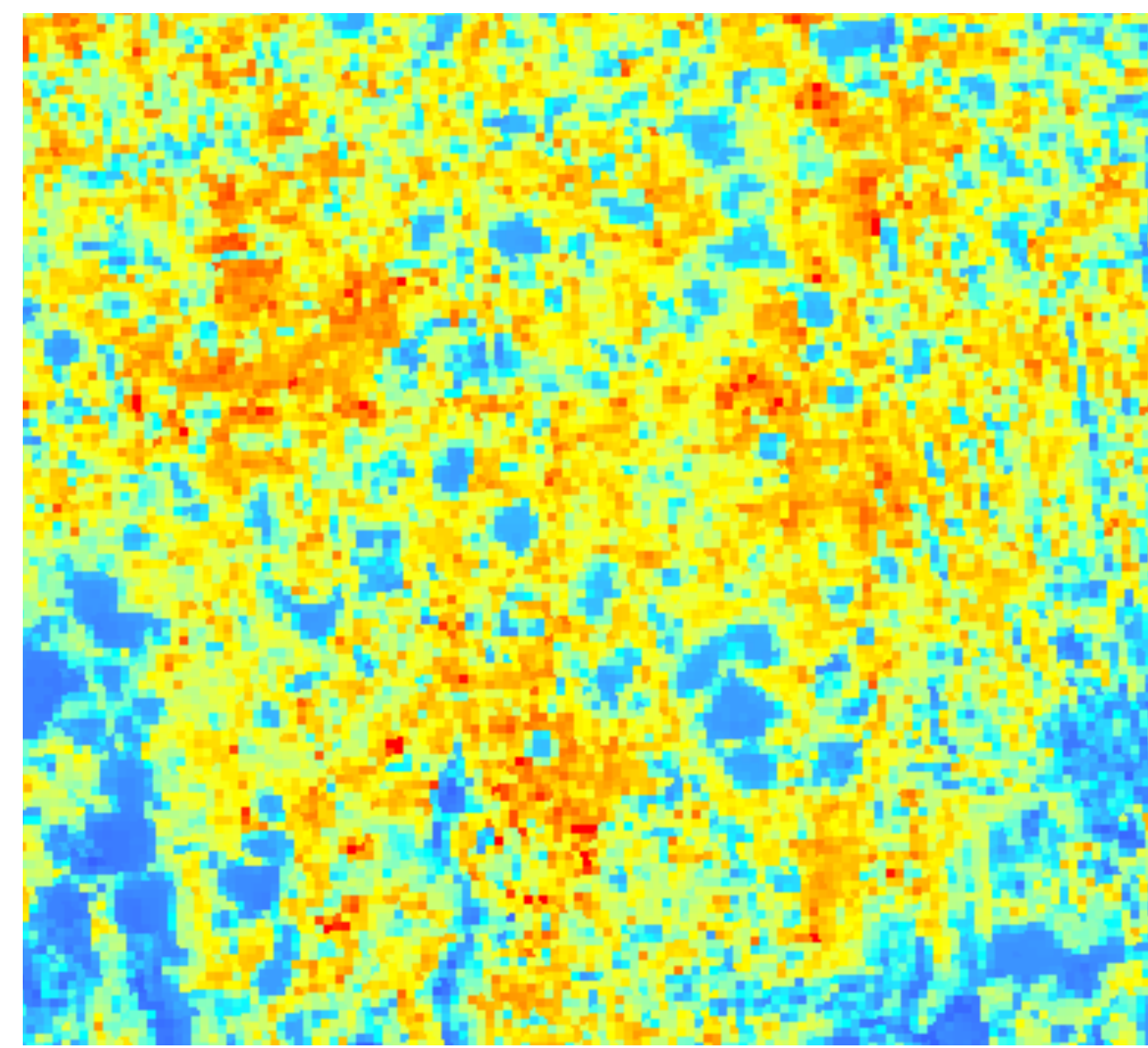


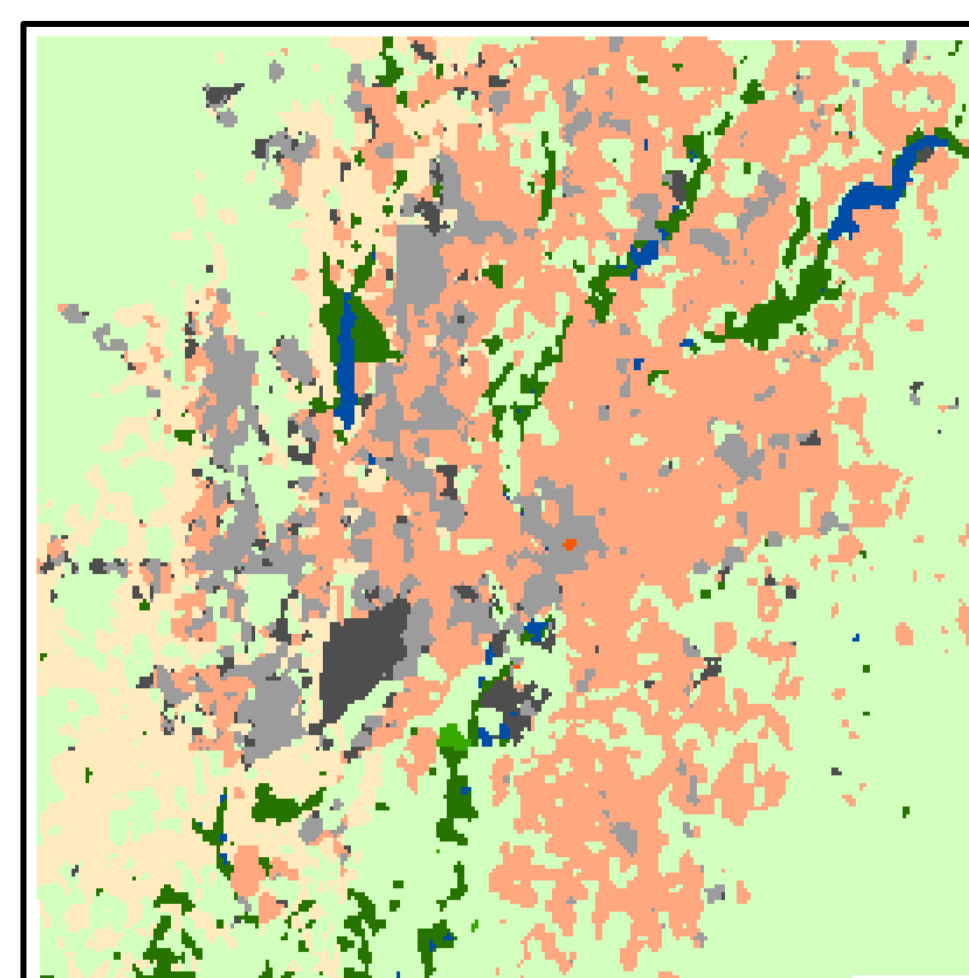
Image: Land Surface Temperature from Landsat 8



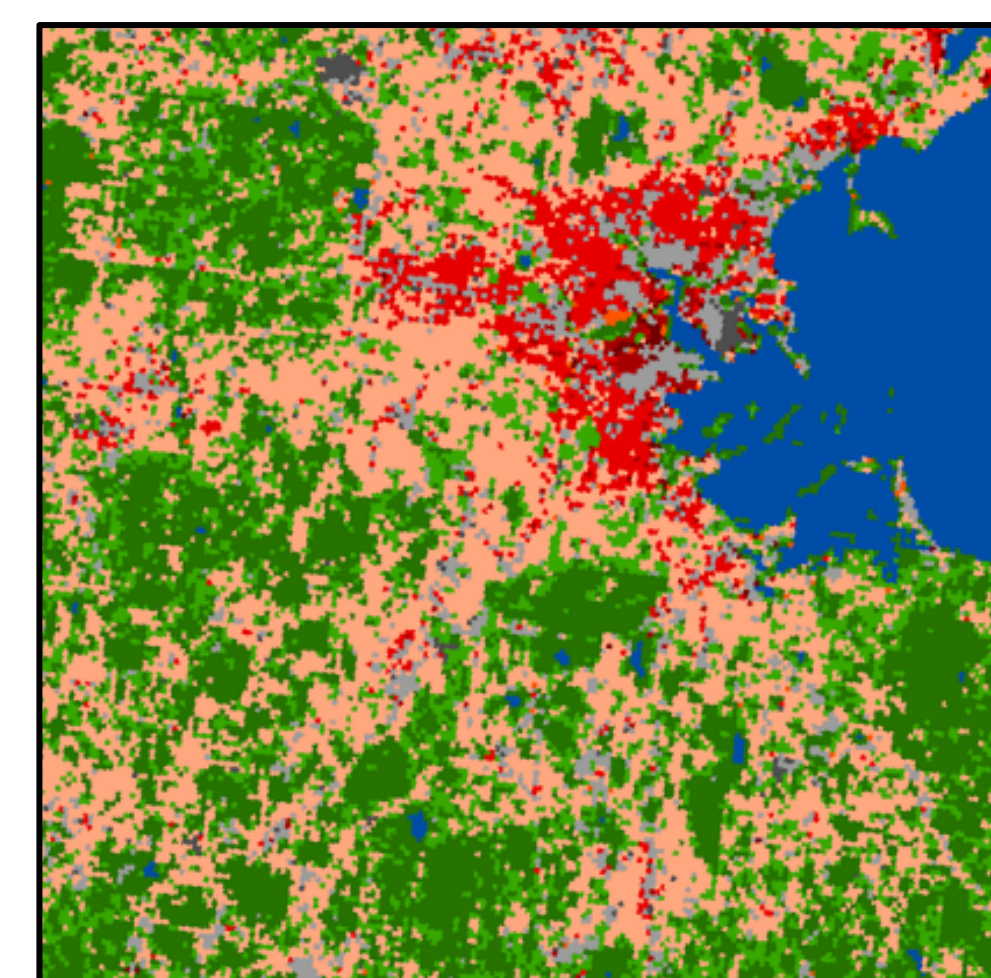
Image courtesy: sumedh.info

(Left) Orlando : An example of high spatial heterogeneity in LSTs due to presence of multiple lakes that act to produce "source-sink" pairs. (Right) Mumbai : An example of a stark contrast in LCZs coexisting within a few hundreds meters distance - a trait frequently noted in organically developed cities.

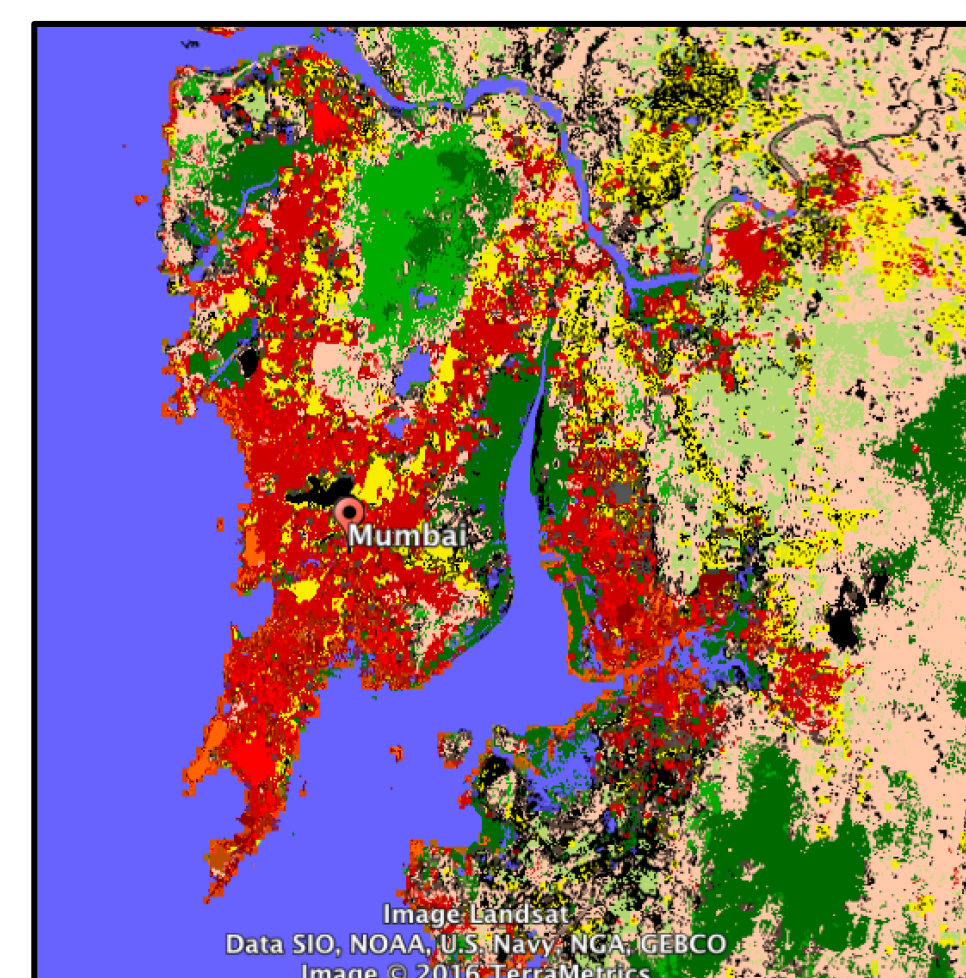
## DATA USED



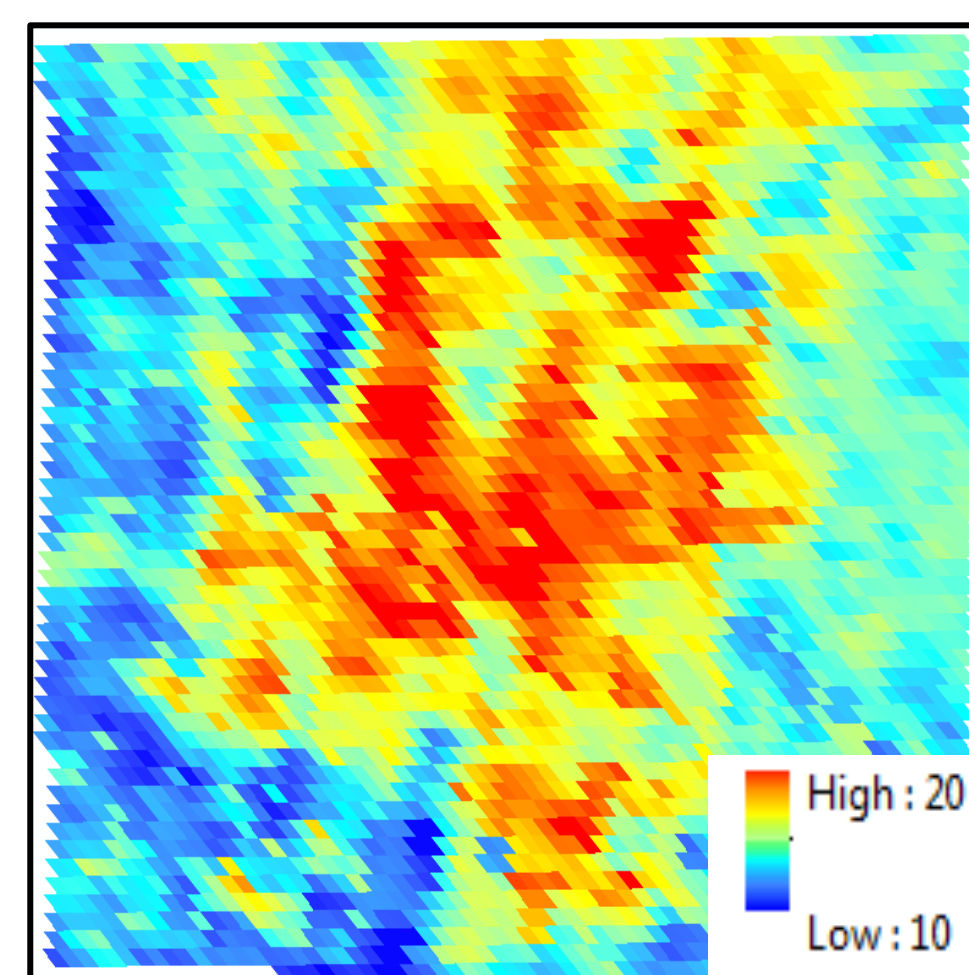
Indianapolis



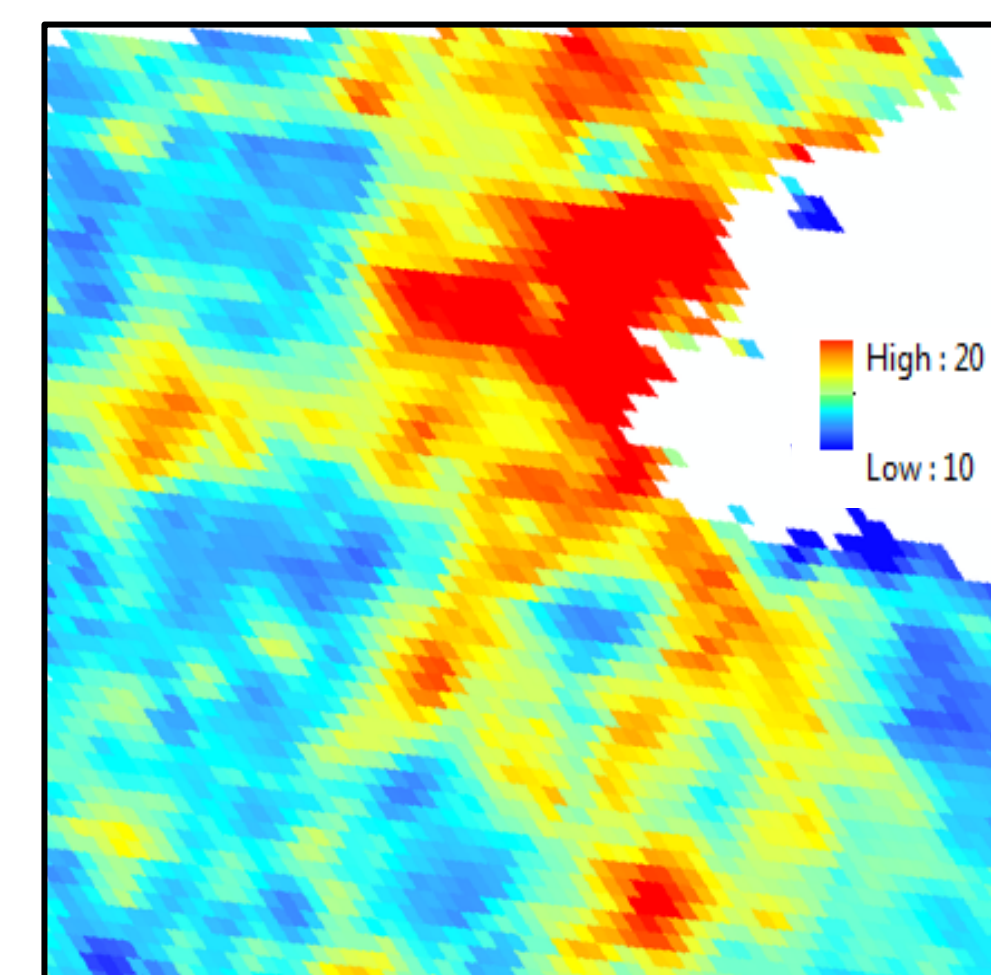
Boston



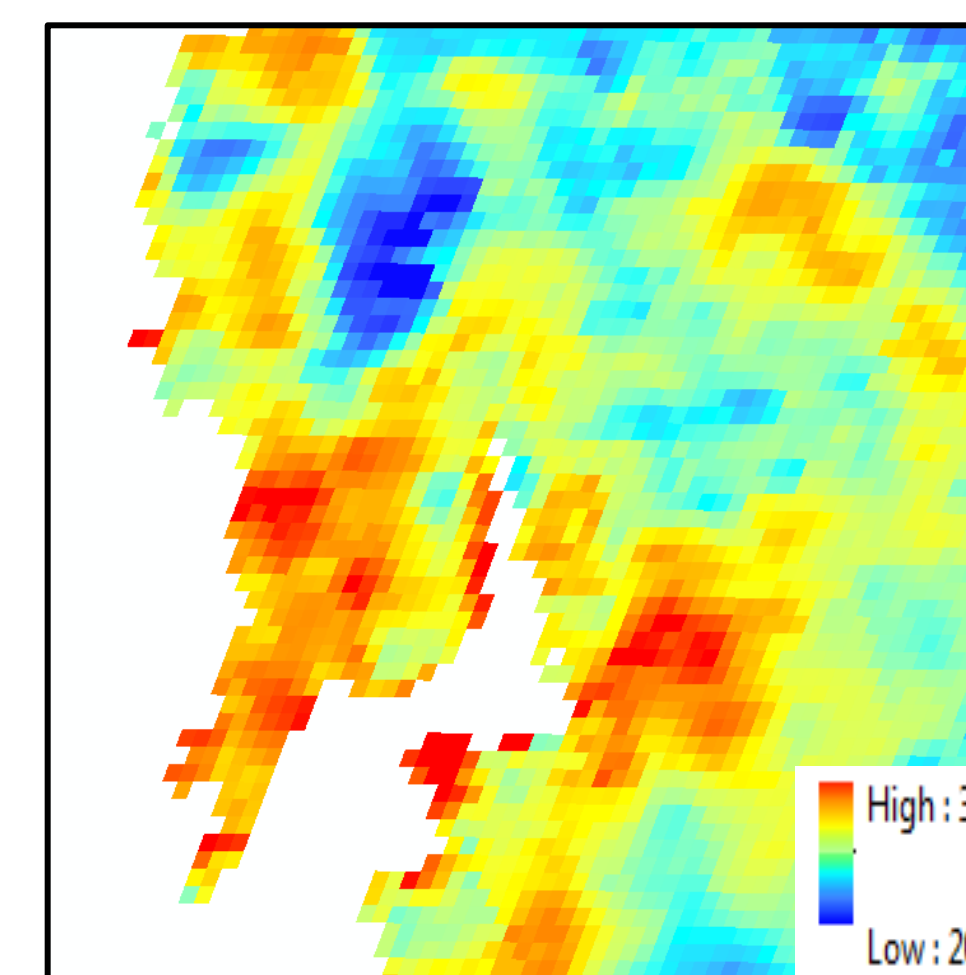
Mumbai



LST (°C)



LST (°C)

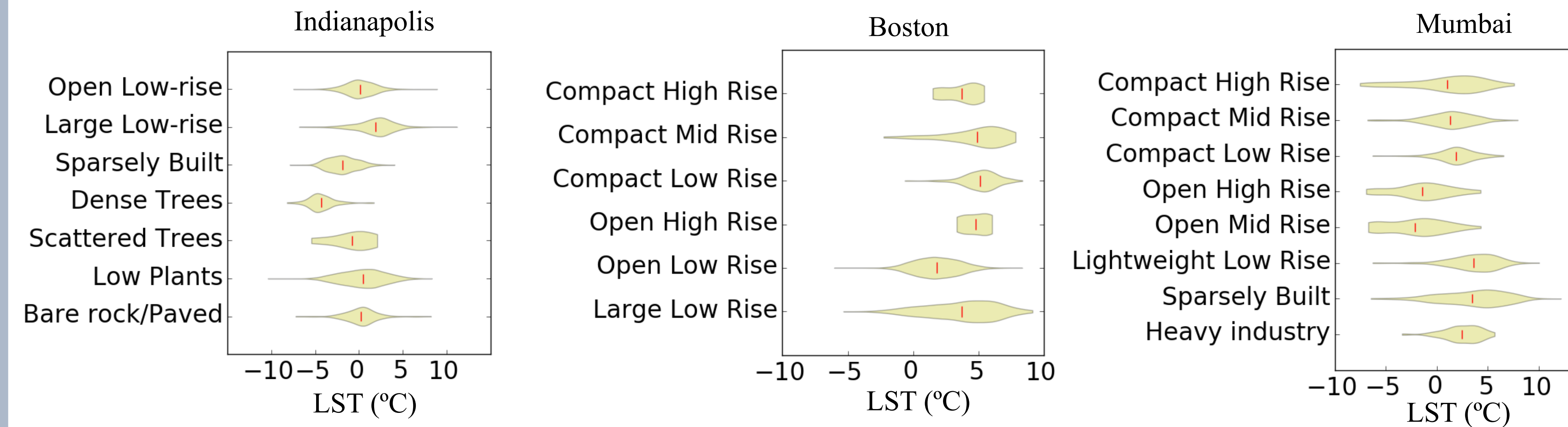


LST (°C)

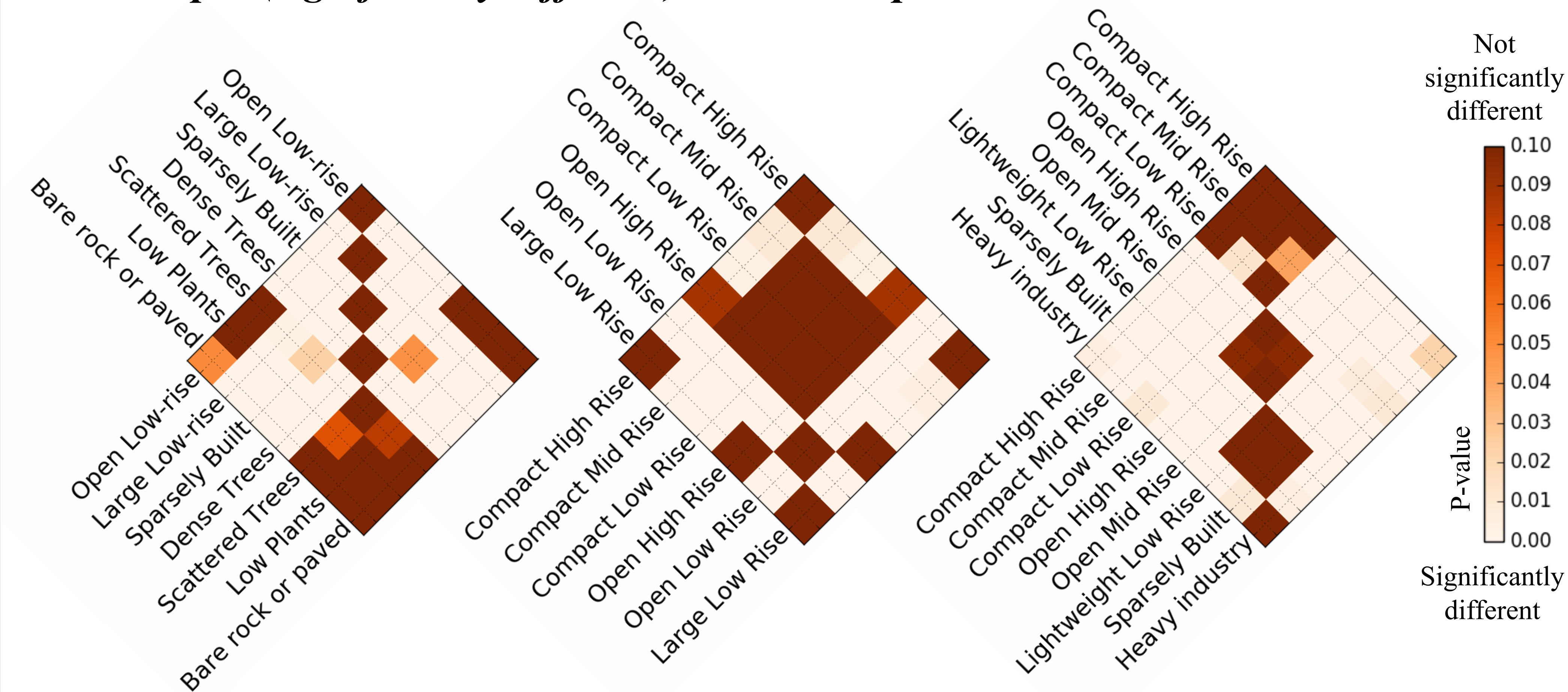
Land use maps made using Local Climate Zones, Land Surface Temperature generated using MODIS data

## ANALYSIS AND RESULTS

### PDFs of deviation of Land Surface Temperature for each LCZ



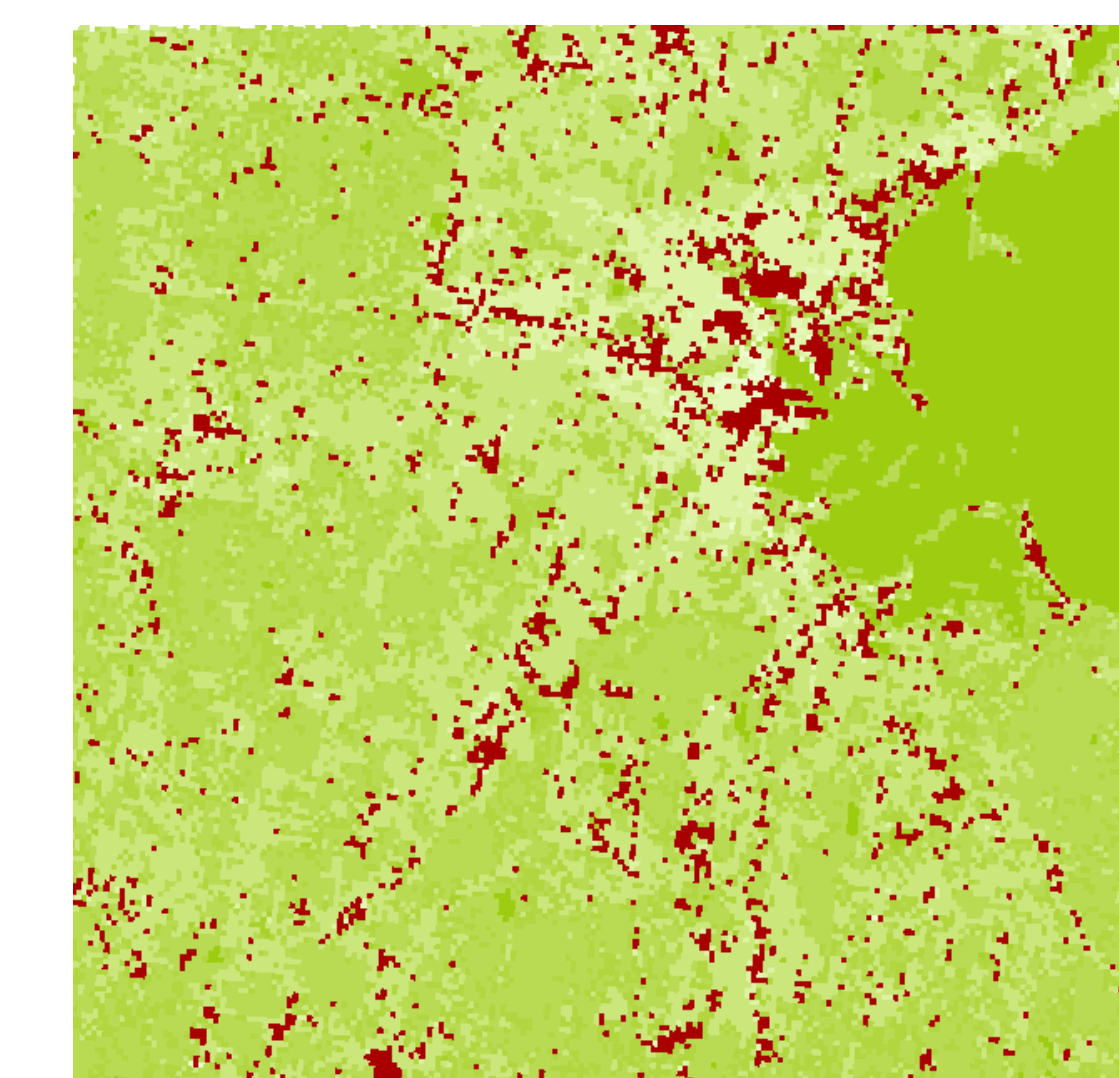
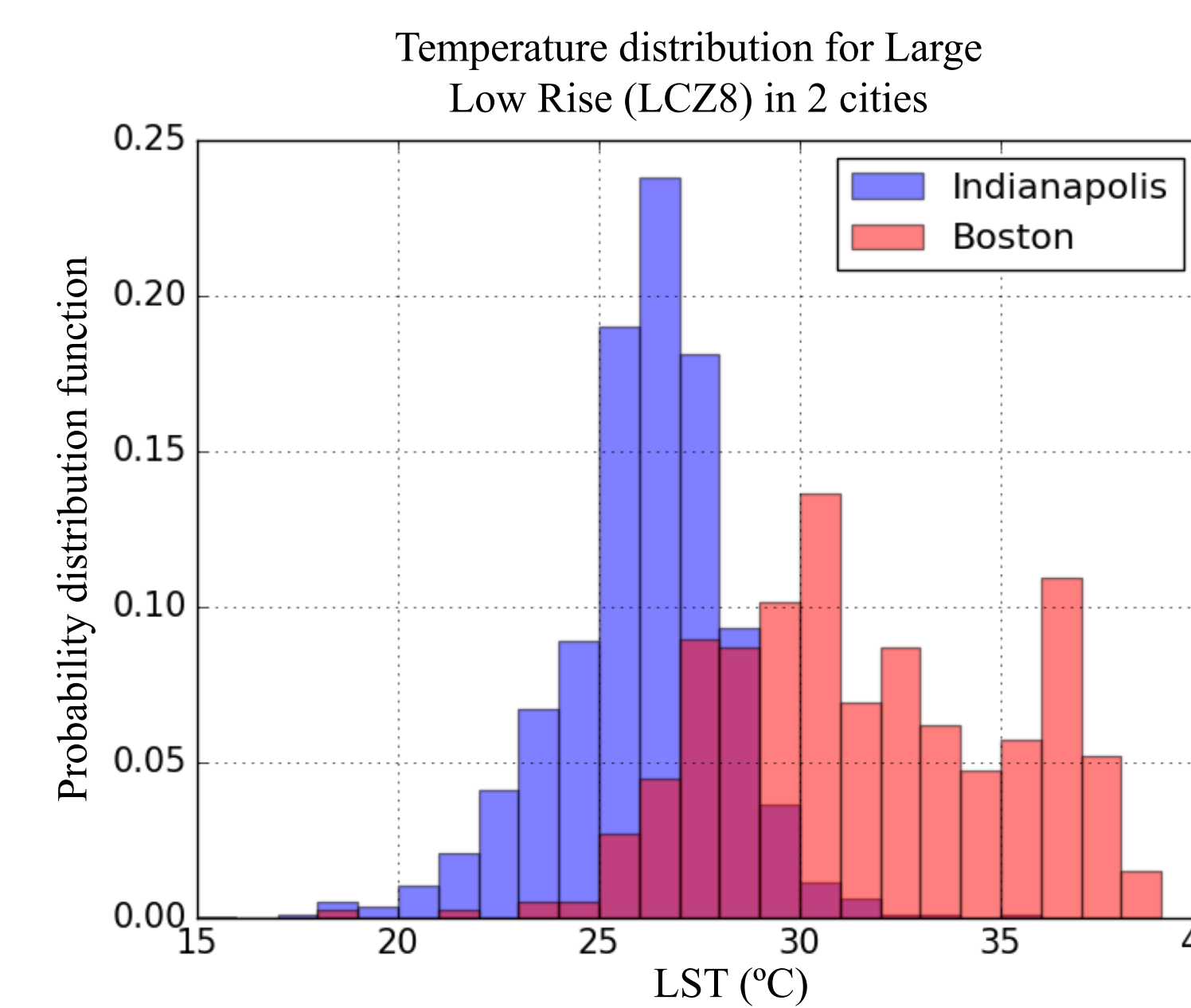
### How unique (significantly different) are the temperature distributions across LCZs?



### How do the temperature distributions vary for the same LCZ under different heterogeneities?



LCZ 8 in Indianapolis



LCZ 8 in Boston

## ONGOING WORK

- Characterize heterogeneities (population based as well as spatial) based on Shannon's entropy estimates.
- Develop LCZ maps of archetype cities representing varying degrees of heterogeneities.
- Understand the role of factors such as winds, stability of the atmosphere, or time of the day that might affect the impact of land surface heterogeneities.
- Study the evolution of a city and its resultant land surface temperature over time.

## DATA AND METHODS

- Urban land use clustering and classification system employed – **Local Climate Zones** (Stewart and Oke, 2012)
- LST data obtained from Landsat 8
- Mann Whitney's U test used to estimate statistical significance in the difference between LST populations

$$U = n_1 n_2 + \frac{n_2(n_2 + 1)}{2} - \sum_{i=n_1+1}^{n_2} R_i$$

Where,  
U = Mann-Whitney U test;  $R_i$  = Rank of the sample size  
 $n_1$  = sample size one;  $n_2$  = sample size two

- LCZ 1 Compact high-rise
- LCZ 2 Compact mid-rise
- LCZ 3 Compact low-rise
- LCZ 4 Open high-rise
- LCZ 5 Open mid-rise
- LCZ 6 Open low-rise
- LCZ 7 Lightweight low-rise
- LCZ 8 Large low-rise
- LCZ 9 Sparsely built
- LCZ 10 Heavy industry
- LCZ A Dense trees
- LCZ B Scattered trees
- LCZ C Bush, scrub
- LCZ D Low plants
- LCZ E Bare rock or paved
- LCZ F Bare soil or sand
- LCZ G Water

Local Climate Zones (LCZ) classes: where 1-10 are the urban land use types, and A-G are non-urban

## REFERENCES

- Stewart, Ian D., and Tim R. Oke. "Local climate zones for urban temperature studies." *Bulletin of the American Meteorological Society* 93.12 (2012): 1879-1900.

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