A Global Database of Surface Urban Heat Island Intensity

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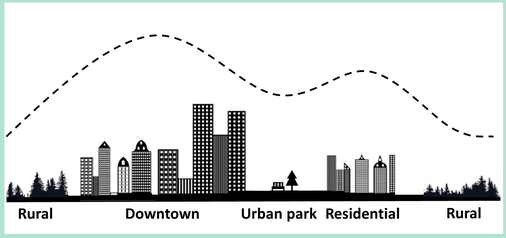
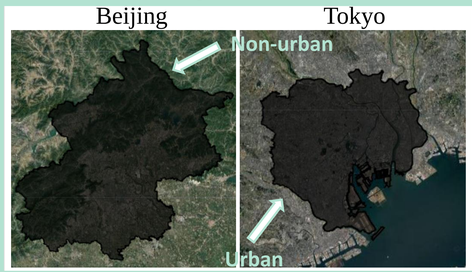
Background and Research Methodology

The Urban Heat Island Effect



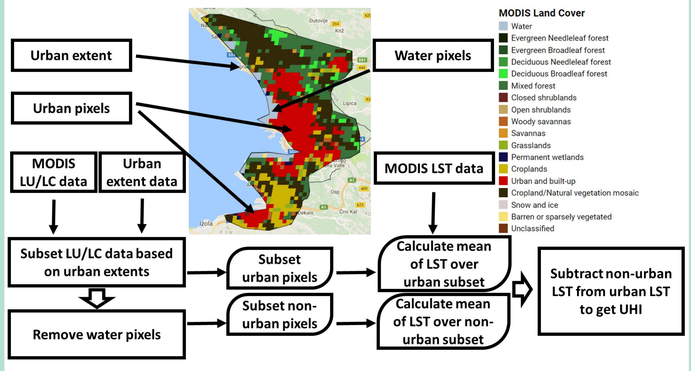
Cities are hotter than surroundings; leads to heat stress, higher energy use, secondary air pollution, etc.

Methodological Deficiencies in Previous Studies



- Using administrative boundaries as urban units
- Identical buffer size to get rural reference
- Focus on larger cities

The Simplified Urban-Extent (SUE) Algorithm



Data Sources

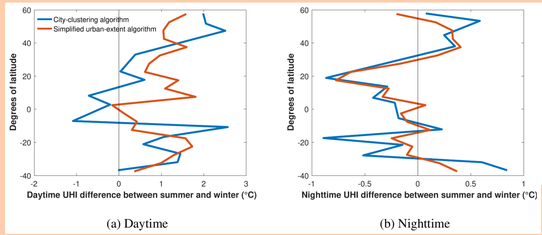
- Natural Earth urban extent dataset **(2001-2002)**
- MODIS 500 m Land Cover product **(2003-2013)**
- MODIS 1 km Land Surface Temperature (LST) data **(2000-2017)**
- Global Multi-resolution Terrain Elevation Data **(2010)**

Research Objectives

- Create new algorithm to quantify surface UHI intensity at global scale using all available MODIS observations
- Investigate seasonal and temporal trend of surface UHI intensity for world and different climate zones
- Design interactive web portal to visualize results

Validation of SUE Algorithm and Major Results

Algorithm Validation



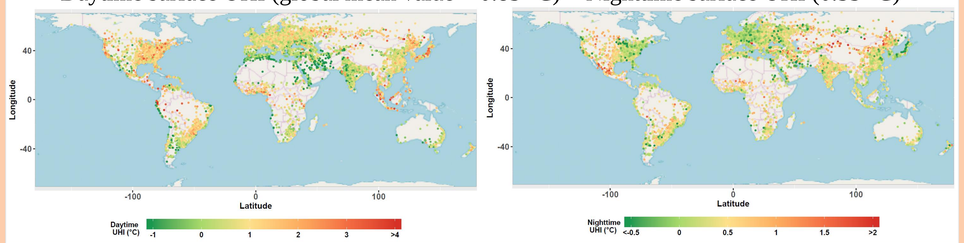
(a) Daytime (b) Nighttime

Local time	Present study (SUE)	Clinton and Gong (5 km buffer)	Clinton and Gong (10 km buffer)
0130 LT	0.51 ± 0.47	0.60 ± 0.90	0.70 ± 1.00
1030 LT	0.73 ± 0.86	0.70 ± 1.40	1.00 ± 1.60
1330 LT	1.00 ± 1.08	0.90 ± 1.60	1.10 ± 1.80
2230 LT	0.60 ± 0.47	0.60 ± 0.90	0.80 ± 1.00

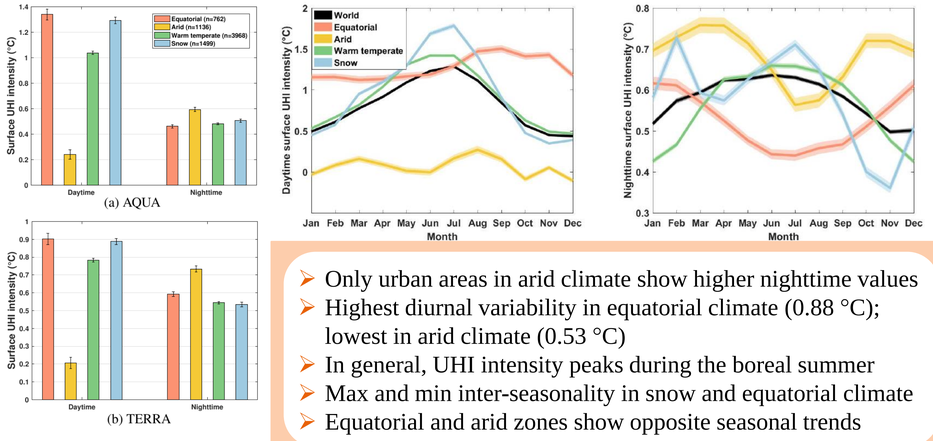
Results closely match previous studies

Global Map of 16-year Mean Surface UHI Intensity

Daytime surface UHI (global mean value = 0.85 °C) > Nighttime surface UHI (0.55 °C)

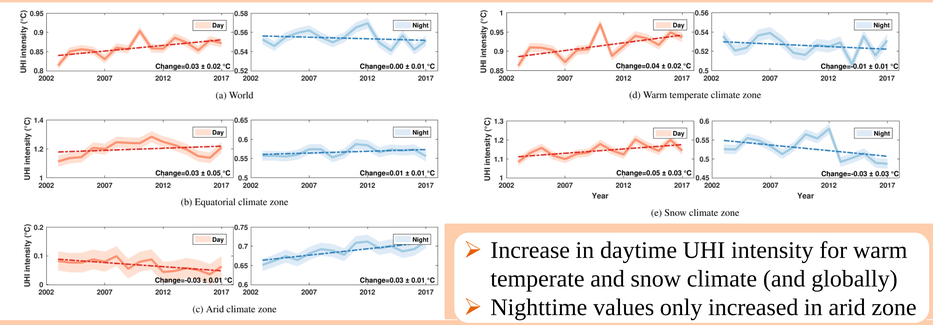


Diurnal and Seasonal Patterns of Surface UHI for Different Climate Zones



- Only urban areas in arid climate show higher nighttime values
- Highest diurnal variability in equatorial climate (0.88 °C); lowest in arid climate (0.53 °C)
- In general, UHI intensity peaks during the boreal summer
- Max and min inter-seasonality in snow and equatorial climate
- Equatorial and arid zones show opposite seasonal trends

Long-term Trends in Surface UHI Intensity



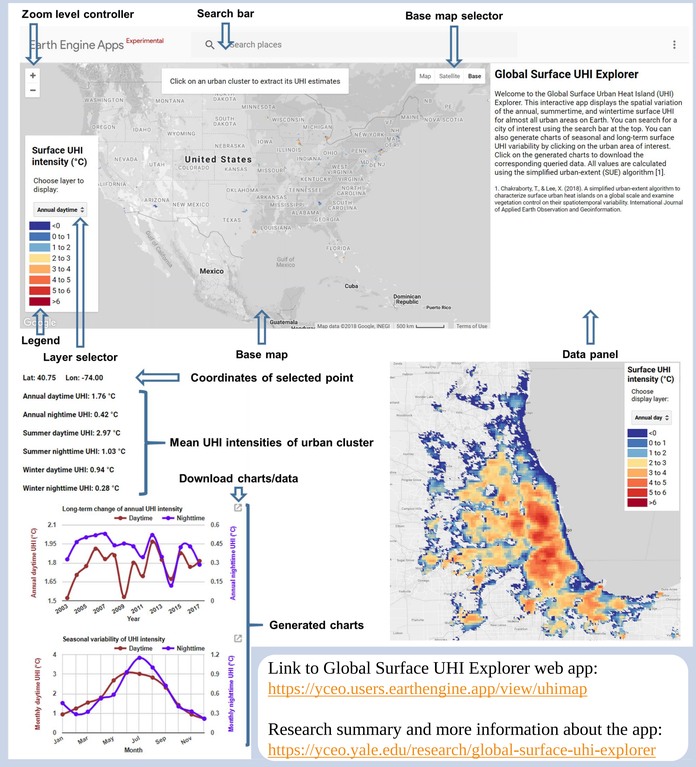
- Increase in daytime UHI intensity for warm temperate and snow climate (and globally)
- Nighttime values only increased in arid zone

Conclusions and Web App Development

Summary of Results

- New algorithm developed to create most comprehensive dataset of surface urban heat island intensity at a global scale
- Daytime UHI higher than nighttime UHI for non-arid urban areas
- Seasonal, and long-term patterns quantified for each climate zone; unique characteristics based on background climate
- Observations show that daytime surface UHI intensity has increased at 0.03 °C per decade for the globe

The Global Surface UHI Explorer



Link to Global Surface UHI Explorer web app:
https://yceo.users.earthengine.app/view/uhimap

Research summary and more information about the app:
https://yceo.yale.edu/research/global-surface-uhi-explorer

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