Modeling of Urban Heat Island

Looking through more cities

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Candidate Causes for UHI

- Known thoughts:
  - Decreased longwave radiation loss and increased absorption of solar radiation and longwave radiation (canyon effect)
  - Anthropogenic emission of heat
  - Reduction of evapotranspiration
  - Increased storage of sensible heat within urban materials
  - Reduced transfer of heat
What else?

- Any factors else other than these traditional causes? for example,
  - City forms?
  - Background Environment?
  - ...

- In order to address this question, we looked through more cities to establish the intuition
Looking at More Cities

- Data: MODIS Terra LST 8-day Composite
- Cities: One city of each state in the US (Capital or large city of each state)
- Ten years’ composite analysis of each city
- When selecting pixels to calculate the UHI Intensity:
  - avoid large water bodies
  - avoid altitude difference
  - avoid latitude difference
  - choosing the large enough cities
  - Median value of the selected pixels
Looking at More Cities

- Why using median value:
  - could avoid the few extreme numbers which would affect the mean value.
  - the extreme numbers could be the pixels of lake or river in the city or rural area.
Looking at More Cities

Ten Years Composite of MODIS LST at Olympia WA 2001~2010

- City day
- City night
- Suburb day
- Suburb night
Looking at More Cities

Ten Years Composite of MODIS LST at Helena MT 2001~2010

- City day
- City night
- Suburb day
- Suburb night
Looking at More Cities

Ten Years Composite of MODIS LST at Cheyenne WY 2001~2010

- City day
- City night
- Suburb day
- Suburb night
Looking at More Cities

Ten Years Composite of MODIS LST at Denver CO 2001~2010

- City day
- City night
- Suburb day
- Suburb night
Looking at More Cities

Ten Years Composite of MODIS LST at Pierre SD 2001~2010

- City day
- City night
- Suburb day
- Suburb night

MODIS LST

Time of the Year

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Looking at More Cities

Ten Years Composite of MODIS LST at Minneapolis MN 2001~2010

- City day
- City night
- Suburb day
- Suburb night
Looking at More Cities

Ten Years Composite of MODIS LST at Jackson MS 2001–2010
Looking at More Cities

![Graph showing MODIS LST at Columbus OH 2001-2010](image)

- **City day**
- **City night**
- **Suburb day**
- **Suburb night**
Looking at More Cities

Ten Years Composite of MODIS LST at Indianapolis IN 2001~2010

- City day
- City night
- Suburb day
- Suburb night
Looking at More Cities

Ten Years Composite of MODIS LST at Augusta ME 2001~2010

- City day
- City night
- Suburb day
- Suburb night

MODIS LST vs Time of the Year (January to December)
Ten Years Composite of MODIS LST at Albany NY 2001~2010

- City day
- City night
- Suburb day
- Suburb night
Looking at More Cities

Ten Years Composite of MODIS LST at Trenton NJ 2001~2010

- City day
- City night
- Suburb day
- Suburb night
Looking at More Cities

Ten Years Composite of MODIS LST at Dover DE 2001~2010

- City day
- City night
- Suburb day
- Suburb night
Looking at More Cities

Ten Years Composite of MODIS LST at Columbia SC 2001~2010

- City day
- City night
- Suburb day
- Suburb night
Looking at More Cities

Ten Years Composite of MODIS LST at Olympia WA 2001~2010

MODIS LST

City day
City night
Suburb day
Suburb night

Time of the Year
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Looking at More Cities

Ten Years Composite of MODIS LST at Sacramento CA 2001–2010

- City day
- City night
- Suburb day
- Suburb night
Preliminary Trend Analysis

Daytime UHI Intensity vs. Latitude on Cities of US

Nighttime UHI Intensity vs. Latitude on Cities of US
Preliminary Trend Analysis

Daytime UHI Intensity vs. Annual Mean Precipitation for the US Cities
Preliminary Trend Analysis

Nighttime UHI Intensity vs. Annual Mean Precipitation for the US Cities
Some Intuitions

- In most of the cities, UHI at daytime is stronger than that at nighttime (MODIS LST derived UHI), which contradict the traditional idea.
- In some cities, daytime LST even do not indicate UHI
- Nighttime temperature can always show UHI
- Summer seasons have the stronger UHI intensity than winter seasons, which contradict the traditional idea.
Some Intuitions

- Background environment does influence the UHI, for example. Wet background environment seems to increase the UHI.
- UHI intensity is formed by complex causes, cities with similar background environment and similar scale still have difference UHI intensity. City forms and other factors do influence.
Upcoming work

- Correlate UHI with:
  - Aridity index
  - Vegetation fraction in the city
  - Population density
  - City size
  - Mean building height
- Define the parameters to embody the various factors of UHI.