Overview of urban heat island formations in cities

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Why do cities have a different climate?

- Natural surfaces (meadows, forests, fields) are turned into stone or concrete surfaces
- Introduction of new surface materials (changes reflectivity of solar radiation; capacity to store heat; ‘sealing’ of surfaces)
Cities as heat generators

If we were all in a room!!

300 watts (average) X 100 people = 30,000 watts of HEAT energy

The average human, at rest, produces around 100 watts of power. [2] Over periods of a few minutes, humans can comfortably sustain 300-400 watts; and in the case of very short bursts of energy, such as sprinting, some humans can output over 2,000 watts.

http://large.stanford.edu/courses/2014/ph240/labonta1/
Urban Heat Island Intensity

- Difference in temperature between the urban area and surrounding rural area. Generally $3^\circ-5^\circ$ F difference.

- Surfaces that were once permeable and moist become impermeable and dry. These changes cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape.

- [http://www.youtube.com/watch?v=t-sXHl3l-rM](http://www.youtube.com/watch?v=t-sXHl3l-rM)
UHI effect is proportional to the size of the city – but all cities, large and small, have them.

The annual mean air temperature of a city with one million or more people can be 1.8 to 5.4°F (1 to 3°C) warmer than its surroundings, and on a clear, calm night, this temperature difference can be as much as 22°F (12°C).

Heat Island effect often decreases as city size decreases.

Seasonality – summer and winter

"warm island" among the "cool sea"
Hot-lanta

Urban temperature anomaly

https://tackyraccoons.com/2013/01/30/hot-lanta-in-may/
Small and Medium sized cities also matter!!


- peaked during the night


- peaked during the day

Measurements done using iButton sensors

Hug and Mitra 2014
Heat Waves and connection to Urban Heat Islands
Heat Wave definitions

- There are > 15 definitions for heat waves in the literature
  - The most important ones out there are –
  - NWS – 3 consecutive days with Tmax at least of 90°F (32.22°C) – Absolute numbers
  - Robinson (2001): At least 2 days of Tmin >26.7 °C or Tmx >40.6 °C – Relative numbers
  - Steadman (1984): Tmax (apparent) > 85th, 90th and 95th percentile (1 day) – relative numbers
Dynamical linkage and feedback among atmospheric blocking, drought, heatwave and urban heat island across multiple scales

Around 2°F (1°C) Urban Heat Island intensity increase over Birmingham AL because of blocking, drought and heatwave – August 13th – 17th 2007.

Limitation of study was less data points in Birmingham

Urban Heat Island effects on other weather phenomenon
Risk: Urban Storms

In circumstances where the regional airflow is very weak, a strong urban heat island could produce convergence over the city.

Seino et al. 2018  [https://doi.org/10.1016/j.uclim.2016.11.007](https://doi.org/10.1016/j.uclim.2016.11.007)
This visualization shows evaporation rates predicted by the NASA Land Information System (LIS) for a day in June 2001.
Thank you!!  Questions please

Bibliography:

- Seino et al. 2018  https://doi.org/10.1016/j.uclim.2016.11.007
- https://www.arcgis.com/apps/dashboards/73e329457b6644e7aeff3ecce43c8d8
Thank you!!

Questions please
Effects of Urban Heat on Health

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Health Impacts of Heat

• Emergency department visits, hospitalizations, and deaths all rise during extreme heat events.

• Heat cramps, heat exhaustion and heatstroke

• Exposure to high temperatures increases risk for many other conditions
  – Cardiovascular disease
  – Kidney disease
  – Respiratory disease
  – Poor reproductive outcomes
  – Behavioral and mental health conditions
Public Health Burden of Heat

- **A Silent Killer**
  - On average, heat is associated with more fatalities than other weather-related events
  - Deaths and illness *directly attributable* to heat are only a portion of total health impacts
    - Excess deaths and illnesses can be estimated from statistical approaches
Heat Vulnerability and Inequity

- *Not an equal-opportunity killer*
- Vulnerability: exposure, sensitivity, adaptive capacity
- Populations particularly vulnerable to heat-related illness and death
  - Older populations, those with chronic conditions, pregnant women
  - Socially isolated individuals
  - Communities of color and low-income populations
- Vulnerability linked to residential neighborhood and indoor home environment conditions
Heat Risk Perceptions

• Climate change is impacting heat-related illness and death now

• Perception of health risk due to extreme heat varies across populations
  – Age
  – Climate
  – Social vulnerability

• Health is an important motivator in discussions of climate change
Additional Resources


Follow Up Media References

3. https://e360.yale.edu/features/can-we-turn-down-the-temperature-on-urban-heat-islands
10. https://www.nationalgeographic.com/pages/topic/nat-geo-explores-video-series#3391ef35-0ca8-4a04-93b5-dd8543e5d71d