

Understanding Your City's Heat Islands: Overview and Key Considerations

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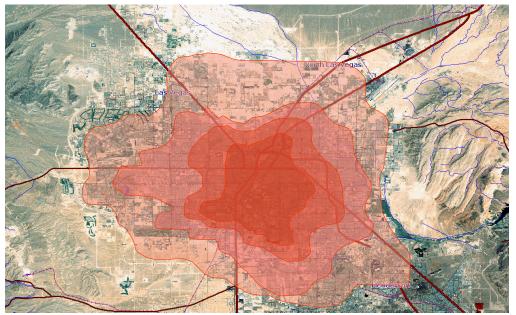
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> ARIZONA STATE UNIVERSITY September 7, 2017

Defining "the Urban Heat Island (UHI)"

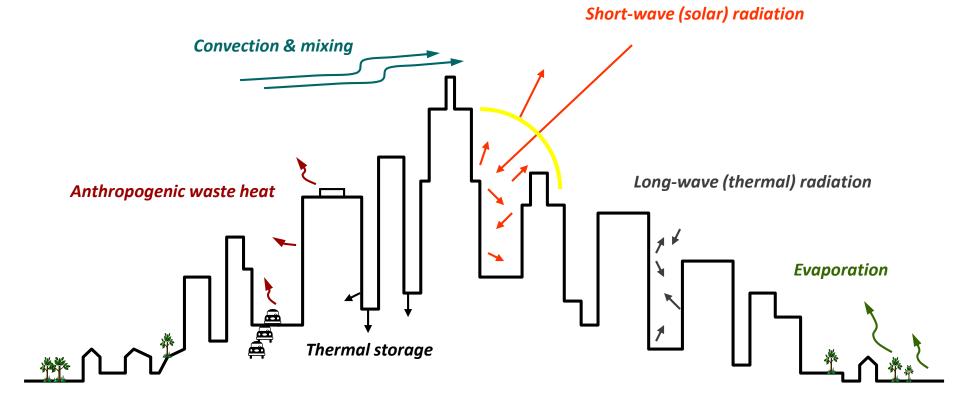
"An area of higher temperatures in an urban setting compared to the temperatures of the suburban and rural surroundings. It appears as an 'island' in the pattern of isotherms on a surface map."

- Glossary of Weather and Climate, Ira Geer, Ed.



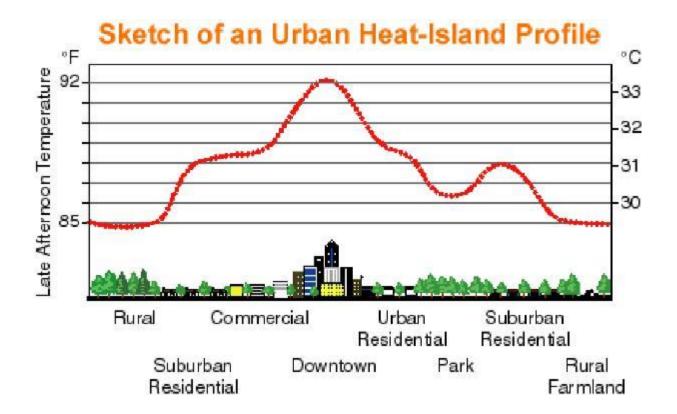


What causes the urban heat island phenomenon?





Most common image when searching the internet for "Urban Heat Island"





Air Temperature UHI via empirically-based models

Theor Appl Climatol (2009) 95:397–406 DOI 10.1007/s00704-008-0017-5

ORIGINAL PAPER

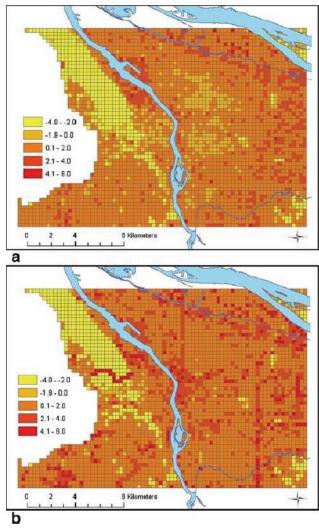
Quantifying the influence of land-use and surface characteristics on spatial variability in the urban heat island

Melissa A. Hart • David J. Sailor

Received: 5 July 2007 / Accepted: 30 January 2008 / Published online: 7 May 2008 Springer-Verlag 2008

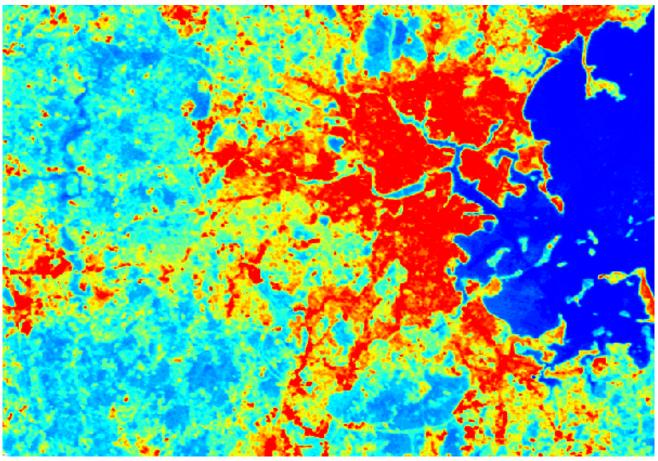


... usually the "shelter" height of 1.25 to 2 m (~4 to 6 ft)





Another common type of UHI image...



Camilo Pérez Arrau, 2010



Surface Temperature UHI is by definition highly variable...

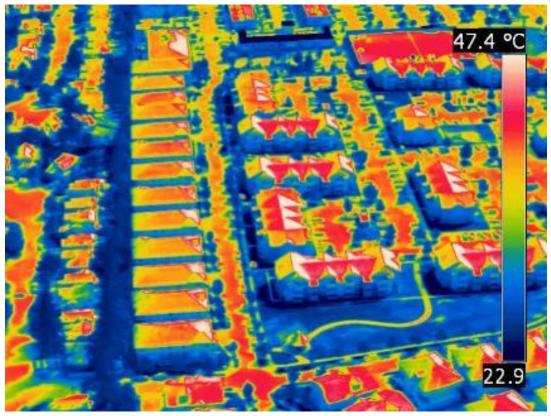


Image from Moody and Sailor

... and consists of horizontal and vertical surfaces



A Cautionary Note

"Overall, the quality of the UHI literature and its empirical content is low at best... **nearly** half of the evaluated studies provide estimates of UHI magnitude that are unacceptable in terms that environmental science can reasonably expect." INTERNATIONAL JOURNAL OF CLIMATOLOGY Int. J. Climatol. 31: 200–217 (2011) Published online 15 April 2010 in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/joc.2141



A systematic review and scientific critique of methodology in modern urban heat island literature

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ABSTRACT: In the modern era of urban climatology, much emphasis has been placed on observing and documenting hear island magnitudes in cities around the world. Urban climate literature consequently basts a remarkable accumulation of observational heat island studies. Through time, however, methodologists have raised concerns about the authenticity of these studies, especially regarding the measurement, definition and reporting of heat island magnitudes. This paper substantiates these concerns through a systematic review and scientific critique of heat island magnitudes. This paper substantiates these concerns through a systematic review and scientific critique of heat island magnitudes. This paper substantiates these concerns through a systematic review and scientific critique of heat island magnitudes. This paper substantiates these concerns through a systematic review and scientific critique of heat island magnitudes. This paper substantiates these concerns through a systematic review and scientific critique of heat island singuity score of the sample is just 50 percent, and nearly half of all urban heat island magnitudes, and there quarters sample are controlled measurement and openness of method; one-half of the sample studies fail to sufficiently control the confounding effects of weather, relief or time on reported 'urban' heat island magnitudes, and three-quarters fail to communicate basis metadata regarding instrumentation and field site characteristics. A large proportion of observational heat island iterature is herefore componised by poor scientific practice. This paper concludes with recommendations for improving method and communication in heat island studies through better scrutiny of findings and more rigorous reporting of primary research. Copyright © 2010 Royal Meteorological Society

Stewart, I.D., 2011.

- Recommendations
 - 1. Representativeness of sites
 - 2. Standardized site reporting guidelines
 - 3. Disclose limits of data (uncertainty)
 - 4. Use terminology with discretion (e.g., "the UHI")



Further Caveats about Working with UHI

- Do we really care about a UHI magnitude?
 - What is important, ΔT_{u-r} or T ?
- In fact, how much do we care about T itself?
 - Think about the end points that we actually do care about...
- Thermal comfort, heat-related mortality and morbidity
 - Air temperature, humidity... and surface temperatures
 - Daytime highs are important, but so too are nighttime lows.



Measuring Urban Thermal Environments Air Temperatures

- Traditional first-order (NWS) weather stations
 - High quality instruments and generally sound siting
 - Long-term hourly records
 - Limited spatial coverage
- Networks of "lower-quality" stations
 - Lower quality instruments and siting
 - Better spatial coverage
- Mobile traverses
 - Poor temporal resolution
 - Good spatial coverage (on roads/paths)
- Crowd-sourced data
 - Quantity and extensive QA/QC protocols help to make up for poor quality data.











General Considerations for Air Temperature Measurements

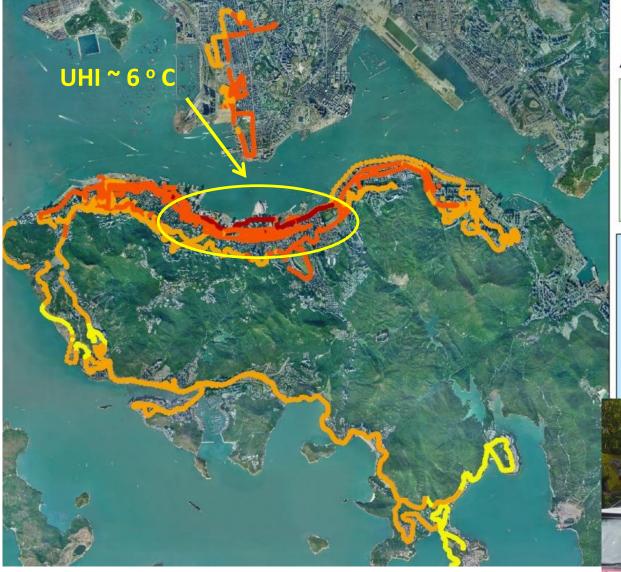
- Accuracy of temperature measurements influenced by
 - Sensor type (e.g. Thermistor, Thermocouple, RTD)
 - Sensor temporal response characteristics
 - Instrumentation/circuitry
 - Sensor environment (e.g. radiation shielding, aspiration)
 - Nearby microclimate
- Representativeness is key to generating useful data

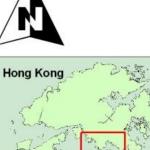






Traverse Measurement Example







UHI Magnitude (°C)

- -3.99 -2.00
- -1.99 0.00
- 0.01 2.00
- 2.01 4.00





Measuring Urban Thermal Environments Surface Temperatures

- Radiometers on satellites and aircraft
 - Often limited to a few overpasses per day and require cloud-free conditions
 - Vertical surfaces not "visible"
 - Intervening atmospheric attenuation and surface emissivity must be estimated
- Hand-held IR cameras
 - Capable of measuring horizontal and vertical surfaces
 - Limited spatial coverage
 - Surface emissivity must be estimated
- Relating to air temperatures
 - Uncertainties/errors can be high









In Summary...

You must be careful in defining your measurement objectives, designing your measurement/analysis system, and conveying your results... or they are useless.



