

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

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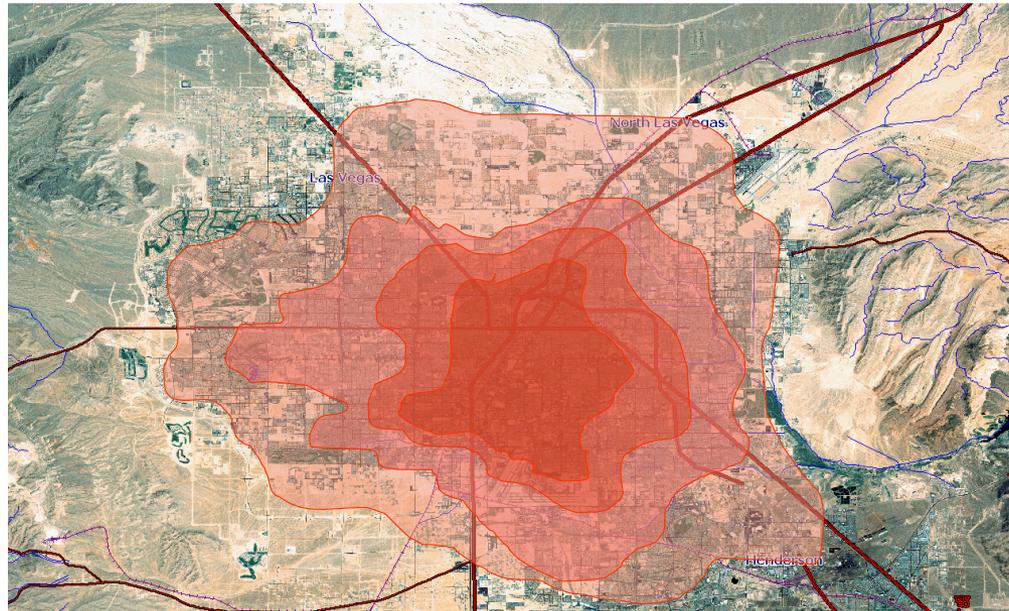
ARIZONA STATE UNIVERSITY

September 7, 2017

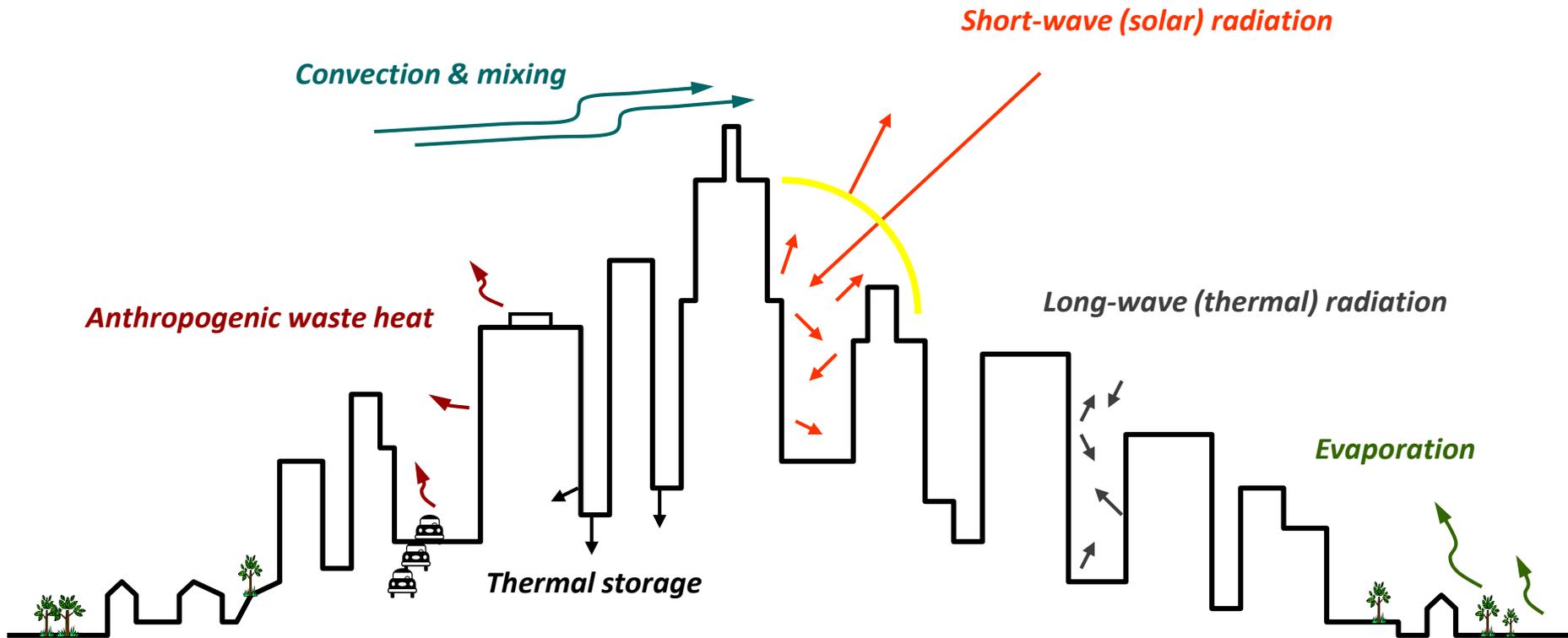
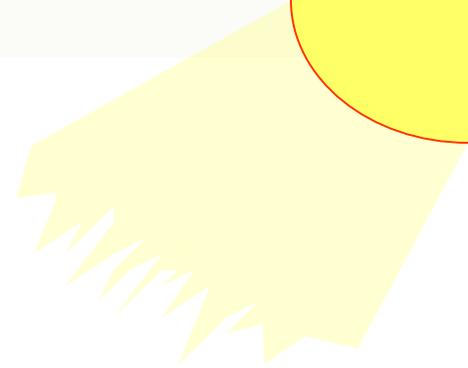
Defining “*the Urban Heat Island (UHI)*”

“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.”

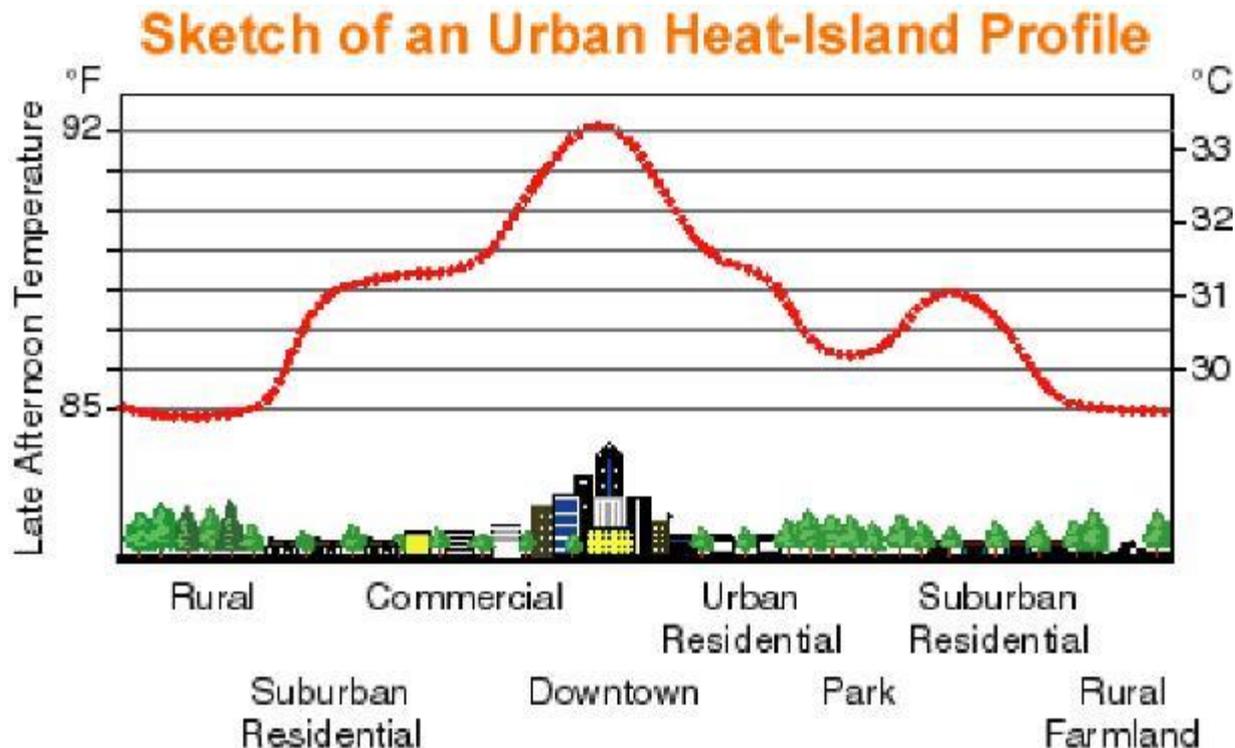
- *Glossary of Weather and Climate, Ira Geer, Ed.*



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

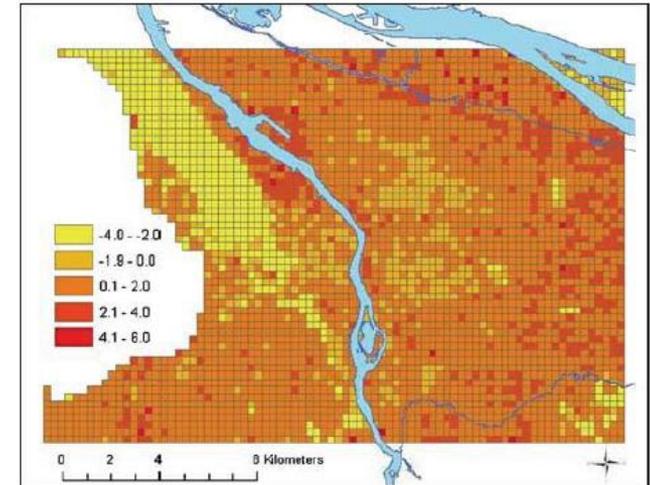
Quantifying the influence of land-use and surface characteristics on spatial variability in the urban heat island

Melissa A. Hart · David J. Sailor

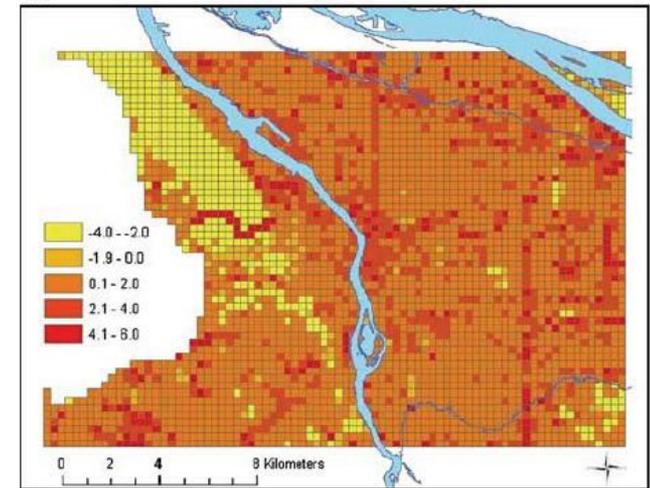
Received: 5 July 2007 / Accepted: 30 January 2008 / Published online: 7 May 2008
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... usually the “shelter” height of 1.25 to 2 m (~4 to 6 ft)

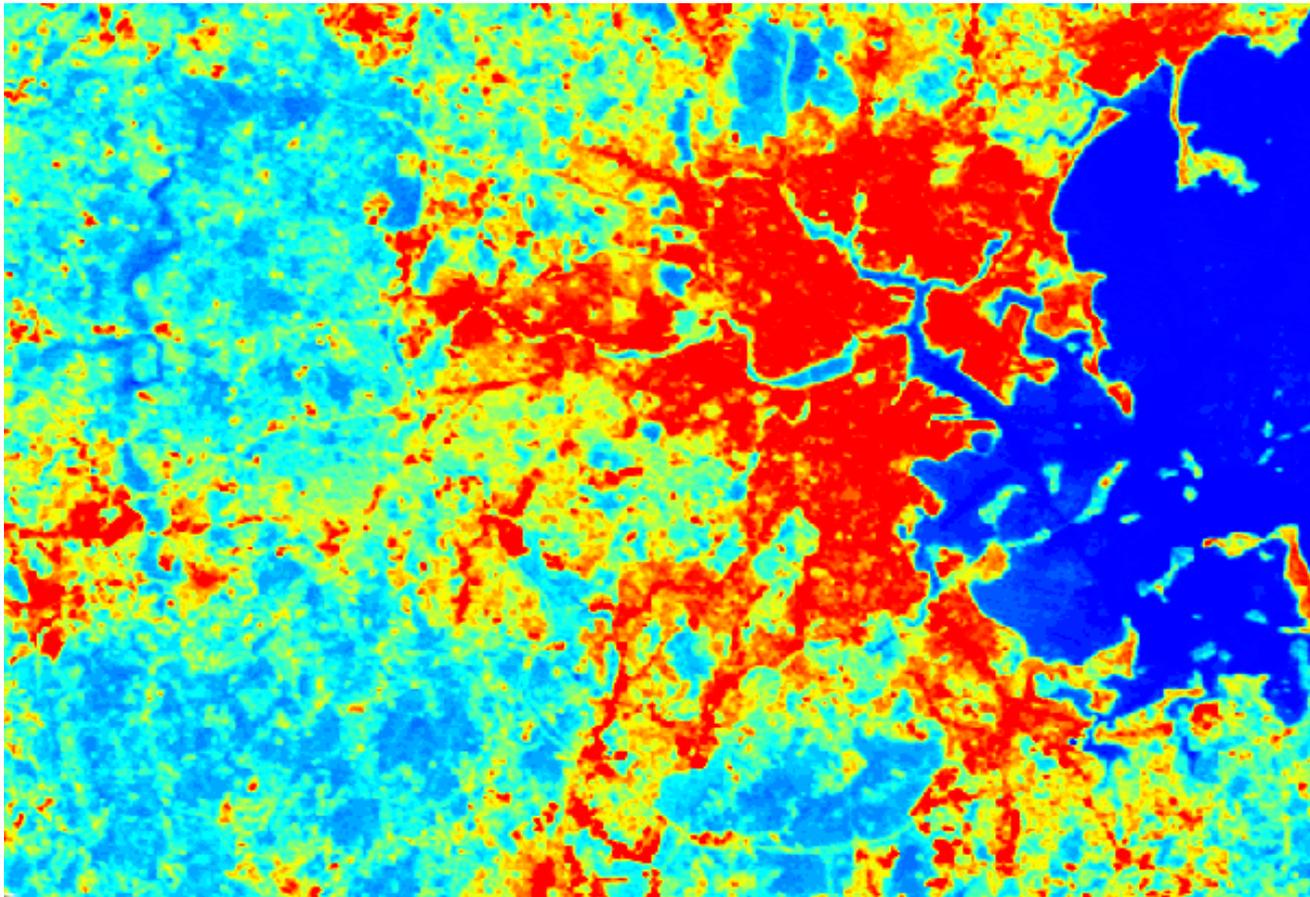


a



b

Another common type of UHI image...



Camilo Pérez Arrau, 2010

Surface Temperature UHI is by definition highly variable...

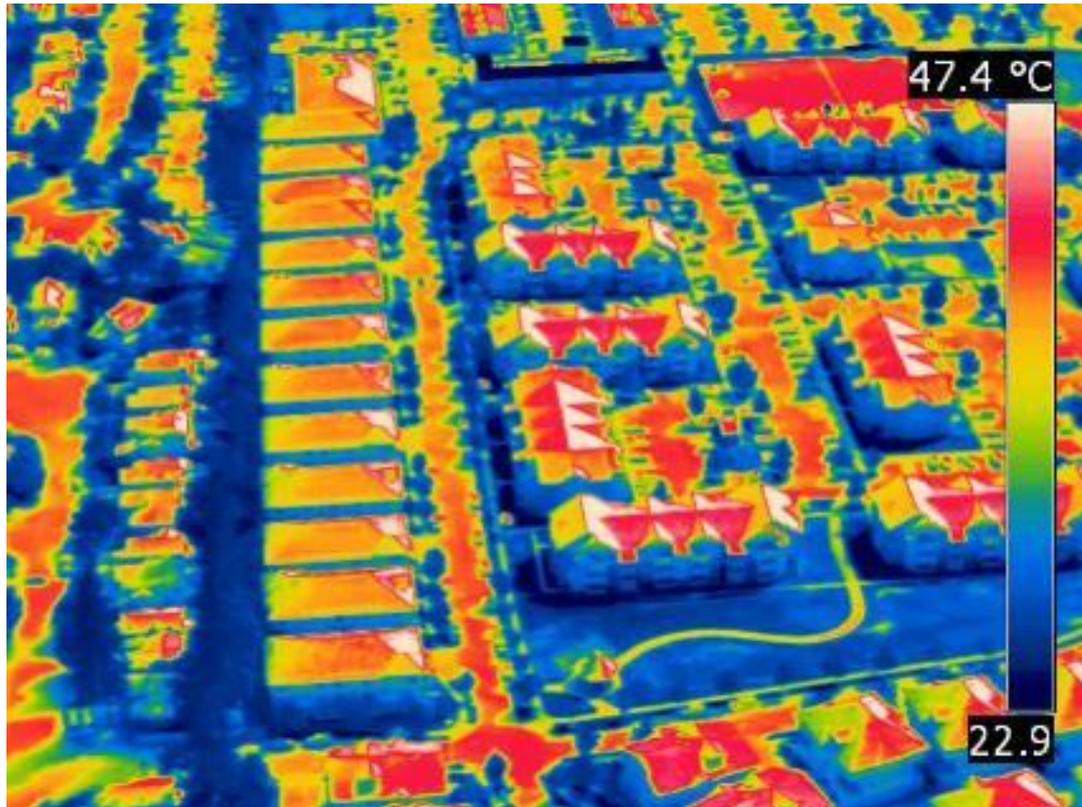


Image from Moody and Sailor

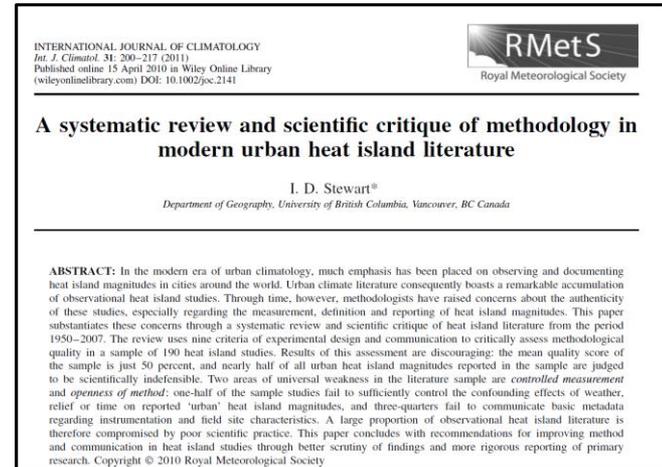
... and consists of horizontal and vertical surfaces

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.”

- 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”)



Stewart, I.D., 2011.

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.

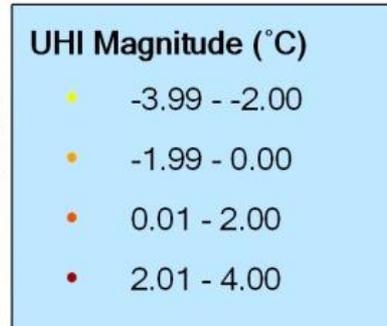
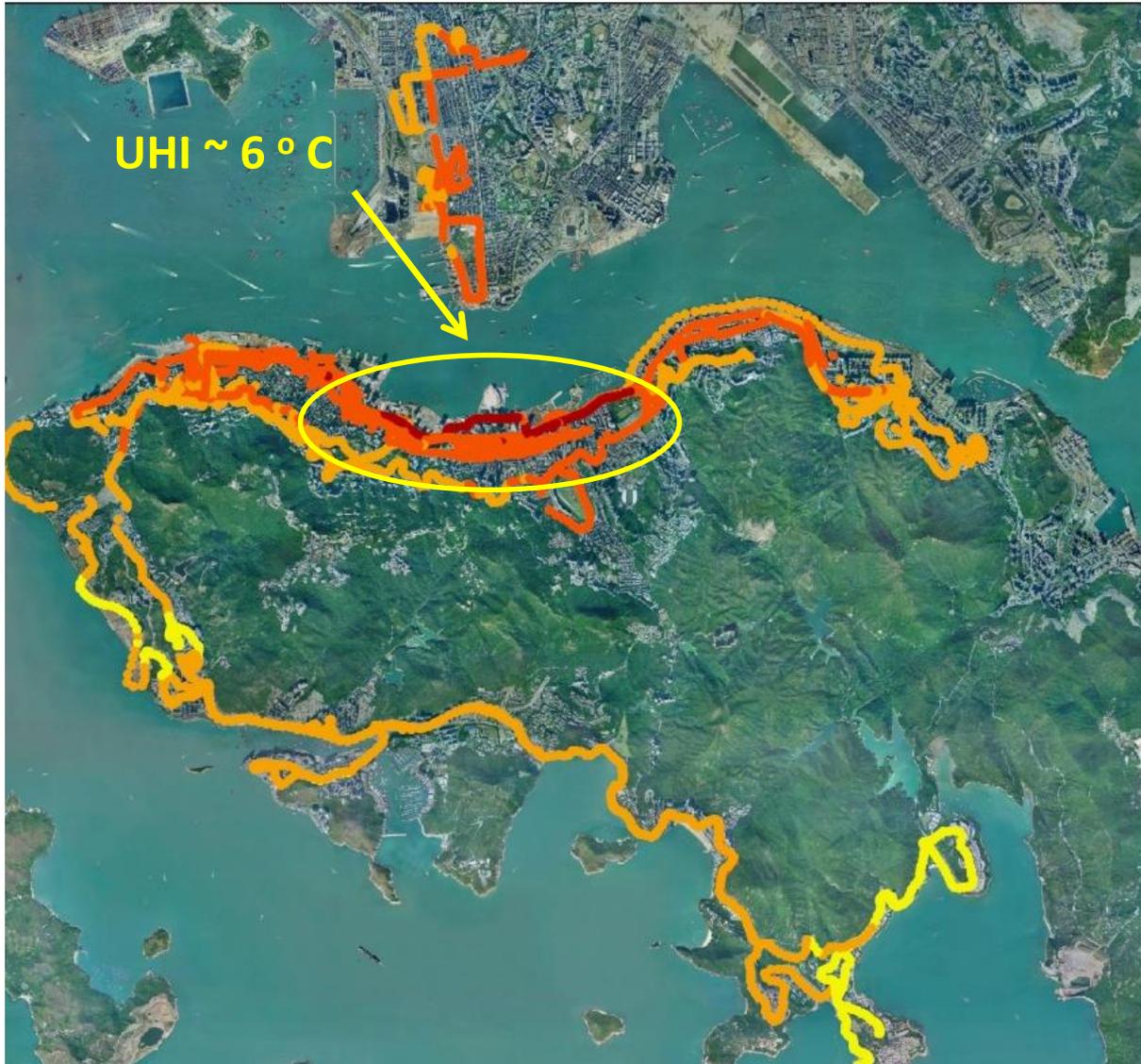


General Considerations for Air Temperature Measurements

- 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



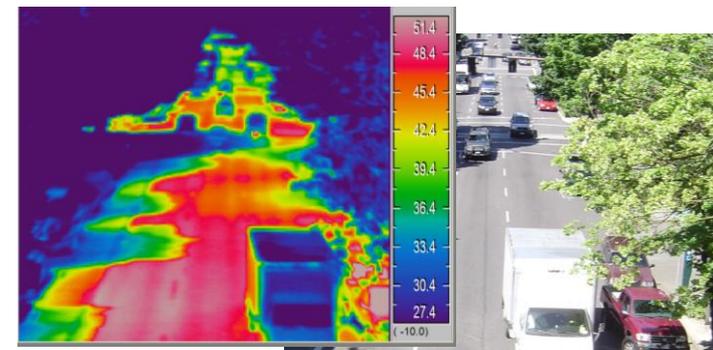
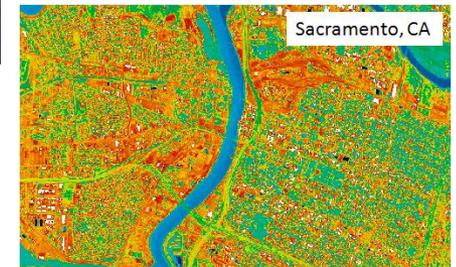
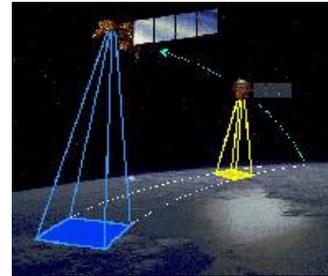
Traverse Measurement Example



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.

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