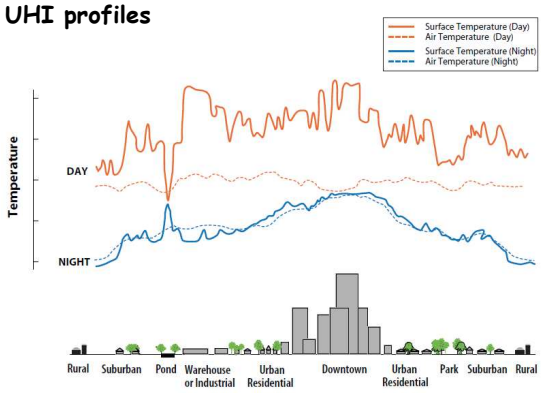
URBAN CLIMATOLOGY

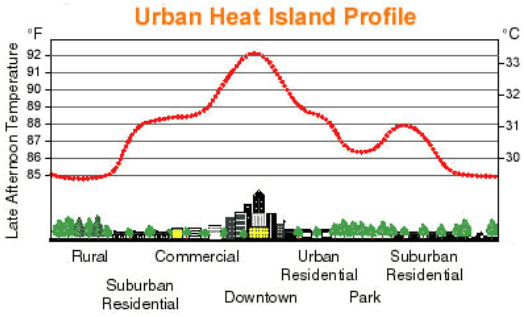
4. Urban heat Island, UHI types, atmospheric UHI, UHI intensity

UHI profiles



Reducing Urban Heat Islands: Compendium of Strategies and (Voogt 2000)

4.1 Urban Heat Island concept



http://weather.msfc.nasa.gov/urban/urban_heat_island.html)

Simplified model – role of natural and anthropogenic factors?

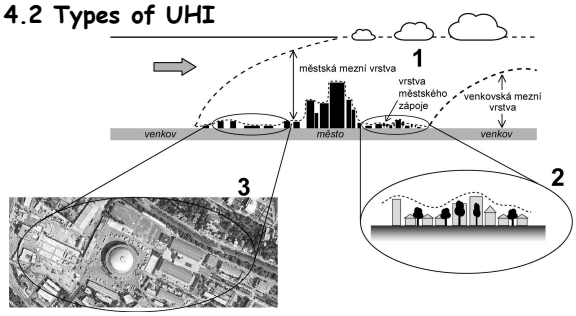
UHI types characteristic

Table 1: Basic Characteristics of Surface and Atmospheric Urban Heat Islands (UHIs)[4]

Feature	Surface UHI	Atmospheric UHI
Temporal Development	• Present at all times of the day and night • Most intense during the day and in the summer	• May be small or non-existent during the day • Most intense at night or predawn and in the winter
Peak Intensity (Most intense UHI conditions)	• More spatial and temporal variation: ▪ Day: 18 to 27°F (10 to 15°C) ▪ Night: 9 to 18°F (5 to 10°C)	• Less variation: ▪ Day: -1.8 to 5.4°F (-1 to 3°C) ▪ Night: 12.6 to 21.6°F (7 to 12°C)
Typical Identification Method	• Indirect measurement: ▪ Remote sensing	• Direct measurement: ▪ Fixed weather stations ▪ Mobile traverses
Typical Depiction	• Thermal image	• Isotherm map • Temperature graph

Reducing Urban Heat Islands: Compendium of Strategies and (Voogt 2000)

4.2 Types of UHI

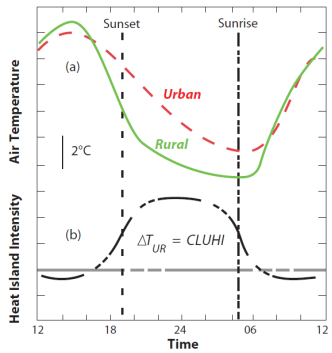


1. Atmospheric Boundary layer Urban Heat Island
2. Atmospheric Canopy Layer Urban Heat Island
3. Surface Urban Heat Island)

(Oke 1976)

What variables are measured?

UHI intensity (ΔT_{u-r})



Conceptual Drawing of the Diurnal Evolution of the Urban Heat Island during Calm and Clear Conditions (modified from Oke, 1982)

UHI intensity (ΔT_{u-r})

The size of the city forms the intensity of UHI in general

The size of the city can be characterized via number of inhabitants

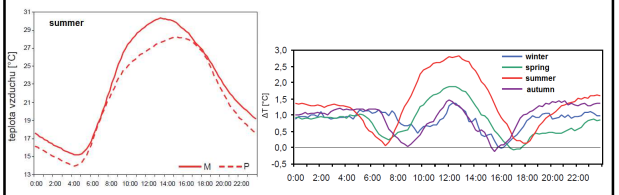
There is a relation between maximum UHI intensity (*UHImax*) and number of dwellers(*P*) (van Hove et al. 2011):

$$UHImax = 2{,}93 \log P - 11{,}95$$

For Brno (P = 380 ths.) UHImax = 4,4 °C

How we can estimate UHI intensity depending on available data?

UHI Intensity in Brno



Mean daily variations of summer air temperature at urban (M) and rural (P) stations during clear and calm days in Brno region (left) and daily variation of urban heat island intensity (ΔT); UHI intensity is expressed as a difference between mean air temperature at urban and rural stations (right)

4.3 Measuring the UHI effect

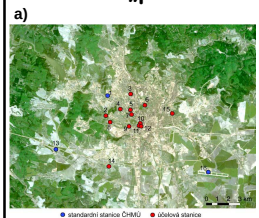
- „Point" measurements – standard meteorological stations
- „Point" measurements – special-purpose automatic stations
- Mobile measurements
- Urban remote sensing
- Urban climate and UHI intensity modelling

All types of measurements also involve three different components that are hardly to quantify (Lowry 1977):

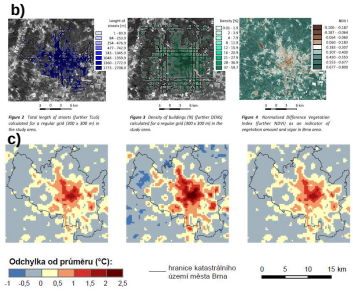
1. the „backgound" climate
2. the effects of local climate (topoclimate)
3. the effect of local urbanization

Where are the spatial limits of the urban effect?

UHI – „point" measurements

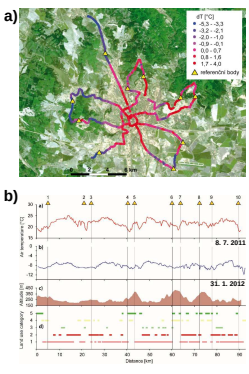


Spatial distribution of meteorological stations in Brno area (**a**); selected explanatory variables (**b**)



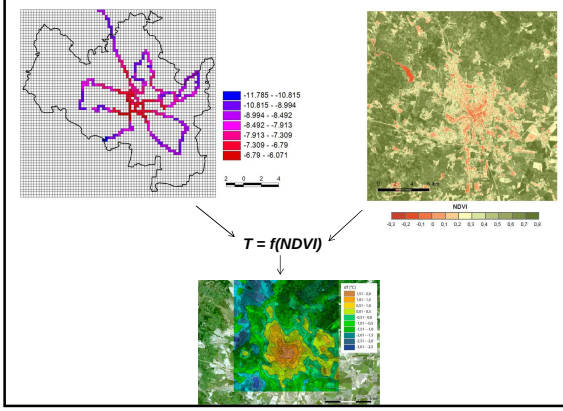
Spatial distribution of mean daily air temperature (Tavg), temperature minimum (Tmin) and intensity of UHI (ΔT) in Brno area during clear and calm days in summer; air temperatures are expressed as deviations from mean temperature of the study area (**c**)

AUHI – mobile measurements



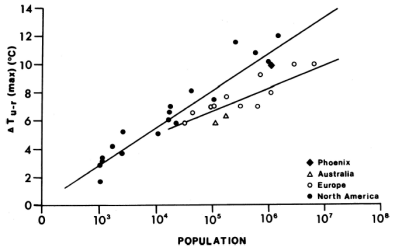
Design of measuring routes (**a**), air temperature profile along measurement routes (**b**) and typical spatial distribution of air temperature in central part of Brno in early night hours; air temperature is expressed as deviation (dT) from mean value of the study area and is typical for clear and calm weather during summer (**c**)

AUHI – mobile measurements



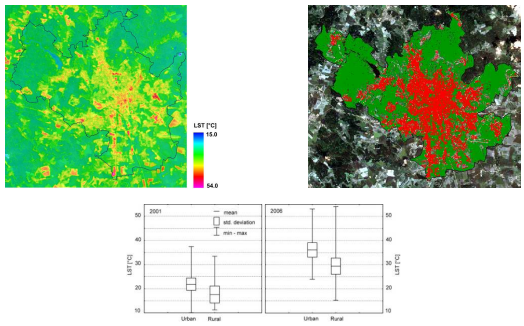
4.5 Final remarks and questions

- UHI intensity in different parts of the wolrd



- Canopy layer urban heat islands exist in the layer of air where people live. So why we are taking care about boundary layer UHIs?

SUHI – remote sensing



(a) Spatial variability of LST values within the Brno region; LST derived from Landsat thermal imagery acquired on 15 June 2006. (b) Intensity of surface UHI in Brno region defined as the difference between urban (M) and rural areas (P); LSTs

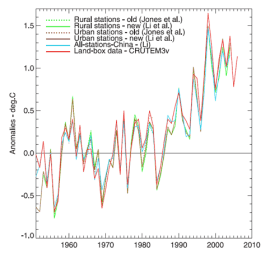
4.5 Final remarks and questions

- How do Urban Heat Islands form?
- How we can estimate UHI intensity depending on available data?
- What are the main problems related to UHI?
- Can be there any benefits of UHI?
- Is there any relation to recent global climate change?

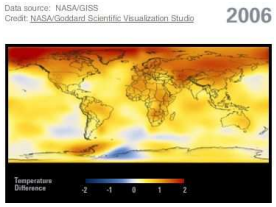
(Strategies to Reduce Urban Heat Islands will be discussed in the final lecture)

4.4 UHI and recent global warming

A paper by McKitrick & Michaels concludes that half of the global warming trend from 1980 to 2002 is caused by Urban Heat Island.



Urban and rural regions show the same warming trend.



The greatest difference in temperatures for the long term averages where across Russia, Alaska, far north Canada and Greenland and not where major urbanisation has occurred.