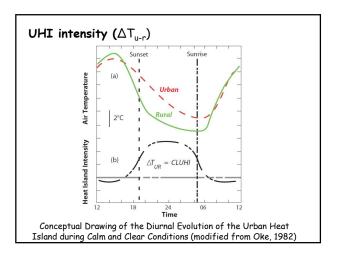


Feature	Surface UHI	Atmospheric UHI
Temporal Development	Present at all times of the day and night Most intense during the day and in the summer	May be small or non-existent during the day Most intense at night or predawn and in the winter
Peak Intensity (Most intense UHI conditions)	More spatial and 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



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?

4.3 Measuring the UHI effect

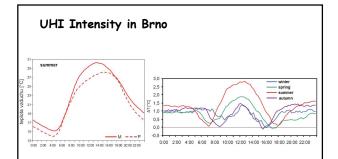
- · "Point" measurements standard meteorological stations
- · "Point" measurements special-purpose automatic stations
- · Mobile measurements
- · Urban remote sensing
- · Urban climate and UHI intensity modelling

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

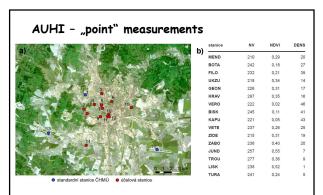
- 1. the "backgound" climate
- 2. the effects of local climate (topoclimate)
- 3. the effect of local urbanization

Where are the spatial limits of the urban effect?

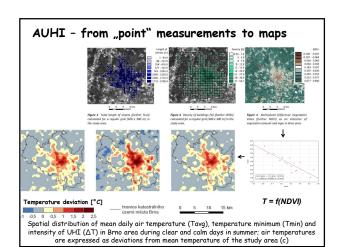


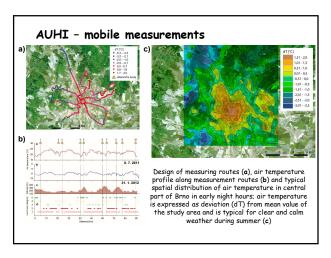


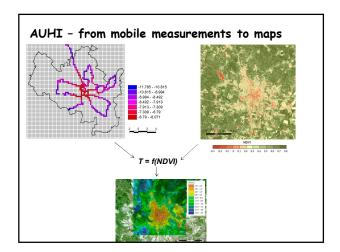
Mean daily variations of summer air temperature at urban (M) and rural (P) stations during clear and calm days in Brno region (left) and daily variation of urban heat island intensity (ΔT); UHI intensity is expressed as a difference between mean air temperature at urban and rural stations (right

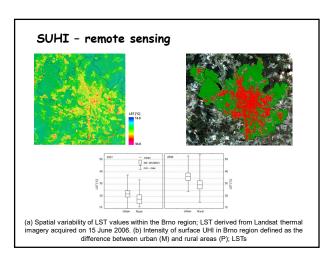


Spatial distribution of meteorological stations in Brno area (a) and their characteristics: Elevation (NV), density of buildings (DENS), and amount of vegetation (NDVI) (b)









UHI consequences

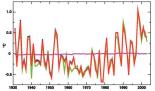
- UHI impacts may be **direct** and **indirect**, negative effects prevail in general
- Diurnal Temperature Range is smaller in cities
- Higher air pollution reduce nighttime cooling, both factors increase a discomfort for city dwellers
- Increased temperatures during summer in cities amplify energy demand for air conditioning.
- Higher surface temperatures can heat storm water runoff with negative effect of various water ecosystems (thermal pollution)
- Impacts to plants through changes in phenology may be ambiguous (beginning and end of individual phases of the growing cycle)

4.4 UHI and recent global warming The question is whether urban-affected temperature records have significantly biased large-scale temporal trends. One of the discontinuous process of the

UHI and recent global warming

 $\label{thm:continuous} \mbox{Urban and rural regions show the same warming trend.}$





Anomaly (**) time series relative to the 1961 to 1990 mean of the full US Historical Climatology Network (USHCN) data (red), the USHCN data without the 16% of the stations with populations of over 3,000 within 6 km in the year 2000 (blue), and the 16% of the stations with populations over 30,000 (green). The full USHCN set minus the set without the urban stations is shown in magenta. Source 1PCC 2007

Parker (2004, 2006) noted that warming trends in night minimum temperatures over the period 1950 to 2000 were not enhanced on calm nights, which would be the time most likely to be affected by urban warming.

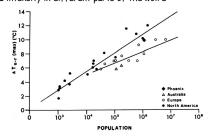
CISTEMP v4 Annual Trend 1979-2019 Temperature change (C)

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

Source https://climate.nasa.gov

4.5 Final remarks and questions

· UHI intensity in different parts of the wolrd



 What is the main reason of a different relation between UHI intensity and population in different regions?

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?
- What is a relation between heat waves and 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)