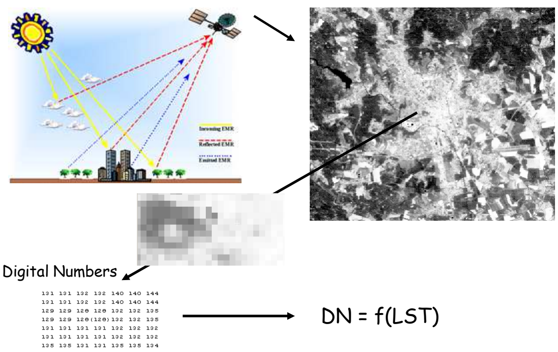
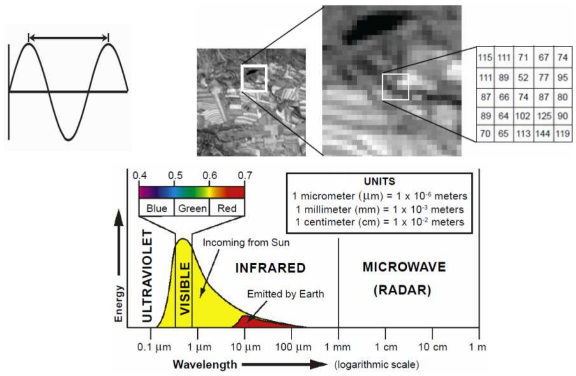
URBAN CLIMATOLOGY

5. Urban Remote Sensing

5.1 Remote Sensing Principles



5.1 Remote Sensing Principle



http://www.remote-sensing.net/concepts.html

5.1 Remote Sensing Principle

Stefan-Boltzmann law: The thermal energy radiated by a **blackbody** is proportional to the fourth power of the absolute temperature:

$$M = \sigma T^4$$

M - thermal energy
T - absolute temperature
σ - the Stefan–Boltzmann constant

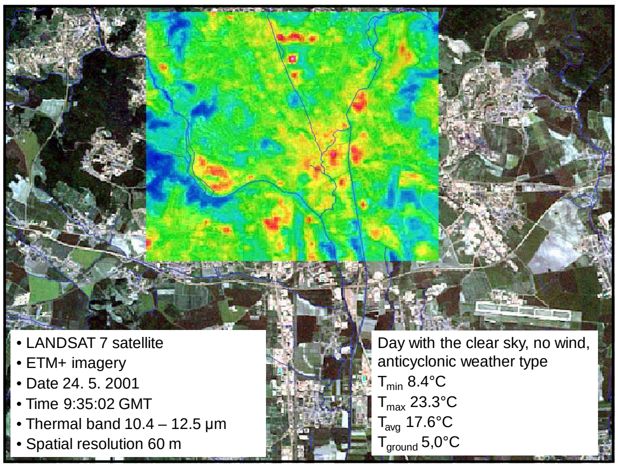
Real surfaces

$$M = \varepsilon \sigma T^4$$

ε - emissivity

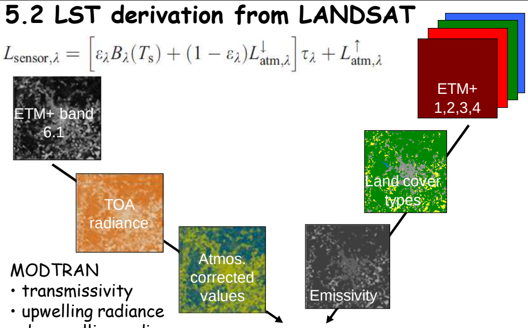
There are at least **two problems** in urban remote sensing:

1) How to determine emissivity of real surfaces in highly heterogeneous urban environment
2) How to recalculate LST - Land Surface Temperature to air temperature

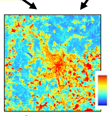


5.2 LST derivation from LANDSAT

$$L_{\text{sensor},\lambda} = \left[\varepsilon_\lambda B_\lambda(T_s) + (1-\varepsilon_\lambda)L^{\downarrow}_{\text{atm},\lambda}\right]\tau_\lambda + L^{\uparrow}_{\text{atm},\lambda}$$

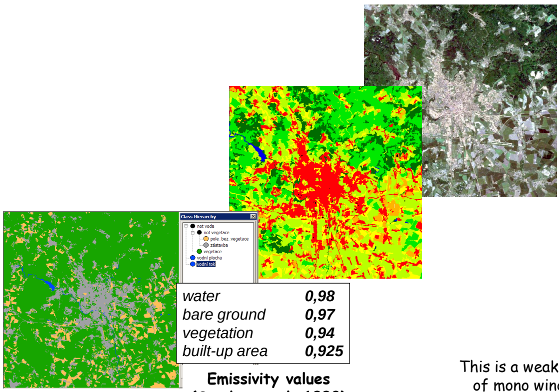


MODTRAN
• transmissivity
• upwelling radiance
• downwelling radiance
(Barsi et al. 2005)



Land surface Temperature

Emissivity map of basic land cover types

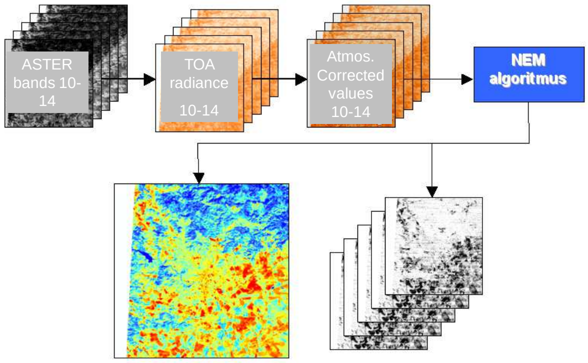


water	***0,98***
bare ground	***0,97***
vegetation	***0,94***
built-up area	***0,925***

Emissivity values (Snyder et al. 1998)

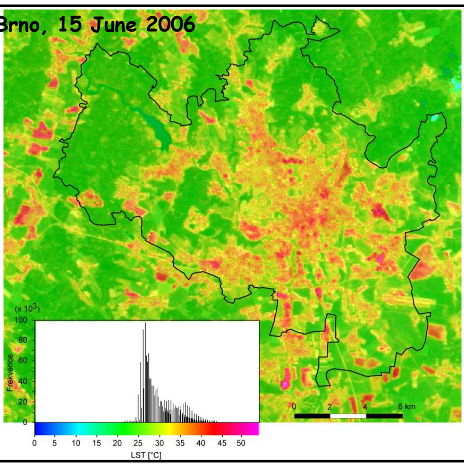
This is a weak point of mono window algorithms

LST derivation from ASTER data
(more thermal images)

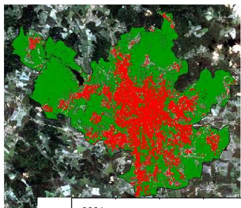


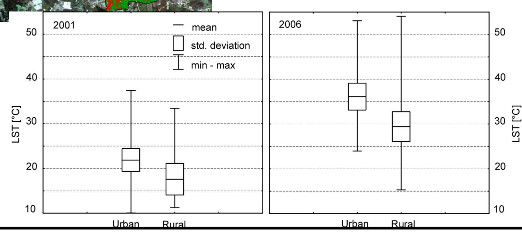
Land Surface Temperatures **Emissivity at bands 10-14**

LST, Brno, 15 June 2006

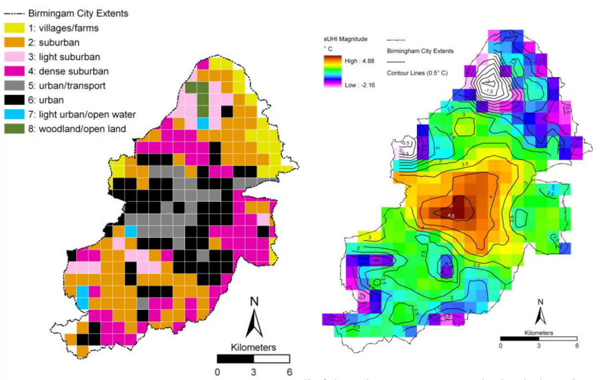


Intensity of SUHI





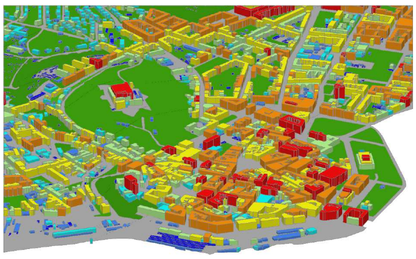
Examples of SUHI analysis



Spatial distribution of land classification (left) and SUHI magnitude (right) within Birmingham city extents for heatwave event at 18 July 2006 (Tomlinson et al., 2010)

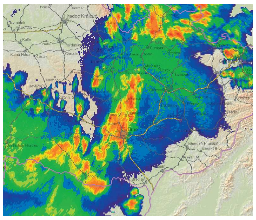
Another useful Remotely Sensed variables for UC

1. Spatial distribution of the Land Surface Temperature
2. Terrain model with 3D building model (laser scanning)
3. Land use mapping, vegetation mapping

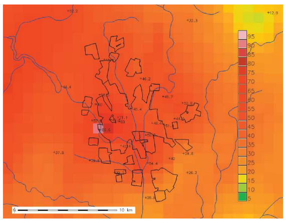


Various parameters derived from 3D model of buildings and from Digital Elevation Model explain spatial variability of land surface temperatures.

Precipitation and weather RADAR

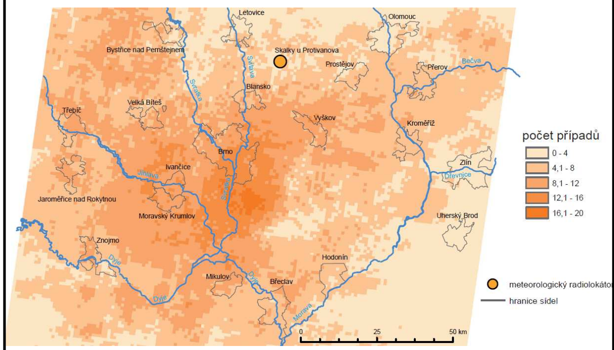


Spatial distribution of radar reflectivity (maximum values in vertical direction) measured at meteorological radars Skalky and Brdy at 15 July 2009, 19:25 hours of central European summer time



Spatial distribution of daily precipitation totals (mm) computed as a combination of radar-based precipitation estimate and rain-gauge measurements from 15 July 2009 (measured at 16 July 2009, 08 h central European summer time). Stations with higher precipitation totals are preferred in the map. Spatial distribution of precipitation totals is given in 1 x 1 km grid

Precipitation and weather RADAR



Frequency of the above-average maximum radar reflectivity in Brno region composed from 26 situations with extreme convection at Tuřany station in the period 2000–2007

5.5 Final remarks and questions

1. What are limitations of URS in terms of spectral, spatial and temporal resolution?
2. What are the main benefits of URS for heat wave studies compared to air temperature analysis?
3. How can be URS used for practical urban planning, regional development and for better adaptation to climate change?