Geophysical Research Abstracts
Vol. 14, EGU2012-12458, 2012
EGU General Assembly 2012

Differences between satellite- and ground-based urban heat island effect – Case study for the Budapest agglomeration area

R. Pongracz (1), J. Bartholy (1), E. Lelovics (1), ZS. Dezso (1), and I. Dobi (2)

(1) Dept. of Meteorology, Eötvös Loránd University, Budapest, Hungary (prita@elte.hu), (2) Hungarian Meteorological Service, Budapest, Hungary

Urban heat island (UHI) is defined as the positive temperature anomaly occurring between built-in areas and their surroundings. For detailed analysis of UHI in a particular area, different approaches can be used. Here, two different techniques (ground-based and satellite-based) are applied to the Budapest agglomeration area and the results are compared. (1) Hourly recorded air temperature observations are available from six automatically operating climatological stations of the Hungarian Meteorological Service. Two stations are located in the downtown of Budapest (Kitaibel Pál street and Lágymányos); two stations can be found in the suburbs (Újpest and Pestszentlőrinc); and two stations are in the rural region (Penc - located to the northeast from the capital, and Kakucs - to the southeast from Budapest). These ground-based observations at the Budapest weather stations provide air temperature data at standard 2 m height above surface. However, due to the limited station number, this approach is not suitable for detailed evaluation of spatial UHI distribution. (2) Remotely sensed surface temperature values are available from seven thermal infrared channel measurements of the multi-spectral radiometer sensor called MODIS (Moderate Resolution Imaging Spectroradiometer), which is one of the sensors on-board satellites Terra and Aqua. They were launched to polar orbit as part of the NASA's Earth Observing System in December 1999, and in May 2002, respectively. Satellite Terra (Aqua) provides surface temperature fields around 09-10 UTC (12-13 UTC) and 20-21 UTC (02-03 UTC) with 1 km spatial resolution. The whole agglomeration has been divided into urban and rural pixels using the MODIS Land Cover Product categories, distance from the city centre, satellite images of the Google Earth, and GTOPO-30 global digital elevation model. However, the main disadvantage of this method is that for UHI analysis, data can be used only in case of clear sky conditions, which occurs less frequently in the Carpathian basin during winter than summer.

The purpose of the present research is to analyze similarities and differences between temperature values observed in the 2001-2010 period by ground-based and satellite-based instruments. Thus, monthly and seasonal mean temperature values for day-time (morning and afternoon) and night-time (late evening and before dawn) are evaluated and compared for Budapest and its vicinity. Furthermore, distribution of temperature values is analyzed on a seasonal scale.

On the basis of the results, the following main conclusions can be summarized. (i) The mean temperature is generally higher in the downtown and lower in the rural region than in the suburbs, especially, at night-time. During day-time it is not so clear, the suburbs may be warmer than the downtown stations. (ii) Day-time/night-time satellite-based surface temperature is higher/lower than ground-based air temperature (especially, in summer/winter). This can be explained by the faster warming and faster cooling of the surface than those of the atmosphere. (iii) The satellite-based average temperature of Kakucs and Penc is highly correlated to the rural mean surface temperature. Thus, the mean temperature of the rural region can be estimated by the average temperature of these two weather stations. Moreover, the UHI intensity can be defined as the difference between the actual temperature value and the average temperature of Kakucs and Penc. This time series are calculated from both ground-based and satellite-based temperature values. (iv) The UHI intensity shows a large temporal variability. During day-time intensity values are larger when the satellite-based method is used than the ground-based measurements. During night-time the difference between the two approaches is very small.