

# ANALYSIS OF THE URBAN HEAT ISLAND EFFECT - COMPARISON OF GROUND-BASED AND REMOTELY SENSED **TEMPERATURE OBSERVATIONS**

## Rita PONGRÁCZ, Judit BARTHOLY, Enikő LELOVICS, Zsuzsanna DEZSŐ

Eötvös Loránd University, Department of Meteorology Pázmány P. st. 1/A. Budapest, H-1117 HUNGARY E-mails: prita@nimbus.elte.hu, bari@ludens.elte.hu, lelovics@zivatar.hu, tante@nimbus.elte.hu



#### Abstract

One of the most obvious and therefore six existies of action embanment is the so-called when least island (UHD). UHI is the anomaly occuring beta areas and their samoundings (Clin, 1962; Landabarg, 1965). There are several possible methods to determine UNI intensity and to measure temperature from which UNI intensity can be calculated. (1) The often used method is to observe calculated; [1] The offen used method is to observe our temperature by using find wastler satisfues; [2] Another possibility is to esa namolaly samed technique; (2), a multipactural woldship samed rates MONS, Seven Infrand charmels of MONS can be applied to achicular samica temperature; 3660– 3640 main (20), 3202-3880 mm (23), 4000-4000 mm Tale and (20), 3202-3880 mm (23), 4000-4000 mm [23], 3833-6700 nm (23], 10,763-11,260 nm [31], 11,770-12,270 nm (32], 13,185-13,485 nm (34].



Satellite-based terrorerature observations provide n ihne suadal ver a lange area, alibrari any large lime-las. On the city



hand, satellite-based mean ents result in surface rature while around based observations at the wather stations provide air temperature data Naturalit, these two variables are different, their spatiol and temporal distributions are also different. Moreover, the spatial resolution of the setalite- and ee positive con built-in meetings are also different To abbased temperature repr nis only the loca supporting of the meether station, while one are alty can be point value of the satelite-lased temper datasel represents a larger area, e.g., 1 km7 in case of MODIS The purpose of our research is to analyze similaritie

and differences between temperature values observed by ground-based and satellite-based instruments. In the current undisks temperature dataways for 2001-2008 have been evaluated usin grand-based temperature data from the weather stations of the Harmarian Meteorological Service in Bentapent, and satellity-based MCOE surface temperature (FMSA, 1969) for the nearest, grid points. We calculated monthly, sessand and anotal mean We continue transmit several and water mean temperature values. The results suggest that dop-tions/right-frame selelitz-based as/new temperature is higher/inner than grannb-hased air temperature (supersisting in swammer/whiter). This can be explained by the bater permise and molles of the sectors that

Mean temperature

· · · ÈB.

Generally, higher temperature is detected by

Higher temperature in the downtown (K, L) and

- Satellite-based rural mean is almost the same as

Air temperature at the weather station (°C)

<u>⊖</u> 20

Summer

Autumn

-20 -10 0

Air temperature at the weather station (°C)

KP satellite-based surface temperature

OKLP KP BERMANNER

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the satellite-based method

lower around the city (KP)

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is high strategies

hose of the atmosphere

2 15

**5** 14

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Winter

Spring



Comparison of the two observing methods

Satellite-based

Ground-based



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Satellite-based observations 2 polar-orbit satellites of NASA Terra: 09-10 UTC and 20-21 UTC - Agua: 02-03 UTC, 12-13 UTC mesaurements from 2003 - Surface temperature is calculated from spectral observations of (Penc. Kakucs)

p. Jacon

Ground-based observations 6 weather stations of the Hungarian Meteorological Service 2 in the downtown area of Budapest (Kitaibel Pál street, Lágymányos) 2 in the suburbs of Budapest (Újpest, Pestszentlőrinc - 2 small towns in the vicinity of Budapest According to WMO standards, Vaisala MILOS-500 and QLC-50 automated instruments Air temperature is measured

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maggesiment hörelget

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Londshows, H. E. (1985): The urban climate. Bartholy I. Powericz R. Bassii 2s. (2005): A Academic Press. 275 p. ies E. (2019): A hasal winasi hõ alaokin Linebuix of the urban heat isk hat is new فرنية والمتكالات وواسيعام فتناب műhokkes mérések teliseseműkisikai recondition satellite images), Apro 21 (itazie) the analysis of Humanian arts island officit using ground and, BSr. thesis satel lite-issued observations) EXtensi Louind University, Sur Porgniczit, Bartholy I. 34 p. INASA (1999): Science writers' galain to Terr MASA Furth Changelog Sectors Region Science Office, Greenbelt, MD, 25 p. Oke T. R. (1982). The energetic bases of the unitary least identify Constants Income of the Royal Metacorological Society 108, pp. 1-24

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usus). We thank NASA and the Earth Observing System Data Gateway for producing the satellite surface data and distributing it the European Union. We thank the Hingarian Meteorological Service for distributing ground-based data.









### Urban mean: rural mean

Satellite-based temperature data The average temperature of the two used weather station is close to rural mean temperature

- The difference between them is above 1 °C Urban mean temperature is 3-4 °C higher then rural mean temperature

#### Frequency distribution of difference between satellitebased surface temperature and ground-based air temperature - Day-time and night-time, Terra passing

time - In general positive differences are dominant in day-time and negatives are night-time, which implies that satellite-

based surface temperature is larger/smaller during day-time/night-time than groundbased air temperature - The smallest difference between the satellite- and the ground-based temperature values can be found in winter - The largest difference between the

temperature values is in spring and summe

satellite- and the ground-based



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#### Ground-based Úlinest: Kitaihel: Lág nvos: Pestszentlőrinc: urban mean

hese values are differences from Kakucs-Penc average

### Geographical location of the analysis





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- We calculated the urban heat island intensity as the difference between the average downtown and the average suburb temperatures - Day-time: heat island intensity is above 0 °C taking

into account the satellite-based observations, while it is below 0 °C in case of the the ground-based air temperature in this time Night-time: heat island intensity is positive in case of

both temperature observations. It is more intense using the air temperature than the surface temperature - Maximum of the surface-temperature-based

intensity: in winter and summer (except 2003, 2007) - Maximum of the air-temperature-based intensity: in

#### Difference between monthly mean temperature values observed with groundbased and satellite-based method

From March until October: - Surface temperature is higher than air temperature

- The warmest: Lágymányos, the coldest: Újpest In winter: - Air temperature is higher than surface temperature

- The two stations located in Buda (west from the river Danube) are warmer then the other ones in Pest (east from the Danube)

Results of the Welch-test: the difference between satellitebased and ground-based temperature values is not significant in spring and autumn. However, the two temperature values are significantly different in winter and

Annual mean temperature: the surface temperature is generally higher than the air temperature at all stations

Linear relationship: correlation coefficients have been calculated between the temperature anomaly values using satellite-based and ground-based measurements. Use the anomaly values was necessary in order to avoid the characteristic annual distribution of temperature, thus we calculated the difference between the actual temperature values and the monthly average. The result suggests that the linear correlation is high (0.85-0.95) and significant. The largest correlation coefficients were found for Újpest and Pestszentlőrinc.

2 m above the surface (standard height) Difference between rural mean



Marine



Satellite-based



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