

URBAN CLIMATE AND SMALL CITIES IN TROPICAL REGION: THE SPATIAL VARIATION OF AIR TEMPERATURE IN ITAJUBÁ, BRAZIL

Rafael Rodrigues FERREIRA, Aline PASCOALINO

Institute of Geosciences, State University of Campinas, Rua Carlos Gomes 250, Campinas, São Paulo, Brazil,
r243468@dac.unicamp.br, apascoal@unicamp.br

Climat urbain et petites villes en région tropicale : la variation spatiale de la température de l'air à Itajubá, Brésil

Mots-clés : îlot de chaleur urbain, variabilité des températures, transect mobile, Itajubá

Keywords: Urban heat island, Thermal variability, Mobile transect, Itajubá

Introduction

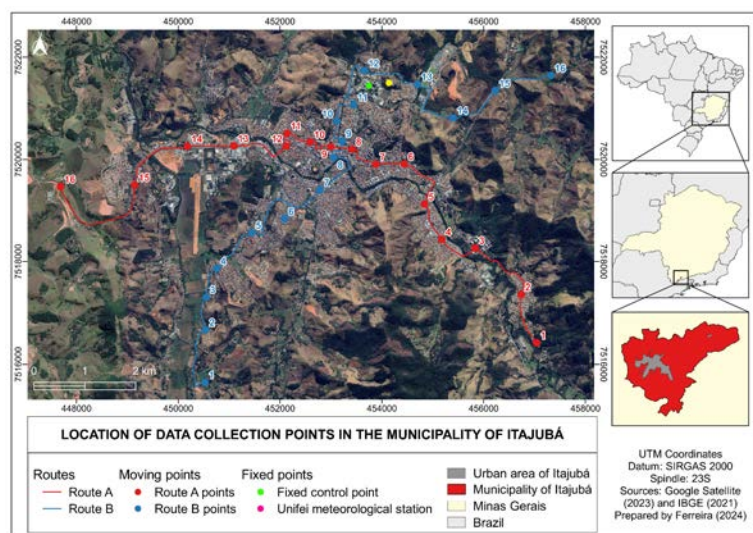
New geosystem dynamics are established in urban areas as a result of changes caused by anthropogenic action. Building density, soil sealing and the removal of vegetation cover, together with the prevailing synoptic conditions, among other factors, promote thermal changes in the urban boundary layer, resulting in differential heating of the city compared to its rural surroundings. Within the urban area, the air temperature is distributed heterogeneously, triggering the formation of urban heat islands (UHI) (Oke, 1979). With this in mind, the aim of this study was to investigate the spatial variation of air temperature in the city of Itajubá, Brazil, during a winter atmospheric episode. With recent evidence of changes in the mountain and valley breezes circulation in the urban space of Itajubá (Reboita *et al.*, 2014), it is possible to infer that the air temperature also undergoes changes in its patterns of intensity and distribution throughout the city.

1. Data and methods

The municipality of Itajubá is located in the south of the state of Minas Gerais, occupying an area of 294.83 km², of which only 19.51 km² is classified as urbanized. It has around 93,073 inhabitants, which gives it a regional influence in the south of Minas Gerais (IBGE, 2023). As for its climate, according to the Köppen classification, the city is characterized by Cwa type, with hot summers and mild, dry winters.

The air temperature data was collected between July 23 and 26, 2022. For this purpose, we opted to use the mobile transect technique. Every day, from 9pm to 10pm, two vehicles equipped with digital thermo-hygrometers traveled two routes through the city, where 32 measurement points were delimited (Fig. 1). The database was corrected using data obtained from a fixed point at the Federal University of Itajubá. Daily isotherm charts were then produced. In addition, a LCZ map is in progress. Finally, using García's classification (1996), the thermal variation of the air (ΔT) across the city was analyzed.

Figure 1. Location of the data collection points in the municipality of Itajubá.



2. Results and discussion

During the month of July 2022, the atmospheric blockade provided by the action of the South Atlantic Subtropical Anticyclone (SASA) prevented the passage of cold fronts over southeastern Brazil, resulting in atmospheric stability and favoring the heating of the city of Itajubá. The thermal variation between urban and rural areas (ΔT_{u-r}) reached values of over 5.5°C on the days under study (Fig. 2). Points 1B and 16B have been used as rural references. It indicates the formation of heat islands of strong, on the 24th, to very strong magnitude, on the 23rd, 25th and 26th, over the city, demonstrating that Itajubá combines characteristics that were capable of altering local climatic conditions during the episode.

Temperature	Data collection days			
	07/23/2022	07/24/2022	07/25/2022	07/26/2022
Highest T (°C)	18,8°C (Point 12A)	20°C (Points 8B and 10B)	18,9°C (Point 8B)	21,3°C (Points 9B and 10B)
Lowest T (°C)	11,9°C (Point 1B)	14,1°C (Point 1B)	11,4°C (Point 16B)	14,5°C (Point 1B)
ΔT_{u-r}	6,9°C	5,9°C	7,5°C	6,8°C

Figure 2. Highest and lowest temperatures recorded during the episode in the municipality of Itajubá.

Moving into the city, the air temperature was distributed heterogeneously as a result of the interaction with the different land uses (Fig. 3). At the rural edges, to the south (point 1B) and northeast (point 16B), 75% and 100% of the records showed a temperature variation between 0°C and 2°C. On the other hand, at points 1A and 16A, where there are paved roads and relative residential occupation, the thermal variation was higher than 2°C. Throughout the peri-urban area, the air temperature rose at different rates and intensities. In the southwest, where the working class neighborhoods of Jardim das Colinas, Rebourgeon and Jardim Santo Antônio are located, there was an increase of around 1°C to 3°C, which was reproduced in the northeastern part of the city, which is characterized by the expansion of gated communities with high construction standards. However, in the neighborhoods to the southeast, where residential occupation is older, a rapid increase in air temperature was recorded, exceeding 4°C in thermal variation. A core of greater heating was established in the central region of the city between the neighborhoods of Centro, Porto Velho, BPS, Avenida and Boa Vista. Marked by high building density, little vegetation cover and the presence of surfaces with low albedo, this is where 28% of heat islands of strong magnitude (4°C < ΔT < 6°C) and 82% of those of very strong magnitude (ΔT > 6°C) were detected during the episode.

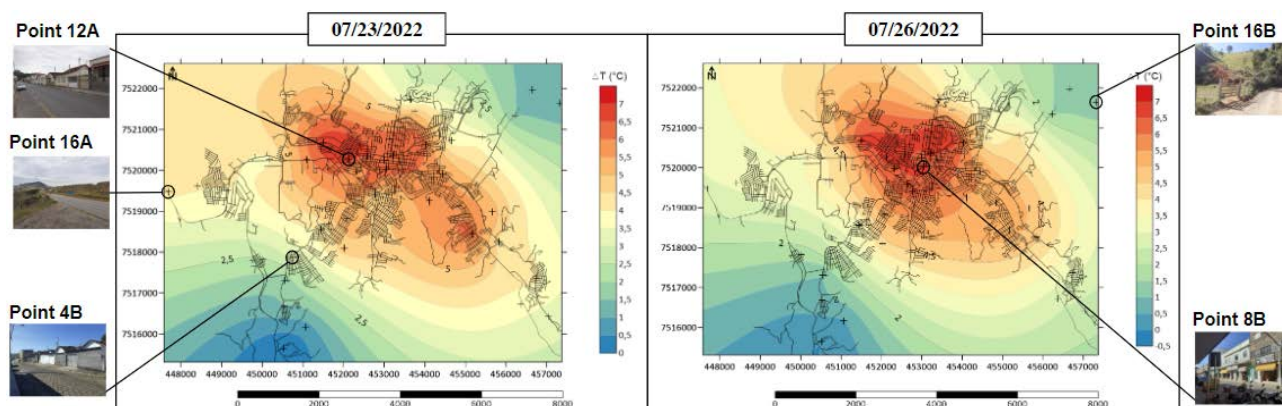


Figure 3. Isotherm charts for July 23 and 26, 2022 in the municipality of Itajubá.

Conclusion

Understanding how climate is processed on an intra-urban scale is an essential requirement for building more resilient cities in the face of climate change. During the episode, although this study is limited to a short period of measurement, the spatial variation of air temperature in Itajubá was closely linked to the land use, suggesting the influence of the city on the climate in the urban boundary layer.

Acknowledgements: We would like to thank the SAE/Unicamp and FAPESP (process no. 2023/06816-4) for financing the research, the CEPReMG/Unifei for supporting the calibration of the thermo-hygrometers and data collection and the LECLIG/Unicamp laboratory, to which the authors are associated.

Bibliography

- IBGE., 2023: *Cidades e Estados do Brasil*. Available in: <https://cidades.ibge.gov.br/brasil/mg/itajuba/panorama>.
- García, F. F., 1996: *Manual de climatología aplicada: clima, medio ambiente y planificación*. Madrid, Editorial Síntesis S. A., 285 pages.
- Reboita, M. S., Assireu, A., Silva, L. C., Rios, N., 2014: Evidências de circulação de brisa vale-montanha na Serra da Mantiqueira: cidade de Itajubá-MG. *Ciência e Natura*, 36(1), 62-71.
- Oke, T., 1979: *Review of Urban Climatology: 1973-1976*. Geneva, WMO, 114 pages.