Urban Heat Island in Lodz

Szymon Wilk
Department of Meteorology and Climatology, Faculty of Geographical Sciences
University of Lodz, ul. Narutowicza 88, 90-139 Lodz, Poland
e-mail: szymon_wilk@yahoo.com

dated : 15 June 2015

Introduction

Lodz, a city with the population of over 700,000, is a sufficiently big settlement and industrial agglomeration for a clearly marked urban heat island to be formed. As a city with a clear urban structure, with the lack of essential vertical differentiation of the terrain and bigger water reservoirs, constitutes a perfect experimental ground for model testing to be performed. The solutions worked out during this process might be successfully applied to the investigation of cities characterized by similar climatic and urban structure traits.

The aims of this work are:

- define the spatial structure and the dynamism of the urban heat island in Lodz,
- asses the intensity and the frequency of the occurrence of the urban heat island, in its diurnal and annual rhythm.

Abstract

The average annual intensity of the urban heat island in the center of Lodz is 2.1 K. It is higher than in other polish cities with a several hundred thousand inhabitants. The highest average intensity of the urban heat island is recorded at night in spring (3.0 K) and in summertime (2.3 K), while the lowest value was recorded in winter (1.5 K). The maximum intensity of the heat island in Lodz reaches 13.9, but it is possible that in favorable weather conditions, within administrative limits of the city, one might note that the thermal differentiation amounting to about 10 K. In contrast to the average values of the UHI intensity, an extremely strong urban heat island is not connected with the spring-summer period, and might practically occur in every season of the year, although the UHI characterized by a high intensity (> 3.0 K) can be observed in summertime more frequently than in the wintertime. In the twenty-four-hour cycle the phenomenon is the most intense at the night hours when it surpasses the intensity of the urban heat island observed at the day-time. The extremely high values of the intensity of UHI are typical for the night hours (fig 8). The intensity of the phenomenon during the daytime reaches 7.2 K at the maximum, and it is the consequence of the differences in the diurnal cycle of air temperature in built-up areas and the non-build-up ones, in accordance with which the urban heat island is formed just before the sunset, and disappears after the sunrise (fig 6, fig 7). An additional reason for the formation of the UHI during the day-time the heat excess in built-up areas can be observed more frequently in wintertime than in the remaining seasons of the year, which only testifies to the essential role the emission of artificial heat, mainly during the heating season plays in forming city's thermal environment.

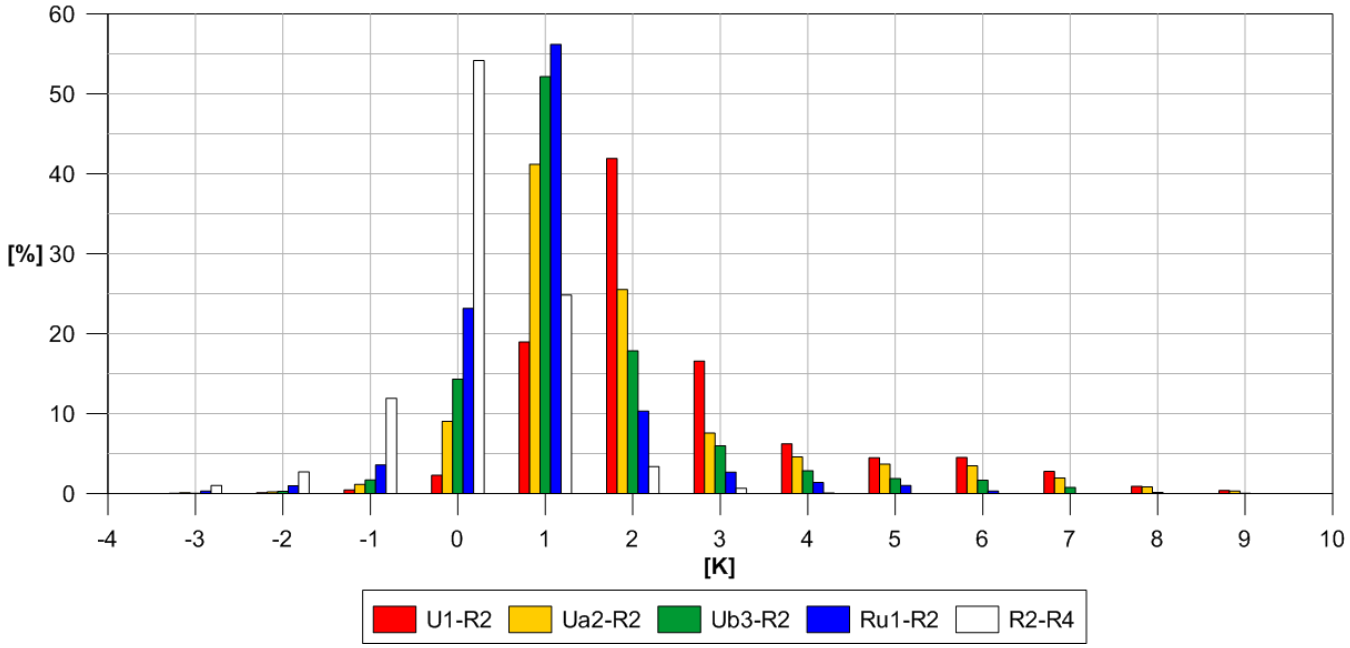

Fig. 1. Frequency of urban-rural air temperature [°C] differences

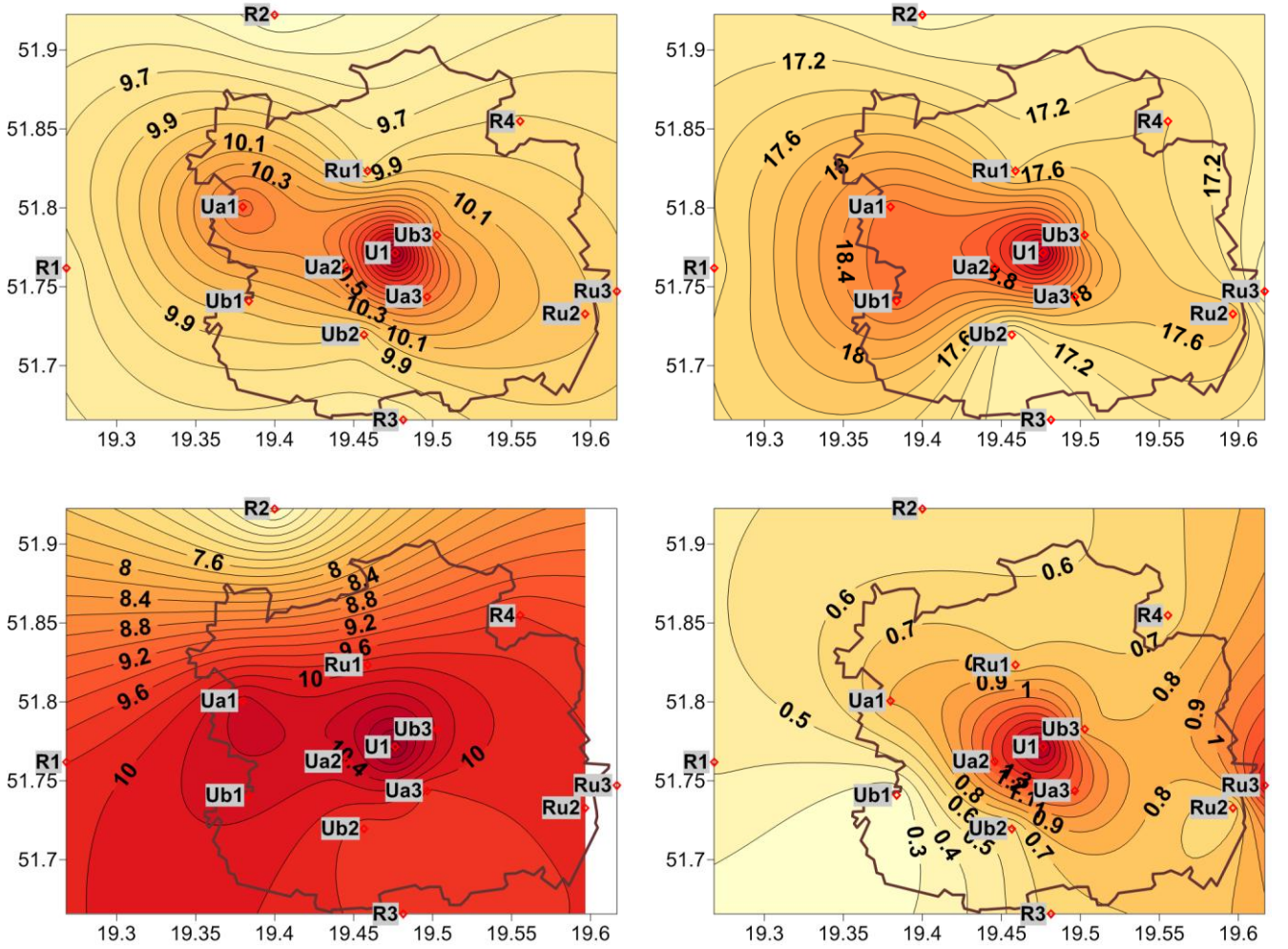

Fig. 2. Air temperature distribution [°C] in a) Spring, b) Summer, c) Autumn, d) Winter

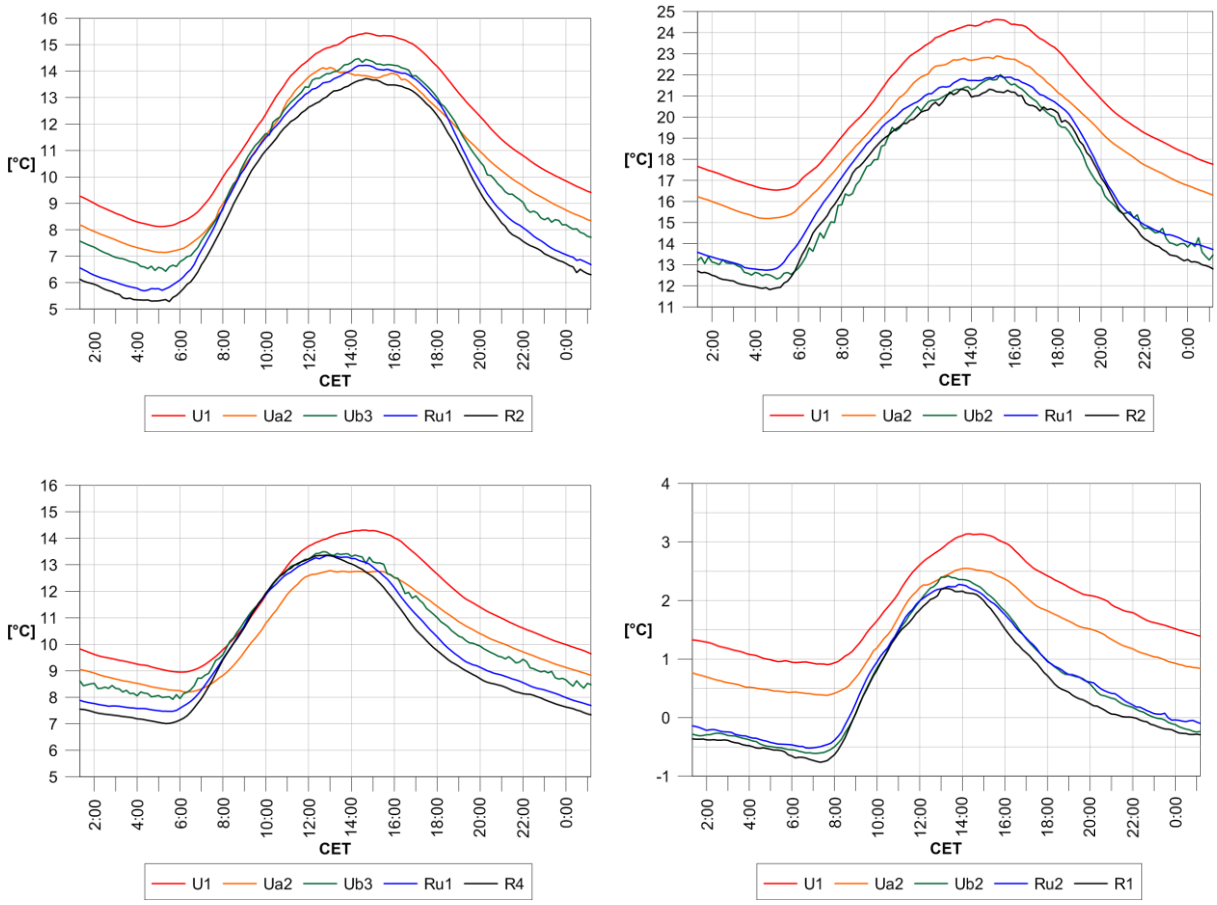

Fig. 3. Mean daily course of air temperature [°C] in different land use types in each season

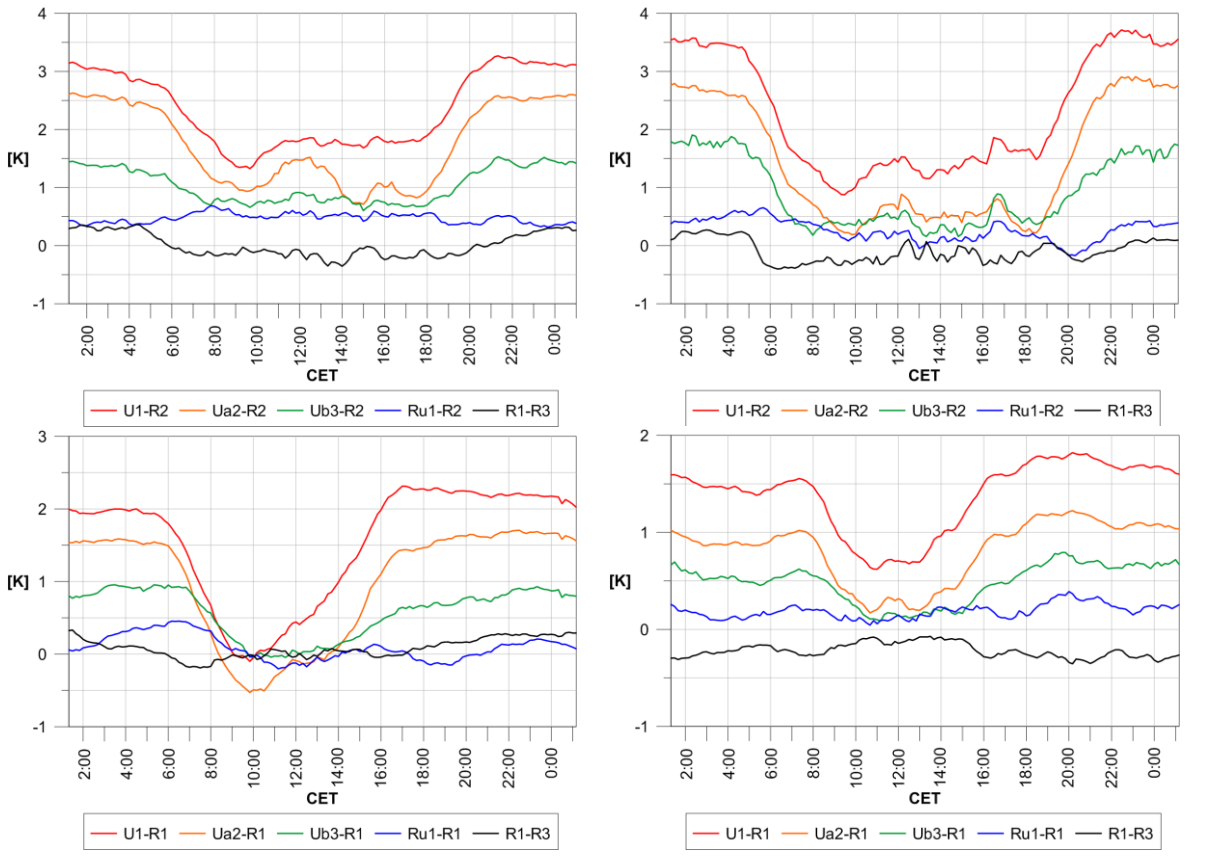

Fig. 4. Urban-rural air temperature differences [K] in different land use types in each season

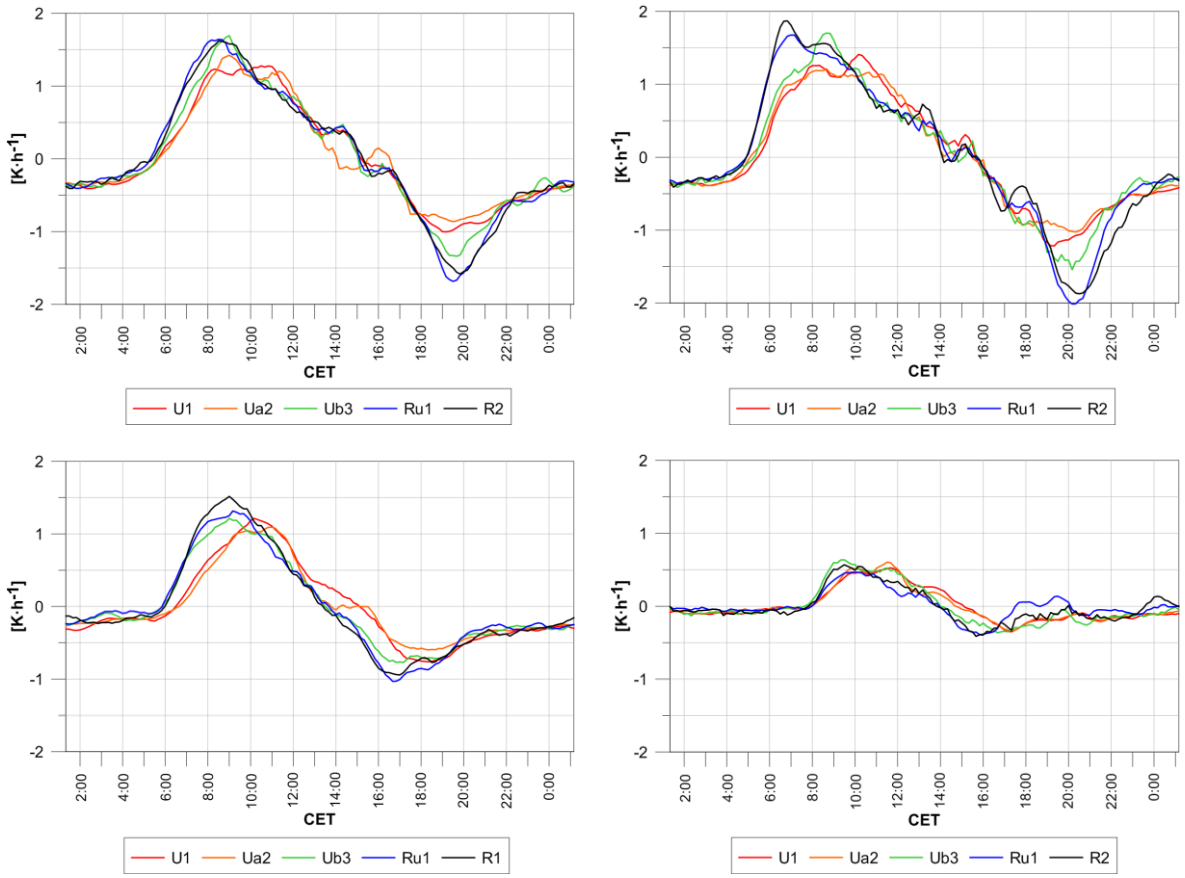

Fig. 5. Cooling rates [K·h^{-1}] in different land use types in each season

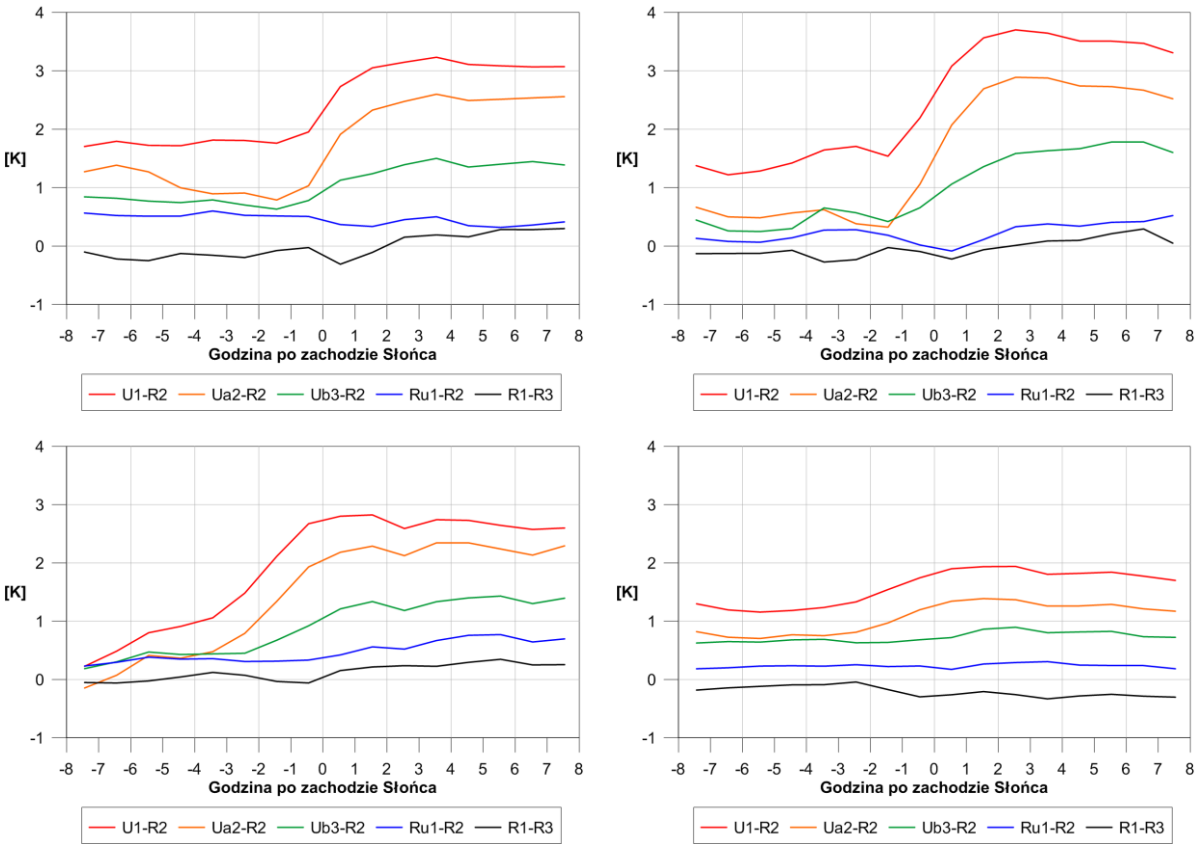

Fig. 6. Mean course of urban-rural air temperature differences with reference to sunset

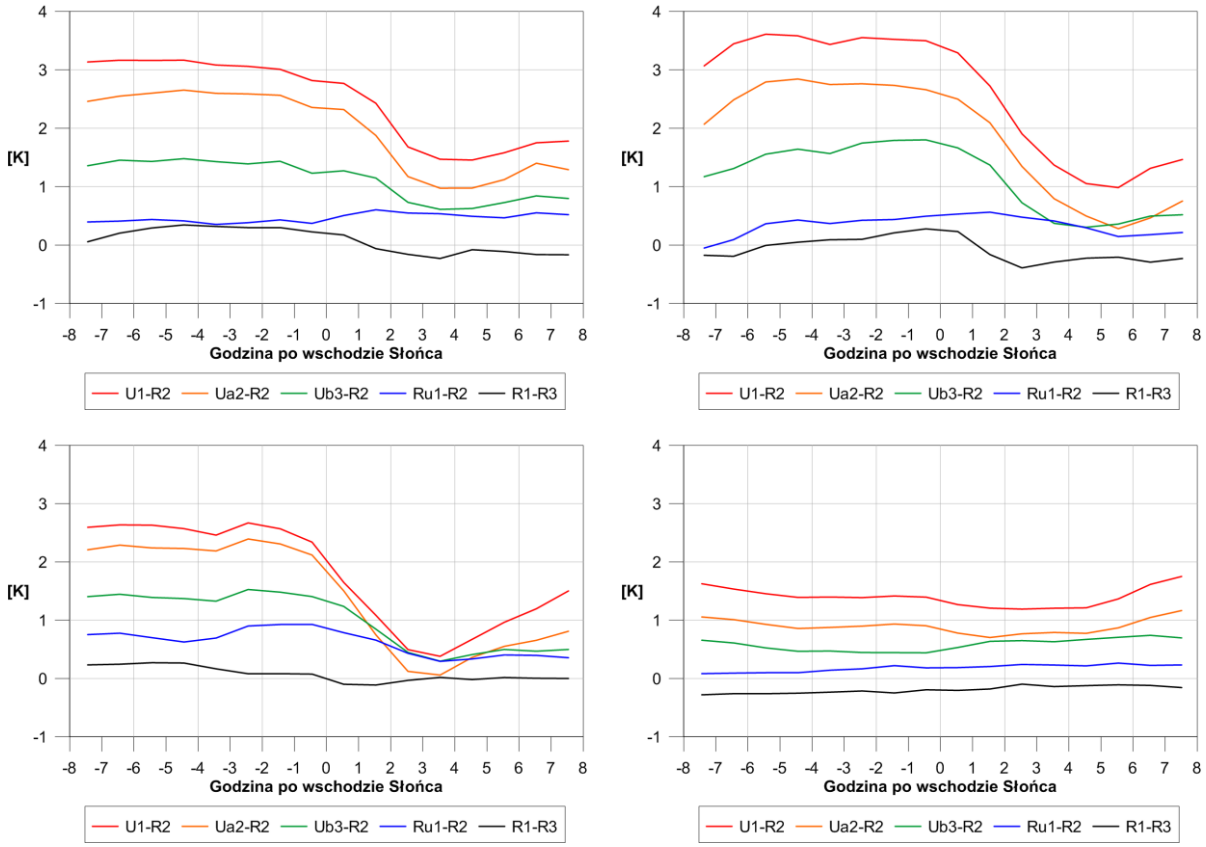

Fig. 7. Mean course of urban-rural air temperature differences with reference to sunrise

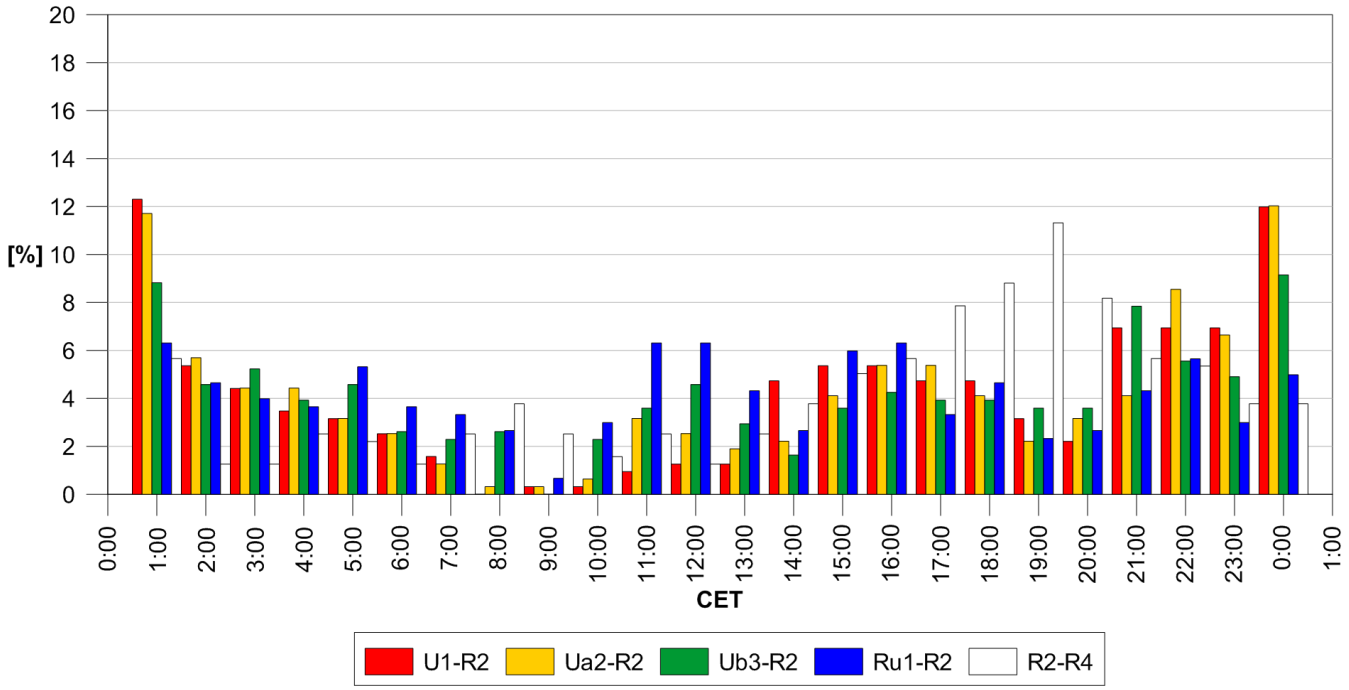

Fig. 8. Frequency [%] of maximal urban heat island intensity during day and night