



Quantification of temporal changes of urban heat island intensity and cooling and heating rates in different local climate zones of mid-sized central European city (Tromp Foundation Travel Award)

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We present the first comprehensive study of air temperature (T_a) dynamics in seven Local Climate Zones (LCZs) of Novi Sad (Serbia) based on measurements from 17 stations during 3-year period (2014–2017). LCZs temperature dynamics were analyzed on seasonal and annual level and during heat and cold wave periods. Stations are located in six built-up and one land cover LCZs: compact midrise (LCZ 2), compact low-rise (LCZ 3), open midrise (LCZ 5), open low-rise (LCZ 6), large low-rise (LCZ 8), sparsely built (LCZ 9) and dense trees (LCZ A). We analyzed seasonal and annual minimum (T_{min}), mean (T_{mean}) and maximum (T_{max}) temperatures and urban heat island intensity (UHII) defined as LCZ temperature difference ($^{\circ}\text{C}$) between built-up LCZs (2, 3, 5, 6, 8 or 9) and natural LCZ A. Furthermore, hourly changes of T_{mean} , UHIIs, cooling rates (CR) and heating rates (HR) parameters (CR_{peak} and HR_{peak} - the most intense cooling and heating rate; CR_{mean} and HR_{mean} - mean cooling and heating rates; CR_{total} and HR_{total} - total cooling and heating) were assessed.

Our results showed substantial T_{min} and T_{mean} differences between LCZs. The largest T_{min} difference of $3.1\text{ }^{\circ}\text{C}$ was noticed between LCZs 2 and A in spring, while it was up to $2.0\text{ }^{\circ}\text{C}$ between the built-up LCZs 2 and 9 in summer. Two-phase nocturnal cooling and two-phase diurnal heating was recognized in LCZs. The first cooling phase is characterized by intense LCZ dependent cooling that starts 1-3 hours before sunset and lasts until 3-4 hours after sunset. The second cooling phase lasts until sunrise and the cooling is not LCZ dependent. The most intense cooling was noticed during the first cooling phase of HW period with CR_{peak} from $-1.6\text{ }^{\circ}\text{C h}^{-1}$ (LCZ 2) to $-3.9\text{ }^{\circ}\text{C h}^{-1}$ (LCZ A) at sunset. CR_{total} differed from $-8.1\text{ }^{\circ}\text{C}$ in LCZ 2 to $-13.5\text{ }^{\circ}\text{C}$ in LCZ A during the 7-hour long first cooling phase of HW period. Differences in CR between the LCZs were not substantial in the second cooling phase. The most intense UHI of $5.5\text{ }^{\circ}\text{C}$ was noticed between LCZs 2 and A one hour after sunset during HW. Seasonal nocturnal temperatures differed among built-up LCZs and decreased by $0.4\text{--}0.7\text{ }^{\circ}\text{C}$ from LCZ 2 to LCZ 5, by $0.4\text{--}0.8\text{ }^{\circ}\text{C}$ from LCZ 5 to low-rise LCZs 3 and 6 and by $0.5\text{--}0.6\text{ }^{\circ}\text{C}$ from low-rise LCZs towards LCZ 9. The first heating phase starts at sunrise, lasts 4-7 hours and is characterized by intense LCZ dependent heating. The second heating phase lasts until sunset and is characterized by HR decrease and convergence. The most intense HR_{peak} of $3.0\text{ }^{\circ}\text{C h}^{-1}$ was registered in LCZ 8 while in LCZ 2 it was $2.0\text{ }^{\circ}\text{C h}^{-1}$ during HW period.