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Evaluating the Impact of Urbanization on Thermal Comfort in Turin: A Numerical Simulation Study

Lippin Pauly[1], Enrico Ferrero[2], and Massimo Canonico[2]
[1]University of Easter Piedmont, Vercelli, Italy (lippin.pauly@uniupo.it)
[2]University of Easter Piedmont, Vercelli, Italy

Heatwaves are increasing in both intensity and frequency every year. In urban areas, the urban heat island (UHI) effect exacerbates this impact, with significant consequences for city dwellers and urban ecosystem functions. This work evaluated the impact of urbanization on thermal comfort in Turin, a city in the North-West region of Italy bordered by the Alps to the west and hills up to 600m high to the east. Two numerical simulations were performed: one representing a real-case urban scenario and another idealized simulation where all urban surfaces were replaced with dense forest. The real-case scenario used weather research and forecast models (WRF) with a multilayer urban canopy model (MLUCM) and was simulated over a heatwave (HW) period in June 2019. High-resolution urban land use/land cover data was taken from local climate zone (LCZ) maps provided by the World Urban Database and Access Portal Tools (WUDAPT) repository. The simulation was validated with data from ARPA meteorological stations located in the region. The lower root mean squared error of air temperature and higher index of agreement showed that the simulation was in good agreement with observational data. Results from both simulations were used to study the effect of urbanization on UHI phenomena by comparing the real case with the ideal simulation where no urban area was present. The study revealed that urbanization had the greatest impact on UHI during nighttime, with a maximum deviation of 5°C, while its effect was less during mid-day, with a maximum deviation of 1.2°C. Furthermore, an average temperature increase of 3°C was found in the city center due to urbanization compared to the idealized simulation.

Keywords
Urban heat island (UHI), WRF/MLUCM, heatwave (HW), Urban Microclimate