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# Evaluation of the change of urban heat island intensity in climate change scenarios over European cities

**Eloisa Raluy-López[1,2*], Sergio Sánchez Fonseca[2], Juan Pedro Montávez[1,2*]**

*[1]Physics of the Earth, Regional Campus of International Excellence (CEIR) "Campus Mare Nostrum", University of Murcia, Spain, eloisa.raluyl@um.es*
*[2]Regional Atmospheric Modelling Group, Physics Department, Faculty of Chemistry, University of Murcia, Spain, montavez@um.es*
*([*]Main presenter and corresponding author)*

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## *1* Introduction

The urban heat island (UHI) is defined as the temperature difference between a city and its rural surroundings, with the urban temperature being generally higher (Oke et al., 2017). The UHI effect can have a negative impact on human health (Piracha and Chaudhary, 2022), potentially leading to respiratory or cardiovascular problems, and causes a significant increase in the overall ecological footprint of the cities (Santamouris et al., 2015). Furthermore, it could exacerbate the impacts of climate change, resulting in more frequent and severe heatwaves and increasing the likelihood of heat-related illnesses and deaths, particularly for vulnerable populations. Thus, the goal of this work is to identify and study the UHI and its evolution in regional climate change projections.

## 2 Data and methods

The employed data was extracted from the RegCM4-6 model driven by the ICHEC-EC-EARTH GCM. It was derived from the EURO-CORDEX EUR-11 project, assuring a spatial resolution of 0.11º. The near-surface temperature data was obtained with a 3-hour resolution. The urban fraction, land fraction and surface altitude model inputs were also used. The historical data covers the period 1971-2000. The future data under the climate change RCP8.5 scenario was divided into near future (2021-2050) and distant future (2071-2100) periods.

There is not a single way to perform the UHI intensity calculation. In this case, the urban temperature of each city was assigned as the temperature series of the most urbanized grid point, which was later confirmed as the hottest (or one of the hottest) urban points. The reference rural temperature was defined as the mean temperature series of all the valid rural points inside a 1º box centered in the most urbanized point. A rural point is considered to be valid if its rural fraction falls below 5%, its land fraction is greater than or equal to 50% and if its surface altitude is not more than 100 meters higher or lower than the urban point altitude. This leads to a different number of valid rural points for each city.

This research presents and compares the historical, near-future and far-future mean annual cycles and distribution functions of the UHI intensity of 12 European cities: Barcelona, Berlin, Birmingham, Brussels, Lisbon, London, Madrid, Milan, Paris, Porto, Rome and Toulouse. The potential changes in the hourly distribution of the UHI daily maximum and in the UHI mean daily cycle were also studied.

## 3 Results

The RegCM4-6 model was able to successfully identify the UHI effect and its annual and daily cycles. The differences between the historical and future mean annual cycles of the UHI daily maximum show small to no changes in most of the cities, with these small differences being generally negative. Barcelona and Lisbon present greater negative changes, with a reduction of the UHI intensity of around 0.2 ºC in the near future and a reduction of around 0.4 ºC in the distant future (Figure 1). In contrast, Porto and Toulouse present positive differences with an intensification of the UHI effect of around 0.3-0.4 ºC in the distant future. Furthermore, the greatest changes in each city occur during the summer season. No important changes in the hourly distribution of the UHI daily maximum were found. In conclusion, the UHI effect seems to generally not aggravate the rising temperatures due to climate change in urban areas.

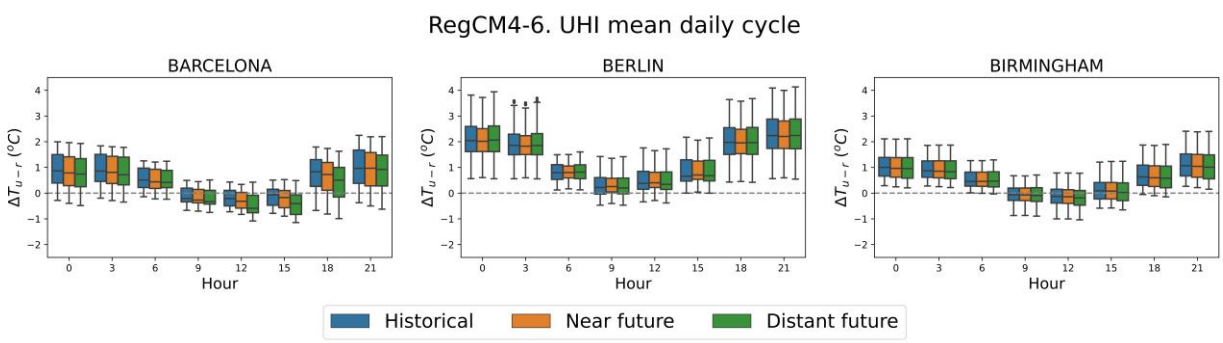


FIGURE 1: UHI mean daily cycle for all the valid rural points in three of the studied cities.

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