

EGU24-5608, updated on 23 Jan 2025

<https://doi.org/10.5194/egusphere-egu24-5608>

EGU General Assembly 2024

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Impacts of urban development on the local weather: A comprehensive analysis from 1970 to 2020 in Madrid.

Juan Carbone¹, Beatriz Sánchez², Carlos Román-Cascón³, Alberto Martilli², Dominic Royé⁴, and Carlos Yagüe¹

¹Dpt. Física de la Tierra y Astrofísica, Universidad Complutense de Madrid, Madrid, Spain

²Atmospheric Modelling Group, CIEMAT, Madrid, Spain

³Dpt. Física Aplicada, Facultad de Ciencias del Mar y Ambientales, INMAR, CEIMAR, Universidad de Cádiz, Puerto Real, Spain

⁴Climate Research Foundation, Madrid, Spain

The proportion of the world's population living in cities has increased from 37% to 56% over the last 50 years, and it is expected to continue rising further to 60% by 2030 (UN, 2022). As an essential effect of this evolution, urban land cover has expanded rapidly. In the case of Madrid, the increase in urban fraction during the period from 1970 to 2020 has been 20%. It is well known that urbanization reduces the vegetated cover and modifies surface properties altering the surface-atmosphere interactions and the different terms of the Surface Energy Balance (SEB) compared to nearby rural areas. Therefore, analyzing the influence of these changes in urban land cover contributes to understand the potential risks that urban residents might face considering the urban growth and the expected temperature increases, as this has adverse impacts on human health, livelihoods, and key urban infrastructure.

The aim of the present study is to examine the consequence of Madrid's urban growth on the near-surface air temperature and on the SEB. We conduct a modeling study using WRF-ARW with the multilayer urban parameterization BEP-BEM, in which the land use and the land cover have been modified according to urban expansion in Madrid and its surroundings from 1970 to 2020. Two scenarios of common meteorological conditions of special interest are selected for this study: a period of intense heatwave during the summer season and a short period of strongly stable atmospheric conditions in winter, both observed in 2020. The results show that in areas where the urban fraction becomes greater an increase in near-surface air temperature is found for both simulated periods, especially during the night, pointing out that the cooling rate decreases in urban areas. The growing of urban land cover over time also modifies the SEB and turbulent transport in Madrid and surroundings, leading to an increase in temperatures, specially for the minima ones.