Analysis of temperature trends and urban heat island in Madrid

Gregorio Maqueda¹, Carlos Yagüe¹, Carlos Román-Cascón²,³, Encarna Serrano¹, and Jon Ander Arrillaga¹,⁴

¹Dpto. Física de la Tierra y Astrofísica. Universidad Complutense de Madrid, Spain (gmaqueda@ucm.es; carlos@ucm.es)
²Centre Nationale d’Études Spatiales, CNES, France.
³Laboratoire d’Aérologie, University of Toulouse, CNRS, UPS, Toulouse, France.
⁴Dept. of Applied Mathematics, Engineering School of Bilbao, University of the Basque Country, Bilbao, Spain.

The temperature in the cities is affected by both global climate change and local changes due to human activities and the different land use compared to rural surroundings. These local changes, which modify the surface energy budget in urban areas, include the replacement of the natural surfaces by buildings and pavements and the heat of anthropogenic origin (heating, air conditioning, traffic). Madrid city (Spain) has a current population of near 3.3 million people and a larger metropolitan area reaching around 6.5 million people. Hence, it is affected by the phenomenon called urban heat island (UHI), which indicates that a higher temperature is found in the city compared with the surrounding rural areas. UHI is defined as the temperature difference between the urban observatory and the rural one and especially affects the minimum temperatures since urban areas cool down to a lesser extent than the neighbouring rural sites. Moreover, the intensity of the UHI is modulated by the meteorological conditions (wind, cloudiness, surface pressure, precipitation), highly associated with different synoptic situations. In this work, we use the Madrid-Retiro meteorological station as the urban one, which has regular and homogeneous data from the beginning of XX century; and the station at Barajas airport (12 km from the city centre) as well as other stations out of Madrid city (but within a range of 20 km from the city centre) as the rural stations. They all have a common measuring period from 1961 until present. The main objectives of the work are: 1) to identify temperature trends in the meteorological stations (both urban and rural); 2) to evaluate the intensity of the UHI for the different rural stations; 3) to apply a systematic and objective algorithm to classify each day in different categories (related to synoptic situation) that produce a different degree of UHI intensity; and, 4) to evaluate possible trends in the UHI intensity.