Geophysical Research Abstracts,
Vol. 11, EGU2009-6123, 2009
EGU General Assembly 2009

Urban enhancement of the heat waves in Madrid and its metropolitan area

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The urban heat island (UHI) is a worldwide phenomenon that causes an increase of the temperatures in the centre of the cities. The process of urbanization has developed an intense urban heat island in Madrid, with temperature differences up to 10ºC higher than the surrounding rural environment. Such differences may potentially increase the magnitude and duration of heat waves within cities, exacerbating their most negative effects over human health, particularly by night, as it deprives urban residents of the cool relief found in rural areas.
In this contribution we study the long term trends on warm extreme temperature episodes in the Madrid metropolitan area, and their impact at local scale, on the onw city of Madrid. For the first task, we have compared maximum and minimum temperatures from rural (Barajas and Torrejón) and urban (El Retiro, Cuatro Vientos, Getafe) stations from 1961-2008; for the second one a local network of automated meteorological stations inside the city provided hourly data from the 2002-2004 years. Finally, the 2003 heat wave is used as an example of the spatial and temporal patterns of temperature and ozone concentrations during those extreme episodes.
Our results show a regional increase in the frequency and duration of those extreme warm episodes since the end of the 80´s, although their absolute magnitude remains unchanged. The urban environment exacerbates the heat load due to the persistence of the high temperatures during the night-time hours, as it is shown by the above average number of tropical nights (> 20ºC) inside the urban spaces, simultaneous to the increasing trend of maximum temperatures. Besides, the diversity of urban morphologies introduces a spatial variability on the strength of this nocturnal heat load, aggravating it in the densely urbanized areas and mitigating it in the vicinities of the green areas. The regional meteorological conditions associated to these warm episodes, characterized also by low wind speed and high values of sunshine and solar irradiation, are very favourable to increases of the levels of ozone, thus exacerbating the negative effects of the heat waves.