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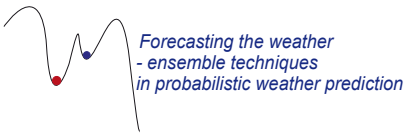

Spatial and temporal variability of Madrid Urban Heat Island

D. Rasilla (1) and F. Fernández (2)

(1) Departamento de Geografía, Urbanismo y OT, Universidad de Cantabria (domingo.rasilla@unican.es), (2) Departamento de Geografía, Universidad Autónoma de Madrid (felipe.fernandez@uam.es)

The difference in temperature between cities and their surrounding rural zones is a phenomenon known as the 'urban heat island' (UHI). It has been documented in extent for many cities with varying population, topography and climate regimes. Madrid is the largest urban agglomeration in Spain; the city spans a total of 698 km^2 and its population is roughly 3.3 million, but the entire population of the metropolitan area (urban area and suburbs) is calculated to be nearly 6.5 million. Most of that difference is the result of the growth of satellite suburbs at the expense of the downtown since 1970. Its climate is typically mediterranean, although modified by the high altitude and the continentality.

In this contribution Madrid′s UHI is spatially and temporally characterized using long term (1961-2010) time series of daily maximum and minimum temperatures and shorter (2001-2010) hourly temperature time series from 4 weather stations, one located inside an urban park (El Retiro), two airfields placed on the suburbs (Cuatro Vientos and Getafe), and another outside the city (Barajas), supply by AeMet (Spanish Meteorological Office). Besides, a denser network of automated weather stations, under the local (Ayuntamiento de Madrid) and regional (Comunidad Autónoma de Madrid) have been also used. Additionally, long term records of cloudiness, sunshine and wind intensity and direction were also used in order to assess the sensibility of the UHI Madrid to different meteorological conditions. Furthermore, the UHI is analyzed separately for different groups of synoptic (circulation) types, using an automated typing procedure based on the Lamb catalogue.

The diversity of building density explains differences of UHI magnitude, stronger (about 2ºC on average) between the urban park station and the outside observatory at night. Seasonally, the UHI is more intense in winter and summer, but weaker in spring. The urban park reproduces a daytime "cool" island, particularly in summer, almost undetectable in the suburban meteorological stations. The denser automated network allows highlight the relevance of other factors, such as topography, in the spatial configuration of the UHI, usually splitted in two nucleus by the arrival of cool air masses from the northern uplands channelled through the River Manzanares valley.

The increase of the magnitude of the UHI, related with an expansion in the size of the urban population and the urban built-up areas and the increasing consumption of energy, appears to change with the time, in relation with the evolution of the most influential weather parameters, which in turn are controlled by the atmospheric circulation at regional scale. The effect become weaker from the 70′s onwards in the city center, but conversely, become stronger in the suburban stations, probably as a consequence of the slowing down of the population, which moved out to the suburbs. Day to day variability in the magnitude of the UHI depend on meteorological variables such cloudiness/sunshine and wind. Anticyclonic patterns show the largest differences, accordingly with their predominately calm and cloudless conditions; conversely, cyclonic patterns offer the lowest differences, in consonance with the cloudy skies and moderate wind speeds. Some of the trends detected, for example in summer, can be explained by local modifications of the heat balance, relatively independent from the long term changes in the atmospheric circulation around the Iberian Peninsula. Besides, no weekly effect is detected in Madrid.