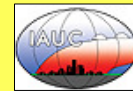
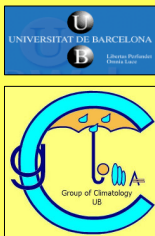


URBAN HEAT ISLAND INTENSITY IN BARCELONA AND THE WESTERN MEDITERRANEAN OSCILLATION

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ABSTRACT: Even though synoptic conditions favour the event of an intense urban heat island (UHI), some northerly type advections also lead to an intense one in Barcelona (Moreno, 1994). This is demonstrated using a new regional teleconnection pattern at daily resolution, the Western Mediterranean Oscillation (WeMO) (Martin-Vide and Lopez-Bustins, 2006), as its positive phase is mainly defined by northwestern advections. The most significant correspondence is found in winter and autumn.

Key words: Barcelona, UHI, north advection, Western Mediterranean Oscillation.

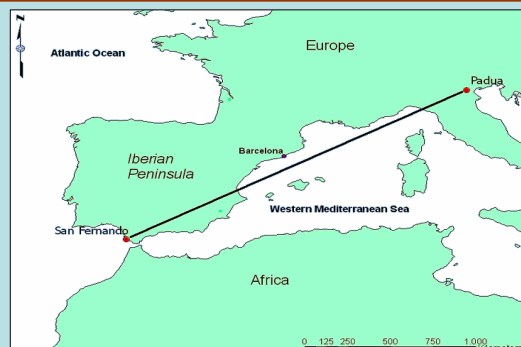
OBJECTIVE

The aim of this research is to demonstrate by means of a regional teleconnection pattern at daily resolution that north advections over Barcelona region increase its UHI intensity. The novelty of this study is in both directions: 1) The performance of relationships between UHI intensities and a regional teleconnection pattern as the WeMO, which is defined by means of the dipole Azores high-Ligurian low (positive phase); 2) The use of a low-frequency pattern at daily resolution. Actually, WeMO potentialities at daily resolution have been already checked by other meteorological phenomena as torrential rainfall (Martin-Vide and Lopez-Bustins, 2006) or sea-breeze occurrence (Azorin-Molina and Lopez-Bustins, 2006).

DATA AND METHODOLOGY

WeMO teleconnection pattern: The daily WeMO index (WeMOi) is defined by the difference between the standardised surface pressure values recorded at two points of the barometric dipole: San Fernando (SW Spain) and Padua (NE Italy). With low pressures over Central Europe and high pressures over southwestern Iberian Peninsula, WeMO shows its positive phase.

Barcelona UHI Data: For assessing the Barcelona UHI, minimum temperatures are used from two meteorological stations, one in the ancient centre next to the harbour, 'Drassanes'; and the other one, in 'El Prat' airport, located in Barcelona surroundings. Both are close to the sea and at a similar height above it. The distance between them slightly surpasses the 15 kilometres. The period study is from 3rd July 1970 to 19th February 1984. Thus, 4,980 minimum temperature differences are calculated, which will be individually corresponded with one daily WeMOi value in order to find some relationship.



ANALYSES

Selection of the days with an intense UHI ($\geq 5^\circ\text{C}$): 458 cases out of the 4,980 days (9.2%).

Once it has been attributed to each day a daily WeMOi value, two WeMOi value means are worked out. One is performed for the days of the whole period, 4,980 cases, and another one for those days with an intense UHI, 458 cases. The analysis is performed for the entire year, and for each season. The highest frequency of intense UHIs takes place in winter (16.2% of the winter days), doubling the number of cases in other seasons. The second season with a highest frequency of intense UHIs is autumn (7.6% of the days).

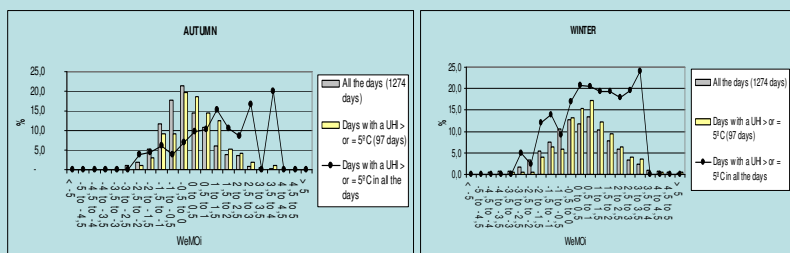
RESULTS

It is in winter when a highest mean of the daily WeMOi values is obtained. Nevertheless, autumn has the largest difference between the means as the mean of the whole period is slightly negative due to the frequent occurrence of Mediterranean storms with easterly flows. These ones are characterised by overcast skies, high relative humidity and moderate or strong winds, which mitigate the UHI development.

The extreme positive WeMOi values, both in winter and in autumn, significantly increase the % of the days with an intense UHI. But, it is also detected in a neutral WeMOi phase, which is mainly represented by flat barometer situations, the increase of intense UHIs frequency. Consequently, two peaks are drawn by the graphic line, one in the intervals around 0, and the other along the extreme positive values. In these intervals, the days with an intense UHI are more concentrated in percentage than considering the whole sample.

	Days of the whole period		Days with a UHI intensity $\geq 5^\circ\text{C}$		Difference between the means
	Cases	WeMOi mean	Cases (% of the whole period)	WeMOi mean/ (Confidence interval at 95%)	
Annual	4.980	0.0381	458 (9.2 %)	<u>0.3177</u> / (0.3124, 0.3230)	+0.2796
Winter	1.254	0.3074	203 (16.2 %)	<u>0.6283</u> / (0.6164, 0.6422)	+0.3219
Spring	1.196	0.0518	86 (7.2 %)	<u>-0.0349</u> / (-0.0646, -0.0052)	-0.0867
Summer	1.256	-0.0963	72 (5.7 %)	-0.0833 / (-0.1088, -0.0578)	+0.0130
Autumn	1.274	-0.1075	97 (7.6 %)	<u>0.2758</u> / (0.2522, 0.2993)	+0.3833

Comparison of the WeMOi means of the days of the whole period and days with an intense UHI annually and seasonally. Confidence interval of the sample mean is displayed, (the underlined WeMOi means with a UHI intensity $\geq 5^\circ\text{C}$ are those ones which are significantly different to the WeMOi means of the whole period; those differences between the means in bold are the largest ones).



% distribution of the WeMOi values of the days for both samples in winter and autumn. % of the days with a UHI $\geq 5^\circ\text{C}$ in the total is calculated for each interval.

CONCLUSIONS

The daily WeMOi has a new meteorological phenomena, UHI, to be applied.

An intense UHI ($\geq 5^\circ\text{C}$) takes place in Barcelona in almost 10% of the days in the study period. The highest frequency is in winter and autumn.

An intense UHI is sensitive to occur under anticyclone conditions (neutral WeMOi phase), but also under northwestern advections (positive WeMOi phase) as it is detected in the annual analysis.

Although winter season reaches the most positive WeMOi mean with intense UHI days, it is in autumn when there is a largest difference between the means due to the Mediterranean cyclones being very frequent at this season (negative WeMOi phase).

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