

# CLIVAR-SPAIN CONTRIBUTIONS: The unprecedented character of the 2003 summer heat wave over the Mediterranean coast of the Iberian Peninsula

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## INTRODUCTION

The 2003 summer heat wave that affected most of the Central and Western Europe, caused a high toll in heat-related deaths and broke European seasonal temperature records also had a remarkable impact over the Iberian Peninsula (IP). Due to the significant impact on society and environment this events are of great interest. We assessed the unprecedented

character of this warm event over the Mediterranean coast of the IP and placed it in the long instrumental context (1900-2007). In this poster we present the results of the exploratory statistical analysis carried out by employing daily adjusted maximum (Tx), minimum (Tn) and mean temperature (Tm) series from 5 representative locations (Fig. 1).

## DATA AND METHODOLOGY

We employed daily Tn and Tx records from 5 stations located over the Mediterranean coast of the IP which take part of the Spanish Daily Adjusted Temperature Series (SDATS) (Fig. 1) developed by Brunet et al. (2006; 2007a) and for the recent years we have updated the data from AEMET sources with running a primary quality control and we are doing now the re-homogenization.

- The 2003 daily Tx and Tn observed values have been compared with their corresponding long-term daily averages and the 90th, 95th and 98th percentiles calculated for the whole period 1900-2007 at each location, in order to initially define the warm episodes that characterised the 2003 summer and assess their departures from the long-term averages and upper percentiles.
- Regional and local Tx and Tn summer anomaly (wrt 1961-1990) values were calculated for placing the 2003 summer averages in the longer historical context.
- The frequency distribution of monthly and seasonal Tm averages was examined.
- The persistence of the heat wave was addressed by calculating and examining 4 temperature extreme indices: the number of days with Tx and Tn above the 90th percentile (warm days and nights, respectively) and an adapted Warm Spell Duration Index (WSDI) applied to both Tx and Tn series for single stations.



Fig. 1. Location map of the 5 stations over the Mediterranean coast of the IP

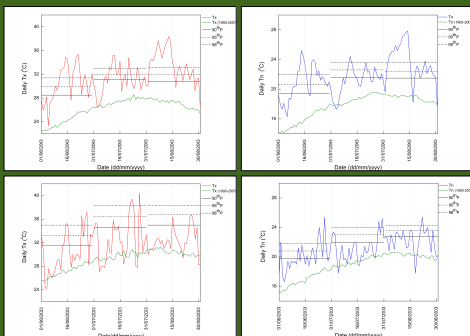


Fig. 2. Daily Tx and Tn of Summer 2003 with 90th, 95th and 98th percentiles and daily Tx and Tn 1900-2007 average at Barcelona (top) and Málaga (bottom).

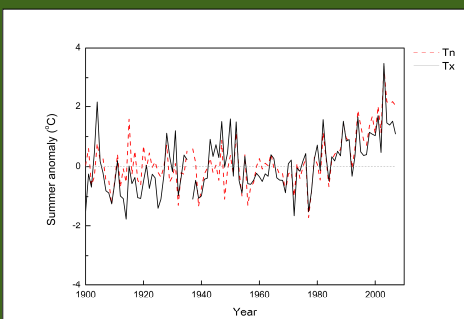


Fig. 3. Anomalies of mean summer (JJA) maximum and minimum temperatures (Tx and Tn) relative to 1961-1990 mean at the Mediterranean coast of the IP from 1900 to 2007.

## RESULTS

### Characterization of the heat wave

All stations showed daily Tx and Tn values were well above from their long-term averages and from the upper percentiles thresholds, although the departures were more pronounced at the northern than at the southern locations.

### Temporal context

Summer 2003 is the one with the highest anomalies over the whole period (1900-2007), both at the regional (Fig.3) and local scales and for both variables, except for Tn in Murcia. The Tm was also exceptionally higher in comparison with the instrumental records. The frequency distributions of Tm show that the heat wave records both for individual summer months and for the entire summer days of 2003 lay on the most extreme tail of the distribution.

### Extremes index

Warm days were ranging from 23 (Málaga) to 65 (Barcelona) days out of the 92 summer days, while warm nights oscillate between 33 and 61 days at the same locations. Results from the WSDI adapted indices shows for Barcelona and Valencia four spells exceeding the Tx 90th percentile during at least 6 consecutive days, accounting for an accumulated total of 43 and 42 days in total. In the case of the WSDI applied to the Tn series, Barcelona with 5 spells and 51 accumulated warm nights was the location more severely affected, followed by Valencia (36 days in total) and Murcia and Alicante (33 and 31 days in total, respectively).

Table 1: Standard deviation, Tm anomaly of 2003 with respect the 1900-2007 average and Standardized anomaly for June, July, August and Summer of 2003 at the Mediterranean coast.

	$\sigma$ (°C)	$Tm'$ (°C)	$\frac{Tm'}{\sigma}$
JJA	0.86	3.3	3.8
June	1.15	4.1	3.5
July	1.01	2.8	2.7
August	0.92	3.0	3.2

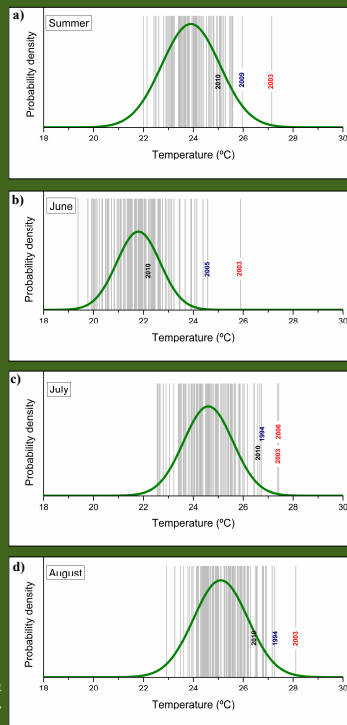


Fig. 4 a-d. Distribution of the Mediterranean coast monthly and seasonal summer mean temperature for 1900-2010. We labeled the hottest year (red), the second hottest year (blue) and the 2010 year (black). In green is showing the fitted Gaussian distribution.

Table 2: Averaged (61-90) number of summer days with Tx>90thP, number of warm days and partial and total duration of warm spells in summer of 2003.

Location	Number of days Tx>90thP (61-90 average)	Number of days JJA 2003	Partial and total number of days in warm spells	
			JJA 2003	JJA 2003
Barcelona	8	65	9, 9, 15, 10	43
Valencia	6	58	6, 12, 15, 9	42
Alacant	8	34	7, 11	18
Murcia	9	25	0	0
Málaga	9	23	0	0

Table 3: Averaged (61-90) number of summer days with Tn>90thP, number of warm nights and partial and total duration in spells of warm nights in summer of 2003.

Location	Number of days Tn>90thP (61-90 average)	Number of days JJA 2003	Partial and total number of days in spells of warm nights	
			JJA 2003	JJA 2003
Barcelona	7	61	10, 11, 6, 15, 9	51
Valencia	7	54	18, 18	36
Alacant	6	47	7, 8, 16	31
Murcia	4	54	18, 15	33
Málaga	9	33	6	6

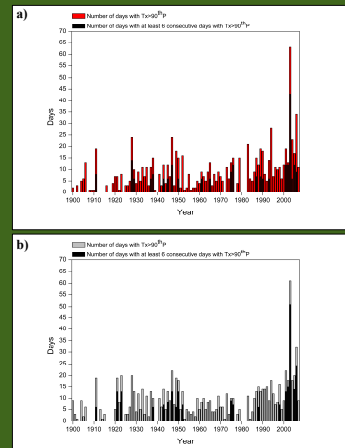


Fig.5a-b. Number of warm days and nights and warm spells duration at Barcelona.

## CONCLUSIONS

- The 2003 summer had an **unprecedented character** when placed in the long instrumental period over the Mediterranean coastal area of the IP.
- It is considered **extreme and unusual** being **more pronounced on the northernmost part** than on the southernmost.
- It was characterized by the **heat persistence** both during the day and night especially on the north coast
- It was **record-breaking seasonal and monthly temperature**.

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