**MedCLIVAR: Mediterranean Climate Variability - Temperature data homogenization and its impact on heatwave changes in the Eastern Mediterranean**

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**INTRODUCTION:**

Extreme temperature events such as the 2003 European summer heat wave have a strong impact on the environment, society and economy (1,2). In order to perform reliable and detailed analysis of extreme temperature events it is important to use long daily, high quality and homogenized temperature series (3). The Mediterranean region is considered as a “Hot Spot” of climate change which will suffer from even more severe and frequent heat waves in the future (4). However, most climate studies are based on non-homogenized data that are not necessarily appropriate for climate analysis and could also lead to inaccurate or even wrong results. To address this problem we developed and applied a new homogenization technique to daily temperature series in the eastern Mediterranean, (ii) proposed a new heat wave definition and (iii) estimated changes in heat wave number, length and intensity.

**DATA AND METHODS:**

Three independent break detection methods (5-7) to detect an unknown number of break points (BP) are used in combination with a non linear model (iii) to correct daily summer (JJAS) maximum (TX) and minimum temperature (TN) series of 246 stations across the eastern Mediterranean covering the period 1960-2006. Advantages of this method are (i) no metadata is needed for break detection (Fig. 2) and (ii) a correction factor (Fig. 3-5) of mean (Daul) values, variance, skewness and higher order moments is possible. A limiting factor is that the break detection and the correction model need highly correlated (>0.80) reference series. After data homogenization, changes in heat wave number, length and intensity are estimated.

**HEAT WAVE ANALYSIS:**

A hot day or night is defined as a day or night when the daily TX or TN exceeds the long-term 95th percentile within a summer (JJAS) season. For each of the 122 summer days, the 95th percentile is calculated from a sample of 15 days (seven days either side of the day) using data from the 1969 to 1998 period (Fig. 1). A heat wave is defined as a period of three or more consecutive hot days and nights not interrupted by more than one non hot or night, respectively. The heat wave number (HWN95), length (HN95) and intensity (HNI95) is calculated for each summer season.

**DATA HOMOGENIZATION:**

**Break Detection:**

We apply the methods of (5-7) to the mean annual TX/TN difference series of the candidate and its 10 highest correlated reference series. The correlation is computed for the common period 1969-1998 years of break points are detected to be valid if (i) three or more shifts (Fig. 2, red dots) are detected amongst all difference series within two consecutive years and (ii) the detected year is confirmed by at least one other method.

**Break Correction:**

The correction model uses the highest correlated reference series for adjusting the candidate series. The reference must not show any break points in the same year as the candidate or 3 years before/after, respectively. The period between two break points is assumed to be homogeneous (HSP) (Fig. 3).

**RESULTS:**

Daily TX and TN series of 246 stations across the eastern Mediterranean are homogenized and used for estimating heat wave changes between 1960 and 2006 (c.f., also 9). 61% and 74% of the TX and averaged temperature and heat wave trends are up to 8% higher (9). During the 1960s many screens were changed in terms of type, size and ventilation, the latter latter making measured tem-

**CONCLUSION & OUTLOOK:**

A new heat wave definition for estimating heat wave number, duration and intensity is proposed and applied to homogenized daily TX and TN series. The Mediterranean climate is becoming more extreme than previously thought when analyzing raw data, underlining the importance of homogenizing climate data for extreme event analysis. Since the 1960s, a significant increase in heat wave number, length and intensity has been detected in most parts of the eastern Mediterranean. The changes are largest across the West Balkan and smallest along the Turkish Mediterranean coastline. The estimated increase in TX is generally higher than in TN, indicating a greater research of heat wave impacts on human health, livestock, ecosystem vitality, agricultural production, or water supply is needed.

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**REFERENCES:**

4. J. Climate
8. Linear trend of HWN95 (°C/decade), (b) HWN95 (°C/decade) from 1960 to 2006 using the OLS method. Red (blue) colored data indicate significant positive (negative) linear trend at the 5% significance level (Mann-Kendall test). Open circles characterize non-significant trends.
9. Fig. 7 Differences in linear trends of HWN95 (°C/decade) from 1960 to 2006 using the OLS method. Red (blue) colored data indicate a significant increase (decrease) of HWN95 trends at the 5% significance level (Kendall test). Open circles characterize non-significant positive (negative) trends. Grey colored open circles indicate stations with no change in trend.