

EXPLORATORY ANALYSIS OF ERA5-LAND DATA TO CHARACTERIZE EXTREME WARM EVENTS IN THE REGION OF LISBON, PORTUGAL



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OBJECTIVE. CASE STUDY

The objective of this investigation was to perform an exploratory study on heatwaves (HW) from 1 October 1980 to 30 September 2021 (41 hydrological years) for a highly populated region of mainland Portugal based on alternative temperature data: ERA5-Land data.

ERA5-Land is a reanalysis dataset produced by the European Centre for Medium-Range Weather Forecasts (ECMWF) with a regular latitude-longitude grid of 0.1°.

The study area comprises 21 ERA5-Land grid-points (grid cell with ca. 8.7 km x 11.1 km) covering Lisbon and its surroundings - area of ca. 2000 km² (Figure 1).

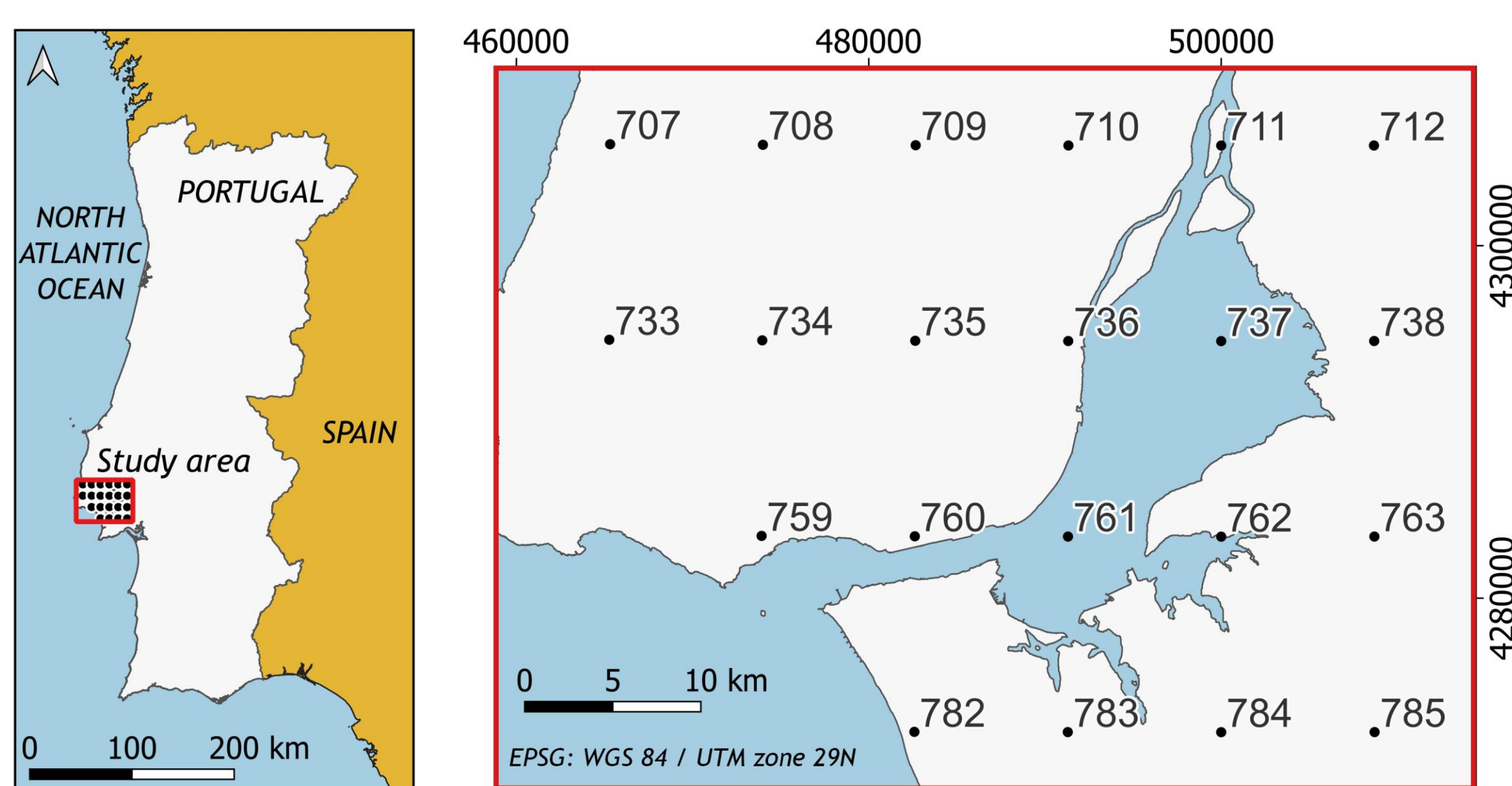


Figure 1: Study area, general location and 21 ERA5-Land grid-points.

MATERIALS AND METHODS

The identification and characterization of HWs used the Heat Wave Magnitude Index, HWMI, defined as the maximum magnitude of the HWs in a year, where a HW is the period of at least 3 consecutive days with temperature above a given threshold. In each day, the threshold is defined as the 90th percentile of the daily temperatures centered on a 31-day window (15 days before and after). The days belonging to HWs were denoted by HWD.

The HWMI was applied to both maximum (Tmax) and minimum (Tmin) ERA5-Land daily temperatures. The HWs can be characterized considering different features (e.g., duration, frequency or peak temperatures) or their trends. In the study, the Mann-Kendall and Sen's Slope estimator tests were applied for trend analysis.

RESULTS AND DISCUSSION

Annual average of daily temperature, °C					
15.6	15.6	15.7	16.0	16.4	16.8
15.9	15.9	16.1	16.5	16.8	16.9
	16.4	16.6	16.8	16.9	16.9
		16.7	16.7	16.7	16.7
Annual average of daily maximum temperature (Tmax), °C					
18.1	18.5	19.4	20.4	21.1	21.8
17.9	18.6	19.6	20.2	20.4	21.4
	19.0	19.9	20.0	20.9	21.7
		19.9	20.2	20.6	21.1
Annual average of Tmax during heatwaves, °C					
22.2	23.3	25.1	27.3	28.0	28.9
22.0	23.4	25.4	26.7	27.3	28.2
	23.9	25.6	26.1	27.3	28.9
		25.3	25.9	26.6	27.9

The spatial pattern of the temperature in the study region is very smooth (Figure 2) as a result to its small area, location near the sea and flat topography.

Figure 2: Characteristic temperatures of the grid-points shown in Figure 1. Continuous color temperature scale adopted.

The results showed that the annual number of HWD is consistently increasing over the study period, being the increase more pronounced regarding Tmax than Tmin. However, the upward trends were not statistically significant except for Tmax in two grid-points located northeastern Lisbon.

The spatial pattern over the study area of the trends of annual HWD based on either Tmax or Tmin is very smooth (Figure 3). Specifically, for Tmax the average increase of annual HWD varies from ca.1 to 4 days per decade, this last result being statistically significant. Regarding Tmin, the average increase in annual HWD ranges from less than 1 to about 3 days per decade, the highest values occurring south of Lisbon.

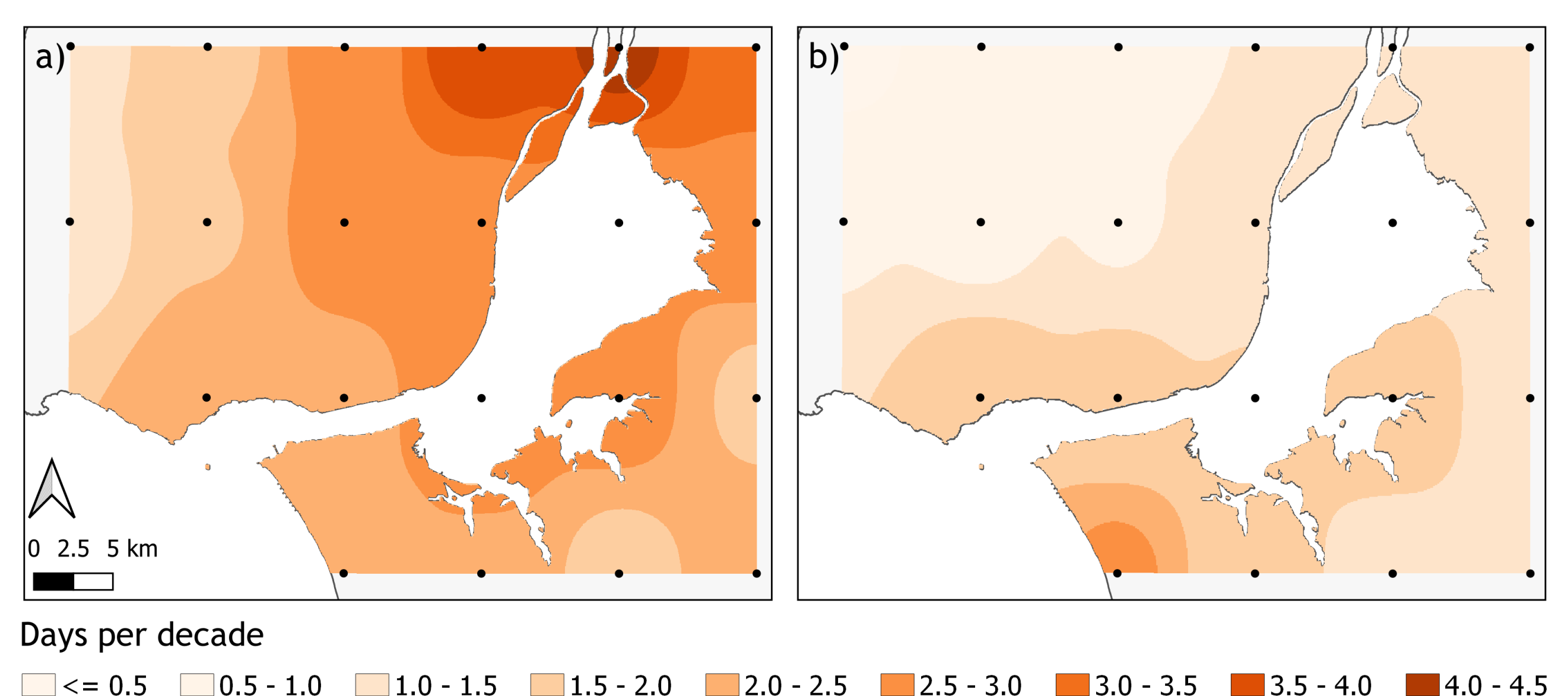


Figure 3: Sen's slope applied to the annual number of HWD for (a) Tmax and (b) Tmin.

The temporal pattern of the annual number of HWD show a sinusoidal behavior with an increase towards the more recent years, except in the coastal grid-points (Figure 4).

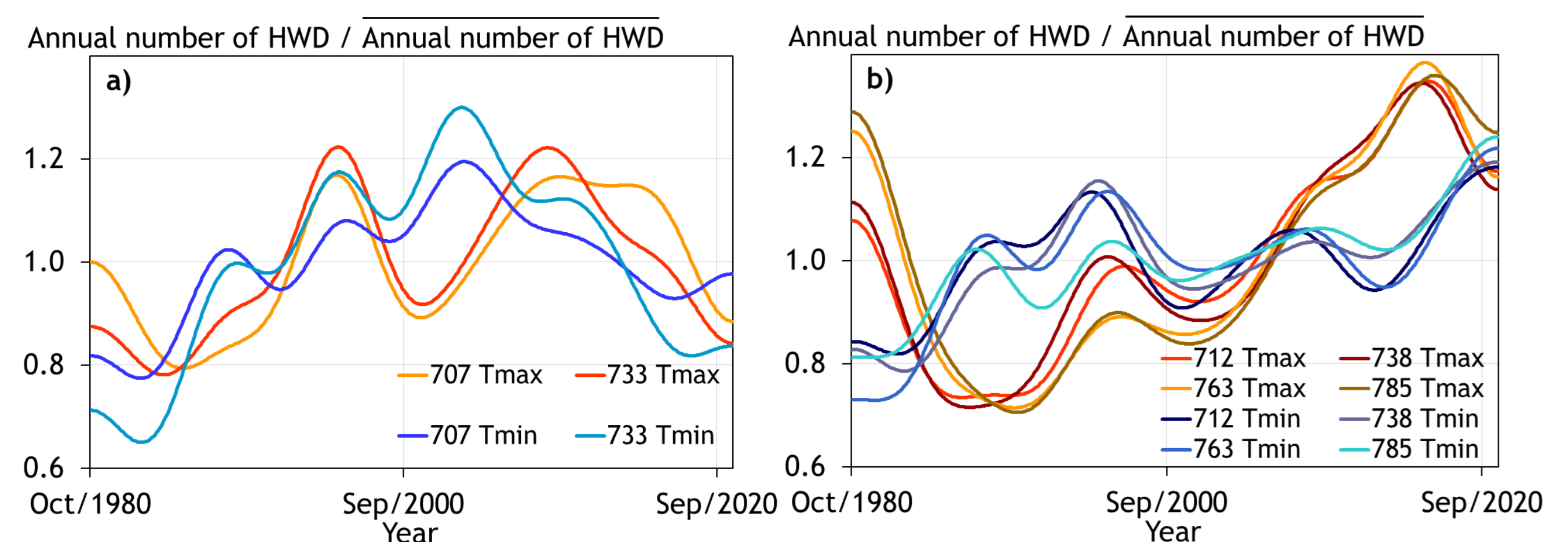


Figure 4: Ratio between the annual number of HWD and the mean annual number of HWD in the (a) two most western and (b) four most eastern grid-point for Tmax and Tmin.

It should be stressed that different behaviors can be detected for a same region depending on the adopted reference period: the longer and further back in time that period is, the more pronounced the trends are and, may even become statistically significant.

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