The Raymond and Beverly Sackler Faculty of Exact Sciences
Tel Aviv University

10th SEMINAR FOR HOMOGENIZATION AND QUALITY CONTROL AND 5th CONFERENCE ON SPATIAL INTERPOLATION TECHNIQUES IN CLIMATOLOGY AND METEOROLOGY 12-14 October 2020 (on-line)

IMS
השירות המטאורולוגי

LONG-TERM TRENDS IN EXTREME TEMPERATURE AND PRECIPITATION INDICES FOR ISRAEL BASED ON A NEW DAILY HOMOGENIZED DATABASE

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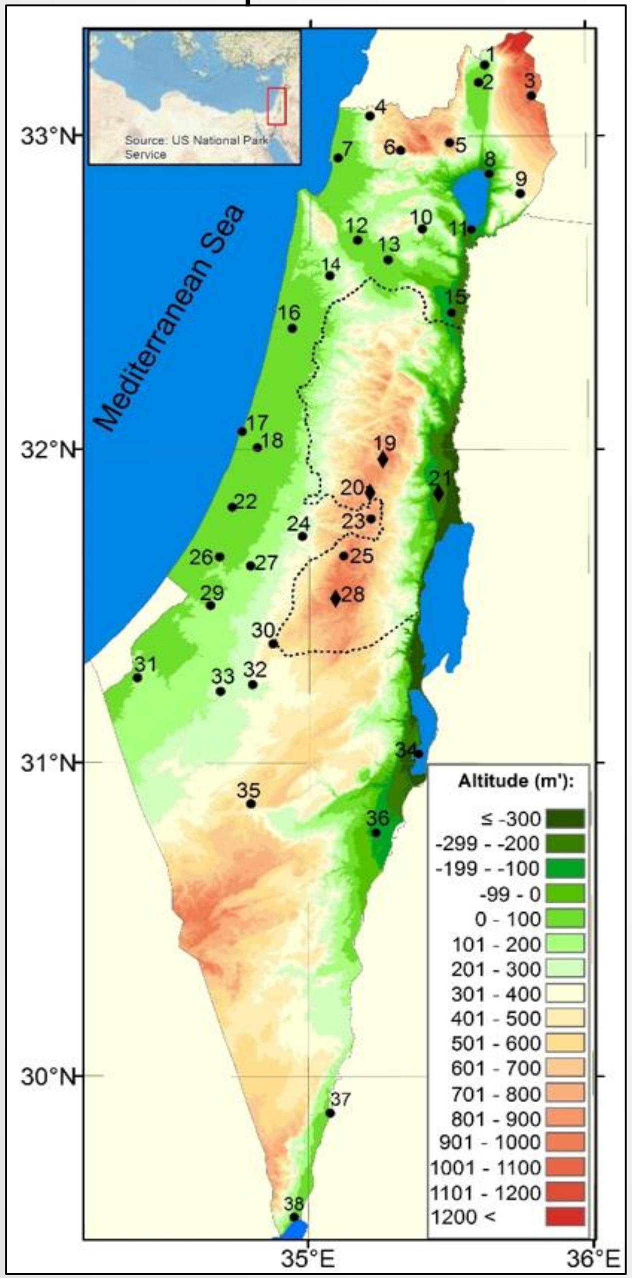
OUTLINES

- **Methodology** – Distribution of stations, Homogenization routine, Extreme indices calculation
- **Results** – Trends for a few temperature and precipitation indices for the period 1950-2017 (and a glimpse to 2100)
- **Conclusions**

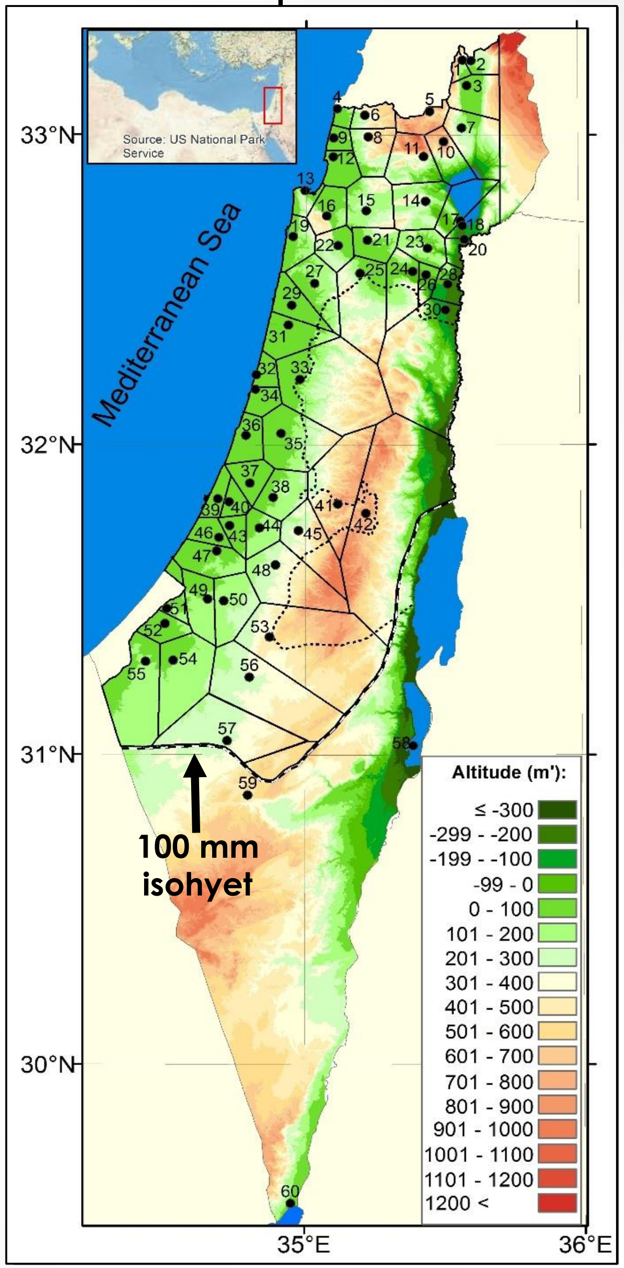
DISTRIBUTION OF STATIONS

Temperature

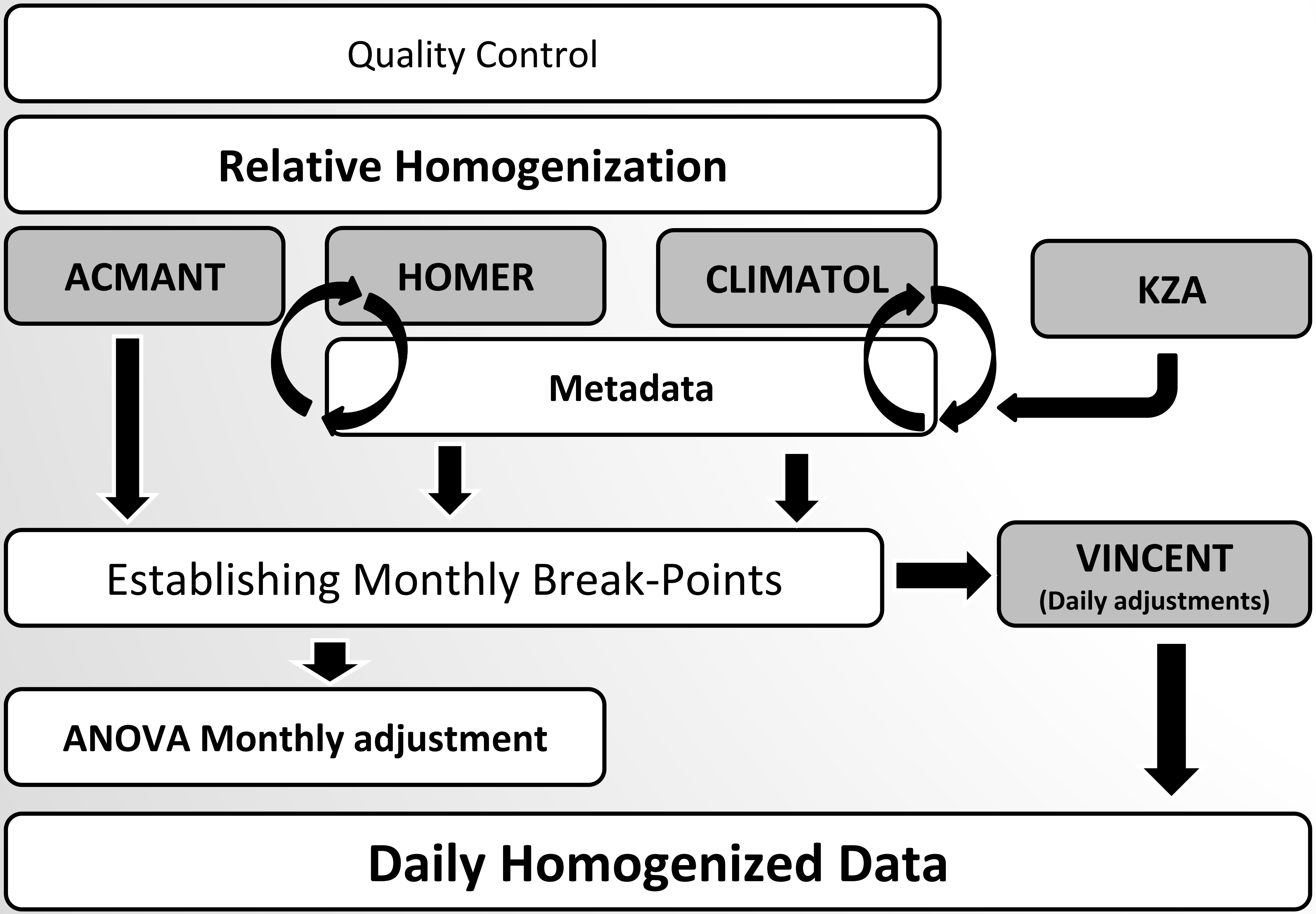


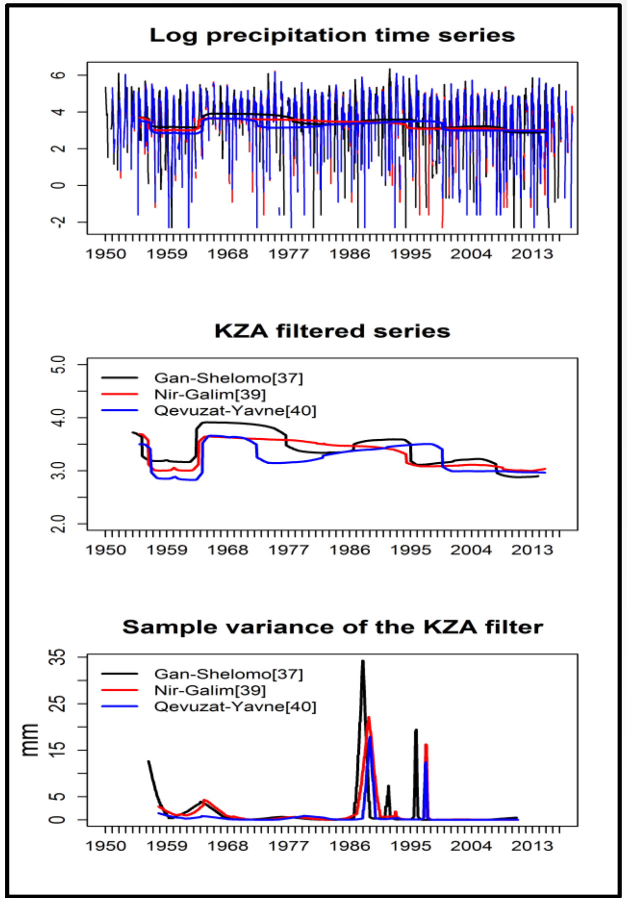
Thiessen polygons

Precipitation

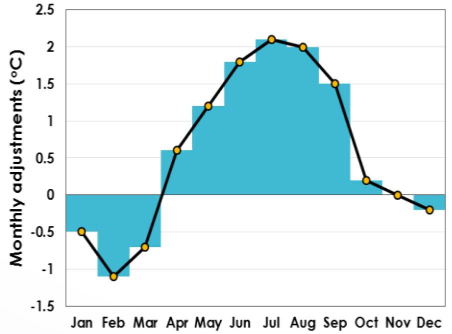


Daily Homogenization Scheme



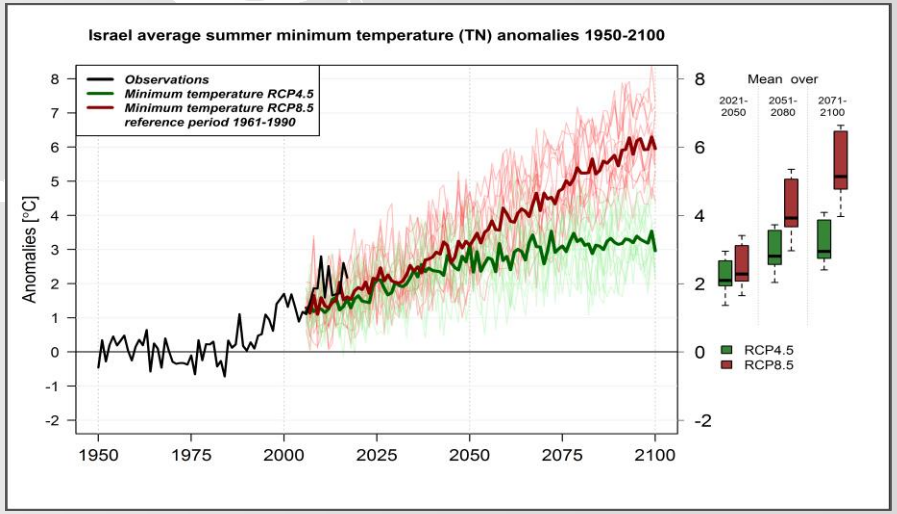


Kolmogorov–Zurbenko Adaptive filter

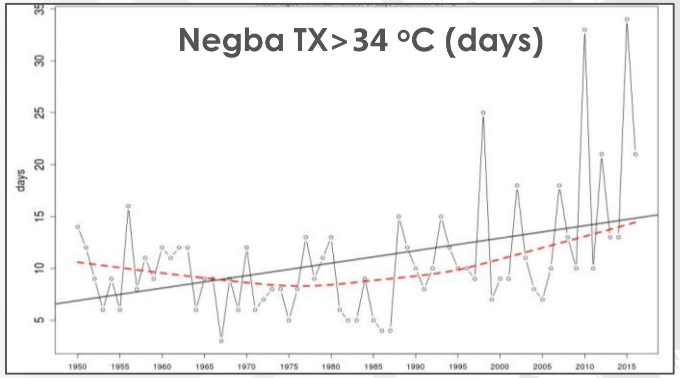


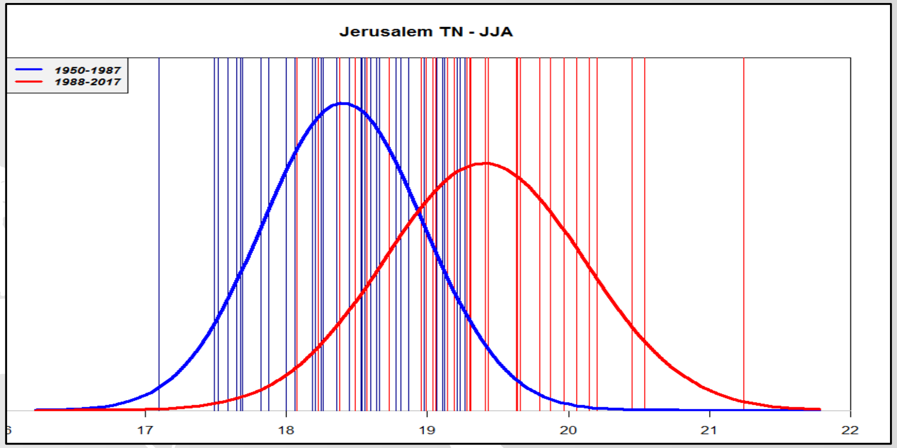
Homogeneous database

Climate change

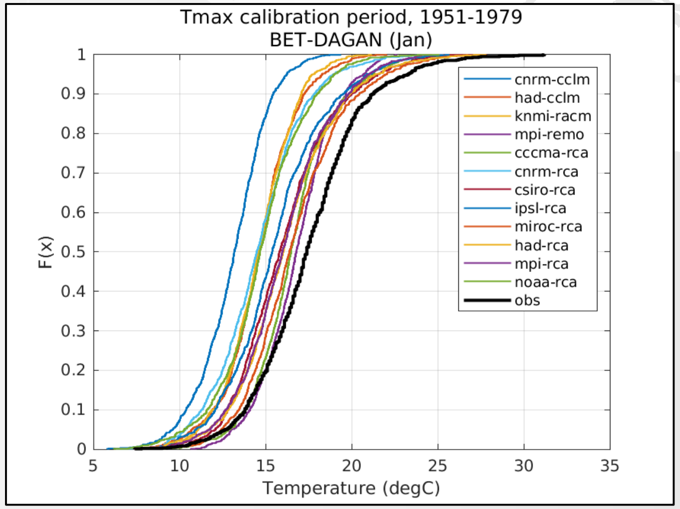


Extreme analyses





Models evaluation and bias corrections



And more….

Expert Team on Climate Change Detection and Indices (ETCCDI) &

Expert Team on Sector-specific Climate Indices (ET-SCI)

1950-2017

TEMPERATURE INDICES

	Index	Indicator name	Definitions	ET	Unit
1	FD0	Frost days	Annual count when TN (daily minimum)<0°C	ETCCDI	Days
2	SU25	Summer days	Annual count when TX (daily maximum)>25°C	ETCCDI	Days
3	ID0	Ice days	Annual count when TX (daily maximum)<0°C	ETCCDI	Days
4	TR20	Tropical nights	Annual count when TN (daily minimum)>20°C	ETCCDI	Days
5	FD2	Frost days 2	Annual count when TN < 2°C	ET-SCI	Days
6	SU30	Hot days	Annual count when TX ≥ 30°C	ET-SCI	Days
7	SU35	Very hot days	Annual count when TX ≥ 35°C	ET-SCI	Days
8	TXx	Max Tmax	Monthly maximum value of daily maximum temperature	ETCCDI	°C
9	TNx	Max Tmin	Monthly maximum value of daily minimum temperature	ETCCDI	°C
10	TXn	Min Tmax	Monthly minimum value of daily maximum temperature	ETCCDI	°C
11	TNn	Min Tmin	Monthly minimum value of daily minimum temperature	ETCCDI	°C
12	TN10p	Cool nights	Percentage of days when TN<10th percentile	ETCCDI	%
13	TX10p	Cool days	Percentage of days when TX<10th percentile	ETCCDI	%
14	TN90p	Warm nights	Percentage of days when TN>90th percentile	ETCCDI	%
15	TX90p	Warm days	Percentage of days when TX>90th percentile	ETCCDI	%
16	WSDI	Warm spell duration indicator	Annual count of days with at least 6 consecutive days when TX>90th percentile	ETCCDI	Days
71	WSDI3	Warm spell duration indicator	Annual count of days with at least 3 consecutive days when TX>90th percentile	ETCCDI	Days
18	CSDI	Cold spell duration indicator	Annual count of days with at least 6 consecutive days when TN<10th percentile	ETCCDI	Days
19	CSDI3	Cold spell duration indicator	Annual count of days with at least 3 consecutive days when TN<10th percentile	ET-SCI	Days
20	DTR	Diurnal temperature range	Monthly mean difference between TX and TN	ETCCDI	°C
21	TX3TN3	Hot days and nights	Annual count of 3 consecutive days where both TX > 95th percentile and TN > 95th percentile	ET-SCI	Number of events

PRECIPITATION INDICES

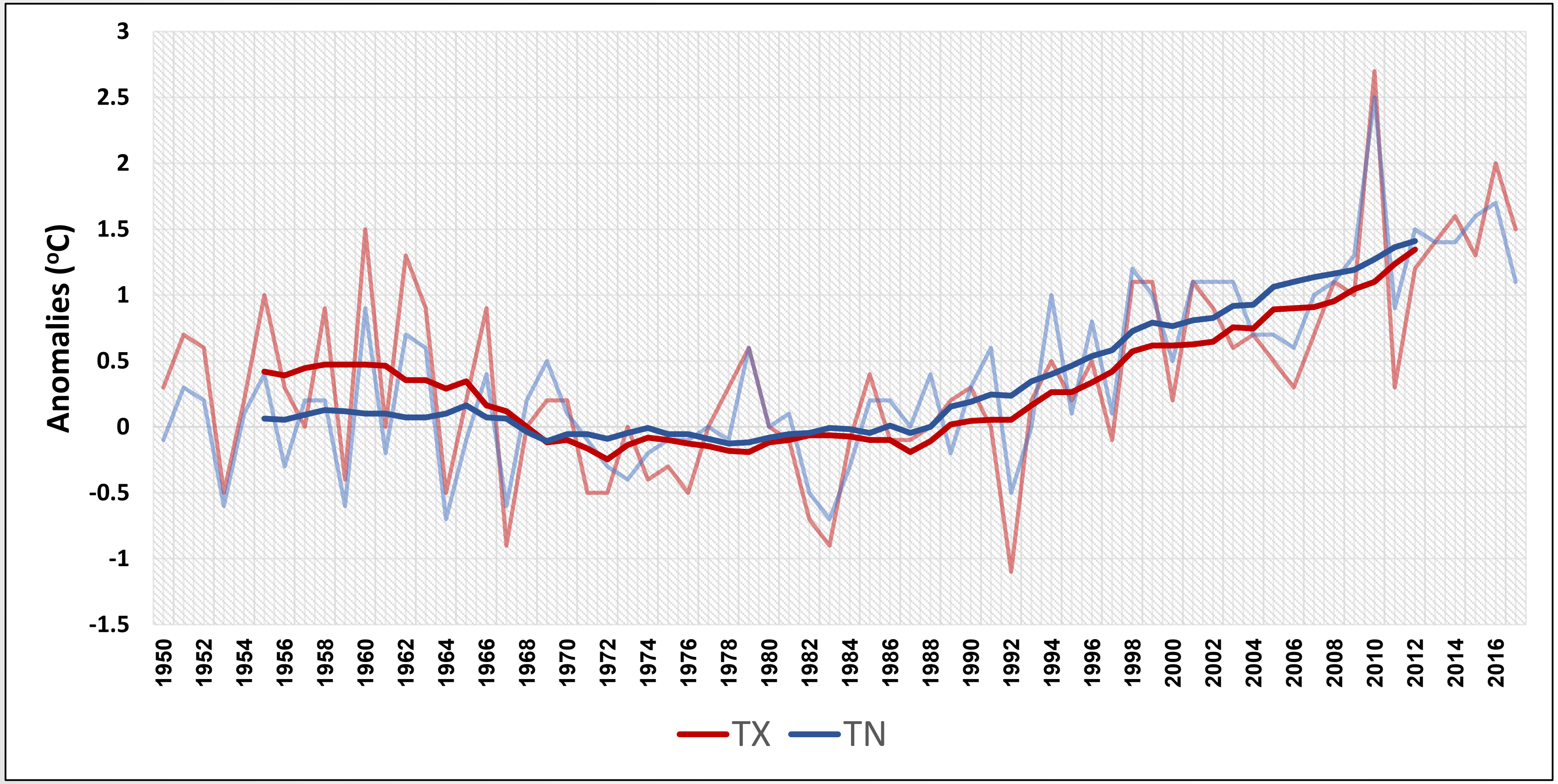
	Index	Indicator name	Definitions	ET	Unit
22	RX1day	Max 1-day precipitation amount	Monthly maximum 1-day precipitation	ETCCDI	mm
23	RX5day	Max 5-day precipitation amount	Monthly maximum consecutive 5-day precipitation	ETCCDI	mm
24	SDII	Simple daily intensity index	Annual total precipitation divided by the number of wet days (defined as precipitation ≥ 1 mm) in the year	ETCCDI	mm/day
25	R1mm	Number of wet days	Annual count of days when precipitation ≥ 1mm	ETCCDI	Days
26	R10mm	Number of heavy precipitation days	Annual count of days when precipitation ≥ 10mm	ETCCDI	Days
27	R20mm	Number of very heavy precipitation days	Annual count of days when precipitation ≥ 20mm	ETCCDI	Days
28	R50mm	Number of days above 50 mm	Annual count of days when precipitation ≥ 50mm	ETCCDI	Days
29	CDD	Consecutive dry days	Maximum number of consecutive days when precipitation <1mm	ETCCDI	Days
30	CDD-DJF	Consecutive dry days	Maximum number of consecutive days when precipitation <1mm, between December to February		Days
31	CDD-NDJFM	Consecutive dry days	Maximum number of consecutive days when precipitation <1mm between November to March		Days
32	CDD-NDJFMA	Consecutive dry days	Maximum number of consecutive days when precipitation <1mm between November to April		Days
33	CWD	Consecutive wet days	Maximum number of consecutive days when precipitation ≥ 1mm	ETCCDI	Days
34	R95p	Very wet days	Annual total PRCP when RR>95th percentile	ETCCDI	mm
35	R99p	Extremely wet days	Annual total PRCP when RR>99th percentile	ETCCDI	mm
36	R95pTOT	Contribution from very wet days	100 * R95p / PRCPTOT	ET-SCI	%
37	R99pTOT	Contribution from extremely wet days	100 * R99p / PRCPTOT	ET-SCI	%
38	PRCPTOT	Annual total wet-day precipitation	Annual total precipitation from days ≥ 1mm	ETCCDI	mm

REGIONAL AVERAGED ANOMALY SERIES OF TX & TN

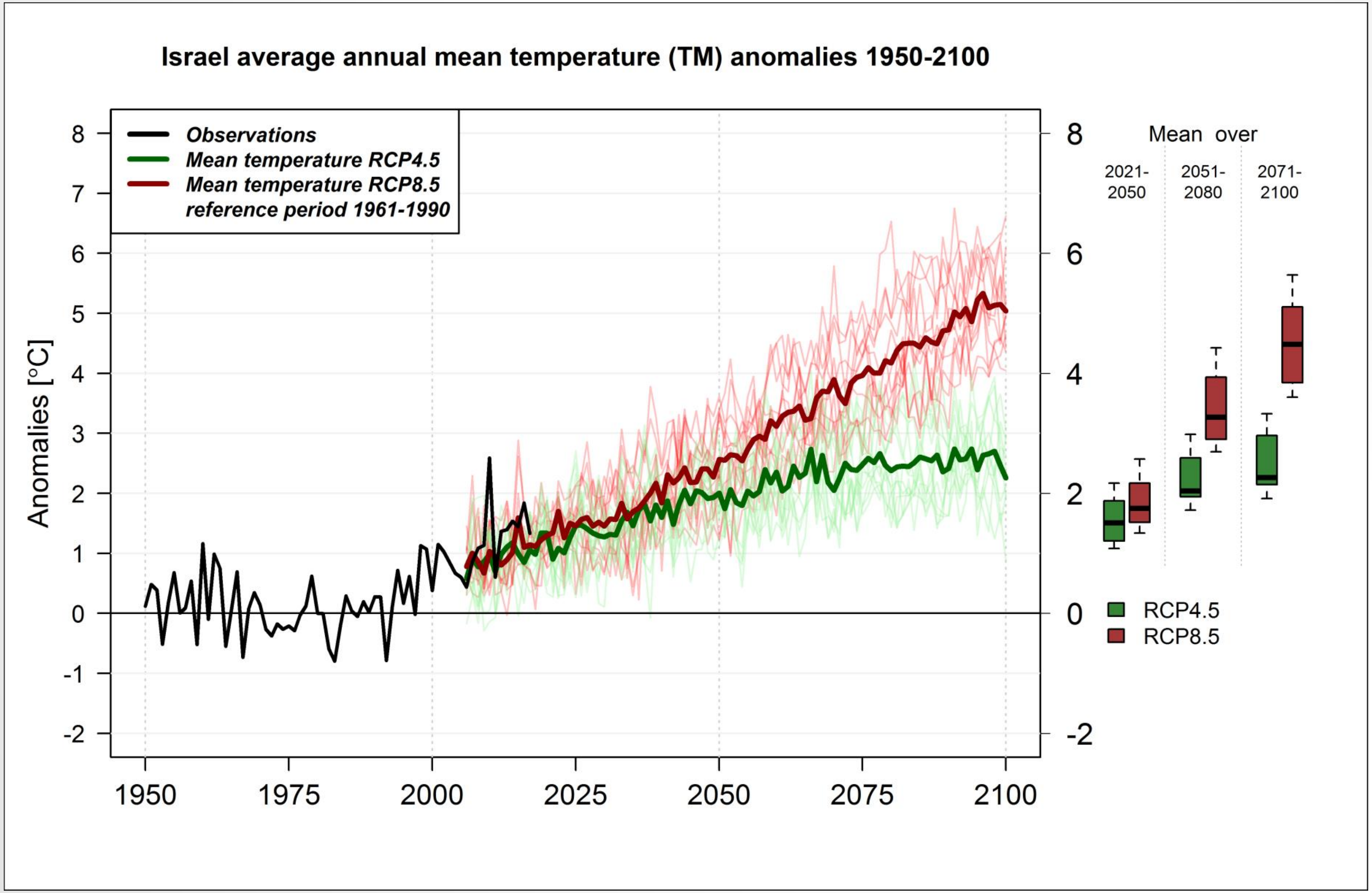
(RELATIVE TO 1961-1990)

(Theil–Sen estimator)

	1950-2017				1988-2017			
	Slope [°C/decade]	Lower bound	Upper bound	Significance	Slope [°C/decade]	Lower bound	Upper bound	Significance
Minimum Temperature (TN)	**0.24**	0.15	0.33	*p<0.0001*	**0.55**	0.38	0.71	*p<0.0001*
Maximum Temperature (TX)	**0.19**	0.07	0.31	*p=0.003*	**0.56**	0.39	0.75	*p<0.0001*

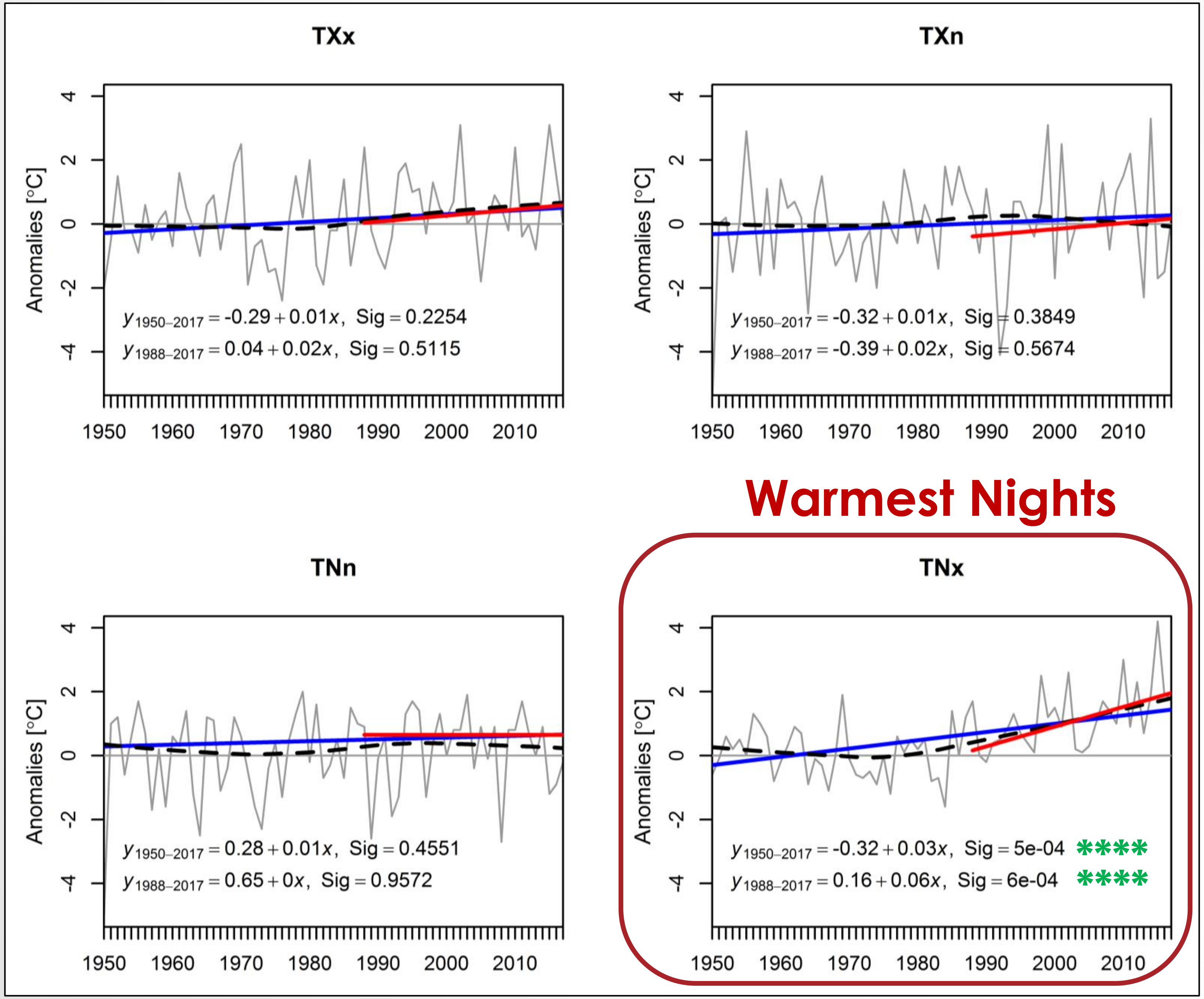


Eleven-year moving average



Yosef, Y., Baharad, A., Uzan, L., Furshpan, A., Levi, Y. (2020). Israel temperature projections by 2100. Research Report No. 4000-0802-2020-0000044, Israel Meteorological Service (in Hebrew).

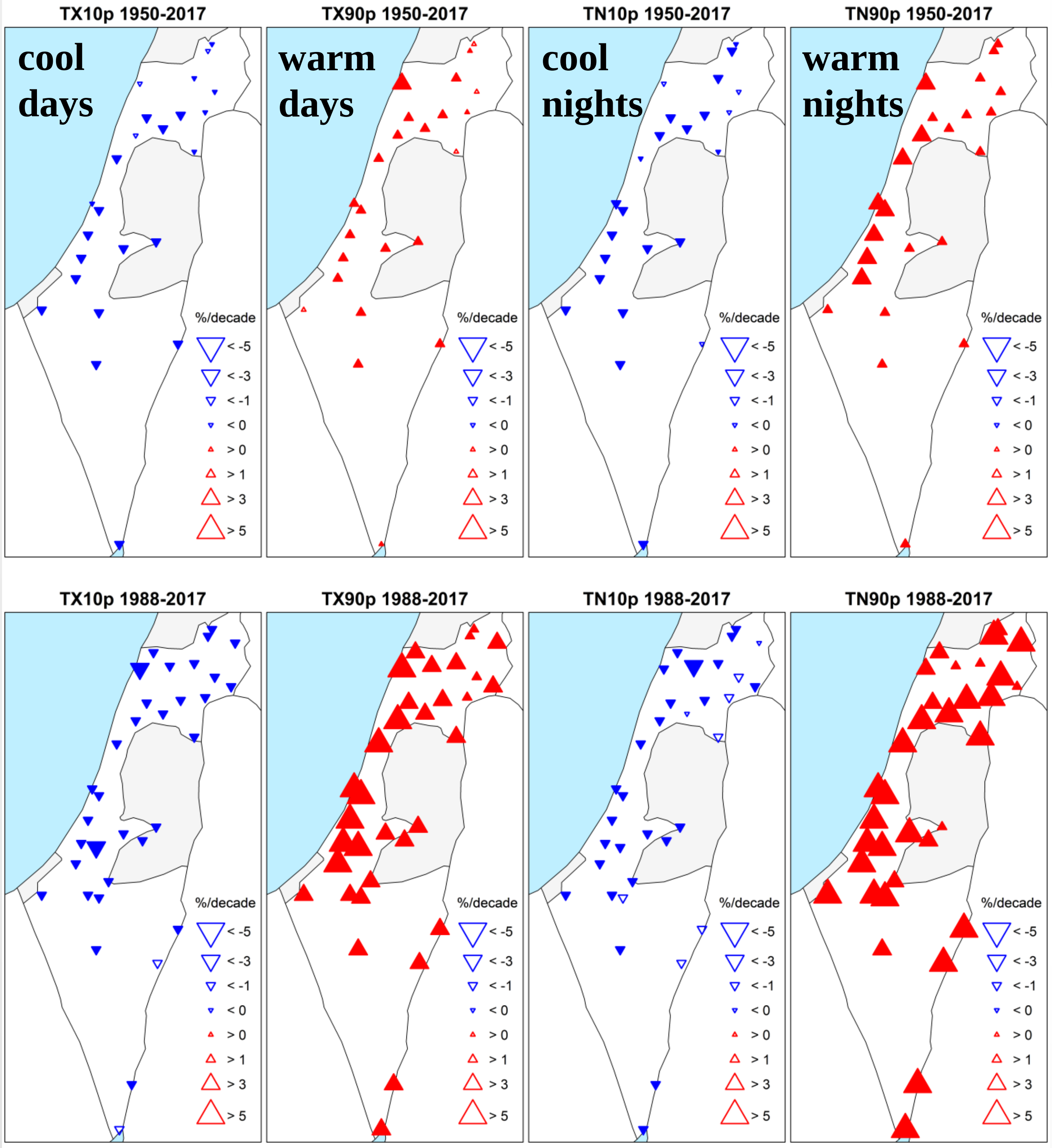
REGIONAL AVERAGED ANOMALY SERIES OF TXX, TXN, TNN & TNX
(RELATIVE TO 1961-1990)



Blue lines represent linear trends for 1950-2017. Red lines represent linear trends for 1988-2017. Dashed black lines are based on the LOWESS smoother (Yosef et al., 2019).

1950-2017

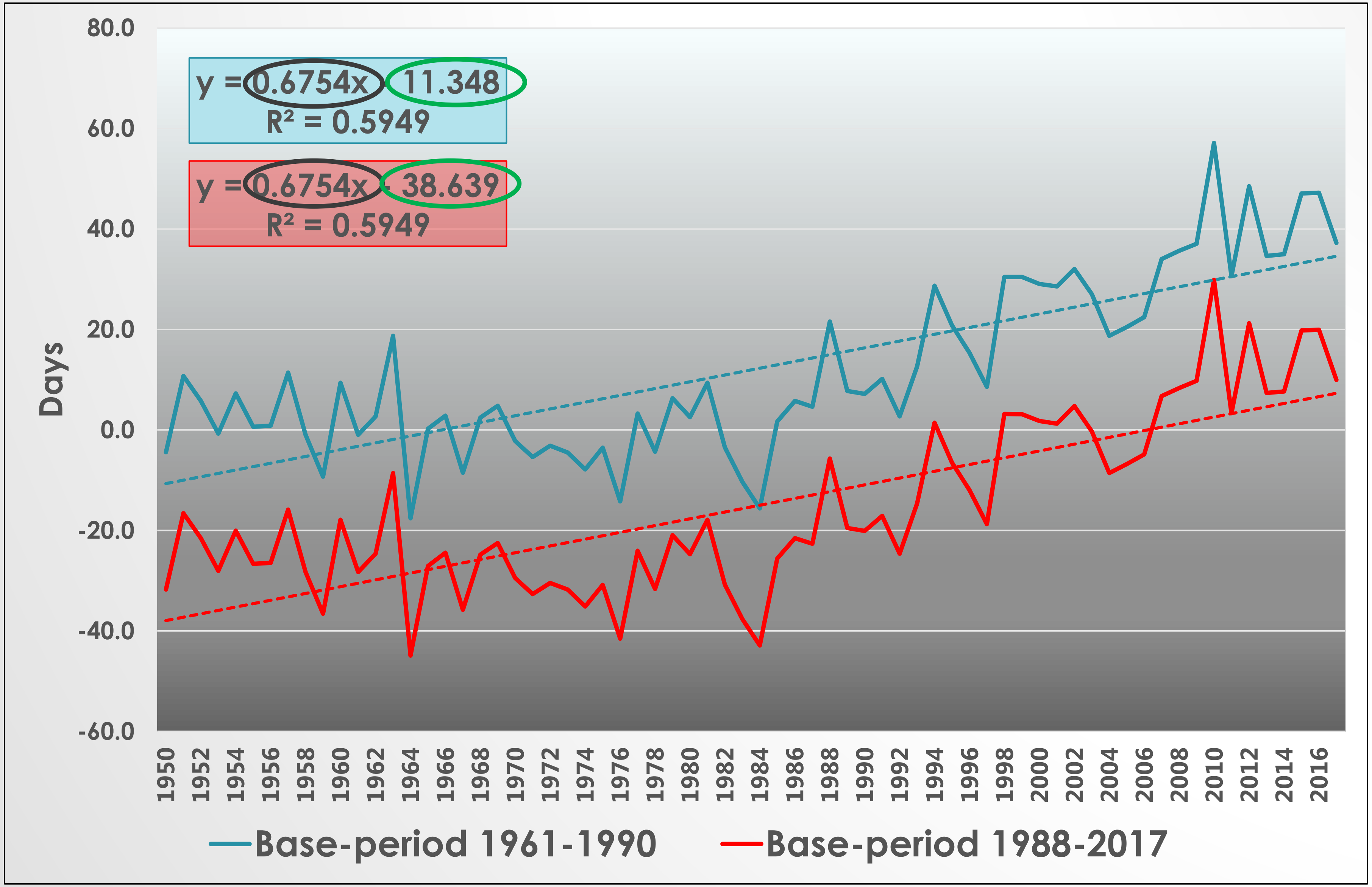
1988-2017



The annual trends of:
TX10p (cool days),
TX90p (warm days),
TN10p (cool nights)
TN90p (warm nights).
(unit: % / decade).

Upward red triangles represent increasing trends, downward blue triangles decreasing trends. Different sizes of triangles indicate different magnitudes of trends. Significant changes ($p \leq .05$) are indicated by filled triangles (Yosef et al., 2019).

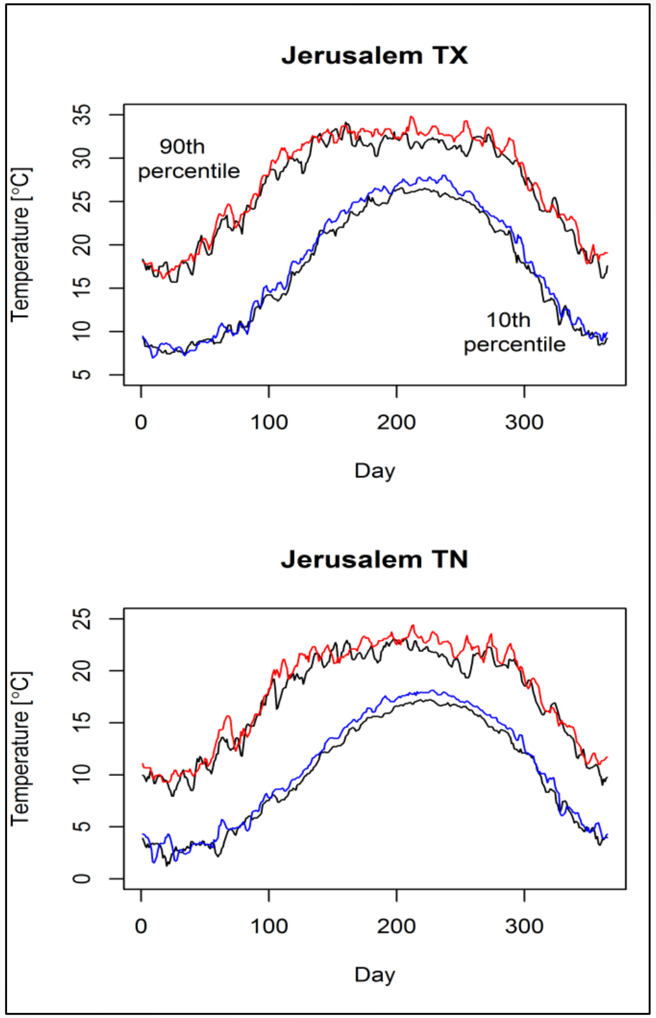
Anomalies of the number of days when the minimum temperature is above 20 °C (TN>20 °C, tropical nights)



Percentile-based extreme indices recommended by the Expert Team on Climate Change Detection and Indices (ETCCDI) & Expert Team on Sector-specific Climate Indices (ET-SCI)

Index	Indicator name	Definitions	ET	Unit
TX10p	Cool days	Percentage of days when TX<10th percentile	ETCCDI	%
TX90p	Warm days	Percentage of days when TX>90th percentile	ETCCDI	%
TN10p	Cool nights	Percentage of days when TN<10th percentile	ETCCDI	%
TN90p	Warm nights	Percentage of days when TN>90th percentile	ETCCDI	%
WSDI	Warm spell duration indicator	Annual count of days with at least 6 consecutive days when TX>90th percentile	ETCCDI	Days
WSDI3	Warm spell duration indicator	Annual count of days with at least 3 consecutive days when TX>90th percentile	ET-SCI	Days
CSDI	Cold spell duration indicator	Annual count of days with at least 6 consecutive days when TN<10th percentile	ETCCDI	Days
CSDI3	Cold spell duration indicator	Annual count of days with at least 3 consecutive days when TN<10th percentile	ET-SCI	Days

And more…



Black lines, percentiles derived from **1961-1990**

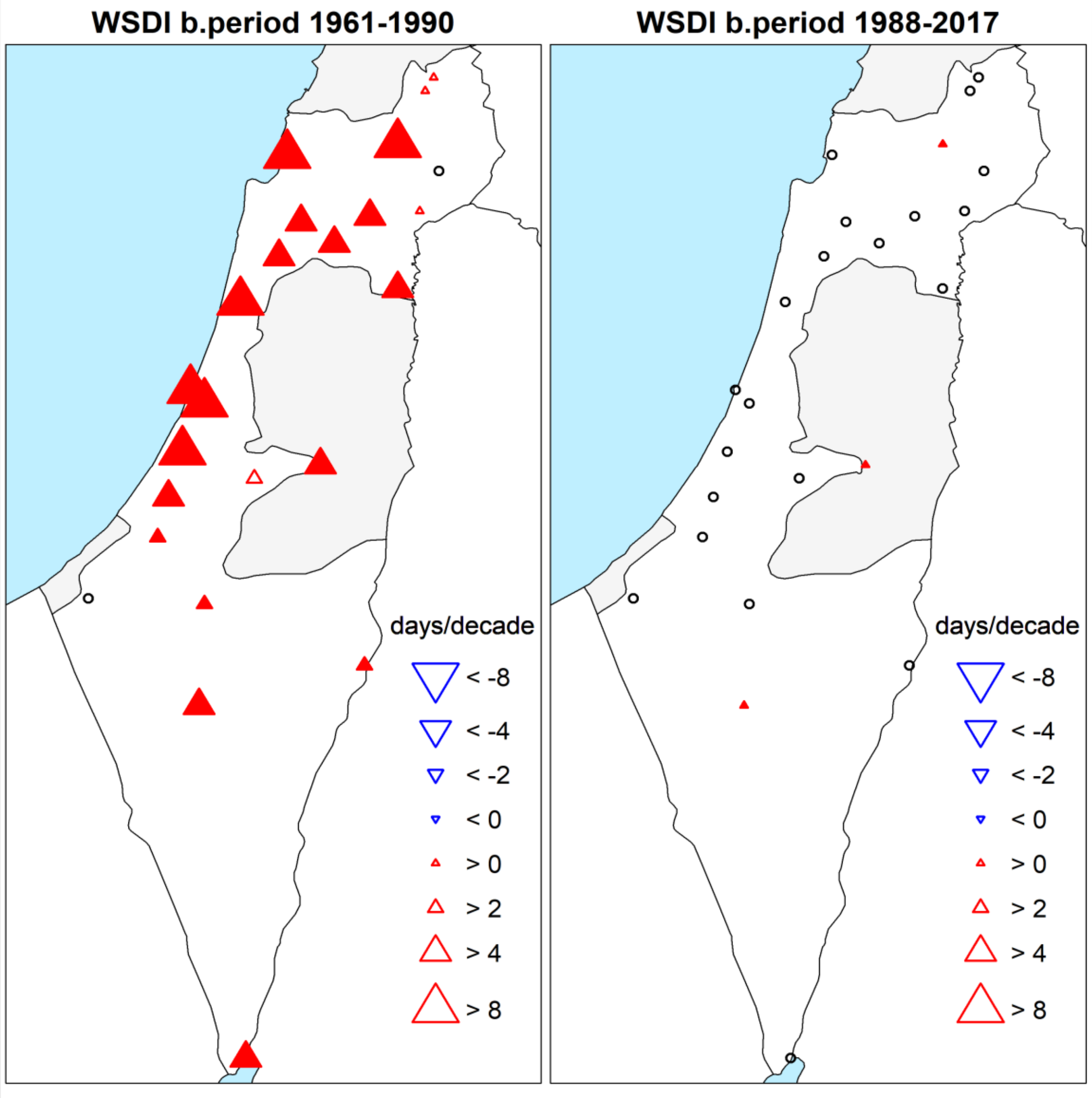
Red lines, 90th percentile derived from **1988-2017**

Blue lines, 10th percentile derived from **1988-2017**

The percentile-based thresholds of the maximum (TX) and minimum (TN) temperature, derived from two base periods, 1961-1990 (black) and 1988-2017 (red and blue). In each panel, the upper curves denote the 90th percentile and the lower curves denote the 10th percentiles (Yosef et al., 2020).

Warm Spell Duration Index (WSDI) trends over 1988-2017

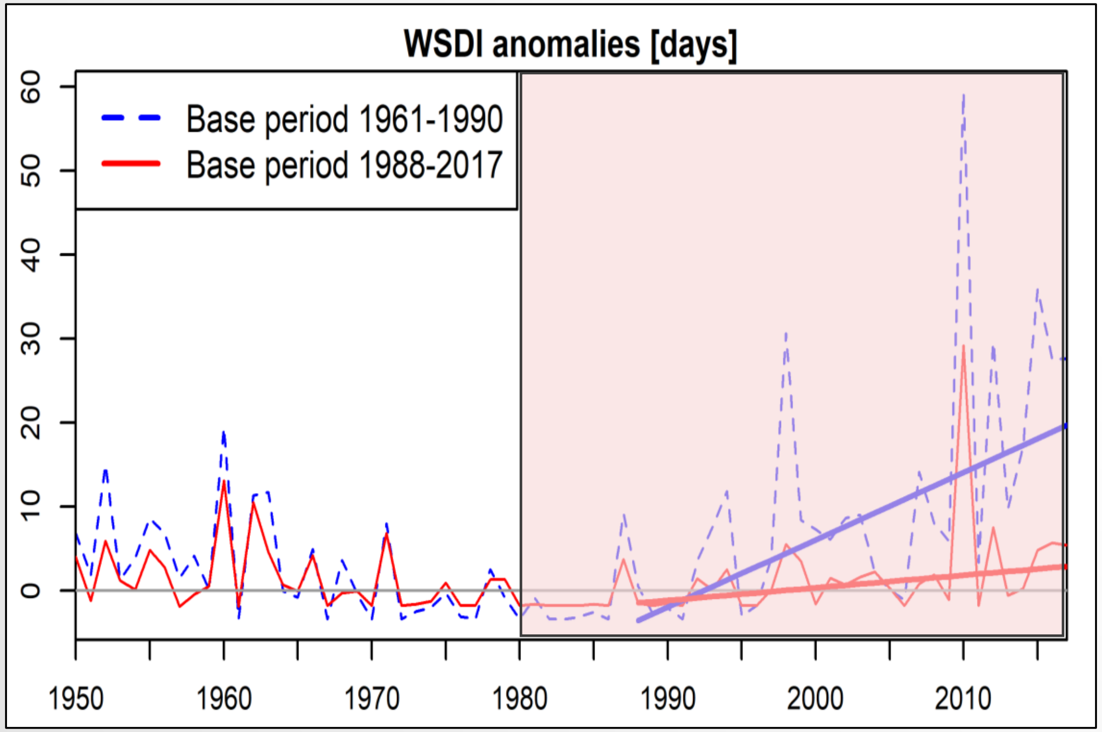
WSDI: Annual count of days with at least 6 consecutive days when TX>90th percentile



Trends in the WSDI index for the period 1988-2017 when percentiles derived from different base periods (b.period 1961-1990 vs. b.period 1988-2017). Upward facing red triangles represent increasing trends and downward facing blue triangles represent decreasing trends. Different sizes of triangles indicate different magnitudes of trends. Filled triangles mark significant changes ($p \leq 0.05$; units: days/decade). Circle denote no trend. (Yosef et al., 2020)

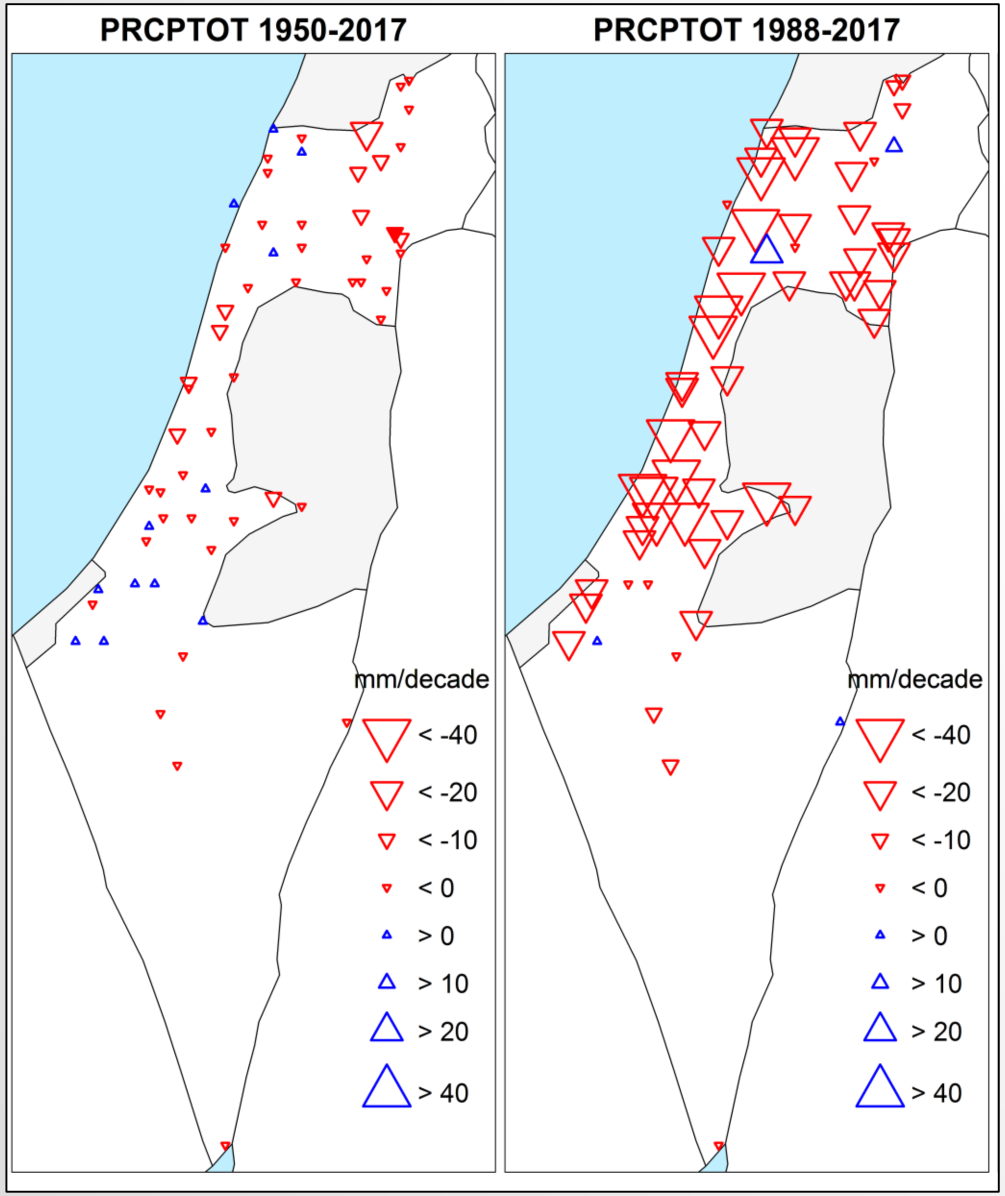
Trend magnitude of the warm indices is dramatically diminished while the trend magnitude of cold percentile-based indices is strongly amplified, when percentiles were derived from a base period that included records from the last two decades (e.g., 1981-2010, 1988-2017).

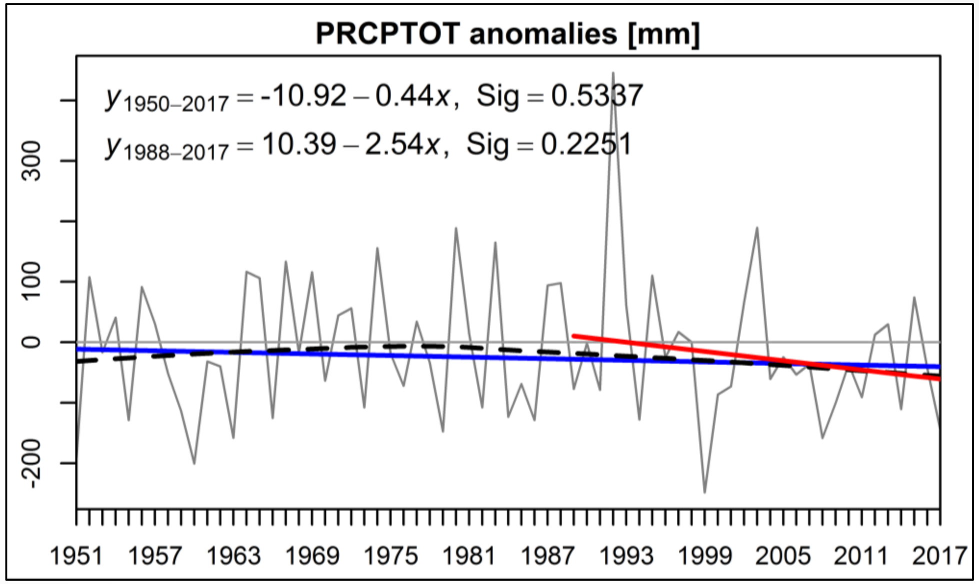
These features are even more pronounced when the study period covers only the last 30-40 years.



Regional averaged anomaly series (1950-2017) relative to 1961-1990 mean values. Solid (red) and dashed (blue) lines represent the different base periods of which the percentiles were derived, 1988-2017 (warmer) and 1961-1990 (colder) respectively. Solid blue and red lines denote the linear trends of the period 1988-2017 for both base periods (Yosef et al., 2020).

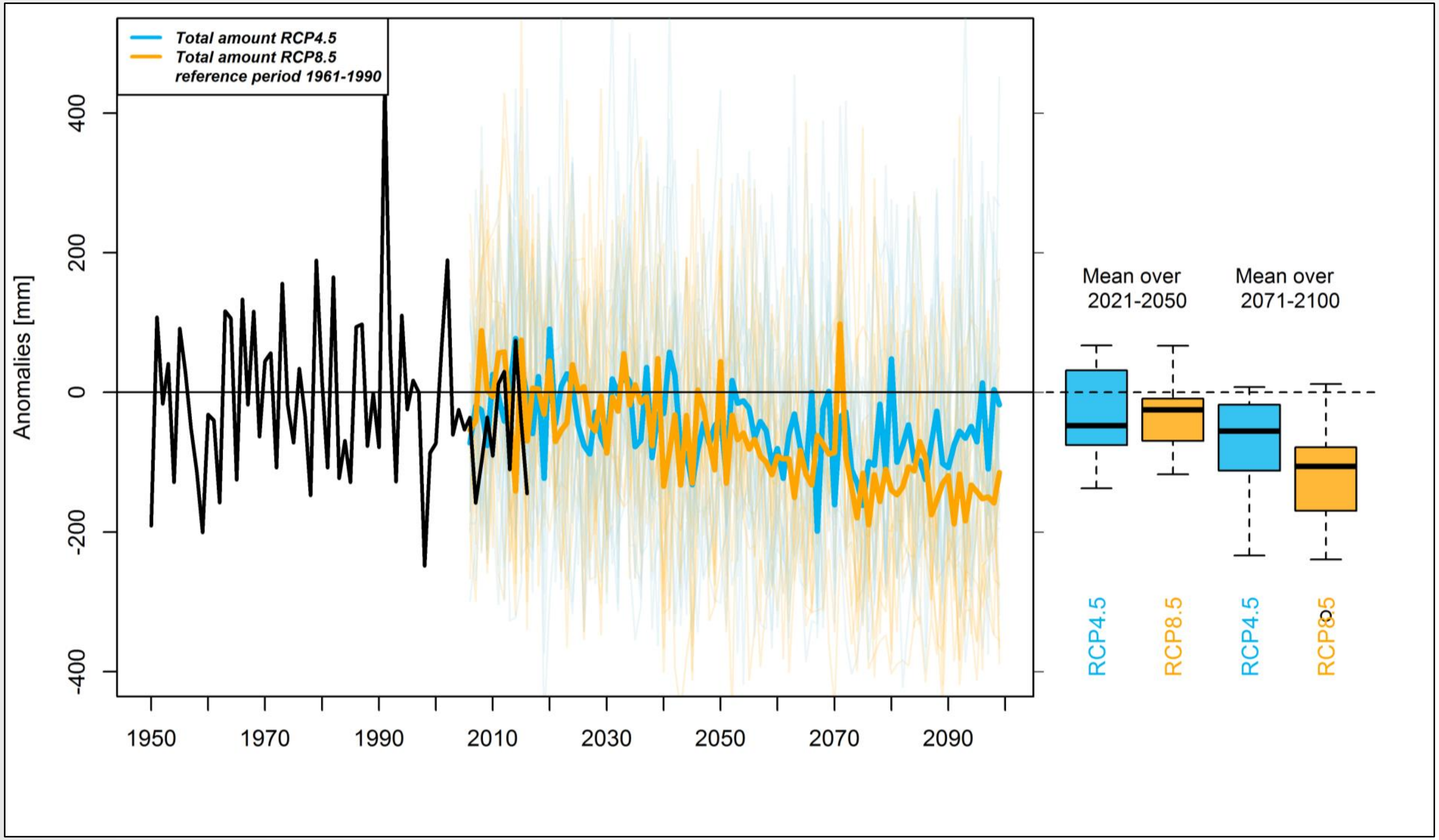
Trend in the annual total precipitation (PRCPTOT) for the period 1950–2017 and 1988–2017





Upward blue triangles represent increasing trends, downward red triangles decreasing trends. Different sized triangles indicate different magnitudes of trends. Significant changes (*p≤0.05*) are indicated by filled triangles. (unit: mm/decade; % / decade, respectively).

Changes in the annual precipitation amount 1950-2100



Yosef, Y., Baharad, A., Uzan, L., Osetinsky-Tzidaki, I., Carmona, I., Halfon, N., Furshpan, A., Levi, Y., Stav, N. (2019). Climate change in Israel – historical trends and future predictions of temperature and precipitation. Research Report No. 4000-0804-2019-0000075, Israel Meteorological Service.

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RESEARCH ARTICLE

International Journal of Climatology RMetS

Changes in extreme temperature and precipitation indices: Using an innovative daily homogenized database in Israel

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[3]Center on Climate Change (C3), Univ... Rovira i Virgili, Tarragona, Spain

Abstract
This study examines the 1950–2017 temporal changes in climate extremes in Israel, which is located in the East Mediterranean (EM), a region which suffers from a scar-

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RESEARCH ARTICLE

International Journal of Climatology RMetS

Is it possible to fit extreme climate change indices together seamlessly in the era of accelerated warming?

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[2]Israel Meteorological Service, Bet-Dagan, Israel
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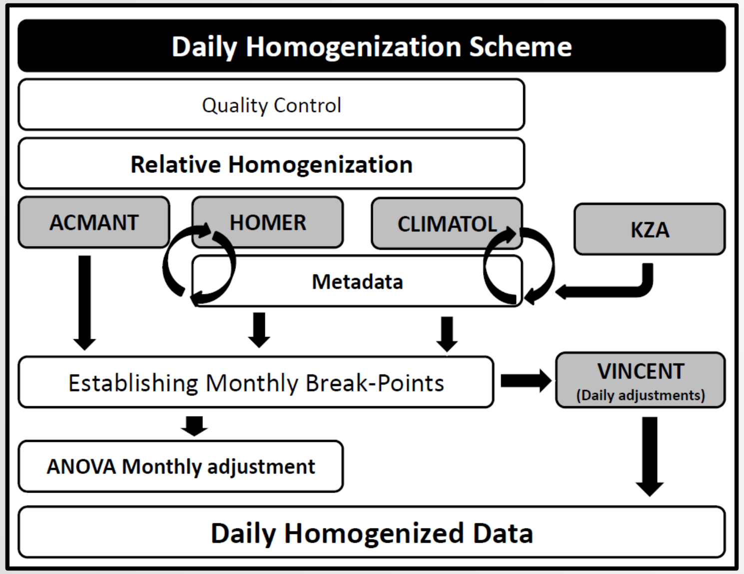
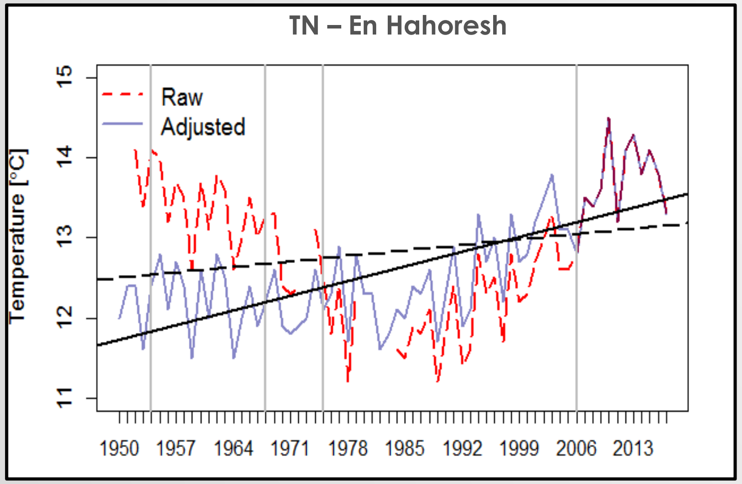
Abstract
This study examines the problematic impact of selecting a different base period (colder 1961–1990 vs. warmer 1988–2017), on the trend magnitude of widely used percentile-based extreme temperature indices (e.g., warm/cold spells, warm/cold days and nights). The percentile-based indices are part of a core set of indices (27 in total) that have become a common standard for monitoring climate change, as recommended by the Expert Team on Climate Change Detection and Indices (ETCCDI). The indices were designed to be comparable

https://rmets.onlinelibrary.wiley.com/doi/abs/10.1002/joc.6740?af=R

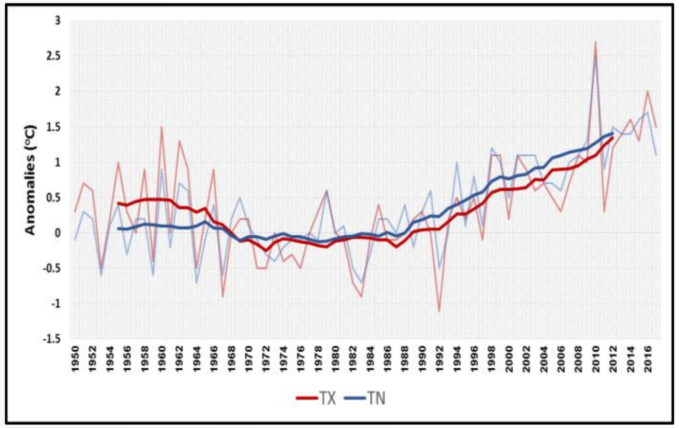
CONCLUSIONS

Homogenization

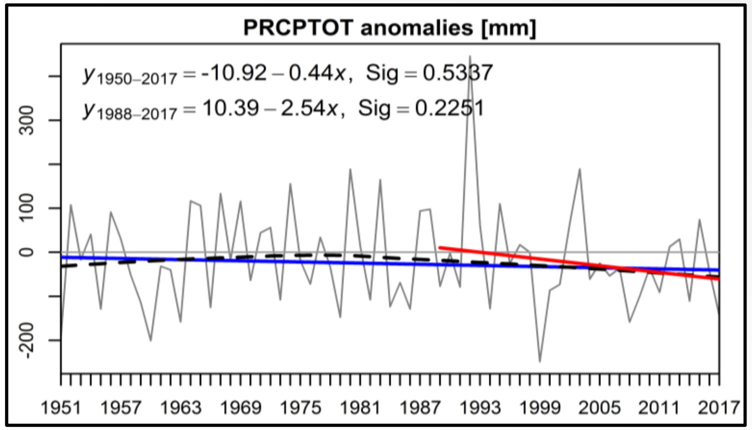




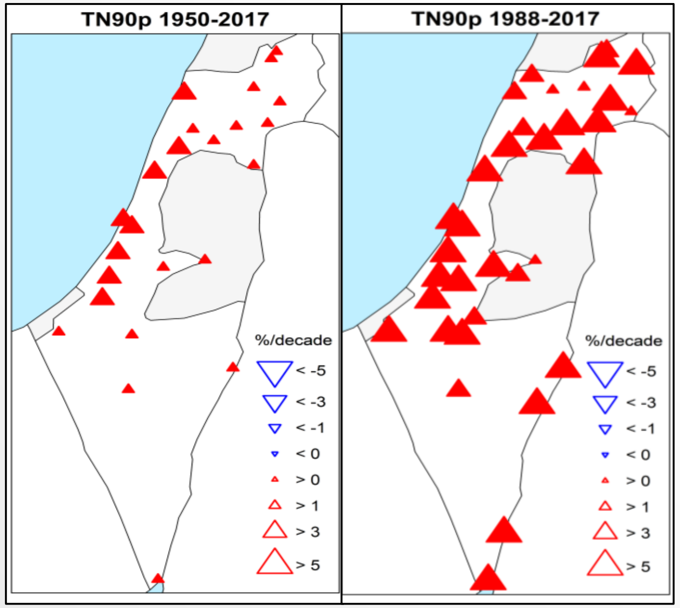
Temperature



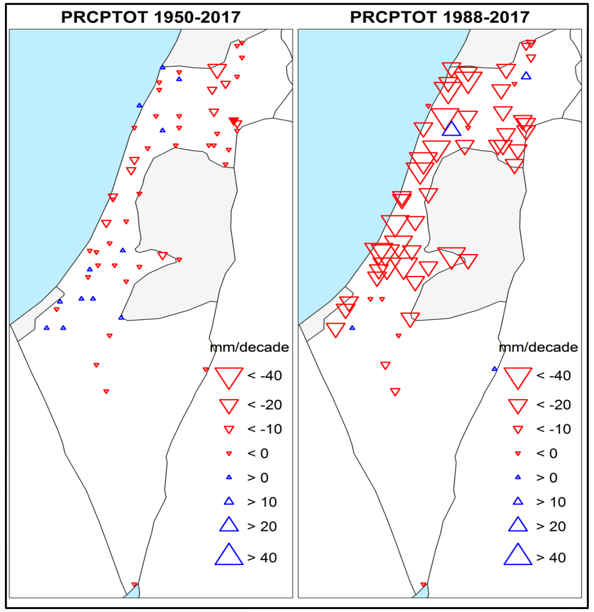
Precipitation



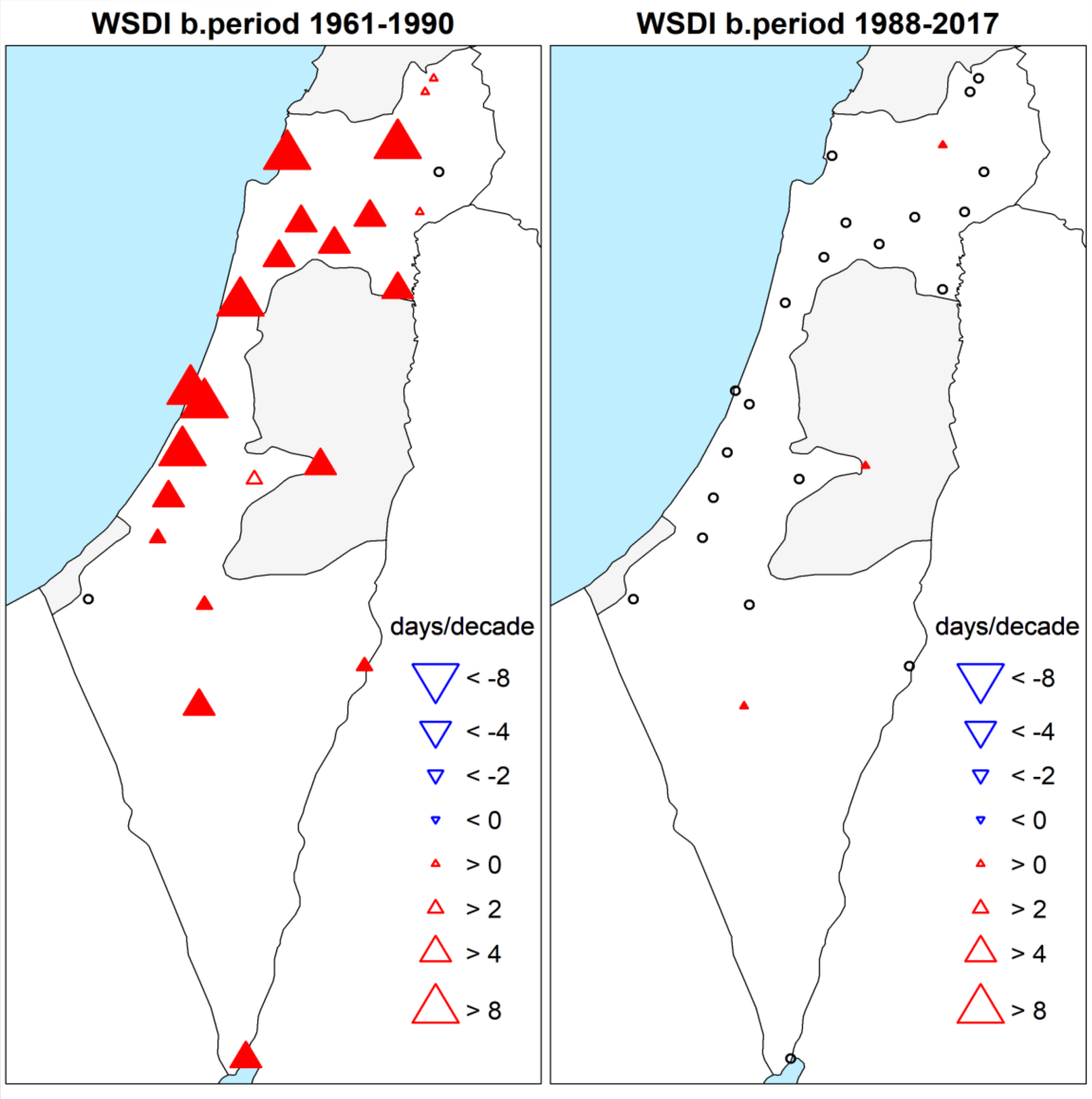
Extreme Temperature



Total amount



CONCLUSIONS



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THANK YOU FOR LISTENING!

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