METHODOLOGICAL EVALUATION OF TEMPERATURE AND PRECIPITATION EXTREMES IN CENTRAL EUROPE USING GRIDDED OBSERVATION DATASETS AND REANALYSIS PRODUCTS

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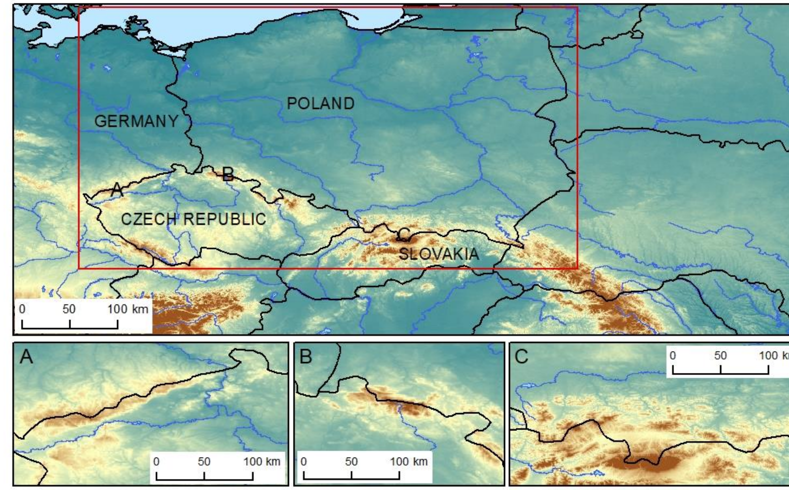
→ methodological evaluation of the representation of **temperature** and **precipitation extremes** within two reanalysis datasets (ERA5, ERA5-Land) and two gridded observational products (E-OBS and a newly developed high-resolution CE dataset), using in-situ station data as a reference.



1961–2024
daily maximum and minimum temperatures (Tmax, Tmin)
daily precipitation totals (RR)

Extremes are identified using both absolute and percentile-based thresholds.
The new CE dataset incorporates homogenised data from approximately 500 climate stations and 1000 rain gauges, offering 2×2 km resolution.

Validation: point-to-grid comparisons and areal buffer analyses, with co-occurrence statistics (e.g., hit rate) and standard metrics (e.g., correlation coefficients, bias estimation, cross-validation) applied to assess spatial and intensity characteristics.

NEW BASELINES, NEW EXTREMES?

Assessing the impact of reference periods on climate extremes in Central Europe

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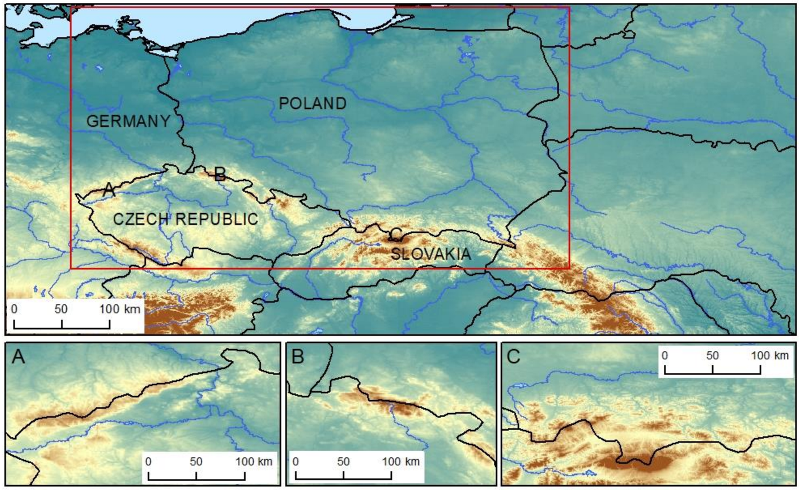
→ Central Europe
→ newly developed 3-km station-based gridded daily
→ air-temperature dataset for 1961–2024 (Tmax, Tmin)



The research study area (red rectangle);
A) Ore Mountains, B) The Sudetes, C) the Western Carpathians

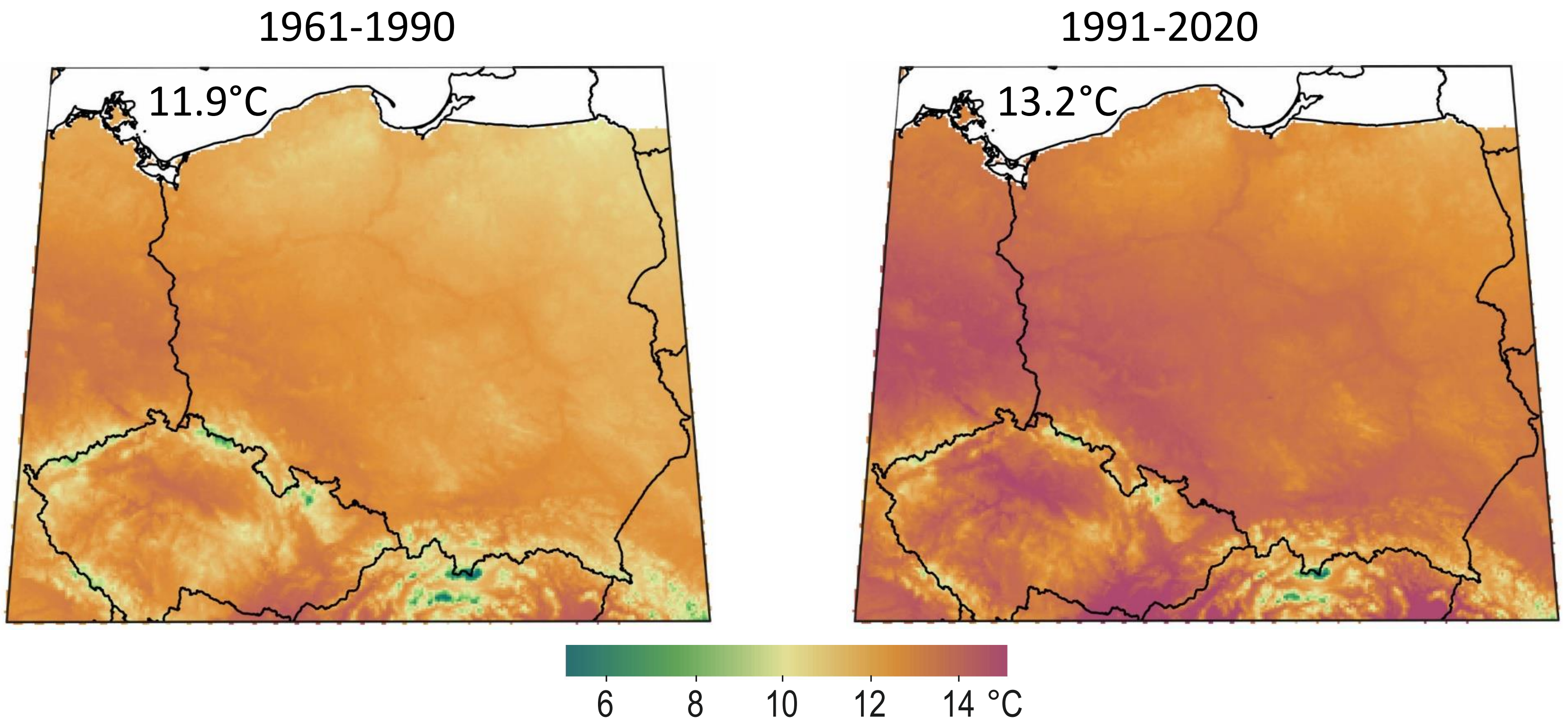
(1) 1961–1990 vs 1991–2020 → mean temperature (annual/seasonal distributions and linear trends)

(2) absolute-threshold extremes (Tmax > 25°C, Tmax > 30°C, Tmin < -10°C) in each 30-year period and counted regional events when ≥ 20% of the domain exceeded a threshold

(3) evaluated baseline sensitivity of percentile-defined extremes:
Tmax > 90p and Tmin < 10p → seasonal frequencies and grid-cell trends (thresholds computed as calendar-day percentiles using a 15-day moving window, separately for each normal period)

1961–1990 vs 1991–2020: how do they compare?

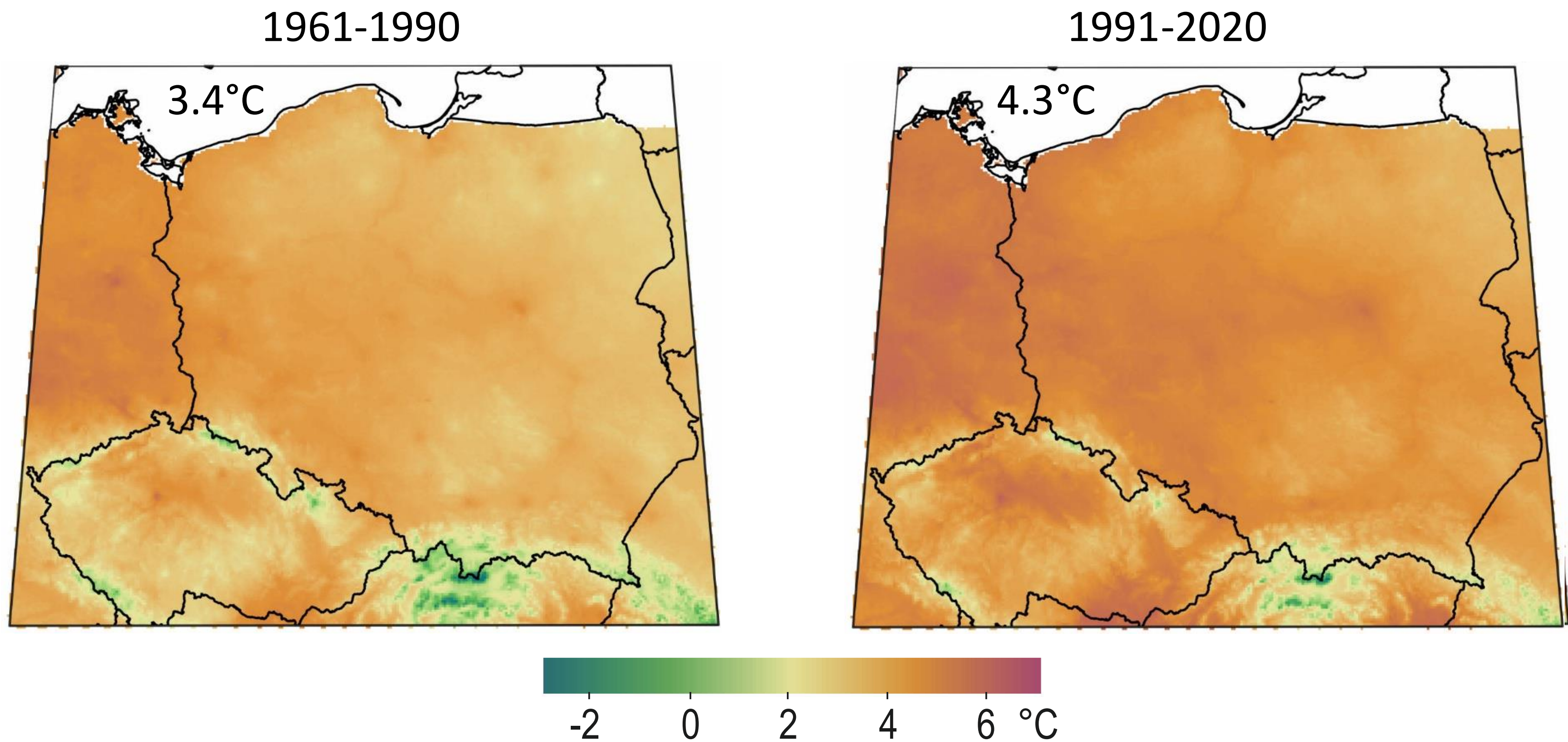
Tmax



Spatial distribution of annual mean Tmax for two climatological normals

1961–1990 vs 1991–2020: how do they compare?

Tmin

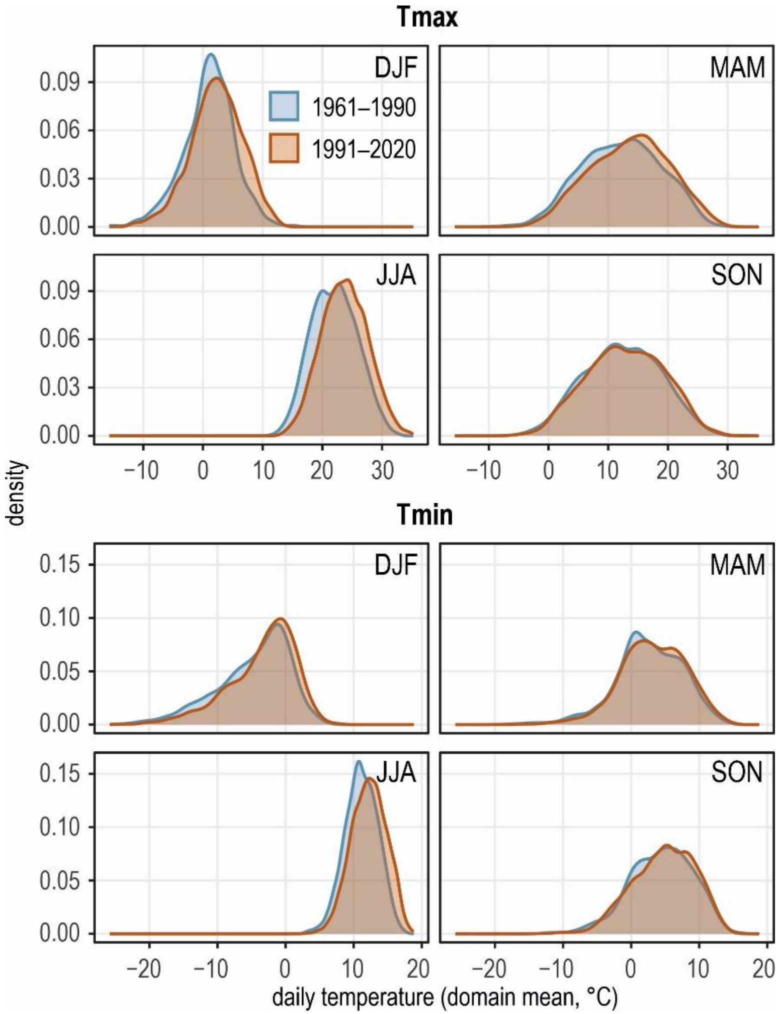


Spatial distribution of annual mean Tmin for two climatological normals

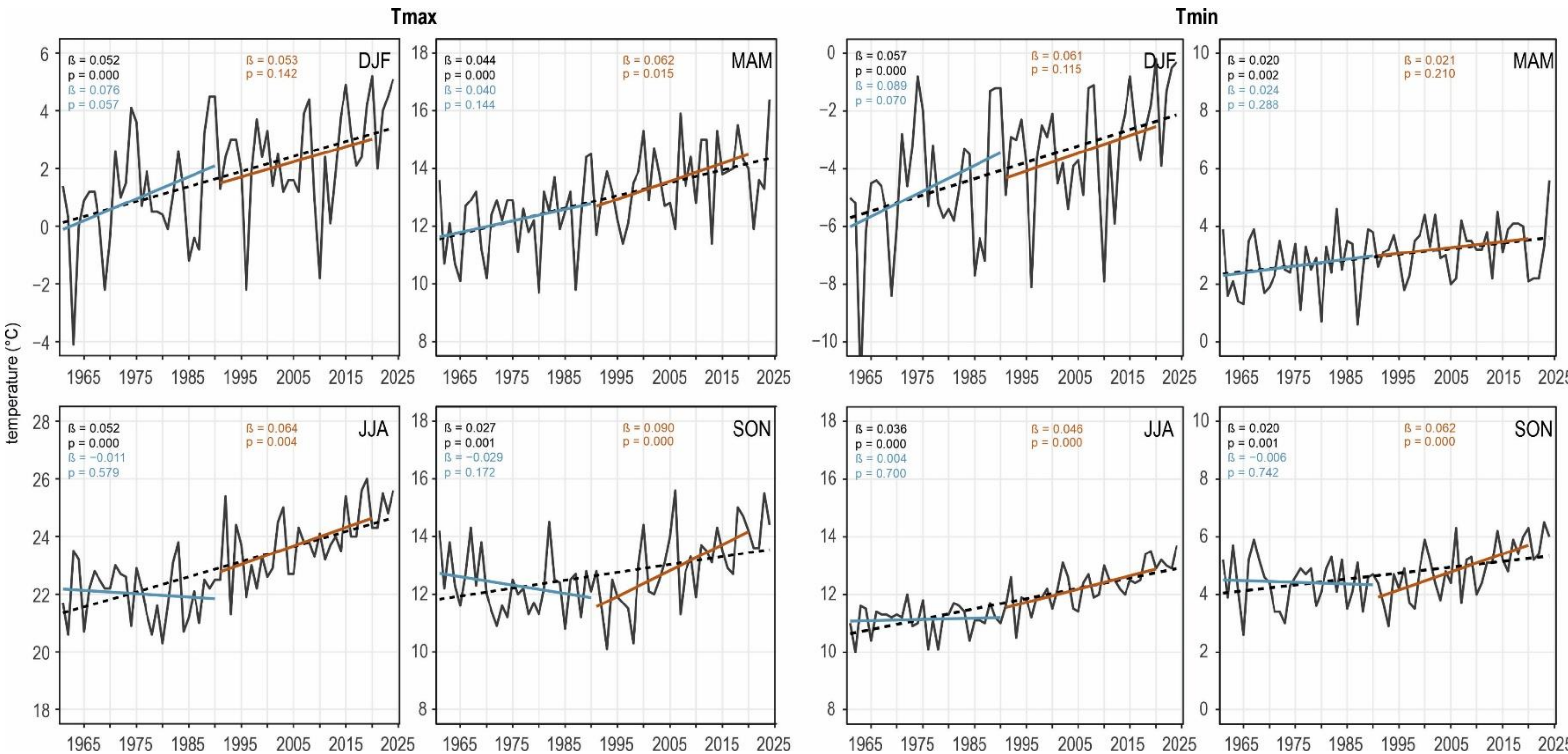
Mean temperature increased across the domain.
The 1991–2020 normal is > 1°C warmer (domain mean) than 1961–1990

1961–1990 vs 1991–2020: how do they compare?

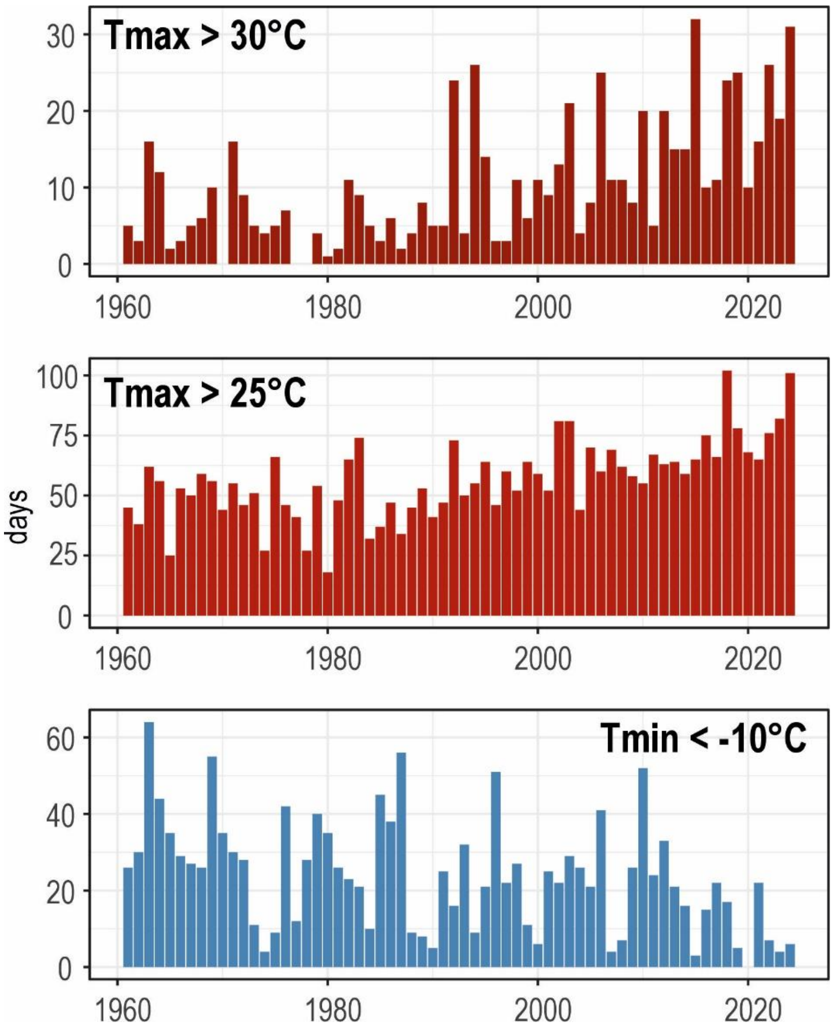
Tmax & Tmin



Seasonal distribution shift of Tmax and Tmin between 1961–1990 and 1991–2020 (domain mean)



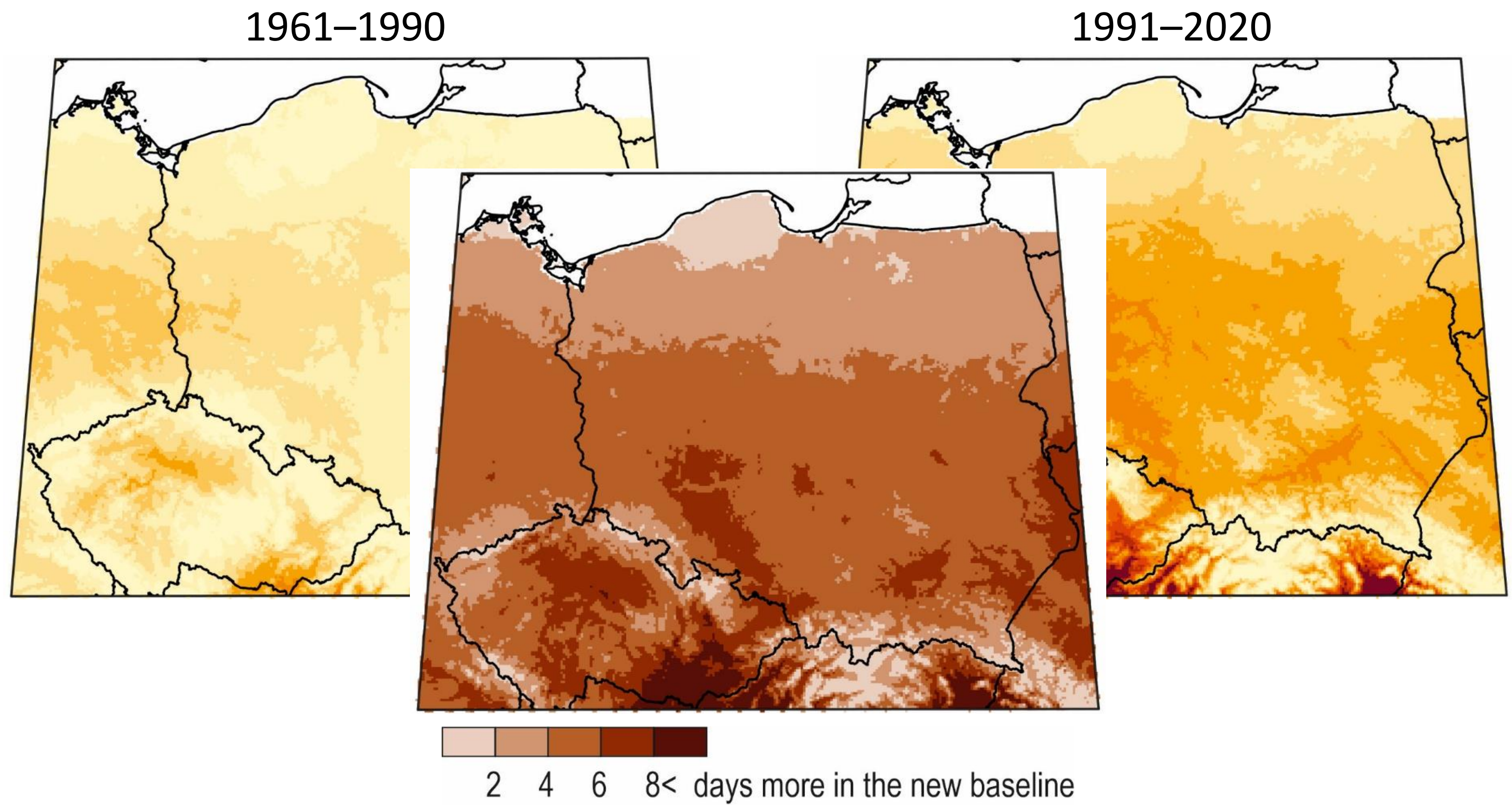
Temporal variability of seasonal Tmax and Tmin with linear trends dashed — overall (1961–2024), blue — 1961–1990, red — 1991–2020 (domain mean; °C)



Annual count of days (1961–2024) when ≥ 20% of the domain exceeded the absolute thresholds

ABSOLUTE EXTREMES

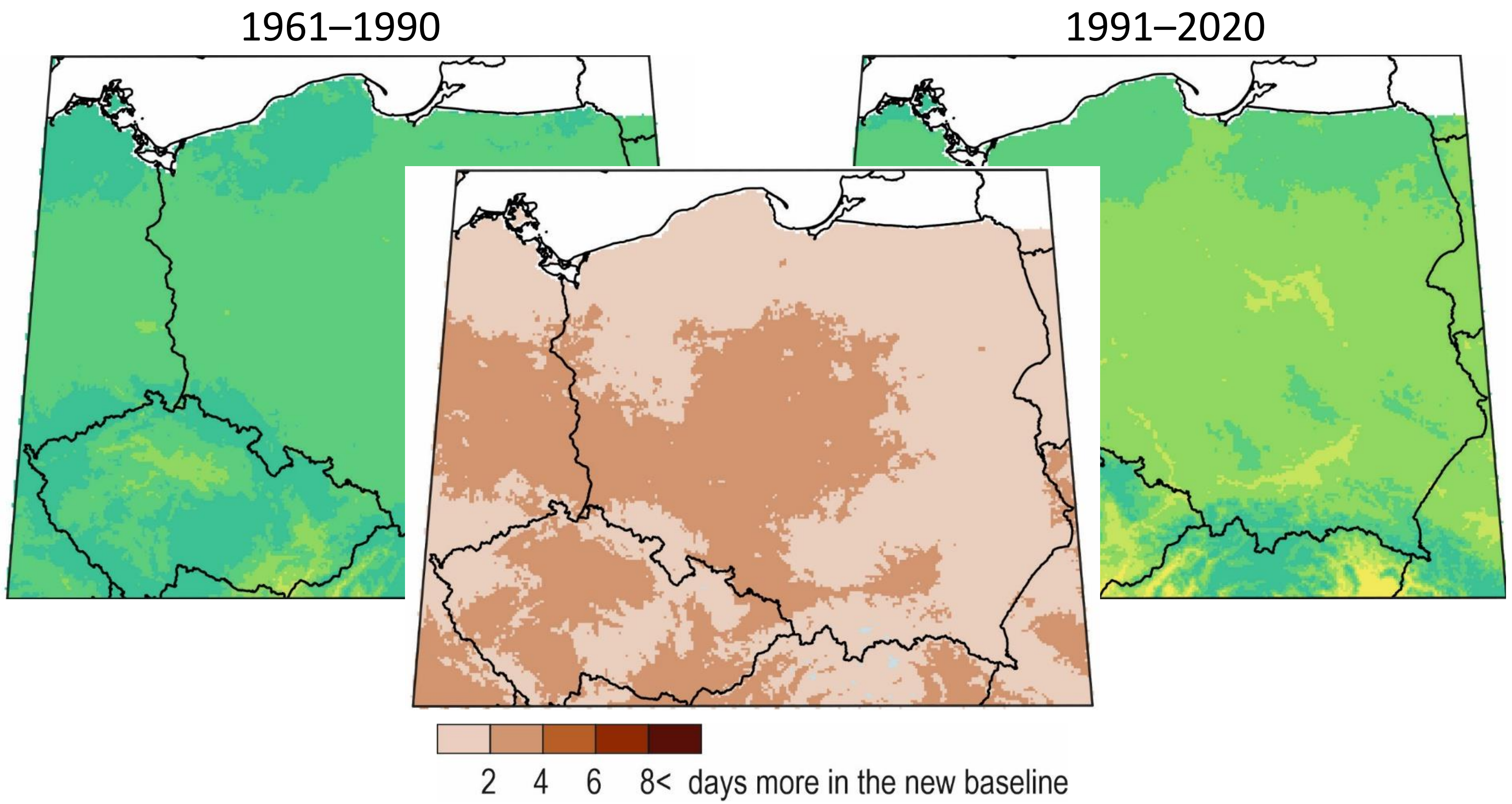
TX > 30°C in summer (JJA)



Mean number of days exceeding absolute threshold at each grid cell

ABSOLUTE EXTREMES

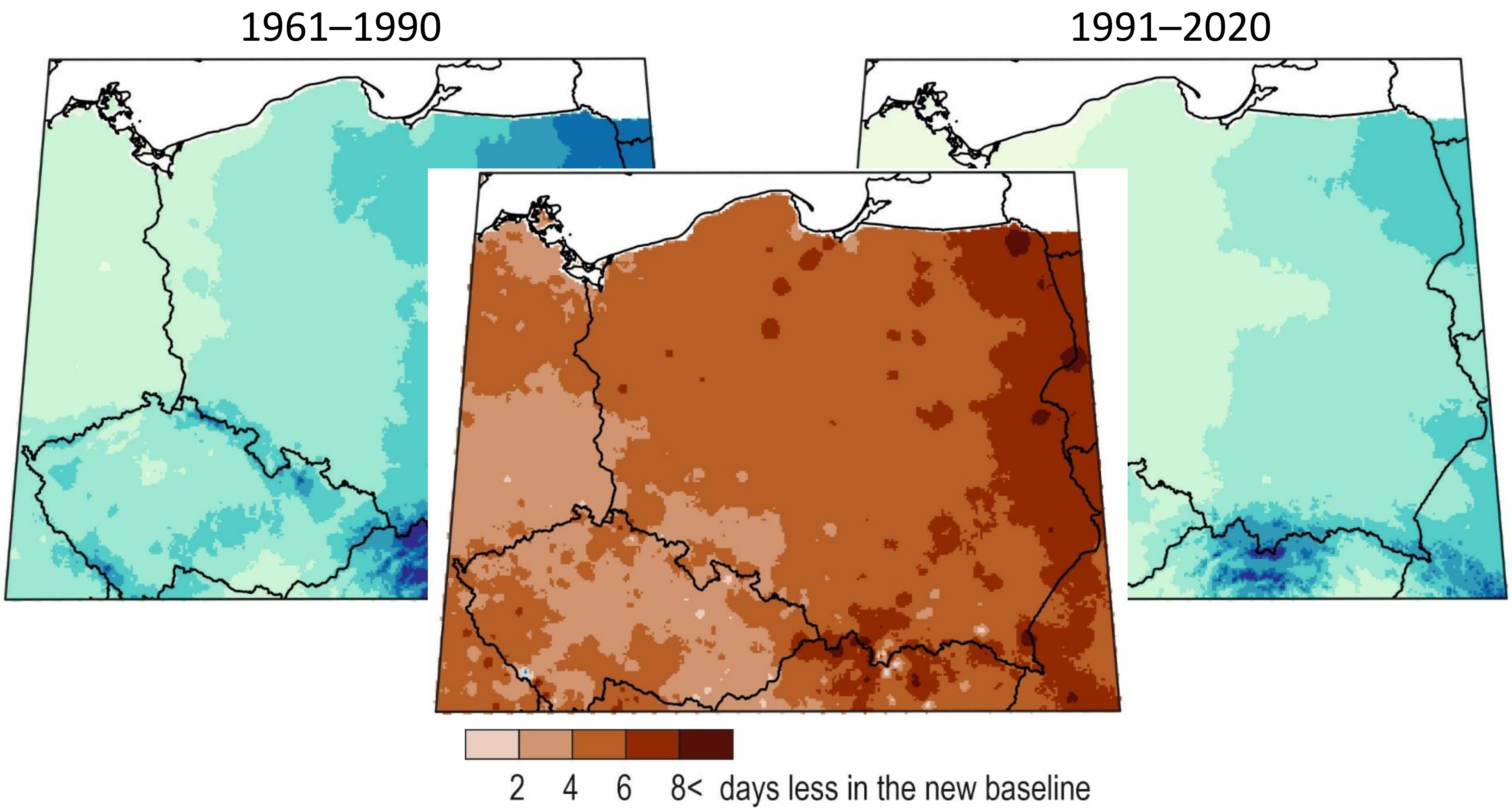
TX > 25°C in spring (MAM)



Mean number of days exceeding absolute threshold at each grid cell

ABSOLUTE EXTREMES

TN < -10°C in winter (DJF)

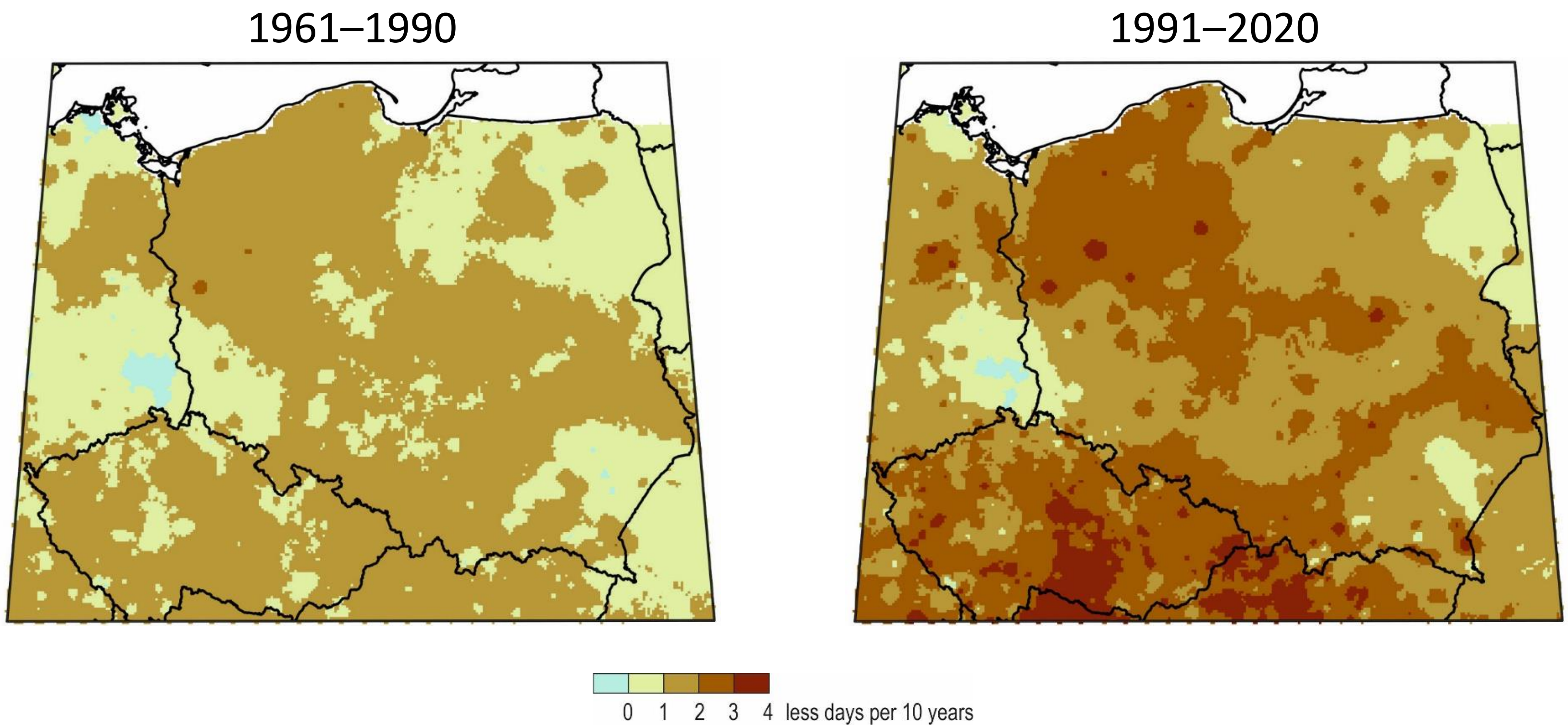


Mean annual number of days exceeding absolute threshold at each grid cell

PERCENTILE-BASED EXTREMES

!

TN < 10 percentile in winter (DJF)



Grid-cell linear trends (days per decade) in seasonal counts of percentile-defined extremes thresholds computed relative to 1991–2020 ; trends evaluated over 1961–2024

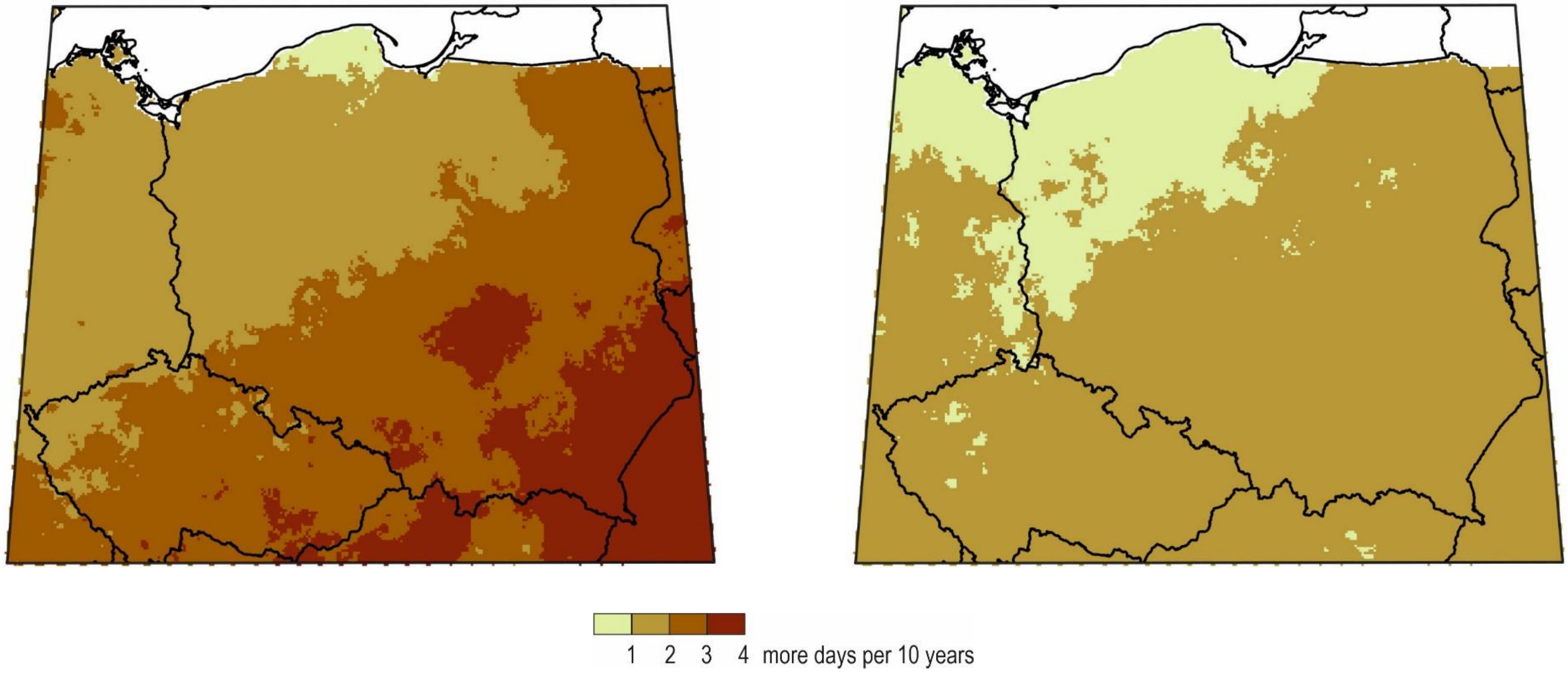
PERCENTILE-BASED EXTREMES

!

TX > 90 percentile in summer (JJA)

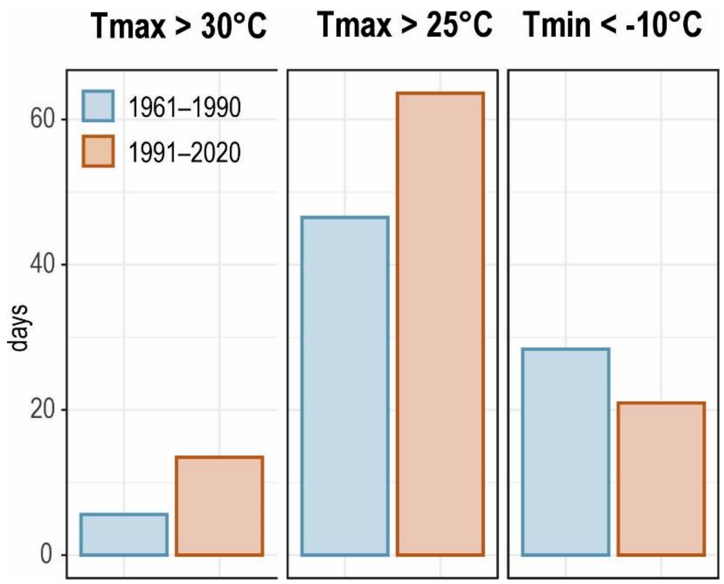
1961–1990

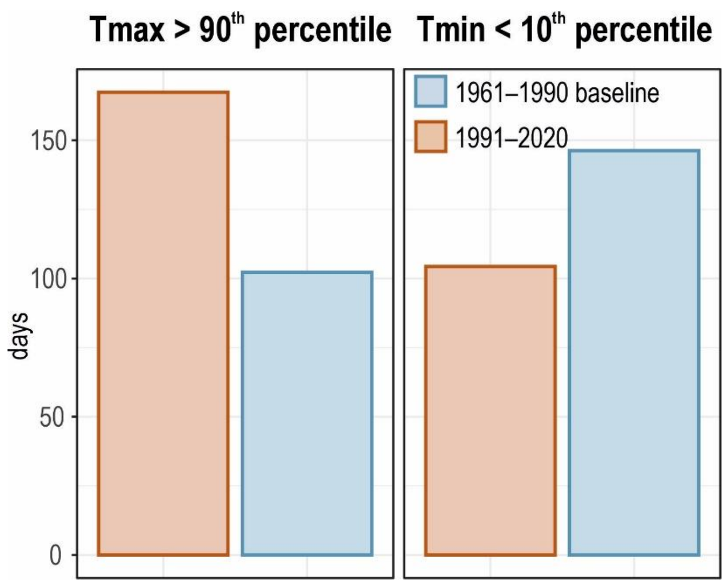
1991–2020



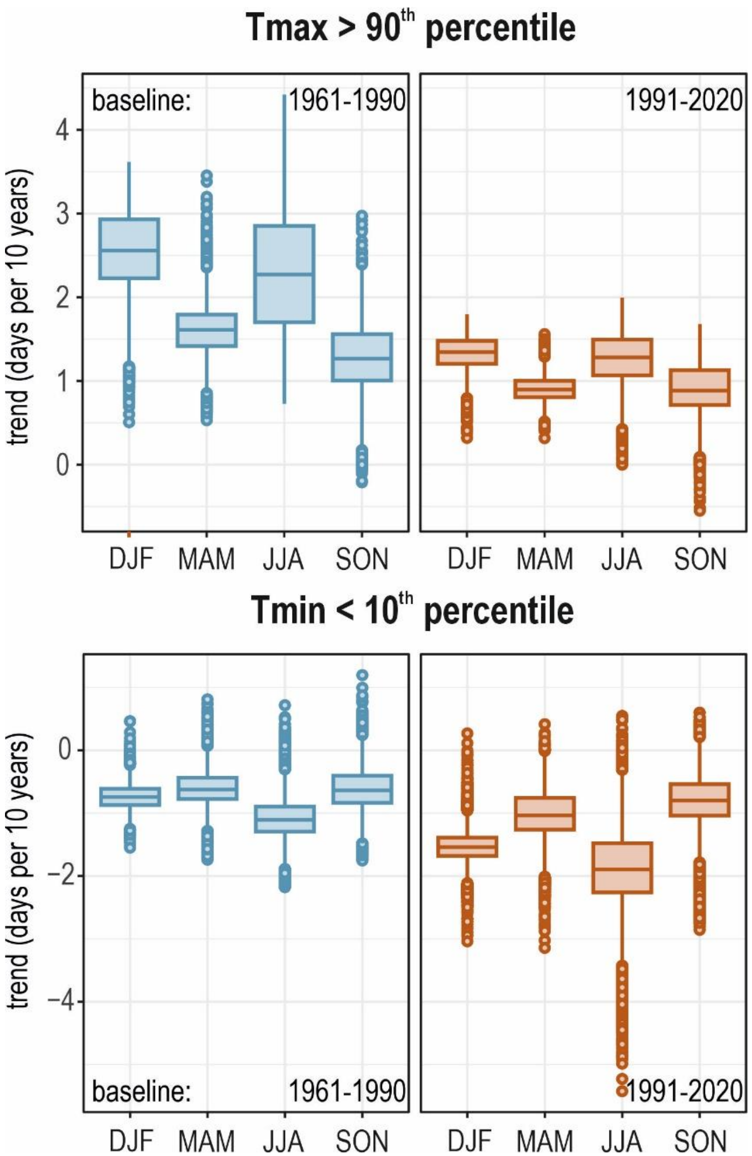
Grid-cell linear trends (days per decade) in seasonal counts of percentile-defined extremes thresholds computed relative to 1991–2020 ; trends evaluated over 1961–2024

SPATIAL APPROACH





Average annual count of days when ≥ 20% of the domain exceeded the thresholds



Boxplots of grid-cell linear trends (days per decade) in percentile-defined extremes depending on the baseline used. Trends evaluated over 1961–2024

→ Differences are evident not only in static means but also in seasonal trend dynamics; seasonal distributions of Tmax and Tmin shift most strongly in winter and summer.

→ Absolute extremes differ markedly between normals. Mean annual pointwise counts of Tmax > 25°C, Tmax > 30°C, and Tmin < -10°C are higher/lower in 1991–2020 in line with warming; differences between normals exceed 10 days and vary by season and region.

→ Regional-scale heat events became more frequent. The average annual number of days when ≥ 20% of the domain exceeded Tmax > 25°C / Tmax > 30°C increased, whereas events with Tmin < -10°C declined; the multi-decadal series (1961–2024) shows a post-1990s acceleration for heat.

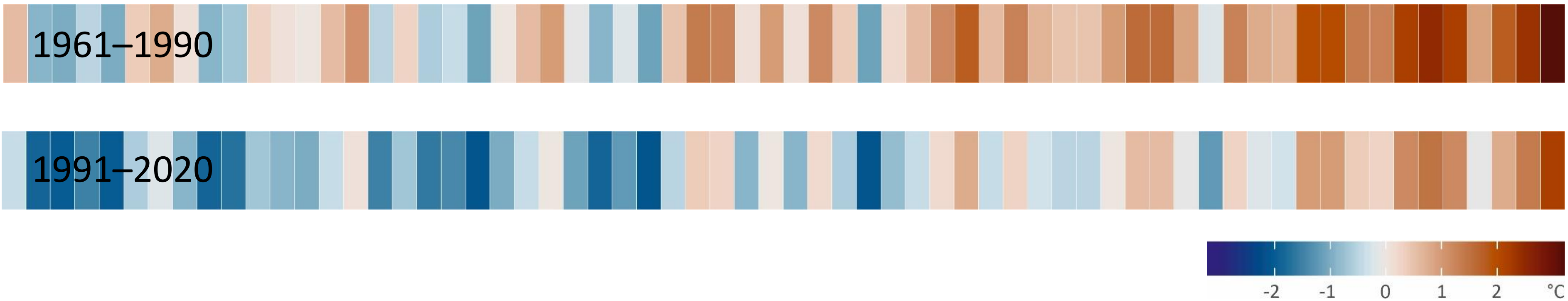
→ Percentile-defined extremes are baseline-dependent by construction. Recomputing calendar-day percentiles for each normal yields fewer Tmax > 90p days under 1991–2020 and more Tmin < 10p days — a classification effect, not a reversal of warming.

→ Mapped trends in percentile extremes change with the chosen normal. Grid-cell trends in Tmax > 90p (JJA) are stronger and more extensive with thresholds from 1961–1990; using 1991–2020 generally dampens magnitudes and modifies spatial patterns. For Tmin <10p (DJF) the response is opposite.

→ Local trend distributions confirm this sensitivity. Boxplots of grid-cell slopes differ systematically in median and spread between thresholds derived from the two normals, for both Tmax > 90p and Tmin < 10p.

METHODOLOGY MATTERS

ANOMALIES RELATIVE TO THE BASELINES:



Baseline choice visibly alters interpretation →
Different anomaly patterns for the same years, highlighting baseline sensitivity

! Always state the baseline with baseline-dependent indices
! Pair absolute and percentile metrics to separate physical change from classification effects
! Keep consistent baselines within any comparison

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