Data Visualization Project

Climate Analysis: Is Italy Warming Up?

> A data-driven journey through historical trends, seasonal dynamics, and thermal anomalies (1901-2024).

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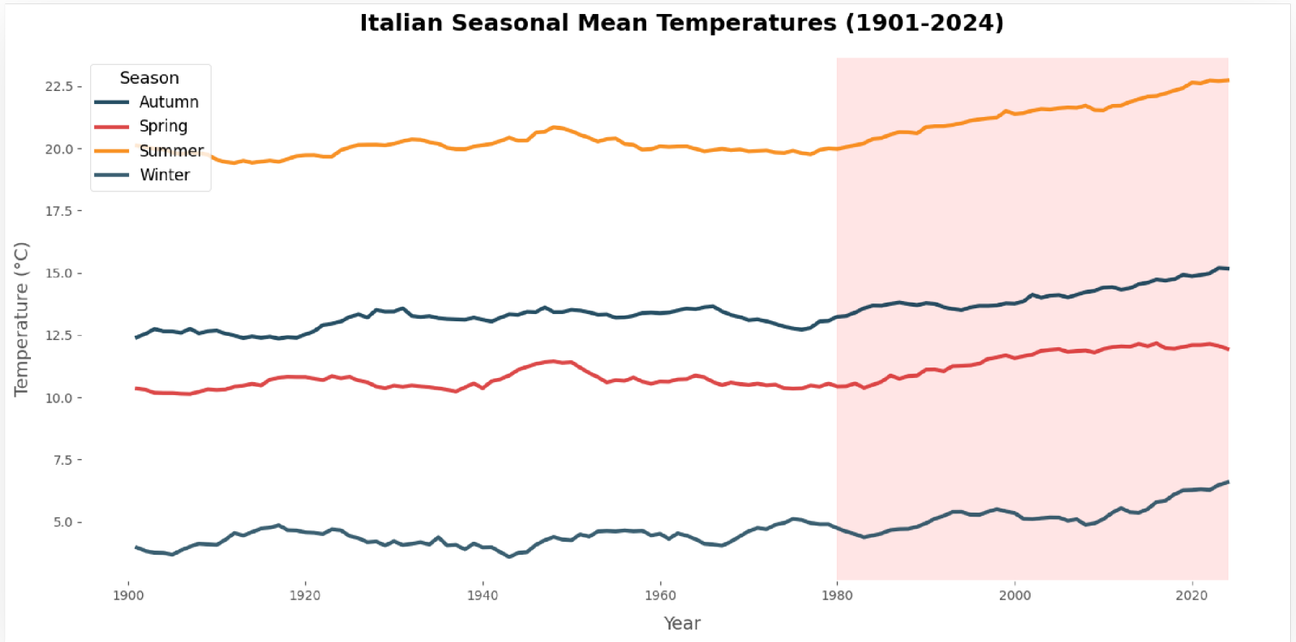


Research Questions

The core questions driving this analysis:

→ Is it True that every year is the hottest summer of the last 50 years?

→ Is there evidence that transitional seasons (Spring/Autumn) are losing their distinctiveness?

→ Are extreme temperature events becoming increasingly frequent and intense over time?

→ How do median monthly temperatures differ among Italy, France, Spain and Belgium?

About Data

Source: Climate-Knowledge Portal (World Bank)

The analysis relies on high-fidelity historical data spanning 1901 to 2024. While global data is available via API, this project specifically isolates the Italian Climate Record to identify local anomalies.

PRIMARY METRIC

tas

Mean Near-Surface Air Temperature

EXTREMES

tasmax / min

Maximum & Minimum Daily Temps

Data Quality Assessment

The dataset proved to be exceptionally robust. Unlike raw meteorological feeds, this data is already **well-structured and consistently formatted**.

Preprocessing steps were minimal:

- Verification of date consistency.
- Basic null-value checks (no critical gaps found).
- Type conversion for efficient time-series analysis.

Status: Reliable and ready for analysis.

Methodology

Technical workflow: From API extraction to statistical insight.

1. Data Collection & Filtering

Automated retrieval via API calls. Data was filtered for the specific geographical parameters of Italy, isolating the three core temperature variables (tas, tasmax, tasmin) over a 123-year period.

2. Processing & Cleaning Stack

Utilized the **Python ecosystem** (Pandas, Numpy). Given the high data quality, the focus was on ensuring the time index was monotonic and variables were cast to correct float types for aggregation.

3. Advanced Transformation

Feature engineering involved extracting granular time components (e.g., 'Month' from 'Date'). We applied **Moving Averages (10-year windows)** to smooth year-on-year volatility and reveal underlying climate signals.

4. AI-Assisted Workflow

AI tools were leveraged as a "coding assistant" for data preprocessing tasks, specifically for generating efficient snippets for datetime manipulation and variable aggregation logic, ensuring code reproducibility.

5. Analytical Techniques

We employed descriptive statistics for baseline establishment, followed by trend analysis (smoothing), comparative analysis (vs. EU neighbors), and percentile analysis (90th/10th) to detect extreme outliers.

6. Reproducibility

The analysis allows for full replication. The source data is publicly available via the World Bank API, and the methodology follows standard Python data science practices. Github Code

Insights from the Data

CLIMATE DESCRIPTIVE STATISTICS (N=1488 MONTHS)

Metric	TAS (Mean)	TAS MIN	TAS MAX
Mean	**12.41**	8.28	16.58
Std Dev	6.37	5.79	6.97
Min	-1.02	-4.81	2.61
25% (Q1)	6.71	3.18	10.23
50% (Median)	12.08	7.89	16.27
75% (Q3)	18.35	13.67	23.08
Max	**24.70**	19.55	**29.96**

The 30°C Ceiling

The absolute maximum recorded for monthly TASMAX is **29.96°C**. This indicates that at its peak, the average daytime temperature for an entire month nearly hit the 30°C mark.

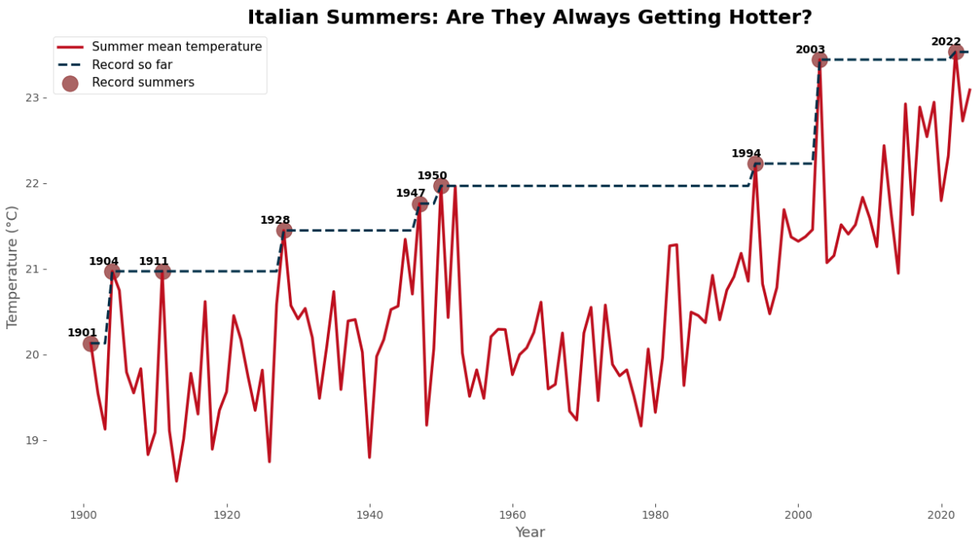
Thermal Spread

With a **Standard Deviation of ~6-7°C** across all metrics, Italy displays high seasonal variability, ranging from -4.81°C (Min) to nearly 30°C (Max).

The Median Core

The median (50%) monthly temperature of **12.08°C** provides a stable baseline, against which recent aggressive anomalies (2003, 2022) are clearly visible.

IS IT TRUE THAT EVERY YEAR IS THE HOTTEST SUMMER OF THE LAST 50 YEARS?



Not every summer is a record, but the regime has changed.

The graph displays the **Summer Mean Temperature** over 123 years. The key insight is not in the individual peaks, but in the **slope of the trend**.

Notice the Heating effect: for the first half of the century, temperatures oscillated around a stable mean. **Post-1980**, the oscillation broke upwards. We are now consistently fluctuating 1.5°C to 2°C above the historical baseline.

PATTERN

Heating Effect

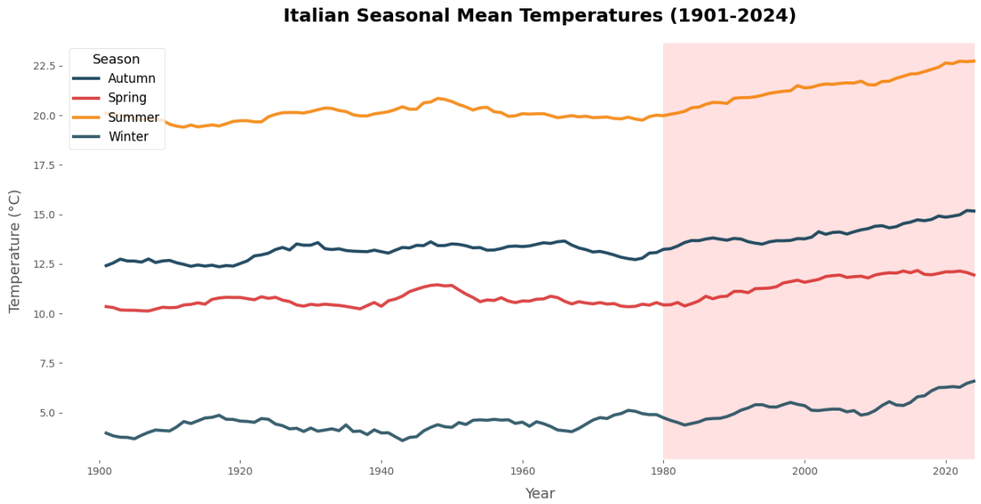
Stable then exponential.

ANOMALIES

2003 & 2022

Statistically significant outliers. The summer of 2022 is considered the hottest summer in Italian history.

IS THERE EVIDENCE THAT TRANSITIONAL SEASONS ARE LOSING THEIR DISTINCTIVENESS?



"Mid-seasons" aren't gone, they have moved vertically.

The graph visualizes the **Vertical Translation** of the climate.

→ **The Ghost of 1950 (Grey Line):** This was the historical standard. Note how the curve sits significantly lower than the modern trend.

→ **The Modern Reality (Red Line):** The shape of the wave is identical, but shifted upwards. We haven't lost Spring; we simply experience "May temperatures" in April.

Key Insight: The gap between the lines (shaded area) represents the thermal excess accumulated over 70 years.

CONTEXT: TRANSITIONAL SEASONS ANALYSIS

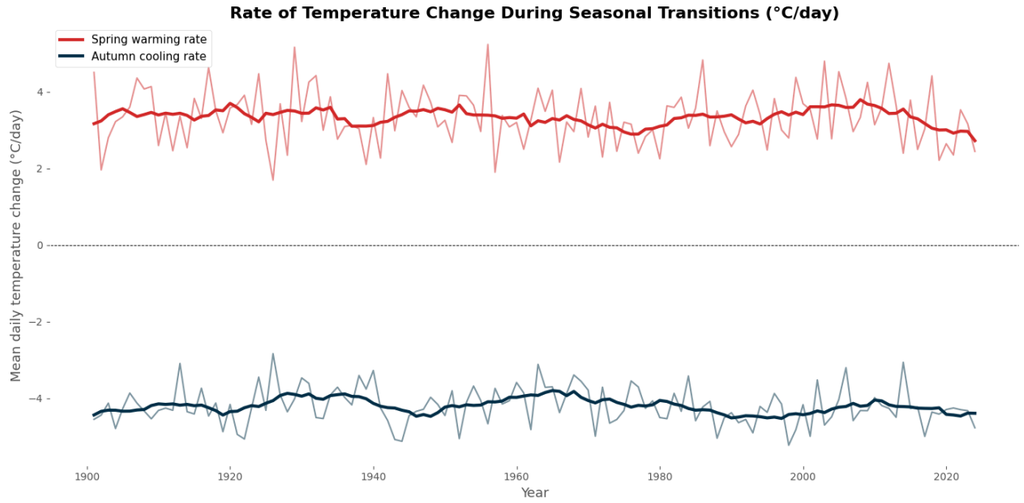
Perception vs. Reality

Why does it feel like summer arrives "all of a sudden"?

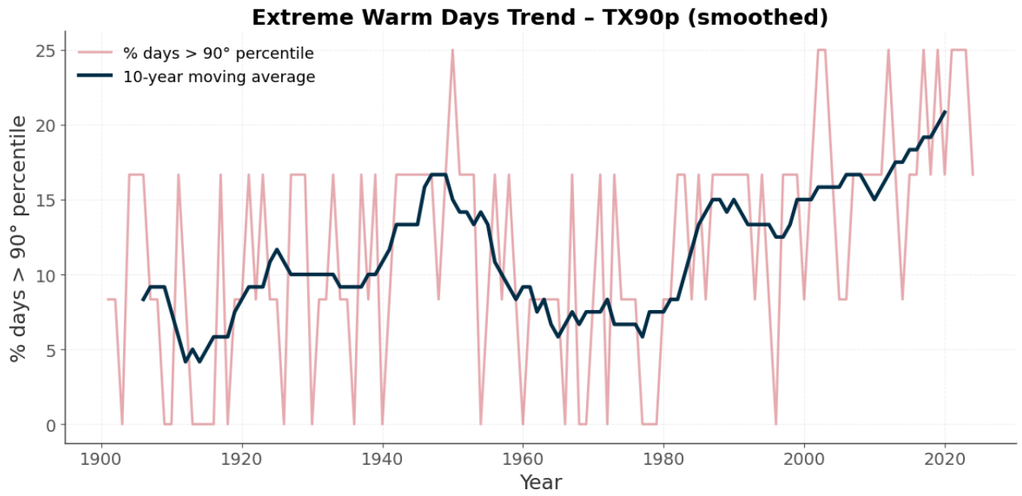
This graph analyzes the **Rate of Change** (how fast temperature rises per day). Surprisingly, the **rate (acceleration) remains stable** (red line). We are not warming up *faster* day-to-day than a century ago.

Conclusion

The "disappearance" of spring is a psychological effect of starting from a **higher baseline temperature**. The seasons follow the same rhythm, just on a hotter stage.



ARE EXTREME TEMPERATURE EVENTS BECOMING INCREASINGLY FREQUENT AND INTENSE?



Extreme heat is the new normal.

This chart tracks the frequency of days exceeding the historical **90th percentile**. Essentially, it shows how often we break the "old limits".

Visual Insight: Look at the density of bars on the right side. What was once a rare event (occurring 10% of the time) now happens with alarming regularity, effectively doubling in frequency in the last two decades.

PAST (1900-1960)

~5-10%

Rare events.

TODAY (POST-2000)

> 20%

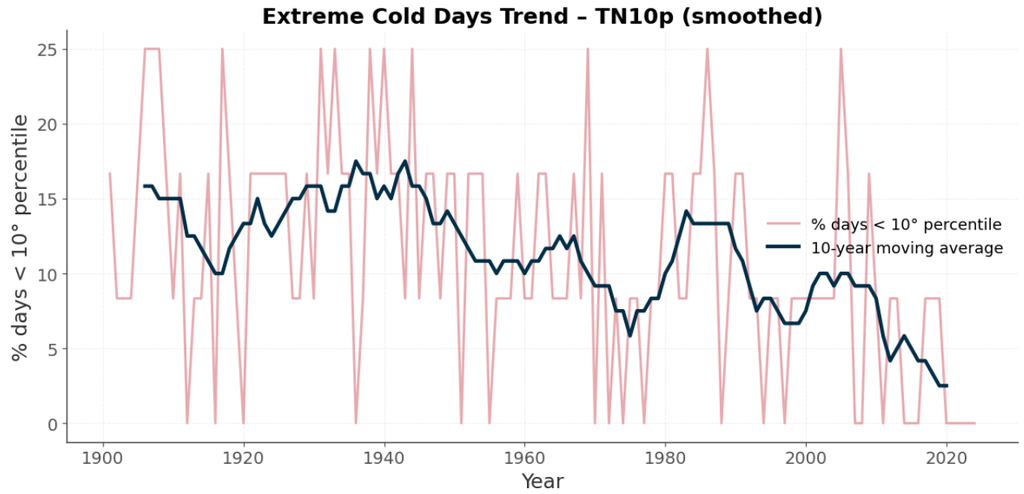
1 in 5 days is "extreme".

ARE EXTREME TEMPERATURE EVENTS BECOMING INCREASINGLY FREQUENT AND INTENSE?

Extreme cold is vanishing.

Conversely, this graph shows days falling below the **10th percentile** (historical cold snaps).

The "Vanishing Tail": The visual disappearance of bars on the right side of the graph is striking. The statistical distribution has shifted so much that the "old cold" is now virtually extinct. The climate system has lost its balance.



PAST

15%

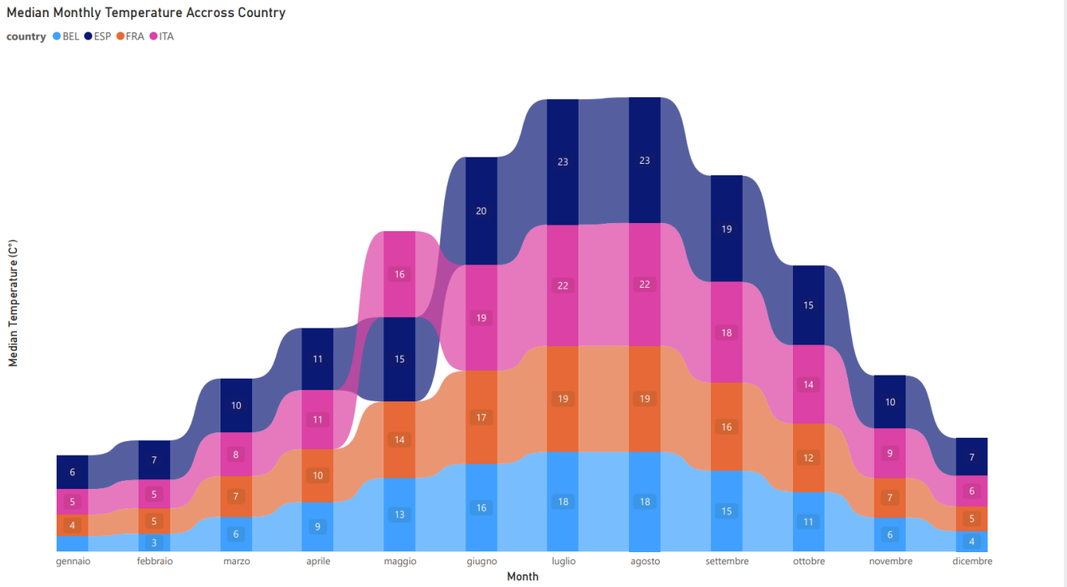
Historical frequency.

TODAY

~0-3%

Almost absent.

HOW DO MEDIAN MONTHLY TEMPERATURES DIFFER AMONG ITALY, FRANCE, SPAIN AND BELGIUM?



Mediterranean vs. Oceanic Cycles

This comparison highlights the **thermal amplitude**. Notice the shape of the curves:

→ **Italy & Spain (Mediterranean):** Steep curves with high summer peaks (>25°C). The sea mitigates winter but allows intense summer heating.

→ **Belgium (Oceanic):** A much flatter curve. The Atlantic Ocean regulates the temperature, preventing the high spikes seen in the South, resulting in a narrower annual range.

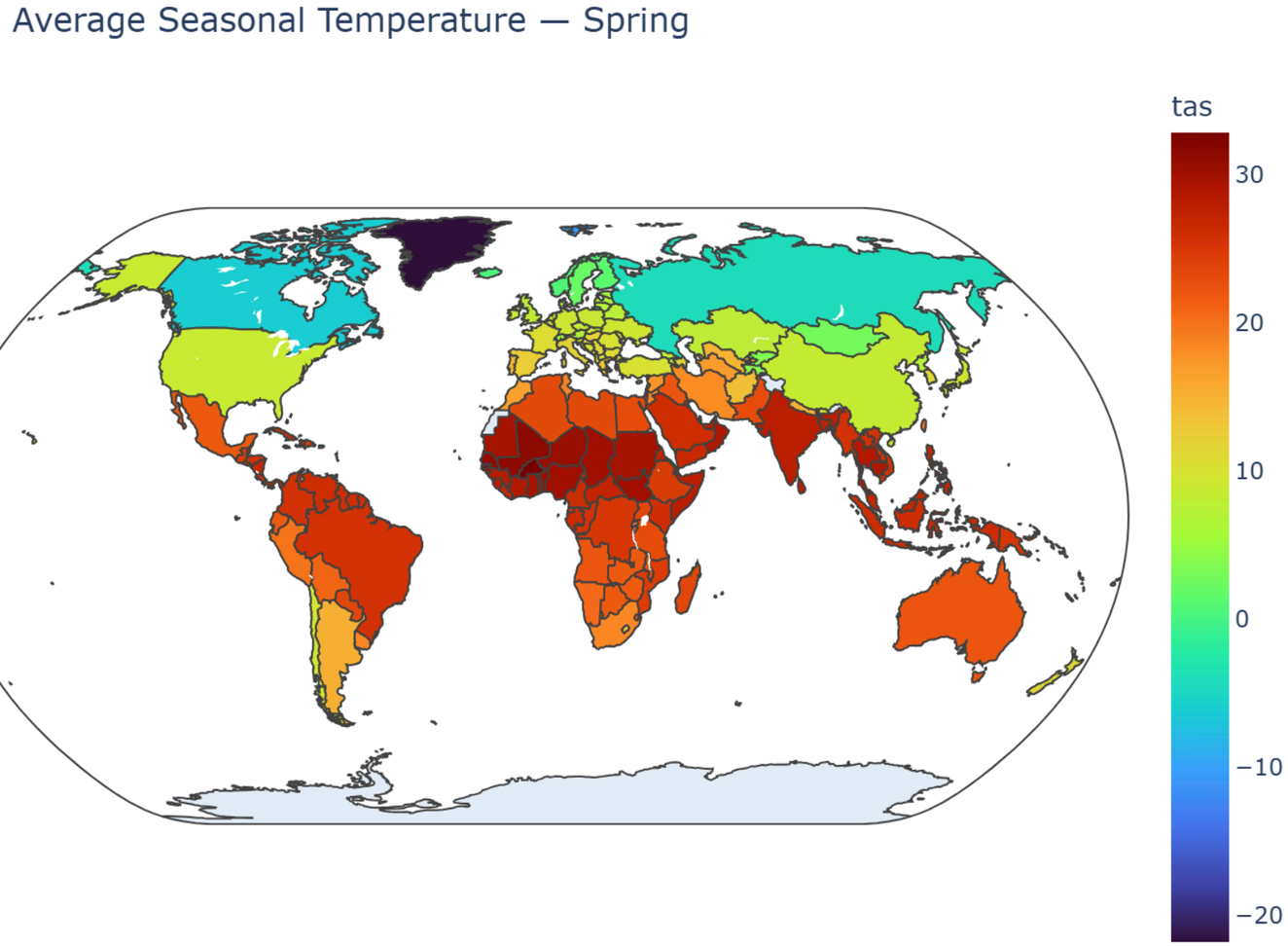
Spatial Analysis: Seasonal Distribution

Visualizing average seasonal temperatures globally.

Spring Distribution

AWAKENING HEMISPHERE

Insight: The Northern Hemisphere begins to warm up. Note the yellow/orange bands covering the Mediterranean latitudes (Italy), indicating the return of milder temperatures compared to the cold blue of Northern Europe.

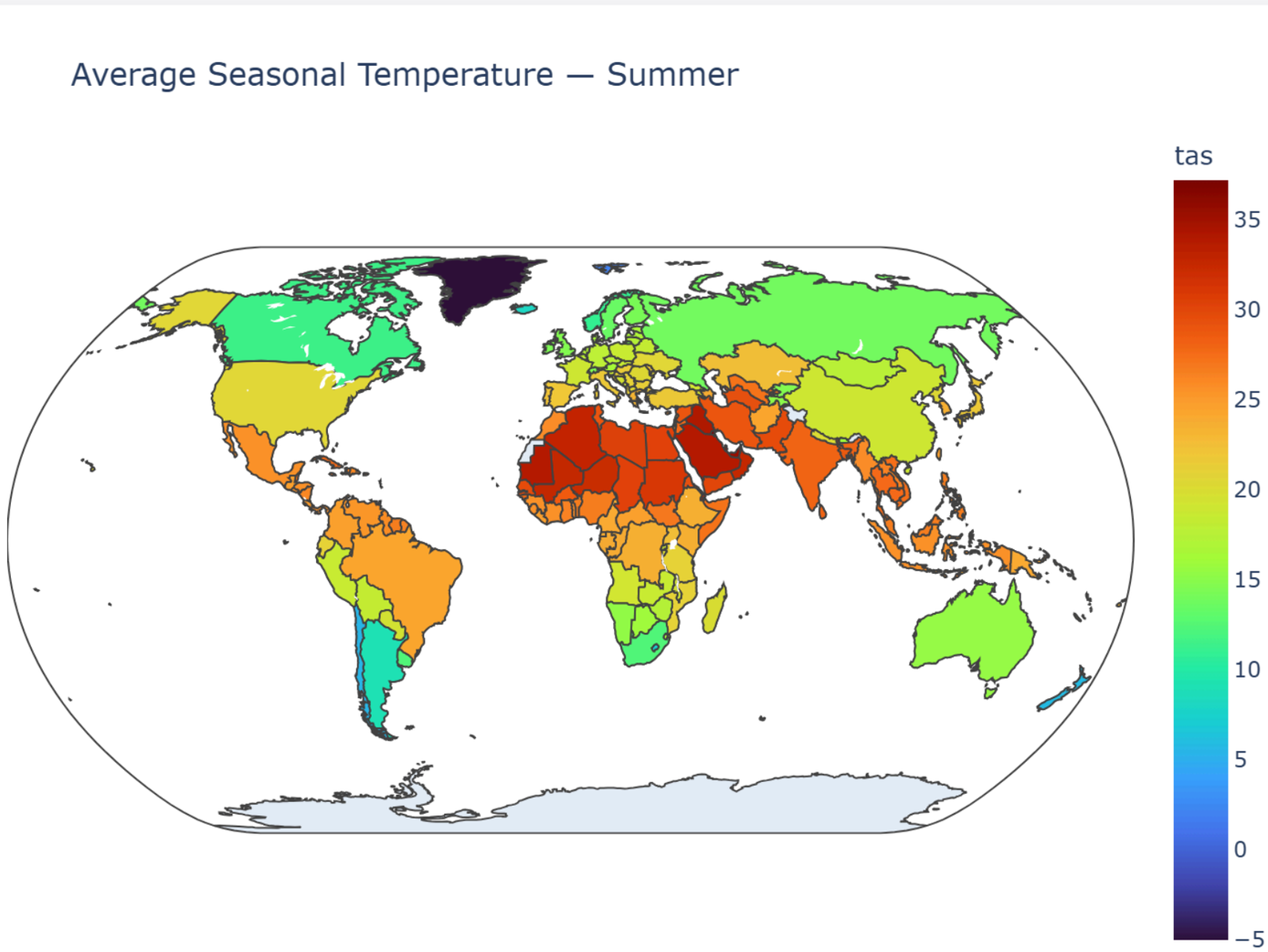


Spatial Analysis: Spring

Summer Distribution

PEAK HEATING

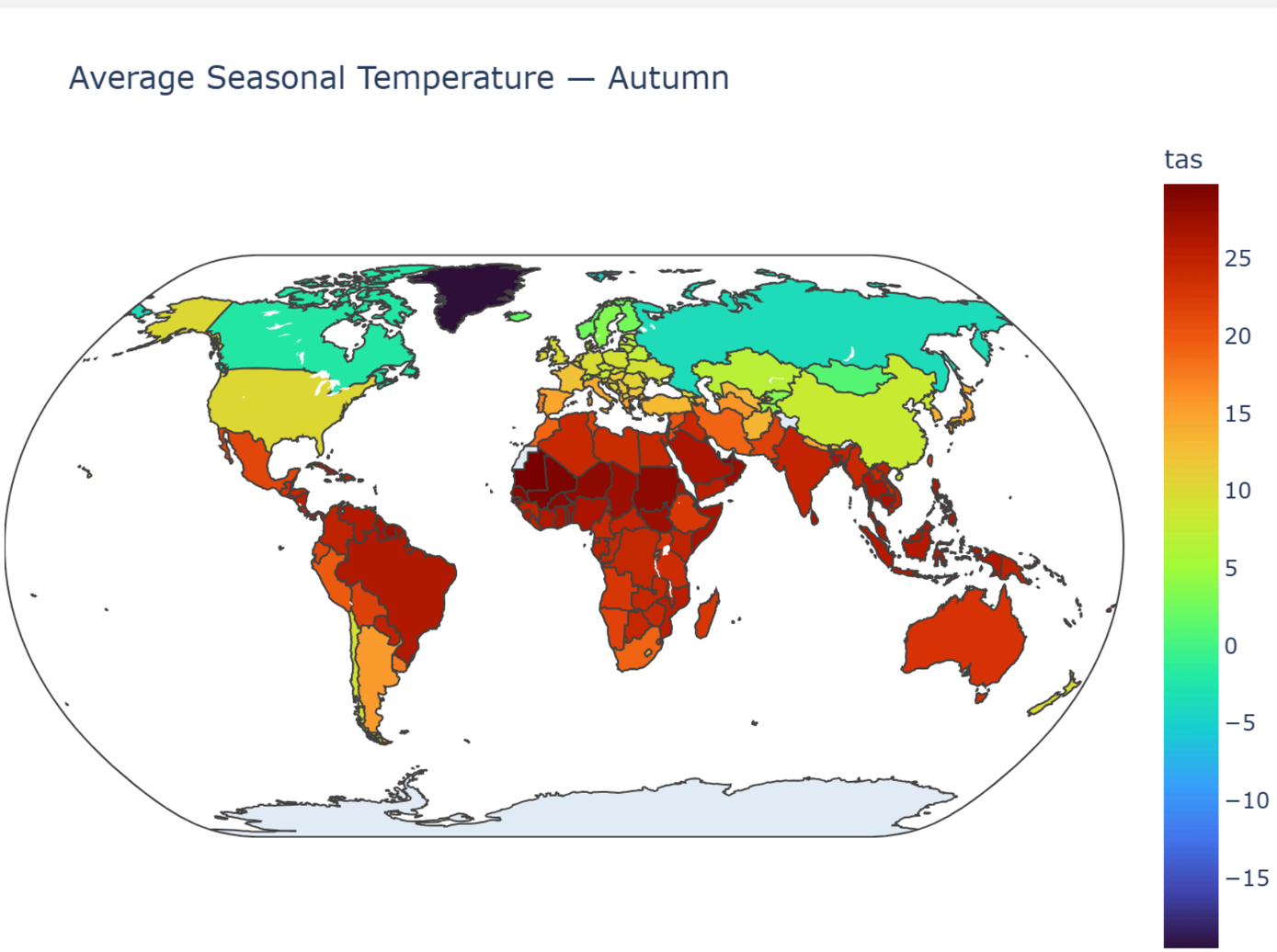
Insight: The deep red zones highlight extreme heat in North Africa and the Middle East. Italy sits on the fringe of this heat reservoir, explaining the intense summer temperatures and frequent heatwaves observed in the data.



Autumn Distribution

THE COOLING PHASE

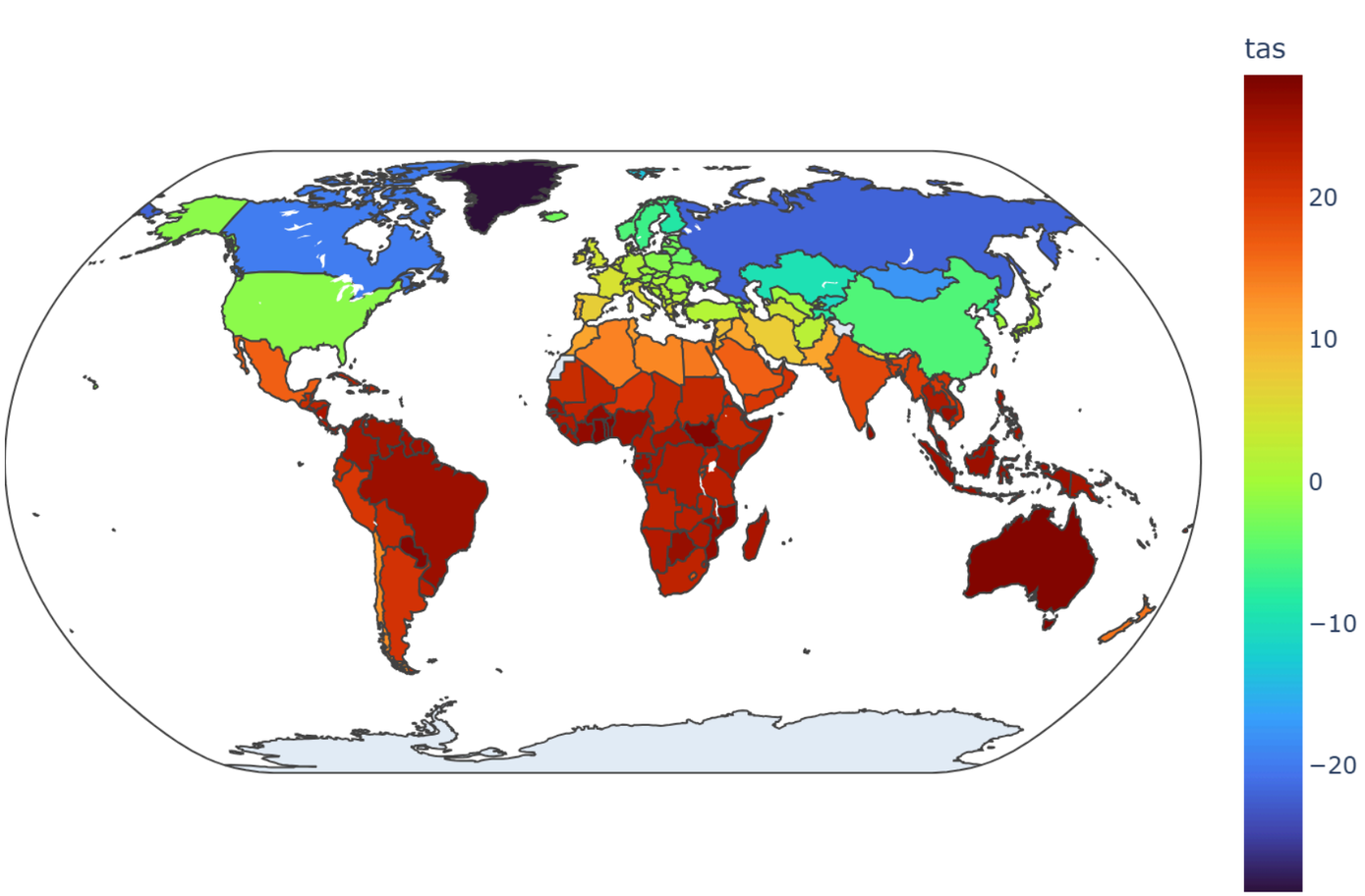
Insight: Heat retreats southward. While land masses cool quickly, the Mediterranean Sea retains warmth longer, keeping the Italian peninsula (orange) significantly milder than the rapidly cooling continental interior (green/blue).



Winter Distribution

HEMISPHERIC DIVIDE

Insight: Maximum contrast. The Northern Hemisphere is dominated by cold (blue), while the Southern Hemisphere enjoys summer. Italy shows a clear temperature drop, but the Alpine barrier protects it from the harshest continental freezes.



Spatial Analysis: Winter

Thank You.

Dataset: World Bank Climate Knowledge Portal

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