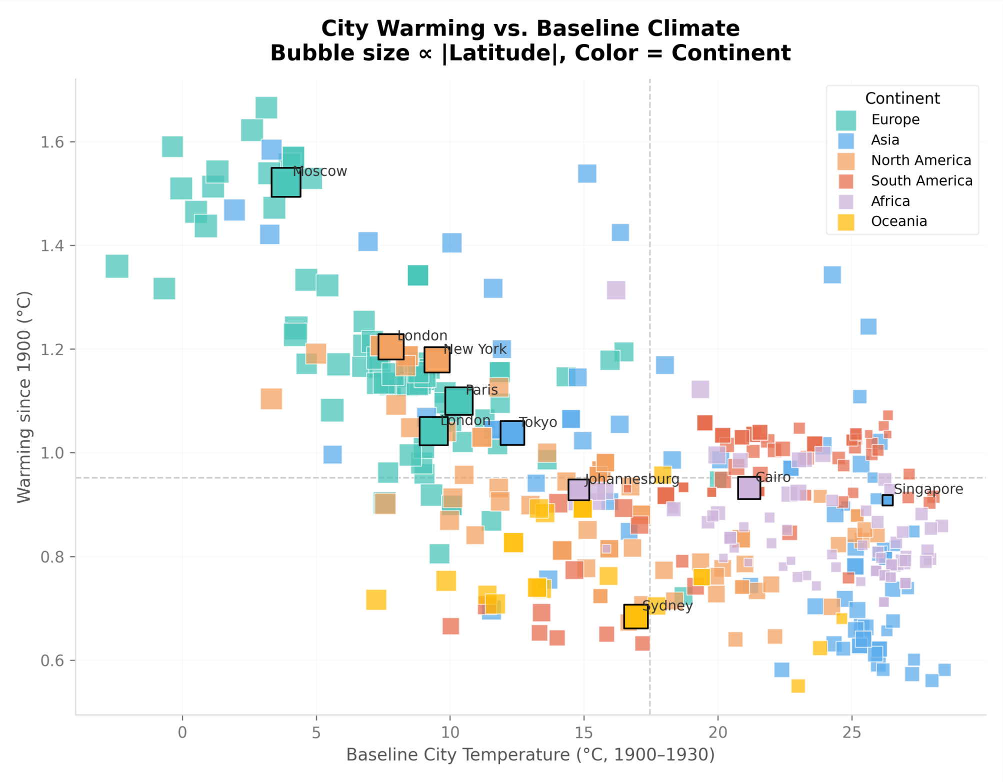
PREDICTING GLOBAL WARMING (1880–2035)

Figure 1. City Warming vs. Baseline Climate



Legend

- **X-axis:** Early-20th-century baseline temperature (1900–1930).
- **Y-axis:** Temperature increase from 1900 to 1991–2020.
- **Squares:** Individual cities.
- **Bubble size:** ∝ |latitude| (higher latitude = stronger warming).
- **Color:** Continent category.
- **Labeled cities:** Selected major cities (e.g., London, Moscow, Tokyo, Cairo, Sydney).
- **Dashed lines:** Approximate global warming (~0.95 °C) and a warm-baseline reference (~18 °C).

Key Findings

- **High-latitude cities warm most strongly**, with several exceeding 1.4 °C of heating (e.g., Moscow).
- **Cities with cooler baseline climates show greater warming**, clustering higher on the y-axis.
- **Hot-baseline cities still experience notable warming** (~0.8–1.0 °C), though typically less than colder regions.
- **Continental differences are evident**, with Europe generally warming more than Africa or South America.
- **Most highlighted cities have warmed around 1 °C**, underscoring widespread urban climate change.

Data and Methods

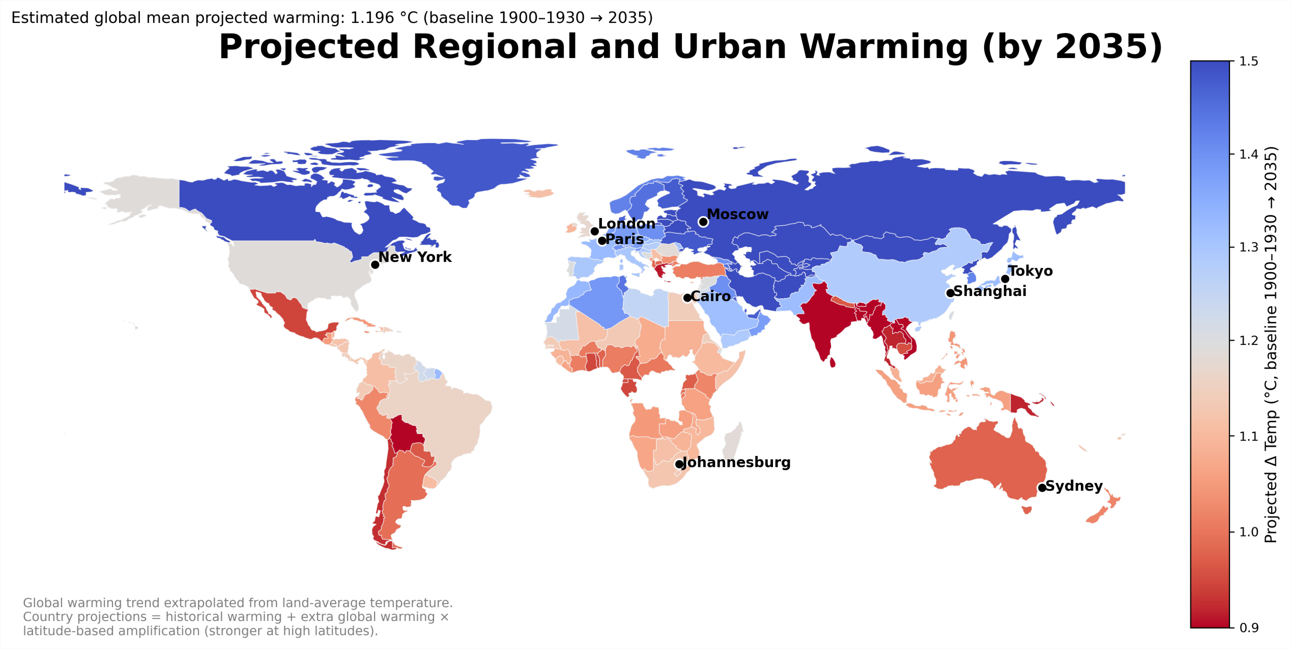
- City temperatures were matched to global gridded land-temperature records (e.g., Berkeley Earth).

- Baseline = mean temperature for **1900–1930**; Recent = **1991–2020**.
- Warming = Recent − Baseline.
- Bubble plot created in Python (`matplotlib`, `pandas`); bubble size uses |latitude|; colors show continents; key cities annotated.

Significance

City-level warming patterns reflect the combined influence of baseline climate and latitude.
The results highlight that **no major city has avoided substantial warming**, with colder and high-latitude cities warming fastest and already-hot cities facing rising heat-stress risks.

Figure 2. Projected Regional and Urban Warming (by 2035)



Legend

- **Background world map:** Countries are shaded according to **projected temperature increase (Δ °C)** between the early-20th-century baseline (1900–1930) and **2035**.
- **Color scale (right):**
  - **Red / light orange (~0.9–1.1 °C):** Lower projected warming.
  - **White / neutral (~1.2 °C):** Around the global average projection.
  - **Blue / dark blue (~1.3–1.5 °C):** Higher projected warming, especially at high latitudes.
- **Labeled cities (black dots and names):** Major world cities (e.g., New York, London, Paris, Moscow, Cairo, Tokyo, Shanghai, Johannesburg, Sydney) used as reference points for regional impacts.
- **Title annotation (top):** States the estimated global mean projected warming from 1900–1930 to 2035 (≈1.2 °C), based on the chosen extrapolation method.

Key Findings

- **High-latitude countries warm most strongly.**
  Northern high-latitude regions (e.g., Canada, Russia, Nordic countries) display the **darkest blues**, indicating projected warming above ~1.3–1.4 °C by 2035.
- **Tropics warm slightly less but still significantly.**

Many equatorial and tropical countries appear in light red to neutral colors (~0.9–1.1 °C), meaning they still warm substantially even if the increase is slightly smaller than in polar regions.

- **Regional contrasts are sharp.**
  Parts of South America and Southern Africa show moderate to high warming, while some maritime or coastal regions retain slightly lower projected changes.
- **Major cities face diverse future climates.**
  Cities such as Moscow and New York are embedded in high-warming regions, while Sydney and some coastal cities see moderate but still impactful warming.
- **Global mean hides local extremes.**
  Even with a global mean increase of around 1.2 °C, many land areas—and thus many cities—experience higher-than-average warming.

Data and Methods

- **Historical trend estimation.** Global land-average temperature anomalies (relative to 1900–1930) were derived from a historical land-temperature dataset (e.g., Berkeley Earth / equivalent). A simple **linear regression** was fitted to annual global land-temperature anomalies from the historical period through the present.
- **Projection to 2035**
  - The fitted linear trend was extrapolated to **2035** to obtain a projected global mean anomaly.
  - Country-level projections were derived by combining:
    1. Each country's **historical warming** (1900–1930 to 1991–2020), and
    2. An additional projected warming increment scaled by **latitude-based amplification** (larger amplification at higher absolute latitudes).
- **Mapping and city overlay**
  - Country polygons from a natural-earth style shapefile were joined with the projected ΔT values and plotted in Python using `geopandas` and `matplotlib`.
  - A continuous **red-white-blue** colormap was used to represent lower-to-higher warming values.
  - Major cities were added as point markers with labels to connect large population centers to their regional projections.

Significance

This map links **global-scale climate projections** with **country- and city-level warming patterns** by 2035. Policymakers, planners, and citizens can see how their region compares with the global mean, helping to prioritize adaptation strategies and international climate cooperation. Highlighting cities within their regional context underscores that climate change is **not uniform**: some areas face especially rapid warming and may require accelerated infrastructure upgrades, heat-health plans, and resilience investments long before 2035.