# Decadal Weather and Climate Analysis for Warsaw (2010–2020)

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**INTRODUCTION:**

The objective of our project was to create a program capable of assessing the local impact of global warming. As a case study, we used weather data from Warsaw, analyzing daily records from 2010 to 2020.

We focused on daily temperature data (mean, minimum, and maximum) to identify seasonal patterns and possible long-term changes, while treating day-to-day fluctuations as short-term noise.

To uncover the actual climate trends hidden in everyday weather variability, we used denoising techniques like rolling averages and seasonal decomposition. The main script `main.py` handles everything - from downloading daily temperature data to cleaning, filling in missing values, reducing noise, and calculating monthly and yearly summaries. All required libraries are listed in `requirements.txt`, and you can install them by running `pip install -r requirements.txt`. Each part of the code is well-documented with comments and function descriptions.

You can find the full code and data on our GitHub repository: here

**MAINBODY:**

The analysis was conducted on a dataset consisting of 4018 daily mean temperature values. The key statistical measures are summarized below:

- **Mean temperature**: ~9.45 °C
- **Standard deviation**: ~8.73 °C, indicating relatively high variability across the dataset
- **Minimum temperature**: –22.8 °C
- **Maximum temperature**: 28.7 °C
- **Median (50%)**: 9.4 °C
- **First quartile (25%)**: 2.9 °C
- **Third quartile (75%)**: 16.7 °C

These results suggest a wide range of temperatures, consistent with a dataset covering multiple years and seasons. The near-equality of the mean and median indicates a roughly symmetric distribution of daily temperatures, although the large standard deviation reflects significant day-to-day and seasonal variation.

The data also confirms the presence of cold extremes (as low as –22.8 °C) and warm periods (up to 28.7 °C), likely reflecting winter and summer conditions, respectively. This supports the goal of identifying seasonal patterns and long-term climate trends in the dataset.

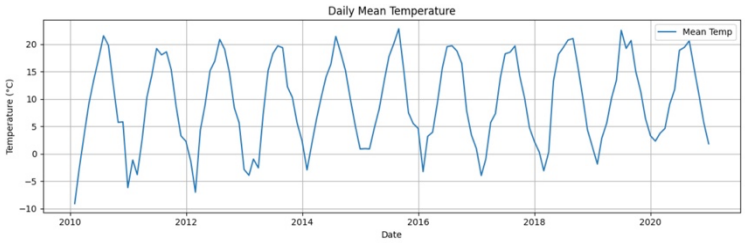


Chart 1: shows the yearly patterns of daily mean temperature after denoising. Summer peaks have remained the same, while winter lows have become less extreme. This shift highlights the overall warming trend when short-term weather fluctuations are removed.

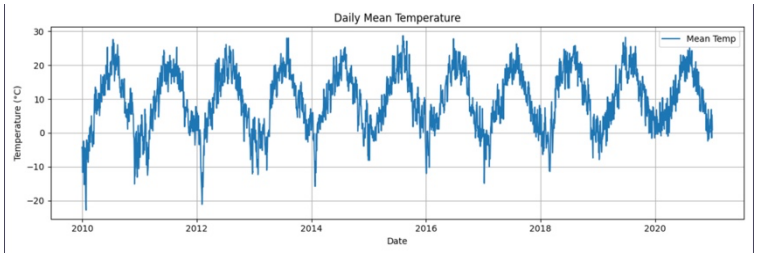


Chart 2: displaysthe raw daily temperature series across all eleven years.

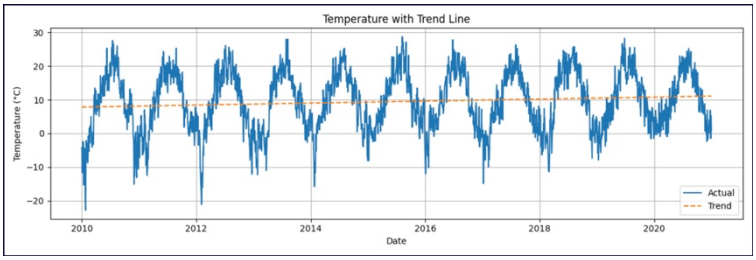


Chart 3: overlays a fitted linear trend line raw dataset. The dashed orange line ascends from roughly 8.8 °C at the start of 2010 to about 10.8 °C by the end of 2020, quantifying the ~2.0 °C increase and demonstrating that the warming trend clearly exceeds natural interannual variability.

Together, these charts illustrate a coherent picture of gradual warming, increasing heat extremes, and slight drying in Warsaw's recent climate.

**CONCLUSION**

From 2010 to 2020, Warsaw experienced noticeable climate changes: the average temperature increased by around 2.0 °C, heatwave days became more common, and humidity slightly decreased. These changes reflect the broader pattern of global

warming. Our project used a fully documented Python workflow - from downloading and cleaning the data to filtering noise and visualizing trends - making the results easy to reproduce. One limitation is that we used data from just one weather station, which may be affected by local factors like the urban heat island. We also didn't include other weather elements such as wind or rainfall, which could provide additional context and strengthen the evidence supporting the observed warming trend.