Analysis of temperature distribution in Poland over 20 and 70 years

1. Purposes of the project

The main purpose of the project was checking how the average and maximum, month and day temperature in Poland was changing, since the official gathering data by IMGW – Polish Institute of Meteorologic and Water Industry.

Nowadays, there is a lot of talk about global warming. Some people decline the fact of existence such a phenomenon, others claims, that it exists, but it's a natural process. The fact is, that we as humans make a significant contribution to the rise in temperatures on Earth.

In this study, however, we will focus only on temperature analysis and only in Poland.

2. Source of data

Temperature data from Poland are based on development by IMGW - Instytut Meteorologii i Gospodarki Wodnej (Polish Institute of Meteorologic and Water Management).

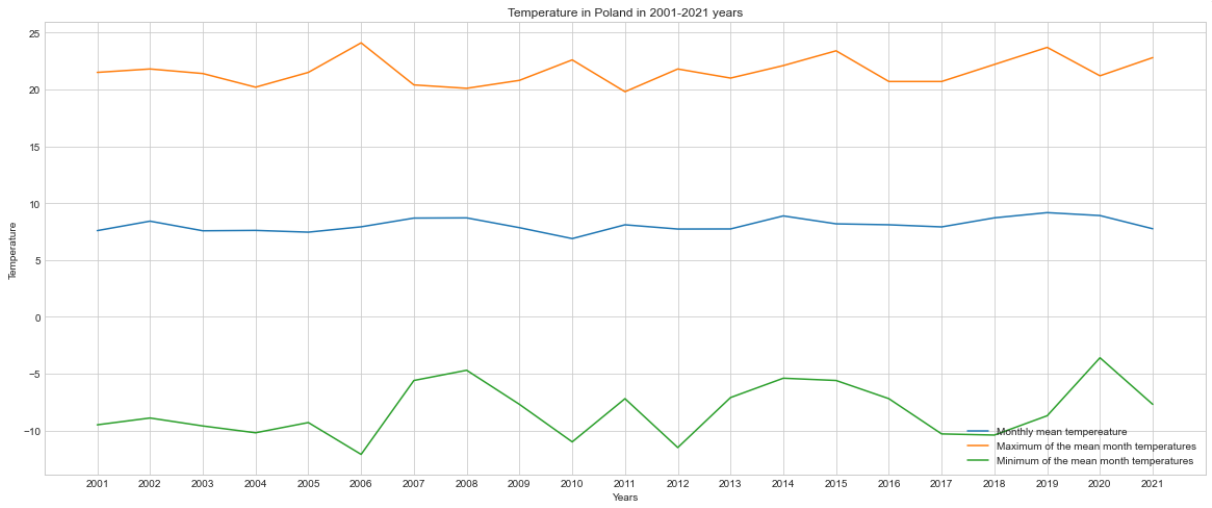
Data, which are publicly shared by the institute can be found on the website: https://danepubliczne.imgw.pl/. We can download historical meteorologic data with monthly average temperature for last 20 years, which helped me with analysis of temperature distribution

Daily data - maximum and average temperatures from the last 70 years - from 1951 were also compiled. These data can be found at https://www.ecad.eu/ - European Climate Assessment & Dataset. I used the collections to analyze the temperatures in a specific city - Wrocław.

3. Analysis

- The distribution of average monthly temperatures for all stations in Poland in the years 2001-2021

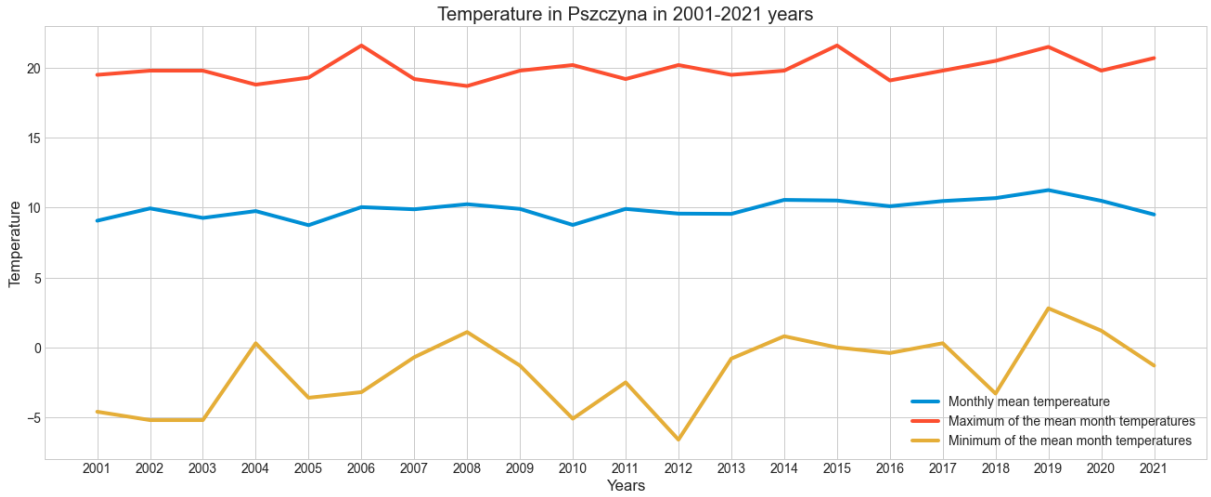
The entire computation process was performed in Python, Pandas, Matplotlib and is available in file: *1-Meteo_Poland_20years.ipynb*



The graph shows the distribution of maximum, average and minimum monthly temperatures for the whole of Poland. Maximum temperature ranged between 20 and 24°C, average between 7 and 9°C, minimum between -3.6 and -12.1°C. It is difficult to find a significant increase in temperatures over the years in the diagram. It may be caused, firstly, by averaging the results to average monthly temperatures and additionally by averaging the results by calculating the average of all weather stations in Poland. The greatest differences are found in the minimum temperature. This is due to the fact that the calculations are shown for all stations in Poland, including those high in the mountains (Śnieżka, Kasprowy Wierch) - therefore this indicator depends on the mountain microclimate. For this reason, I also decided to analyze the same data set, but only on the basis of one city - Pszczyna.

- The distribution of average monthly temperatures in Pszczyna in the years 2001-2021

The entire computation process was performed in Python, Pandas, Matplotlib and is available in file: *2-Meteo_PSZCZYNA_20years.ipynb*

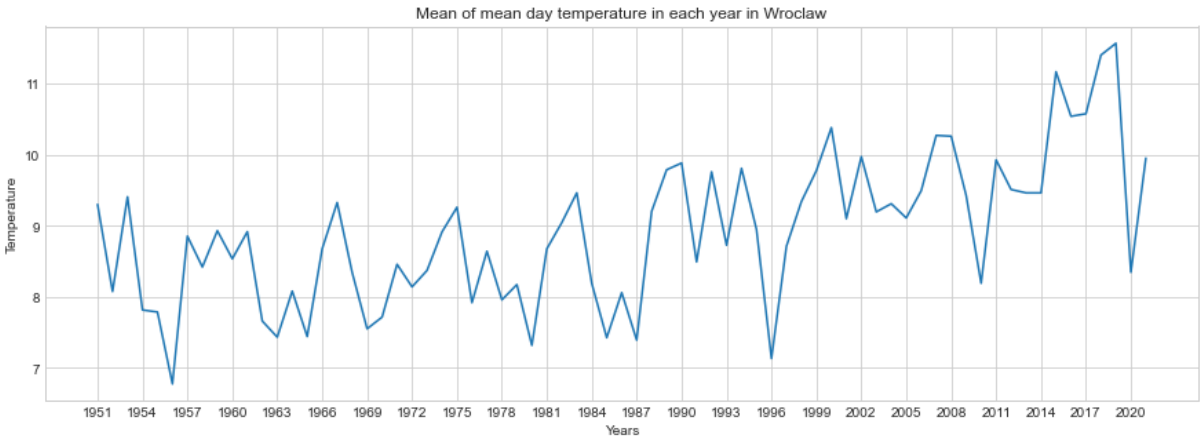


The analysis of data for the city of Pszczyna also does not show a significant increase in temperatures in twenty years. However, we can see some dependencies between the temperatures in Pszczyna and all over Poland. The low minimum temperature in 2012 can be seen on both graphs. We observe the same high maximum temperatures in 2006, 2015 and 2019. This proves that warm summers and cool winters occur more or less equally throughout Poland..

Monthly average data seemed to be too much of a generalization of the climate, so I decided to go two steps further - to analyze the daily results and extend the scope of the analysis to 70 years.

- Distribution of average daily temperatures for Wrocław in the years 1951-2021

The entire computation process was performed in Python, Pandas, Matplotlib and is available in file: *3-Meteo_Wroclaw_70years_mean.ipynb*



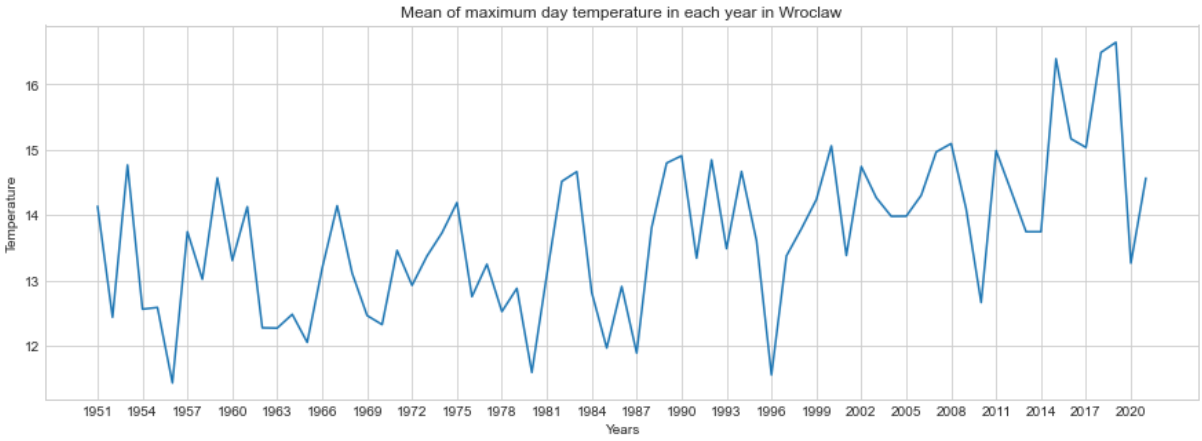
The graph shows the average temperature distribution over the year. There is a clear increase in the average temperature since 2000, with the exception of low values in 2010 and 2020. Analyzing this data, I also decided to calculate the average annual temperature:

- Years 1951-2021 – 8.91°C,
- Years 1971-2000 – 8.71°C,
- Years 2001-2021 – 9.82°C.

For the years 1971 - 2000, the Institute of Meteorology and Water Management determines a typical meteorological year, on the basis of which all standards for thermal and cooling calculations in Poland are built. The official average for Wrocław is 8.1°C. Considering that in the next twenty years the average is almost 10°C - the difference of two degrees in this case is very large (climate.nasa.gov/news/2865/a-degree-of-concern-why-global-temperatures-matter/)

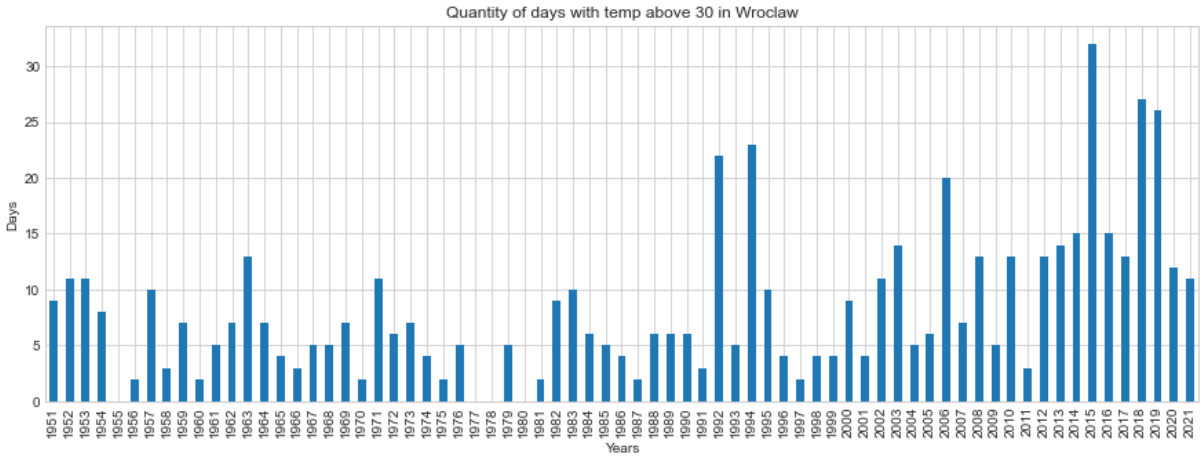
- Distribution of the maximum daily temperatures in Wrocław in the years 1951-2021

The entire computation process was performed in Python, Pandas, Matplotlib and is available in file: *4-Meteo_Wroclaw_70years_max.ipynb*



The next step was to analyze the maximum daily temperatures in Wrocław in the last 70 years. The temperatures fluctuate quite large between 11 and 17°C, and the highest temperatures were recorded in the years 2014-2019.

An interesting aspect is also the number of days when the maximum temperature was above 30°C. It is presented in the graph below:



In the chart, we can see that there were 4 years in which the temperature of 30°C or higher was not recorded in Wrocław (1955, 1977, 1978, 1980). A large number of days above 30°C were recorded in the years 1992, 1994 and a clear increase can be seen in the years 2012-2021, during which it was always at least 10 days, and three times over 25 days.

4. Summary

When analyzing the diagrams of the distribution of average temperatures in the years 2001-2021, it is not easy to find a clear upward trend. This is due to a large generalization of the data by calculating the daily average, then the monthly average and finally the annual average temperature and in one case, additionally, the average of all stations available in Poland.

It is much easier to analyze the data taking into account the average and maximum daytime temperature in one selected city. The analysis of temperature data in Wrocław shows a clear upward trend since 2014. Even better than the average temperature, it is visible in the number of days where the maximum temperature exceeded 30°C. In the years 2015,2018,2019 it was more than 25 days, when in the years 1955,1977,1978,1980 such high temperature was not recorded at all.

Comparing a few years without any temperature higher than 30°C in the 70-80s of the last century to over 30 days in 2015, you clearly can see progressive changes in the climate.