Explore Weather Trends

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Overview

This is my first submission for review of my analysis of the temperature data provided as part of the Data Analysts Nanodegree, Project 1: Explore Weather Trends

Goals

1. **Extract the data** from the database
2. **Open up the CSV** in preferred tool
3. **Create a line chart** using ***moving averages*** that compares the temperatures of the city that is closest to me with global temperatures.
4. **Make observations** about similarities and differences between world averages and local city's averages, as well as overall trends.
    a. Is your city hotter or cooler on average compared to the global average? Has the difference been consistent over time?
    b. "How do the changes in your city's temperatures over time compare to the changes in the global average?"
    c. What does the overall trend look like? Is the world getting hotter or cooler? Has the trend been consistent over the last few hundred years?

Procedure followed

1. Extract the data

In order to extract the data from the database using SQL, I wrote the following three scripts:

```
-- Find closest city to me

SELECT *

FROM city_list

WHERE country IN ('Switzerland');


-- Extract all city data for Bern ordered by year

SELECT *

FROM city_data

WHERE city LIKE ('Bern')

ORDER BY year;


-- Extract all global data ordered by year

SELECT *

FROM global_data

ORDER BY year;
```

2. Open up the CSV

Step 1. allowed me to generate *.csv files of the data which I saved to my local drive. I then used the terminal on my Mac to rename and move the files into my working folder.

I then opened these files in Google Sheets to work on them.

Nota Bene: For the record, I am experienced with excel, but being unemployed I do not have access to it for this nanodegree, I am therefore using Google Sheets instead, for the first time.

3. Create a line chart

Before creating a line chart, I checked the data for min and max to ensure I had consistent data. I also scanned through quickly and noted there were 1) some gaps in the data for Bern (the city closest to me) (but of no consequence to the analysis) and 2) different date ranges for the Bern and Global sets (again of no consequence to the analysis).

I then proceeded to calculate the moving average for the data.

In both cases I took a window of 10 years, including the 10 years leading up to the year of interest, like so:

33	Bern	Switzerland	6.72	6.72	6.684
34	Bern	Switzerland	7.25	7.25	6.74
35	Bern	Switzerland	6.55	6.55	6.756
36	Bern	Switzerland	6.45	6.45	6.781
37	Bern	Switzerland	7.29	7.29	6.88
38	Bern	Switzerland	7.65	7.65	6.978
39	Bern	Switzerland	6.95	6.95	7.021
40	Bern	Switzerland	7.78	7.78	7.145
41	Bern	Switzerland	6.07	6.07	7.017 × 6.959
42	Bern	Switzerland	7.46	7.46	=average(E33:E42)

I also tried a different range to explore the smoothing effect: I used the same method but on a 25 year window, my subjective judgment was that this smoothed the data too much, I therefore conducted my interpretation on the 10-year moving average.

I created the following charts: 1) a chart showing the absolute temperature values, 2) a chart showing values normalized to highests temperature in range, 3) a chart showing delta-Temp between Bern and Global temperatures, and finally 4) a chart showing the rate of change of temperatures for Bern and Global temperatures, using normalised temperatures as input.

I chose to visualize the data like this for the following reasons:

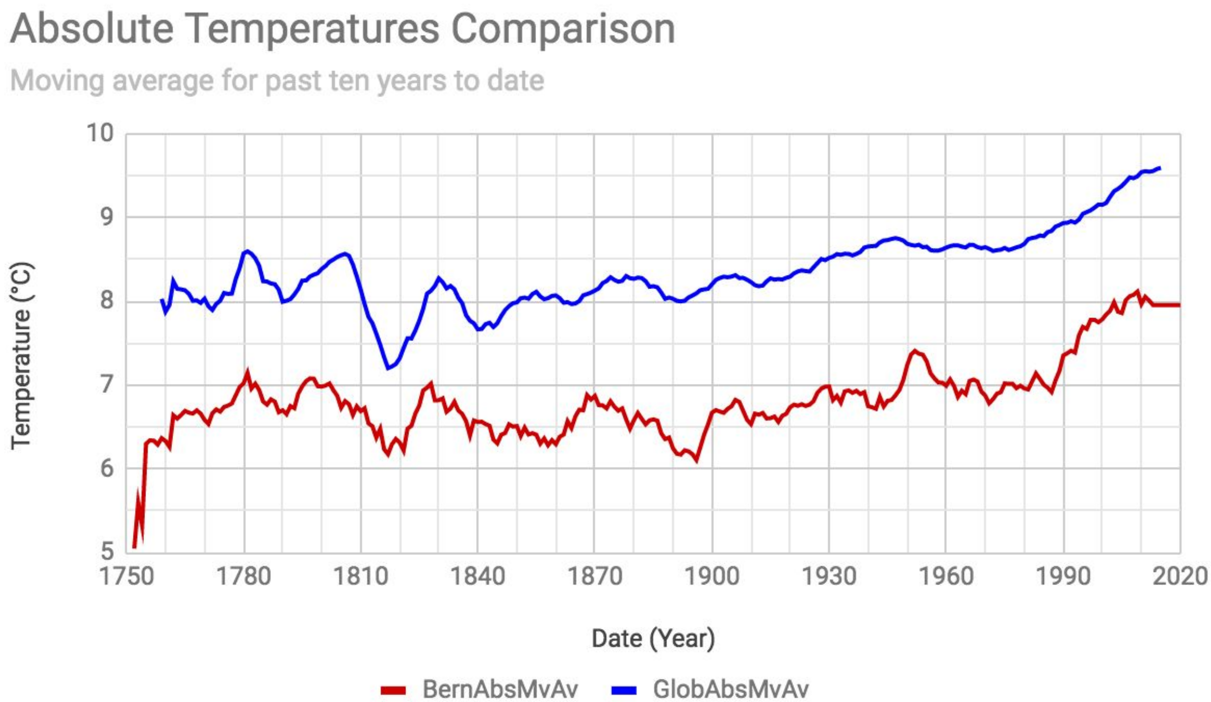
- **Moving average window**: 10 years leading up to year calculated do not smooth the data too much for interpretations of climate change, additionally the Sun is known to have an 11 year cycle, so on the same order of magnitude as the moving average
- **Absolute temperatures comparison**: as a first pass I wanted to plot the “raw data” (albeit the moving average) in order to have a basis of comparison to real-world experiences (weather patterns, glaciers advancing and retreating, etc)
- **Normalized temperatures comparison**: as the focus of climate change is trends in data rather than absolute values, and because the Bern data does not lie on the

same line as the Global data, I decided to normalize both curves to their own maxima, not so that the curves would overlie, but so that I had a dimensionless temperature measurement to interpret

- **Delta-Temperature**: while the normalized plot helps to look at temperature trends in both datasets, I also wanted to explore any convergence or divergence between the two data sets, and a simple chart of difference in absolute value offers a quicklook at that question.
- **Rate of change of Temperatures**: I wanted to be able to see the instantaneous rate of change in order to add some context to the long-scale changes that I was looking at

4. Observations

Absolute Temperature Comparisons



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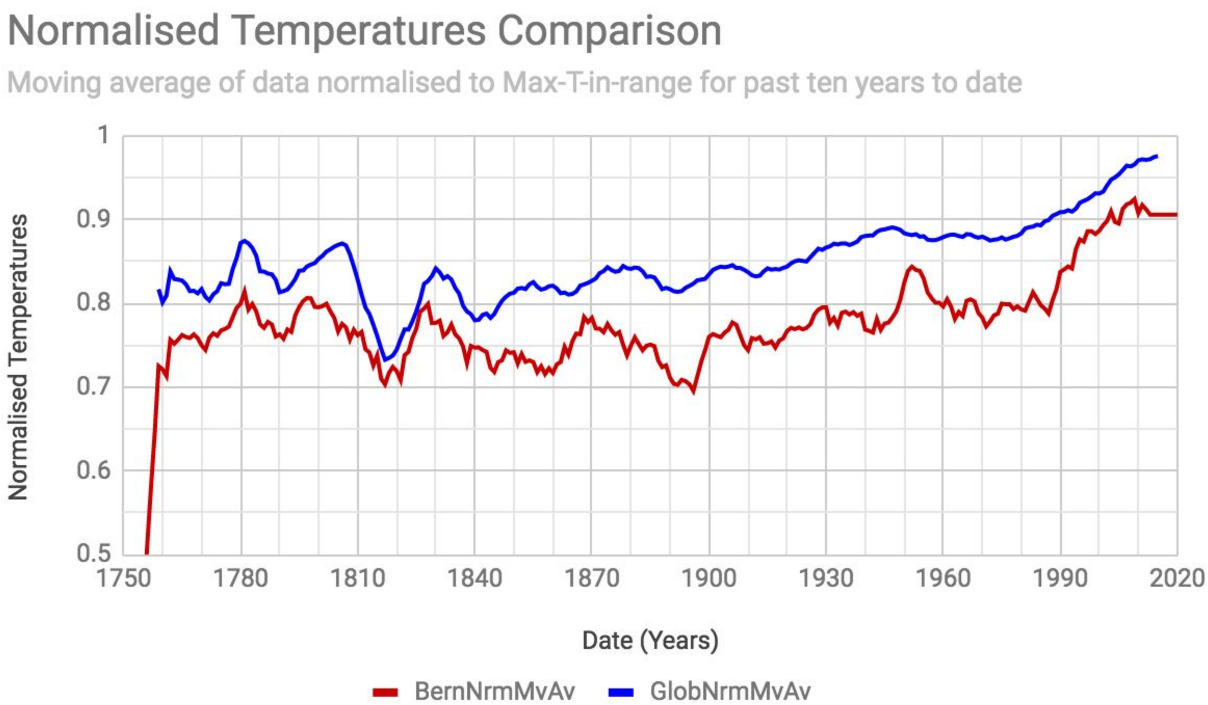
In this chart I make the following observations:

1. Bern average temperatures are consistently colder than Global average temperatures
2. The temperature difference is on the order of 1°-2° approximately
3. Overall trend is increasing , most notably since approximately 1900
4. In Bern in particular but on a Global scale too, the trend appears to accelerate in the past 30 years
5. The overall increase in temperature is measured on the order of 1° degree or so, meaning for instance that Bern now has average temperatures close to the Global average of the late 18th century.
6. Several cycles of sharp increase and slow decrease in temperatures can be seen, notably [1790-1810],[1820-1850],[1860-1890].
7. Such cycles can still be seen albeit with less marked decreases in temperatures until the mid 20th century, but the pattern is not so clearly visible in the last 50 years before present

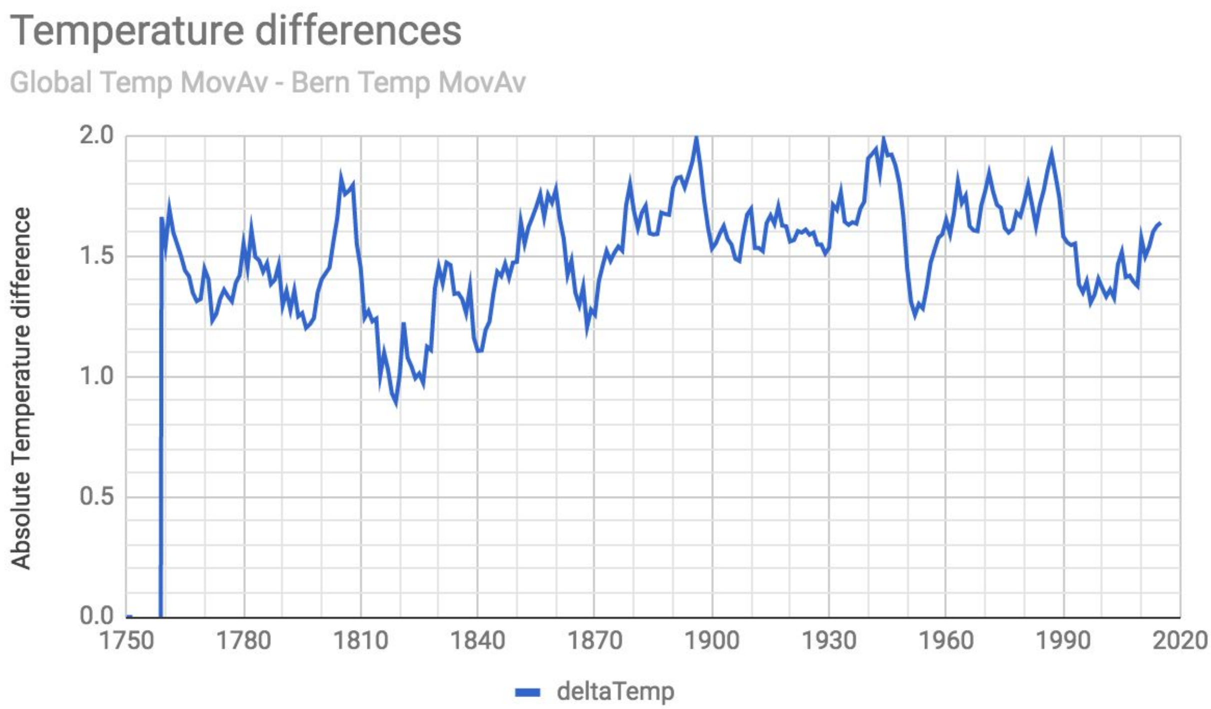
Normalised Temperature Comparisons



For the normalised temperatures chart, the following observations are made:

1. All the previous observations still stand, as is expected
2. No additional pattern emerges, and no significant differences between Global average temperatures and Bern average temperatures are seen
3. It is telling to consider that the increase in temperatures since the mid 18th century is on the order of 20% increase in average temperatures

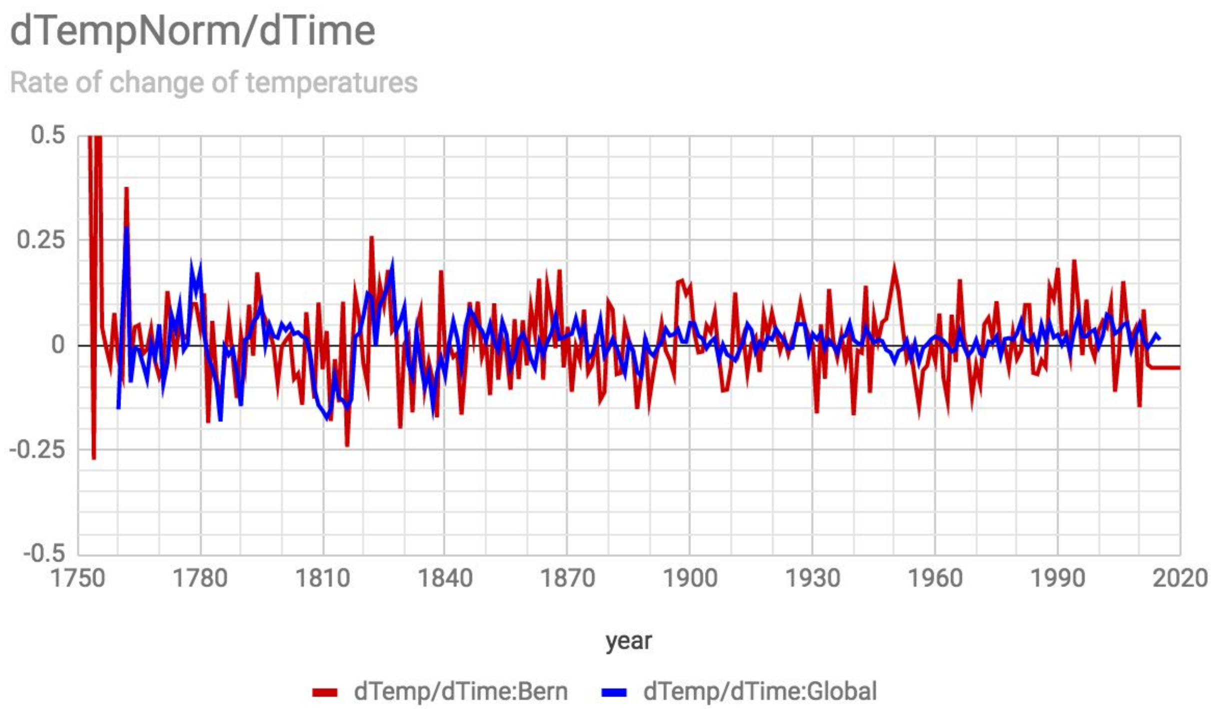
Temperature differences



Plotting the difference in temperature between Global average temperatures and Bern average temperatures:

1. Mirrors the cyclicity alluded to above
2. Shows the range of differences in temperatures, namely 1° to 2° difference
3. Confirms that Bern is tracking the Global temperatures

dTempNorm/dTime



This chart shows the following features:

1. At a seasonal scale, the rate of change of temperature is clearly observable on the Bern data, less so on the Global data - this of course is to be expected as the Global data is averaging points in opposing seasonal regimes
2. The cycles seen in the other charts can also be seen here, although this data is logically a lot more noisy
3. The rate of change at this scale does not truly capture the overall trend seen in the other plots, but neither should it as this is really looking at instantaneous rate of change

5. Interpretations

1. Global and local temperatures are related, as is expected
2. Their rates of change are not discernable at a human life scale, making observations therefore requires historical data
3. Cyclicity is clearly seen at different scales, this is to be expected and has causes ranging from Solar cycles, Earth orbit, seasons, weather systems, and local considerations
4. The Earth has already been through greenhouse and snowball phases throughout its geological history, but the current trend strongly appears to be of increasing temperatures
5. The timing of onset of increase also seems historically related to the industrial revolution and human activity
6. That said, the present study does not investigate other drivers of global climate, more data needs to be investigated (for example volcanic activity, solar activity and other factors mentioned above)

6. Conclusions

Irrespective of the causes of global warming, it seems to be beyond doubt that it is occuring. There are and will be significant effects to this phenomenon, as there have been in the geological past. These include but are not limited to: changes in sea levels, in weather patterns, in carbon storage and capture potential.

The question therefore is not whether we are, or whether we can influence the climate, but what we intend to do to mitigate the damages to our societies and our environment. The Earth does not care whether it's hot or cold, it been hotter and it's been colder, and the Earth does not care whether ***Homo sapiens sapiens*** survives or disappears, but we should.

References

I. Cover photo

https://pixabay.com/en/lightning-bolt-lightning-power-768801/

II. Tools used

Udacity Data Analyst Nanodegree material > to access data

Visual Studio Code > to record sql scripts

https://www.google.com/sheets/about/ > to analyse data

https://www.google.com/docs/about/ > to report analysis