Exploring weather trends

In this project, I will be providing inferences on the average temperature changes observed in the last 250 years. The nearest location chosen in this study to compare the weather to the global temperature trend is New York.

Tools used:
I used SQL commands to retrieve the New York and global temperature data sets. Then, importing the data in google sheets I compute the moving averages, and further plot the graphs shown below. The X and Y axes are labelled by importing the figures in a MS power point for better clarity.

Methodology and observations:
Since the global dataset starts from the year 1750 while the one for New York starts at 1743, we will skip the first seven observations for New York. The overall trend is not going to change due to the seven observations since the time scale considered is for several years. For the year 1780, there is again a missing value for New York for which an average of the former and latter values is taken.

We then plot the average temperature from 1750 till 2013 for the two datasets as shown in Figure 1.

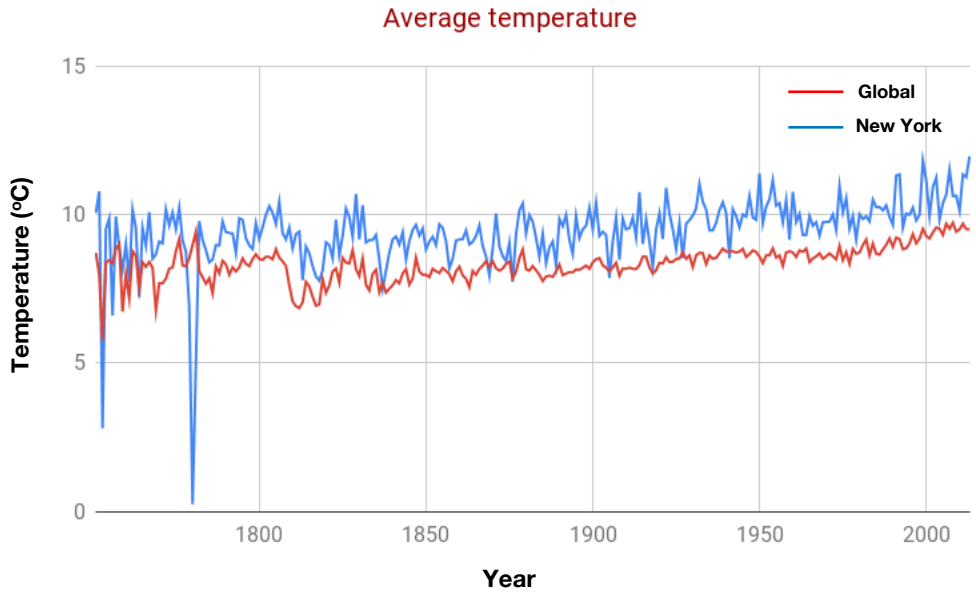

Figure 1: Average temperature of the global and New York temperature between the years 1750 and 2013.

This plot shows us that the temperatures of New York are highly fluctuating compared to the global one. While the fluctuations for New York looks like ± 3°C, the global

temperature fluctuates with ± 1°C. Also noticeable is the huge spike around the years 1750 and 1770 in New York while there has been not a significant change in the global temperature, which actually sees a rise by a couple of degrees. To have a better understanding of the trend, we use the concept of moving averages which helps to clearly observe the change and compare the two curves.

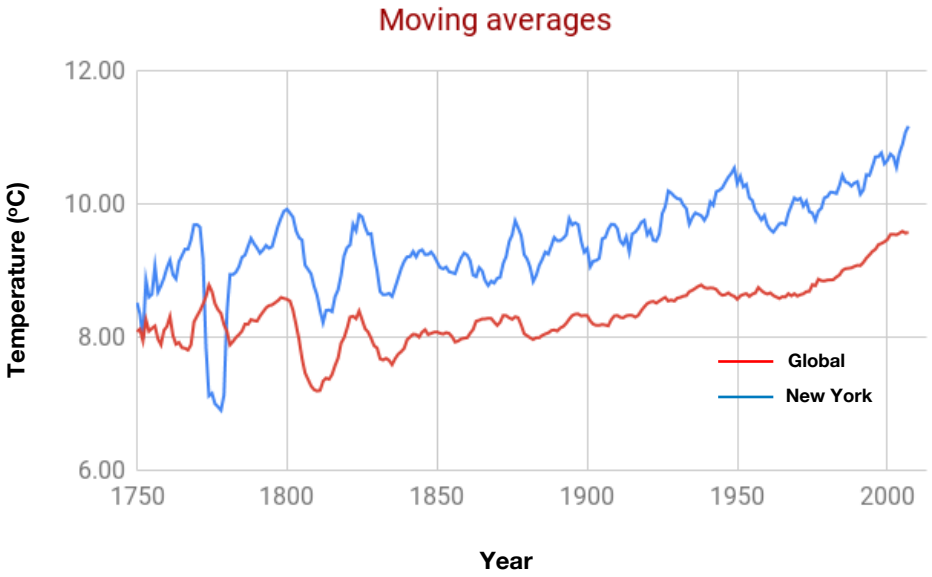

Figure 2: Moving averages of the global and New York temperatures between the years 1750 and 2013.

Figure 2 shows us the moving averages of the temperatures for the datasets and the observations observed in Figure 1 holds here as well. Overall, both the curves show an increasing trend indicating the temperatures have risen over the last 250 years by around 3°C for New York and close to 2°C on the global level. The global temperature has always stayed lower than the average temperature in New York except for the years 1770-1775 where an unconventional dip in New York's temperatures is observed while globally the temperature was relatively higher. Apart from that, qualitatively the trends have been similar. The average New York temperature is 9.47°C and globally it is 8.36°C. It is possible to determine the temperature of New York from the corresponding global temperature for a particular year from a linear least squares regression given by ($y = 0.26*x + 5.88$), where y corresponds to New York's average temperature and x corresponds to the global temperature. The Pearson correlation coefficient is found to be 0.69 between the datasets. Since it is closer to 1, they can considered to be positively correlated to a good extent and the predicted values are reasonably accurate if not to the highest degree.

The difference ($T_{New\ York} - T_{global}$) in the moving average temperatures between the two datasets as a function of temperature is shown in Figure 3.

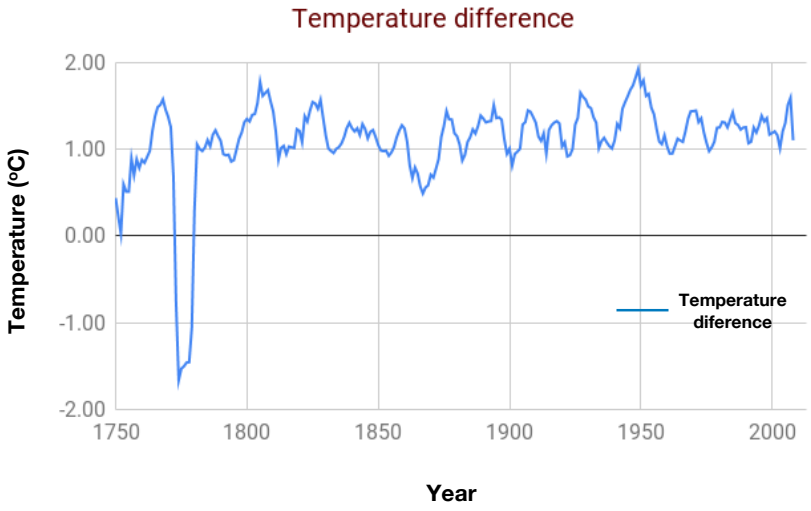

Figure 3: Temperature difference of the moving averages of the New York and Global temperatures between the years 1750 and 2013.

After a steep rise to 1.5°C after 1750 and a major dip near 1770's, the temperature difference between them on an average been around 1.1°C.

Further in this project we also compare the average temperatures for a few other cities, namely, Moscow (Russia), Zagreb (Croatia), and finally Toronto (Canada) as shown in Figure 4.

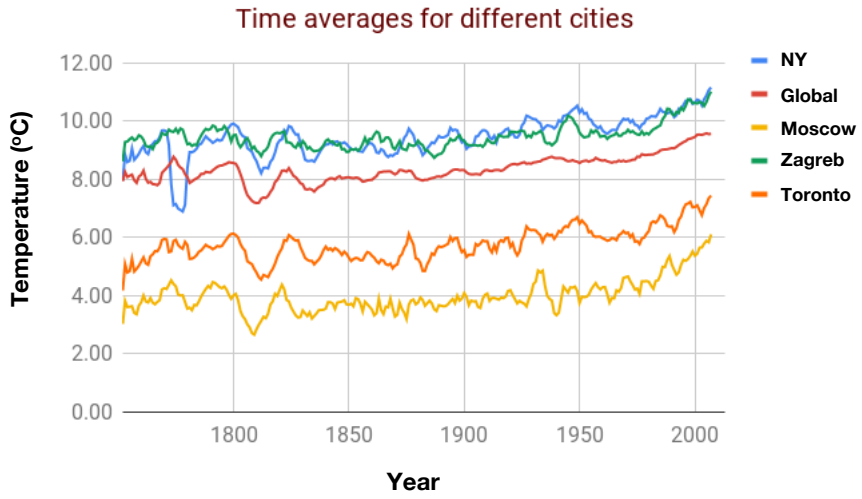

Figure 4: Moving averages of the global, New York, Moscow, Zagreb, and Toronto temperatures between the years 1750 and 2013.

We find that the average temperature of all the cities have increased in the last 250 years except for a trough between the years 1800-1820 in all of them. While all the cities show

an increase of 2.5-3^{o}C, the average global temperature has only increased to about 2^{o}C. Moscow is found to be the coldest place among the cities considered, followed by Toronto. Both of them have their average temperatures below the global one. New York and Zagreb show similar trends, and they lie above the average global temperature.

Conclusion:
To sum up, we have used tools/software such as SQL, google sheets, MS powerpoint and linear regression model to analyze the average temperatures in New York, Moscow, Zagreb and Toronto compared to the global average temperature between the years 1750 and 2013. The trend has been analyzed using moving averages. Linear regression model also provides a way to predict a city's (here New York) temperature from the other dataset (here global temperature) or vice-versa. This can be extended to other cities as well.

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Appendix:

1. SQL queries used for this project:
   a. For identifying the closest city to my place and the list of cities, I initially looked at the data set called ' city_list' using:

```
SELECT *
FROM city_list
```

   b. Next, to extract the data for the specific list of cities (for example, Toronto), the following code was used:

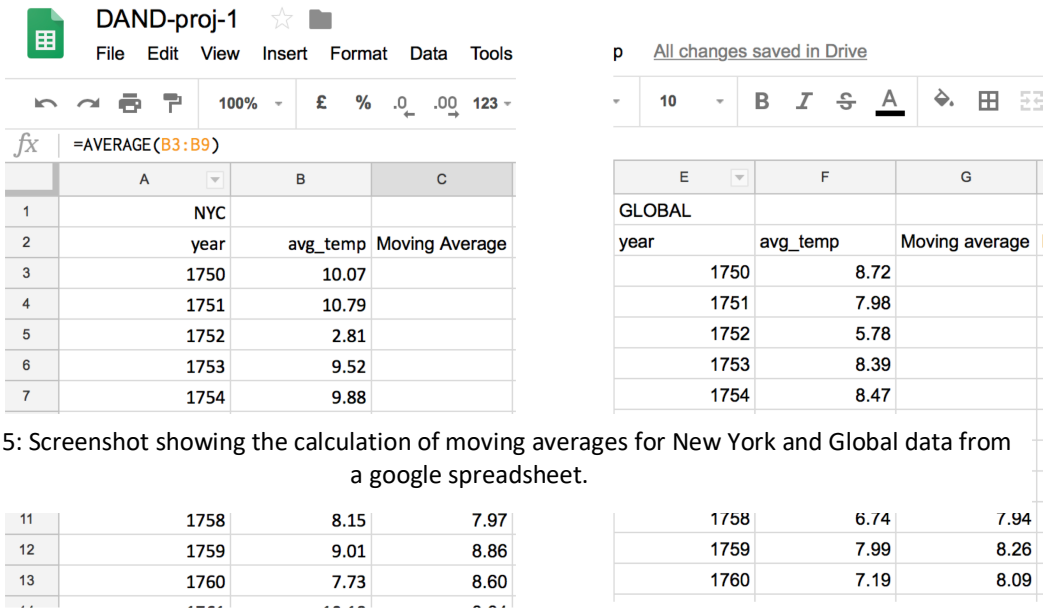
```
SELECT year,avg_temp
FROM city_data
WHERE city IN ('Toronto')
```

   c. The global temperature data was extracted using the following:

```
SELECT *
FROM global_data
```

2. The moving averages were calculated for each of the cities and for the global one using a google spreadsheet. The first moving average was calculated by taking an average of the first 7 observations corresponding to the average temperature extracted using SQL for the years 1750 till 1756. After that, we dragged the formula down to obtain the subsequent averages for the rest of the years. The screenshot for New York and Global data are shown below:

New York **Global**



	A	B	C
1	NYC		
2	year	avg_temp	Moving Average
3	1750	10.07	
4	1751	10.79	
5	1752	2.81	
6	1753	9.52	
7	1754	9.88	
11	1758	8.15	7.97
12	1759	9.01	8.86
13	1760	7.73	8.60

	E	F	G
	GLOBAL		
	year	avg_temp	Moving average
	1750	8.72	
	1751	7.98	
	1752	5.78	
	1753	8.39	
	1754	8.47	
	1758	6.74	7.94
	1759	7.99	8.26
	1760	7.19	8.09

Figure 5: Screenshot showing the calculation of moving averages for New York and Global data from a google spreadsheet.