Climate Confluence: Analyzing the Impact of CO2 Emissions on Global Temperature Trends

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1. Introduction:

The project, "Climate Confluence: Analyzing the Impact of CO2 Emissions on Global Temperature Trends," examines how CO2 emissions influence global temperatures. Worldwide warming and the greenhouse effect are caused by CO2 emissions. This project uses datasets on CO2 emissions and global temperatures to explore this relationship, aiming to provide evidence for effective climate. By analyzing these trends, The goal of the study is to enhance understanding of the critical link between CO2 emissions and temperature changes by answering the questions "How do CO2 emissions correlate with global temperature trends?"

2. Used Data:

I have chosen two datasets for my analysis: CO2 emission data from Our World in Data (available on GitHub) and temperature data from Figshare. By feeding the datasets to the ETL (Extract, Transform, Load) pipeline [Source Code], we got our refined data for the main data analysis.-

2.1 Output of the data pipeline:

	country *TEXT*	year *INTEGER*	co2 *REAL*	AverageTemperatureCelsius *REAL*
1	Brazil	1901	2.103	19.804333333333336
2	Brazil	1902	2.506	20.158416666666664
3	Brazil	1903	2.44	19.913833333333333
4	Brazil	1904	2.62	19.166416666666667
5	Brazil	1905	2.799	19.901666666666667
6	Brazil	1906	3.206	19.973958333333332
7	Brazil	1907	3.451	19.568583333333333
8	Brazil	1908	3.594	19.626
9	Brazil	1909	3.609	19.368666666666666
10	Brazil	1910	4.199	19.509521739130435

Figure: Final data

The output consists of four key columns: ***country***, ***year***, ***co2***, and ***AverageTemperatureCelsius***. The ***country*** column represents the countries (Brazil, France, Japan, New Zealand, Poland, South Africa, Sweden, and Ukraine) where the data was collected and is a categorical variable. The year column records the year in which the data was recorded, making it a continuous numerical variable. The ***co2*** column represents the average CO2 emissions in tons for the respective country and year, while the ***AverageTemperatureCelsius*** column indicates the average temperature recorded in Celsius for the respective country and year.

Each row in the dataset corresponds to the CO2 emissions and average temperature for a particular country in a specific year. This structure allows for a comprehensive analysis of the

relationship between CO2 emissions and average temperatures over time across different countries. By examining these variables, we can identify trends and correlations that may indicate the impact of CO2 emissions on global temperature changes.[detailed data-report]

2.2 Data licenses: Both the CO2 emissions and temperature datasets are licensed under CC BY 4.0. This license allows for use, sharing, and adaptation of the data. I plan to follow the obligations of the CC BY 4.0 license by providing appropriate attribution to the original creators of the CO2 emissions and temperature datasets in all instances of use.

3. Analysis:

The plottings are made with python libraries "***matplotlib***" and "***seaborn***" to visualize the data to find the correlation between CO2 emissions and global temperature.

3.1 Correlation matrix:

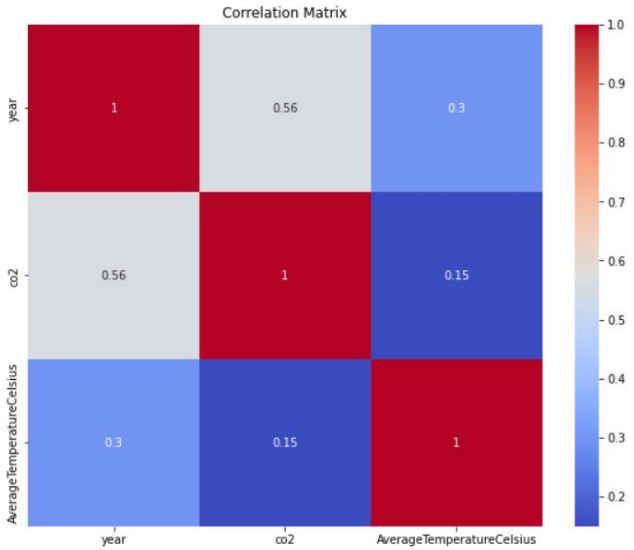

Figure: Correlation Matrix of *year, co2* and *AverageTemperatureCelsius* column

The correlation matrix shows the Pearson correlation coefficients between the variables: ***year***, ***co2***, and ***AverageTemperatureCelsius***.

3.1.1 Interpretation: The correlation matrix reveals a moderate positive correlation of 0.56 between the year and CO2 emissions. This correlation coefficient suggests that CO2 emissions have been increasing over time. As we progress through the years, there is a clear trend of rising CO2 emissions.

In contrast, the correlation between the year and average temperature is weaker, with a correlation coefficient of 0.3. Although there is still a positive relationship, it is not as pronounced as with CO2 emissions. This indicates that while average temperatures tend to increase over time, the connection is not as strong.

Lastly, the relationship between CO2 emissions and average temperature shows a very weak positive correlation, with a coefficient of 0.15. This implies that there is only a slight tendency for average temperatures to increase as CO2 emissions rise. The weak correlation suggests that while CO2 emissions might contribute to temperature increases, the effect is not

very strong and other environmental and climatic factors likely play significant roles in influencing temperature changes.

The matrix provides a clear overview of how these variables are related, highlighting the moderate increase in CO2 emissions over time and the weak relationships between the variables and average temperature.

3.2 Correlation over time:

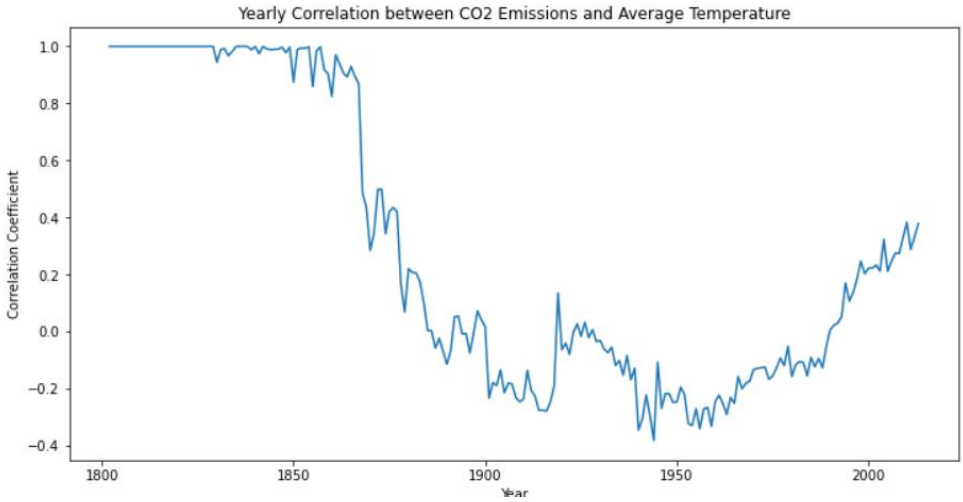

Figure: Yearly Correlation between co2 emissions and AverageTemperatureCelsius

3.2.1 Interpretation: The plot shows the yearly correlation between CO2 emissions and average temperature from the year 1800s to the 2000s.

In the early 1800s, the graph starts with a very high correlation close to 1. It means that as CO2 emissions increased, the average temperature also rose consistently. This strong relationship continued until the mid-1800s.

However, from the mid-1800s onwards, the correlation between CO2 emissions and temperature began to decline rapidly. By the late 1800s and early 1900s, the correlation even dropped to negative values at times. This indicates that during this period, increases in CO2 emissions were somehow associated with decreases in average temperature. Maybe some Industrial Revolution happened between this time.

Throughout the mid-1900s, the correlation remained low and fluctuated, suggesting a weaker and less consistent relationship between CO2 emissions and temperature.

From the 1980s, the correlation began to increase again, reaching values close to 0.6 by the 2000s. This rise indicates a strengthening relationship between CO2 emissions and average temperature.

After analysis, we can tell that the link between CO2 emissions and temperature has changed a lot over time. At first, CO2 and temperature increased together. Later, their connection weakened and even reversed, with higher CO2 sometimes leading to lower temperatures. Recently, the link has grown stronger again, showing that rising CO2 is more clearly connected to higher temperatures.

3.3 Facet Grid plot by Countries:

The FacetGrid plot visualizes the relationship between CO2 emissions and average temperature for different countries.

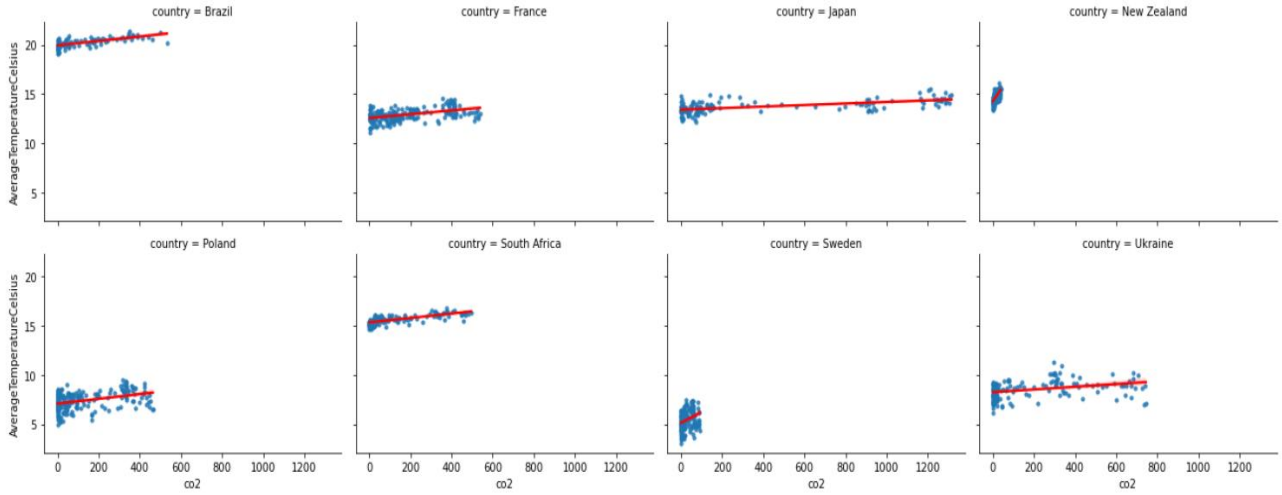

Figure: Facet Grid between CO2 emissions and average temperature for different countries.

3.3.1 Interpretation: The FacetGrid plot visualizes the relationship between CO2 emissions and average temperature for eight countries (Brazil, France, Japan, New Zealand, Poland, South Africa, Sweden, and Ukraine), each represented in a separate subplot with a scatter plot of the data points and a red regression line indicating the trend. The regression line generally shows a positive correlation for most countries, suggesting that higher CO2 emissions are associated with higher average temperatures. However, the strength and clarity of this relationship vary between countries, with some showing a strong positive trend (e.g., South Africa, Poland) and others a weaker or nearly flat trend (e.g., Japan). This plot highlights both the general trend and the variability in the relationship between CO2 emissions and temperature across different regions.

After analysis, we can tell that, most countries show a positive correlation between CO2 emissions and average temperature, indicated by the upward slope of the regression lines. This suggests that higher CO2 emissions are generally associated with higher average temperatures across these countries.

4. Conclusion

The main question of the project is “How do CO2 emissions correlate with global temperature trends?”. With proper analysis of all the data, the conclusion we can made is, CO2 emissions correlate with global temperature trends in an increasing manner but very strongly. The analysis shows that as CO2 emissions rise, global temperatures tend to increase. This trend is evident over time and across various countries, though the strength of the correlation can vary by location. Overall, higher CO2 emissions are associated with rising temperatures.