

CO2 Emissions and Temperature Rise: A Global and Regional Analysis

1. Introduction

Background:

- Climate change poses a critical threat to global ecosystems, economies, and societies
- Therefore, understanding the relationship between CO2 emissions and global temperature rise is essential to address climate change

Key Topics of the Report:

1. How have global CO2 emissions and temperature anomalies developed over the years?
2. How are global and regional CO2 emissions and temperature anomalies correlated?

(Note: „Global“ refers to analyses conducted on a worldwide and continental scale, while „regional“ refers to analyses conducted on a few selected countries)

2. Data Sources

- **Why Chosen:** Dataset provides comprehensive data on CO2 and greenhouse gas emissions, allowing for an analysis of CO2 emissions trends by country and region.
- **Origin:** It is provided by Our World in Data and is accessible through their GitHub repository.
- **Data Content:** It contains data on global CO2 and greenhouse gas emissions by country and region over time.
- **Data Type:** CSV
- **Transformations:**
 - Selecting columns of interest: Country, Year, CO2 emissions, CO2 per capita, CO2 per GDP, Temperature change from CO2
 - Filtering data for years ≥ 1950

- **Data Structure:**

	country	year	co2	co2_per_capita	co2_per_gdp	temperature_change_from_co2
16866	Germany	2003	899.858	11.062	0.314	0.035
16867	Germany	2004	885.633	10.898	0.302	0.035
16868	Germany	2005	865.471	10.657	0.290	0.036
16869	Germany	2006	877.498	10.810	0.280	0.036
16870	Germany	2007	850.230	10.473	0.260	0.036
16871	Germany	2008	852.858	10.501	0.255	0.037
16872	Germany	2009	788.286	9.701	0.247	0.037
16873	Germany	2010	831.130	10.220	0.248	0.037
16874	Germany	2011	807.614	9.919	0.229	0.038
16875	Germany	2012	812.816	9.968	0.230	0.038

- **Why Chosen:** Dataset provides comprehensive data on global temperature through gridded temperature anomalies across the world
- **Origin:** It is provided by the Climatic Research Unit (CRU) at the University of East Anglia and the Met Office Hadley Centre
- **Data Content:** Dataset contains monthly global temperature anomalies from 1850 to the present on a 5-degree grid
- **Data Type:** netCDF
- **Transformations:**
 - Converting the time variable to a common time format
 - Selecting columns of interest: Year, Latitude, Longitude, Temperature anomaly
 - Extracting relevant columns from netCDF format to a pandas DataFrame
 - Filtering data for years ≥ 1950
 - Accumulating temperature anomalies within specific longitude and latitudes ranges corresponding to continents/countries

- **Data Structure:**

		time	latitude	longitude	temperature_anomaly	year
3110400	1950-01-16	12:00:00	-87.5	-177.5	NaN	1950
3110401	1950-01-16	12:00:00	-87.5	-172.5	NaN	1950
3110402	1950-01-16	12:00:00	-87.5	-167.5	NaN	1950
3110403	1950-01-16	12:00:00	-87.5	-162.5	NaN	1950
3110404	1950-01-16	12:00:00	-87.5	-157.5	NaN	1950

3. Results

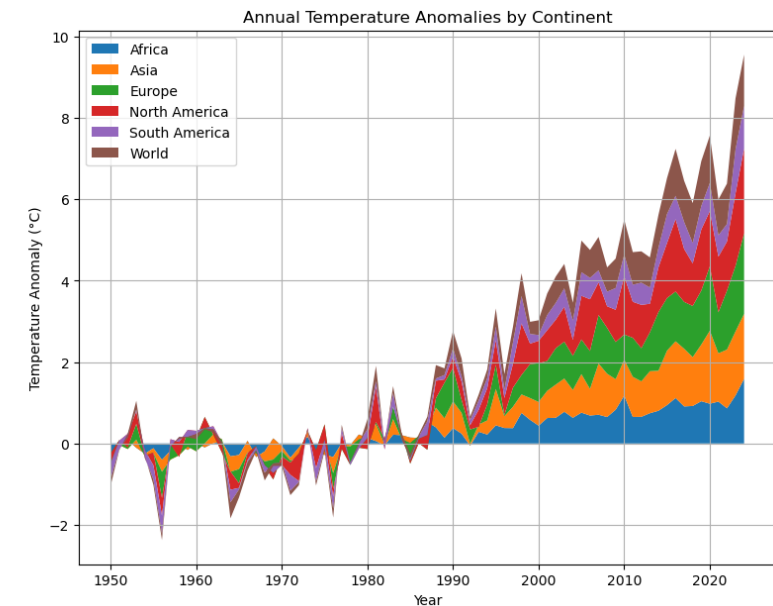
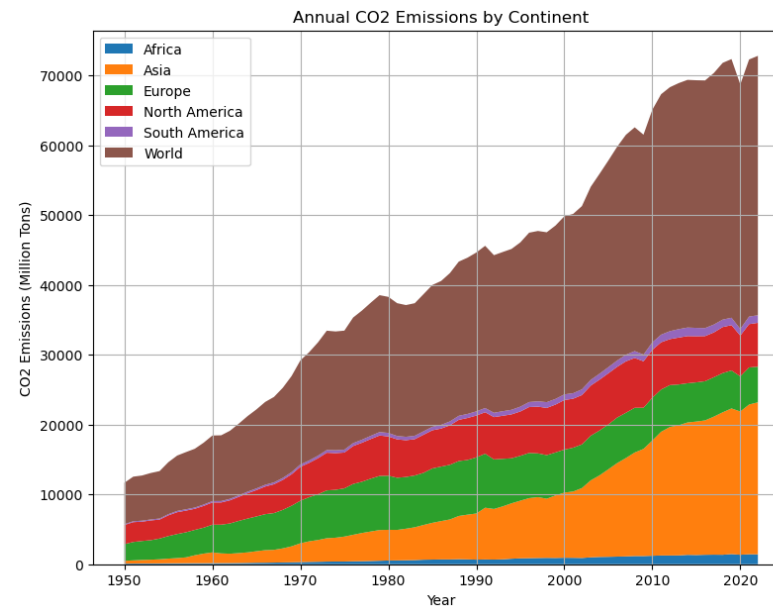
Results

How have global CO2 emissions and temperature anomalies developed over the years?

- Visualizing the global CO2 emissions and temperature anomalies by continent through stack plots

Key Observations:

- CO2 emissions consistently increase overall as well as across all continents
 - Temperature anomalies exhibit a similar upward trend, especially from the 1980s onwards
- ➔ Clear upward trend both in CO2 emissions and temperature anomalies suggests a strong correlation between both, reflecting ongoing climate change



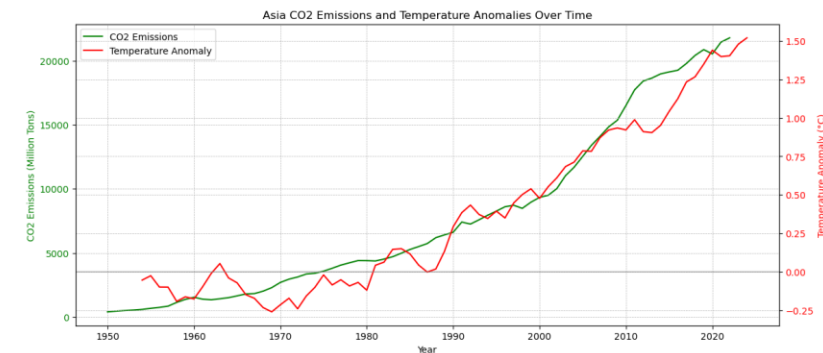
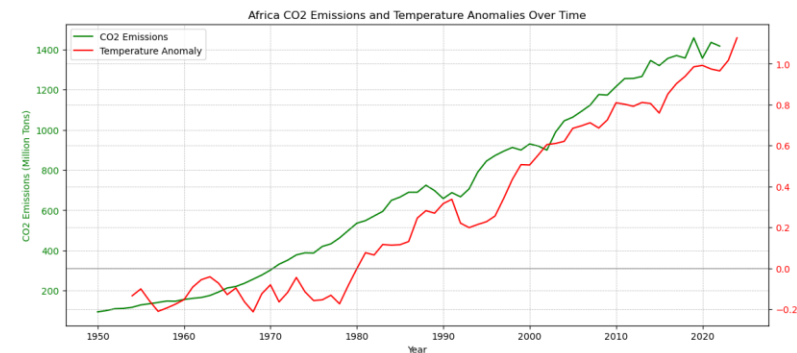
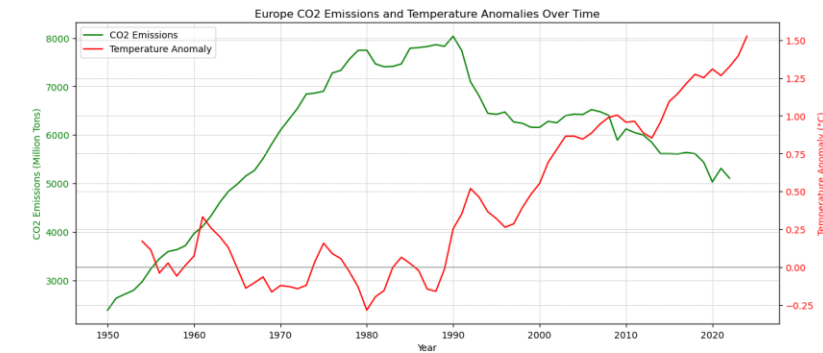
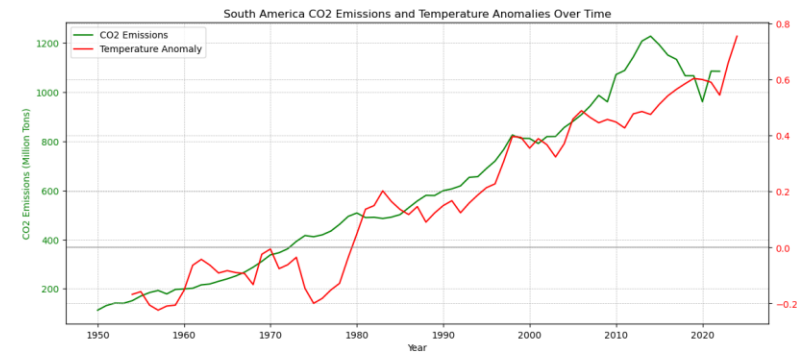
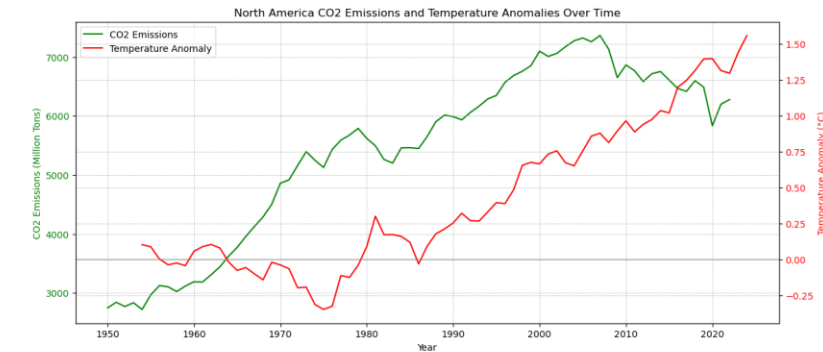
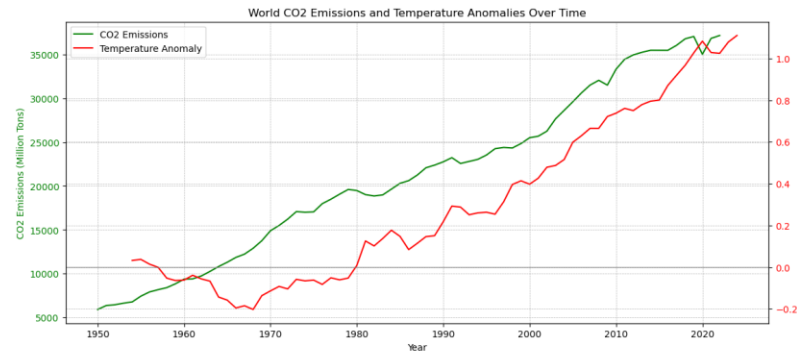
Results

How have global CO2 emissions and temperature anomalies developed over the years?

- Visualizing global CO2 emissions and temperature anomalies over time for each continent through line plots

Key Observations:

- All continents, except for Europe, show increasing CO2 emissions and temperature anomalies over time
 - For Europe, temperature anomalies remained relatively stable while CO2 emissions were rising
- ➔ This discrepancy could be due to Europe's diverse climate zones or effective climate policies
- ➔ Besides this outlier, the subplots clearly indicate and further strengthen the assumption of a strong correlation between CO2 emissions and temperature anomalies



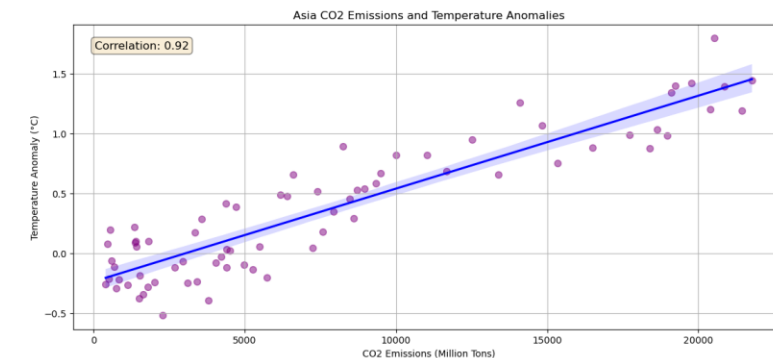
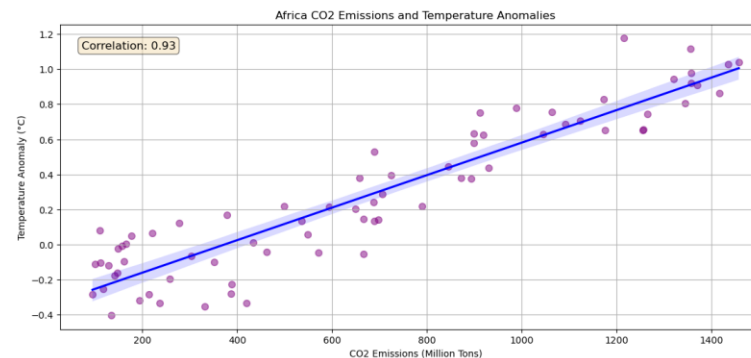
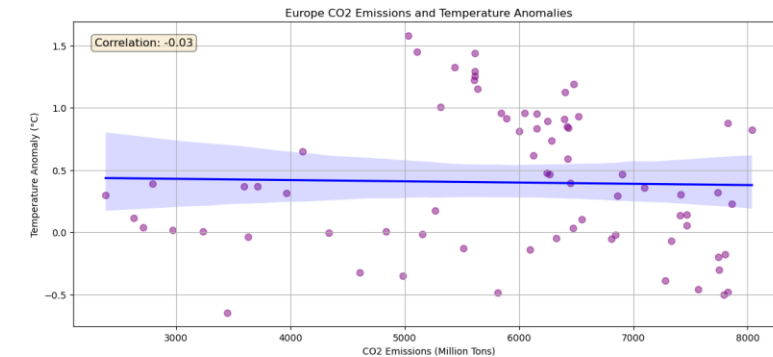
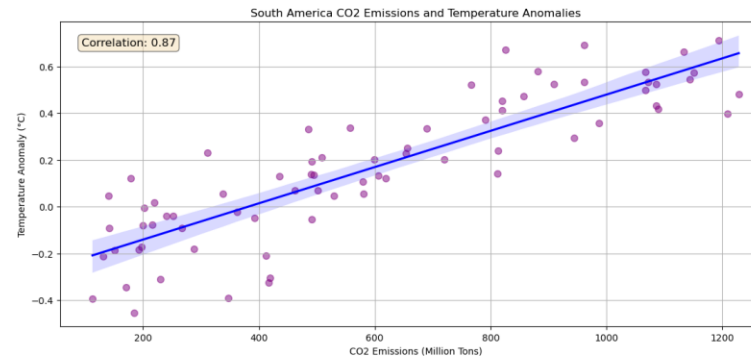
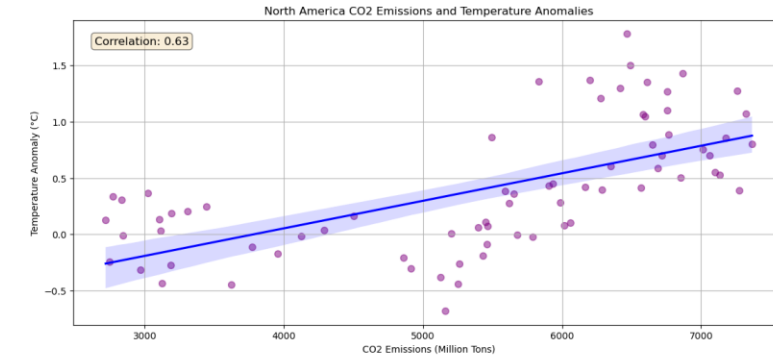
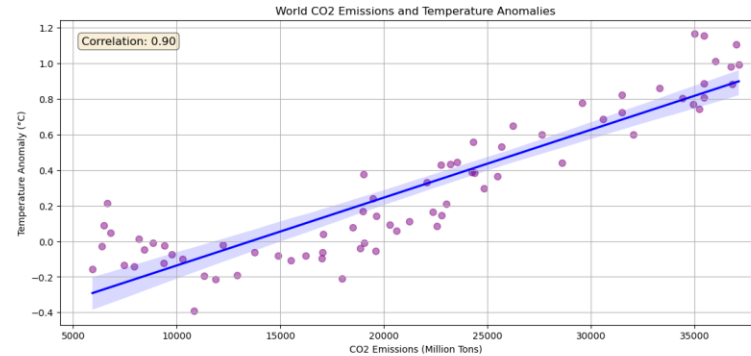
Results

How are global and regional CO2 emissions and temperature anomalies correlated?

- Scatter plots and with regression lines and Pearson's correlation coefficient show correlation between CO2 emissions and temperature anomalies on a global scale

Key Observations:

- Strong positive correlation for World, South America, Africa, and Asia with correlation coefficients of 0.87 to 0.93
- ➔ Higher CO2 emissions are strongly associated with higher temperature anomalies
- No correlation for Europe with a correlation coefficient of -0.03, highlighting the previously mentioned discrepancy which might be due to effective environmental policies or it's diverse climate zones



Results

How are global and regional CO2 emissions and temperature anomalies correlated?

- Scatter plots with regression lines and Pearson's correlation coefficient show correlation between CO2 emissions and temperature anomalies on a regional scale

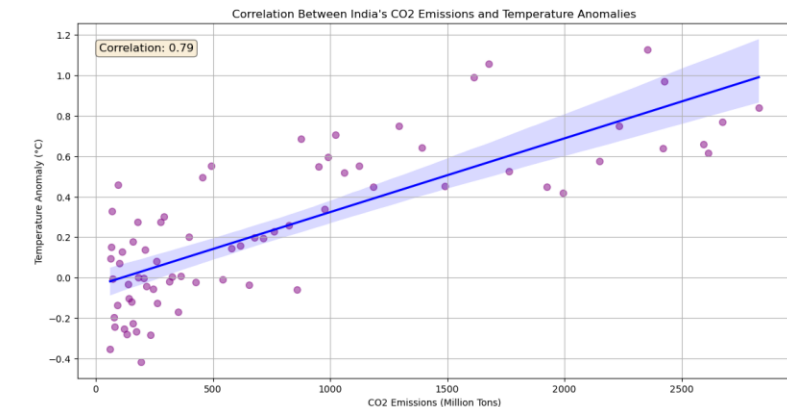
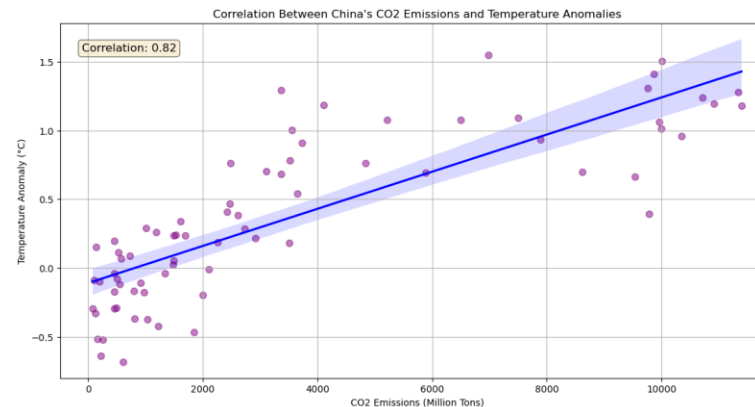
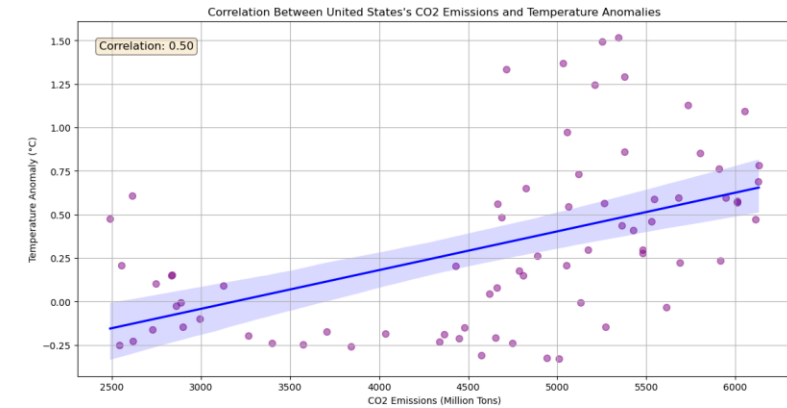
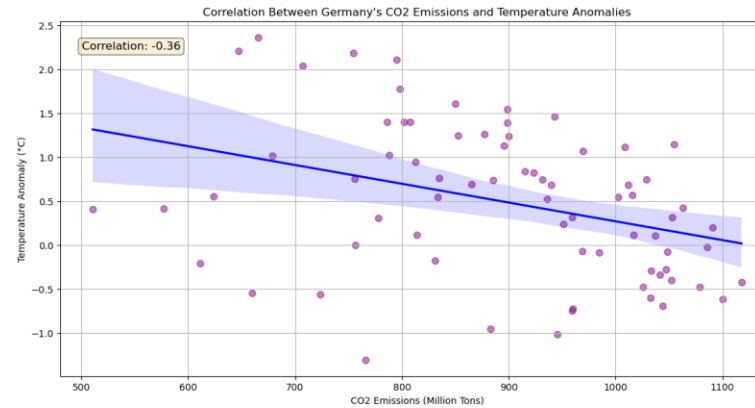
Key Observations:

- Strong positive correlation for China, the US, and India with correlation coefficients of 0.50 to 0.82

➔ Similar to the global correlation results

- Weak negative correlation for Germany with a coefficient of -0.36, indicating that as CO2 emissions increase, temperature anomalies slightly decrease

➔ Regional analyses supports the findings from the global results, but also highlights variations and discrepancies in individual countries, suggesting the need for more advanced and effective climate strategies



4. Conclusion

Global Analysis:

- Consistent increase in CO2 emissions and temperature anomalies over time across all continents
 - Strong positive correlation for all continents except Europe, indicating a strong dependency between the two factors
 - No correlation for Europe, possibly due to effective climate policies
- ➔ Highlights the importance of further region-specific analyses

Regional Analysis:

- Strong positive correlation for China, the United States, and India which underlines the consistent global trend
- Weak negative correlation for Germany

Overall:

- Comparing CO2 emissions and temperature anomalies both on a global and regional scale showed that there is a direct connection and strong correlation between increased emissions and rising global temperatures
- Exceptions for Europe and Germany, which highlights the importance region-specific analysis and the need of further research with additional factors

5. Limitations

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- Selection of continents and countries based on latitude and longitude ranges may introduce limitations, as it can overlook localized climate variations and specific regional factors
 - Other factors like deforestation, land use changes or natural climate variability were not considered

Thank you for your attention!

https://github.com/ordass00/made_fau