Tracking the Planet's Pulse: Analyzing CO_2, Global Temperature Anomalies, and Sea Level Rise

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June 22, 2025

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Introduction

Climate change is one of the most urgent issues of our time, and understanding the interaction between atmospheric CO_2, surface temperature anomalies, and sea level rise is critical for informing global policy. This project uses over a century of monthly time-series data to investigate the relationship between these three climate indicators.

Business Problem/Hypothesis: If CO_2 levels increase, global temperature anomalies and sea levels will exhibit positively correlated upward trends due to anthropogenic emissions.

Methods/Analysis

We sourced and combined datasets from NASA and NOAA:
- CO_2: Mauna Loa Observatory (1958–present)
- Temperature anomalies: NASA GISTEMP v4 (1880–present)
- Sea level: NOAA JPL RECON (1900–2018)

Process:
- Parsed dates and removed missing values
- Merged datasets on monthly timestamps
- Calculated 10-year rolling averages

- Created correlation matrices and visualizations

Tools used: Python (Pandas, Matplotlib, Seaborn), Jupyter Notebook

Results

Figure 1 shows long-term trends from 1880 to 2025 for:

- **CO_2 Concentration** (Mauna Loa): rising steadily at **+1.67 ppm/year**
- **Global Temperature Anomalies**: rising at **+0.0123°C/year**
- **Sea Level Rise**: increasing at **+0.70 mm/year**

All three indicators show significant upward trends, especially after 1950, consistent with known anthropogenic influence.

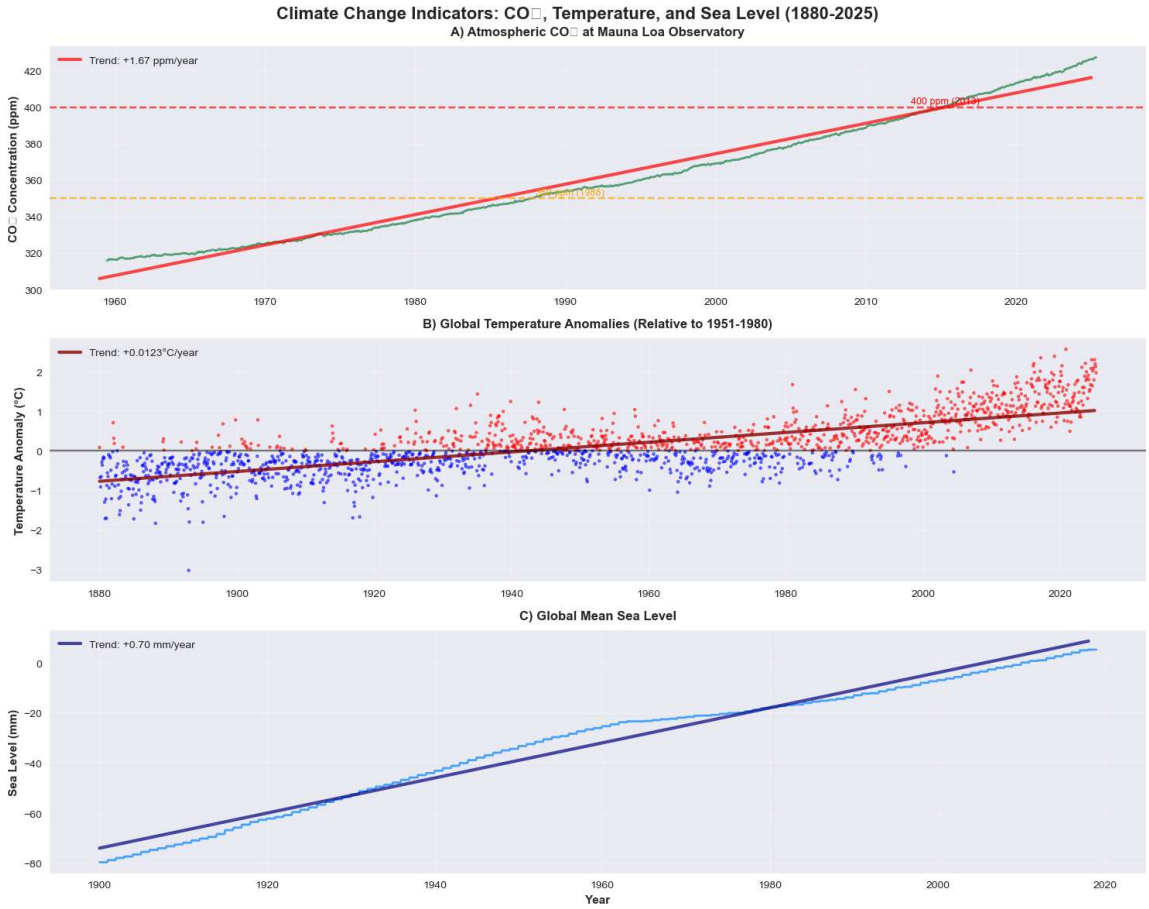


Figure 2 presents a multi-part **correlation and lag analysis**:

- A correlation matrix highlights a strong correlation between CO_2 and temperature.
- A **lagged correlation** indicates that the strongest CO_2-temp link occurs with a **1-month lag**.
- A scatter plot reveals a direct relationship between CO_2 and temperature ($r \approx$ **0.803**).
- The rate of CO_2 change has also accelerated post-1970, averaging **+1.67 ppm/year**.

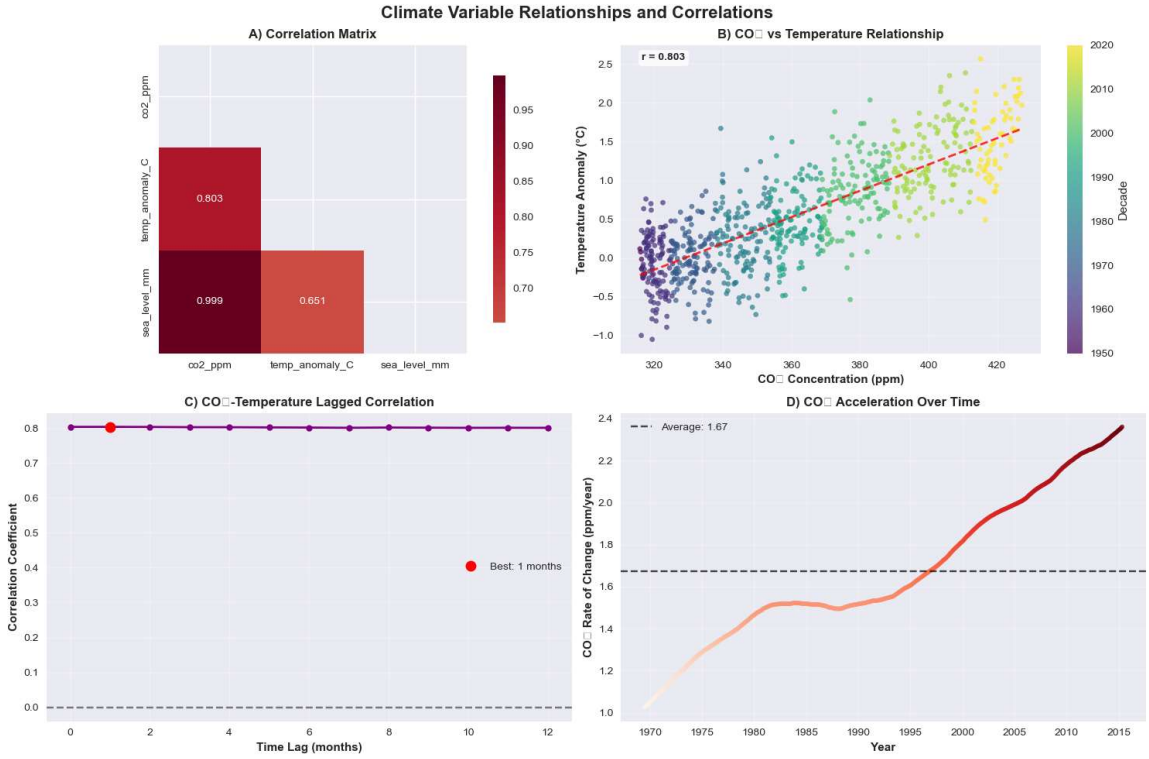
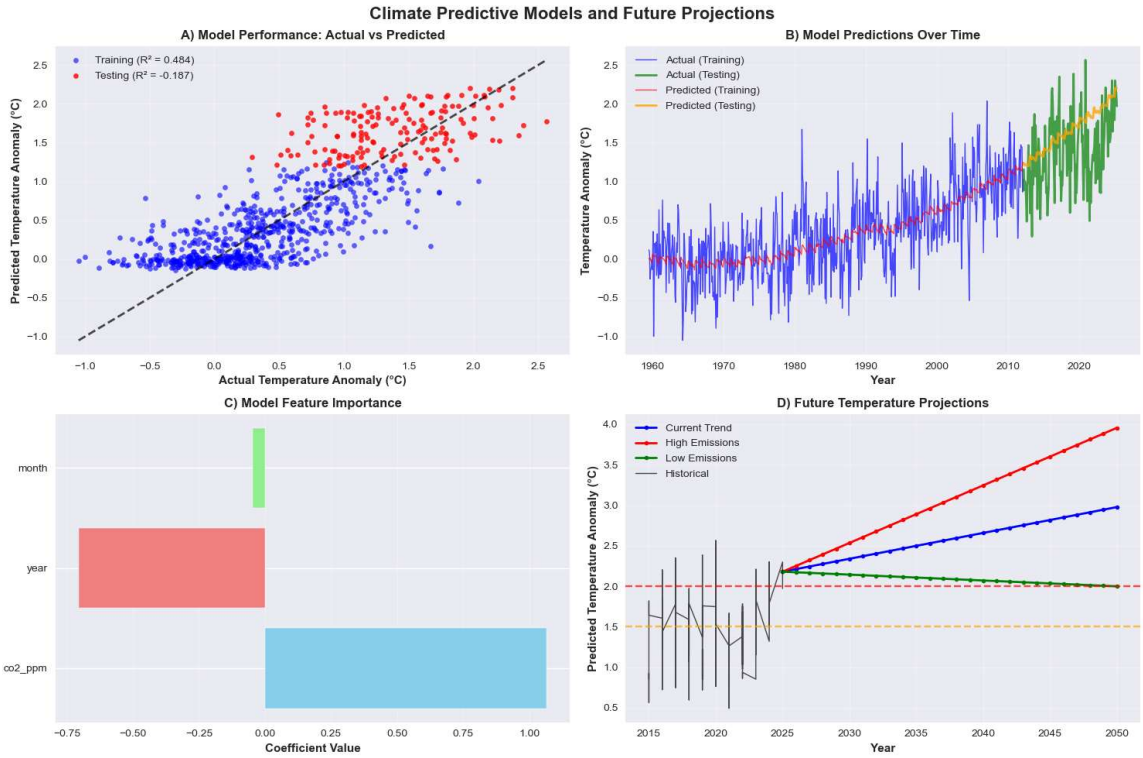


Figure 3 focuses on **predictive modeling**:

- Regression performance shows **training R^2 = 0.484** but a **negative R^2 on testing (-0.187)**, suggesting the model may be overfitting.
- Feature importance emphasizes CO_2 levels as a key predictor.
- Model projections illustrate temperature increases under various emission scenarios, with high emissions producing steep upward trajectories.



Recommendations & Ethical Considerations

Our results support the use of climate indicators for educational and policy purposes. Ethical considerations include avoiding alarmism and responsibly communicating predictive trends. Reproducibility is ensured by dataset documentation and consistent timestamp alignment.

Conclusion

We confirmed significant correlations among CO_2, temperature, and sea level rise using over a century of climate data. These findings support broader climate change evidence and suggest potential for predictive modeling in future work.

References (APA Style)

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GISTEMP Team. (2025). GISS Surface Temperature Analysis (GISTEMP), version 4. NASA Goddard Institute for Space Studies. https://data.giss.nasa.gov/gistemp/

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Appendix

- Code notebooks: DSC450_Week3_Milestone2.ipynb
- Summary statistics of datasets
- Dataset source links and descriptions