

I. INTRODUCTION

Climate change, driven by human activities such as burning fossil fuels and deforestation, has led to a significant rise in global temperatures. This warming causes melting ice caps, rising sea levels, and more frequent extreme weather events. The year 2023 was the warmest year since global records began in 1850 at 1.18°C above the 20th century average of 13.9°C<sup>1</sup>. The 10 warmest years in the 174-year record have all occurred during the last decade (2014–2023). The impacts are widespread, affecting ecosystems, human health, agriculture, and water resources. Despite the overwhelming scientific consensus on climate change, some skeptics persist<sup>2</sup>, questioning the evidence and downplaying the urgency. Creating awareness and convincing skeptics is crucial for fostering the collective action needed to mitigate its effects. In this project, we expanded upon a visualization of global temperature anomalies published by the National Oceanic and Atmospheric Administration<sup>1</sup> (Figure 1). While the original plot effectively summarizes the data, we believe there are several areas where it can be enhanced.

II. ORIGINAL VISUALIZATION

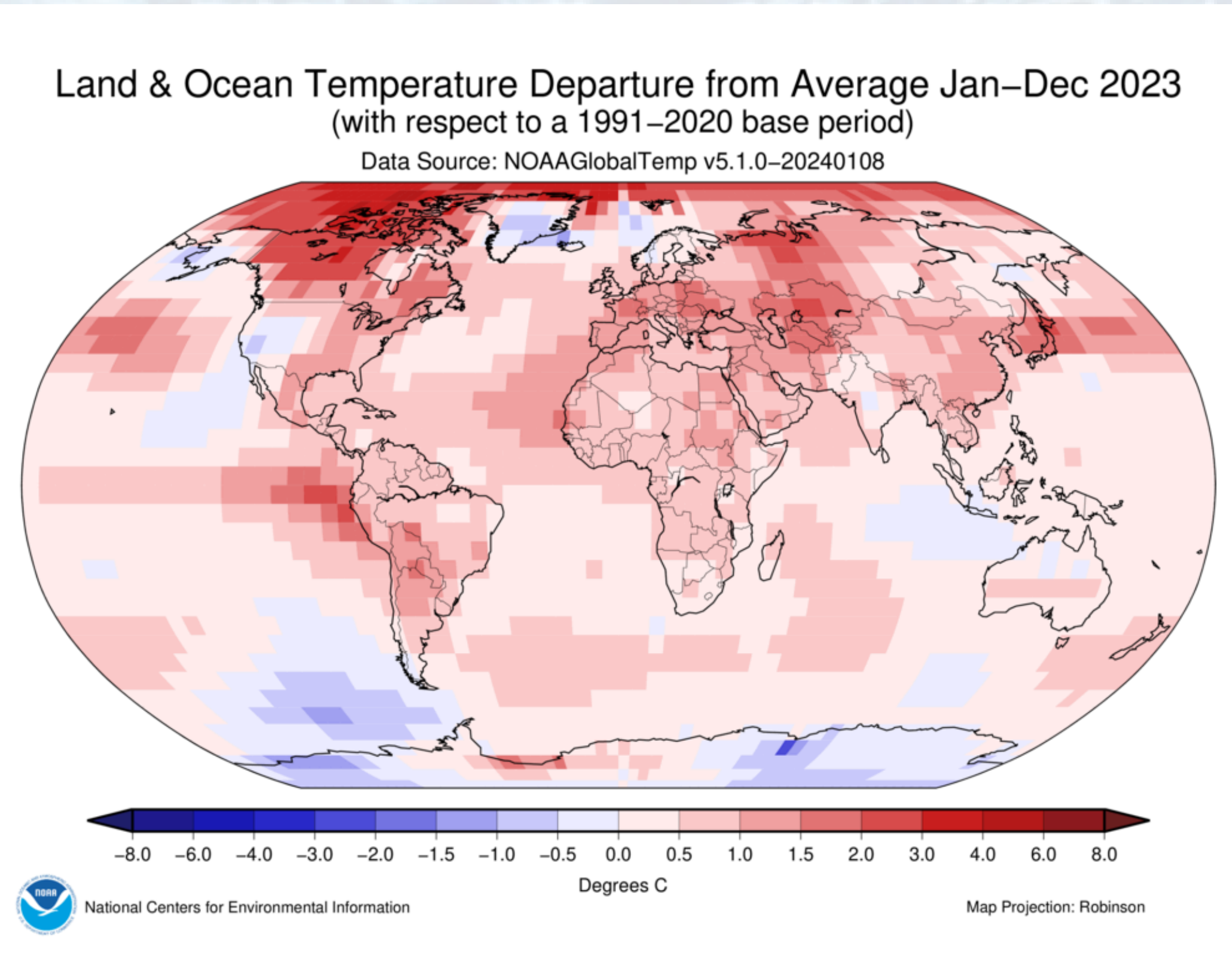


Figure 1: Land and Sea Surface Temperature Deviations in 2023 from the 1991-2020 Average Temperature of 14.4°C, published by the NOAA.

III. CRITICAL ASSESSMENT OF THE ORIGINAL VISUALIZATION

1. Comparison to Baseline: The graph shows anomalies relative to a baseline, but it does not specify what this baseline is.

2. Interactivity: The visualization lacks interactive features that would allow users to explore the data further, such as hovering over data points to see exact values and region.
3. Grid and Colour Legend: The grid and colour legend is rather coarse, which does not allow viewers to distinguish between closer temperature differences and close regions.

IV. SUGGESTED IMPROVEMENTS

1. Baseline Information: Clearly indicate the baseline temperature to provide a reference point for interpreting the data.
2. Interactive Features: Implement interactive elements that allow users to explore the data in more detail, such as tooltips and filters.
3. More Granular Grid and Colour Legend: Use a smaller grid size and more granular colour scale to better differentiate between small temperature anomalies in close regions.
4. Dynamic Range Slider: A dynamic range slider will be added, allowing users to zoom into specific periods for detailed analysis or display a timelapse of temperature changes from 1930 to 2023.

V. IMPLEMENTATION

- i. Data

The gridded surface air temperature anomaly data was obtained from NASA<sup>3</sup>. The data is in NetCDF format and contains selected series on a regular 2°× 2° grid.
- ii. Software

We used the Quarto publication framework and the R programming language, along with the following third-party packages:

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ncdf4: Reads scientific data (NetCDF format)

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reshape2: Reshapes data (wide to long, etc.)

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plotly: Creates interactive visualizations (charts, maps)

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dplyr: Manipulates data (filter, select, etc.)

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sf: Works with spatial data (Shapefiles)

•

rnatualearth: Provides pre-made geographic datasets (maps)
- iii. Workflow

VI. IMPROVED VISUALIZATION

VII. FURTHER IMPROVEMENTS

The visualization can be enhanced by showing additional data, such as sea ice cover or atmospheric CO<sub>2</sub> concentrations. This would illustrate how these factors relate to climate change and provide a more comprehensive view of the issue.

VIII. CONCLUSION

In summary, several key enhancements were made to the global temperature anomalies graph to improve its clarity, accessibility, and interactivity. The baseline temperature was clearly indicated to provide a reference point for interpreting the data. Interactive features such as tooltips and filters, along with a dynamic range slider, were introduced to allow users to explore the data in more detail and focus on specific periods. These improvements make the graph a more effective tool for communicating the reality and urgency of climate change.

IX. REFERENCES

1. NOAA
2. World Economic Forum
3. Land-Ocean Temperature Index, ERSSTv5, 1200km smoothing, NASA