Accessing Global Precipitation Data and Analyzing Total Precipitation Trends over 40 years

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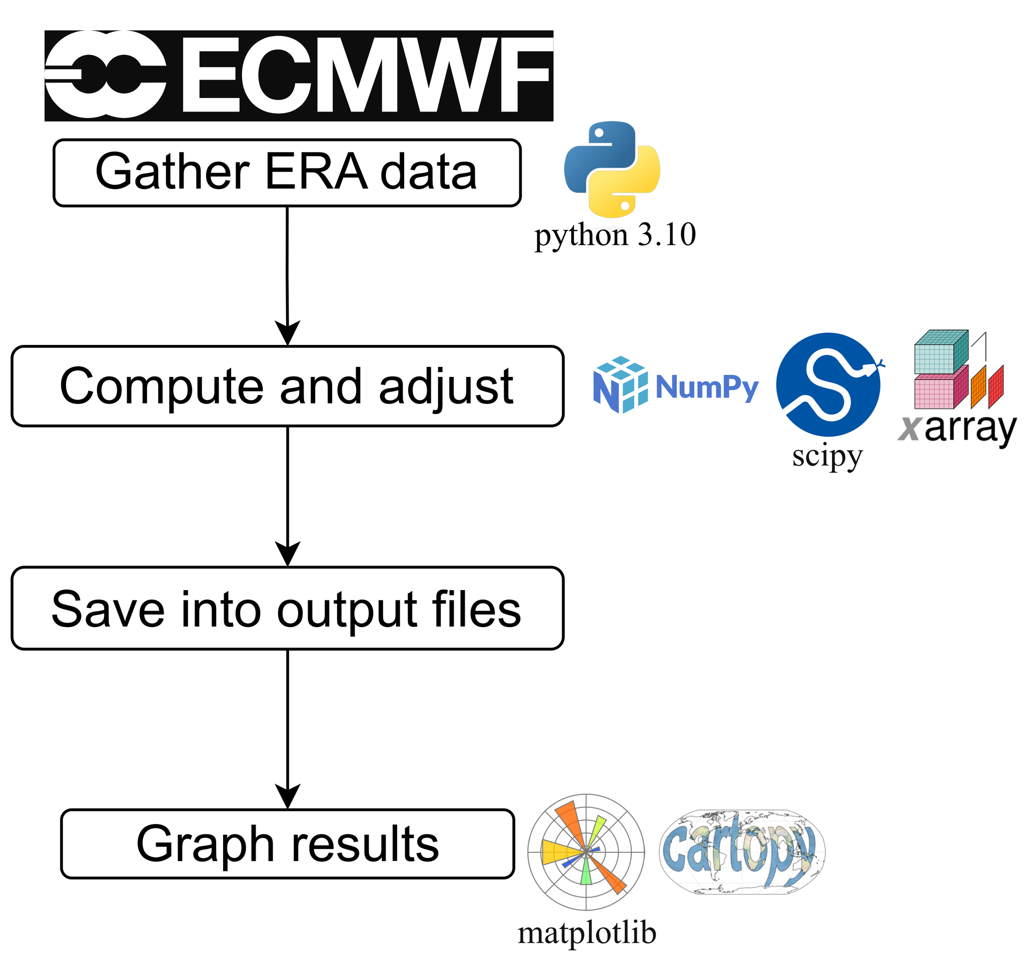
Equatorial regions show greatest changes

Abstract
Precipitation is an integral part of the world's climate. One state-of-the-art extensive dataset is the European Centre for Medium-Range Weather Forecasting (ECMWF) Interim Re-analysis (ERA). Using linear regression, we characterize the precipitation trends globally over 34 years. We find that equatorial regions show the greatest change in precipitation.

Introduction
Over recent years, many places have experienced severe droughts and torrential rains. This motivated our study to characterize the trends in precipitation over the past 34 years. We use the ERA for this purpose. The ERA spans 40 years but only 1984-2017, i.e., 34 years, were used in our analysis. Precipitation was accumulated every 3 hours over each day. To analyze these data, we retrieve it in the netCDF file format, which is the standard for multidimensional data in the atmospheric sciences. We then apply linear regression to each location to ascertain how the precipitation has been changing globally.

Methods
We use python since it has data analysis and graphing libraries. From python, matplotlib and cartopy are the libraries best suited for our purpose. We need xarray to handle reading and writing netCDF files. numpy is used for speeding up calculations. The last library we use is scipy for linear regression. Below is a flowchart showing how these libraries work together.



Implementation
First, we make a result array organized by year, longitude, and latitude. For each year, we get all of the files in the year and then open them as one dataset. We then unpack the values with xarray. We compute the sum of each year and then set the corresponding value in the result array. Next, we create a slope and intercept array organized by longitude and latitude. For each longitude and latitude, we take the 34 years, linearly regress them, and store them in their respective output arrays.

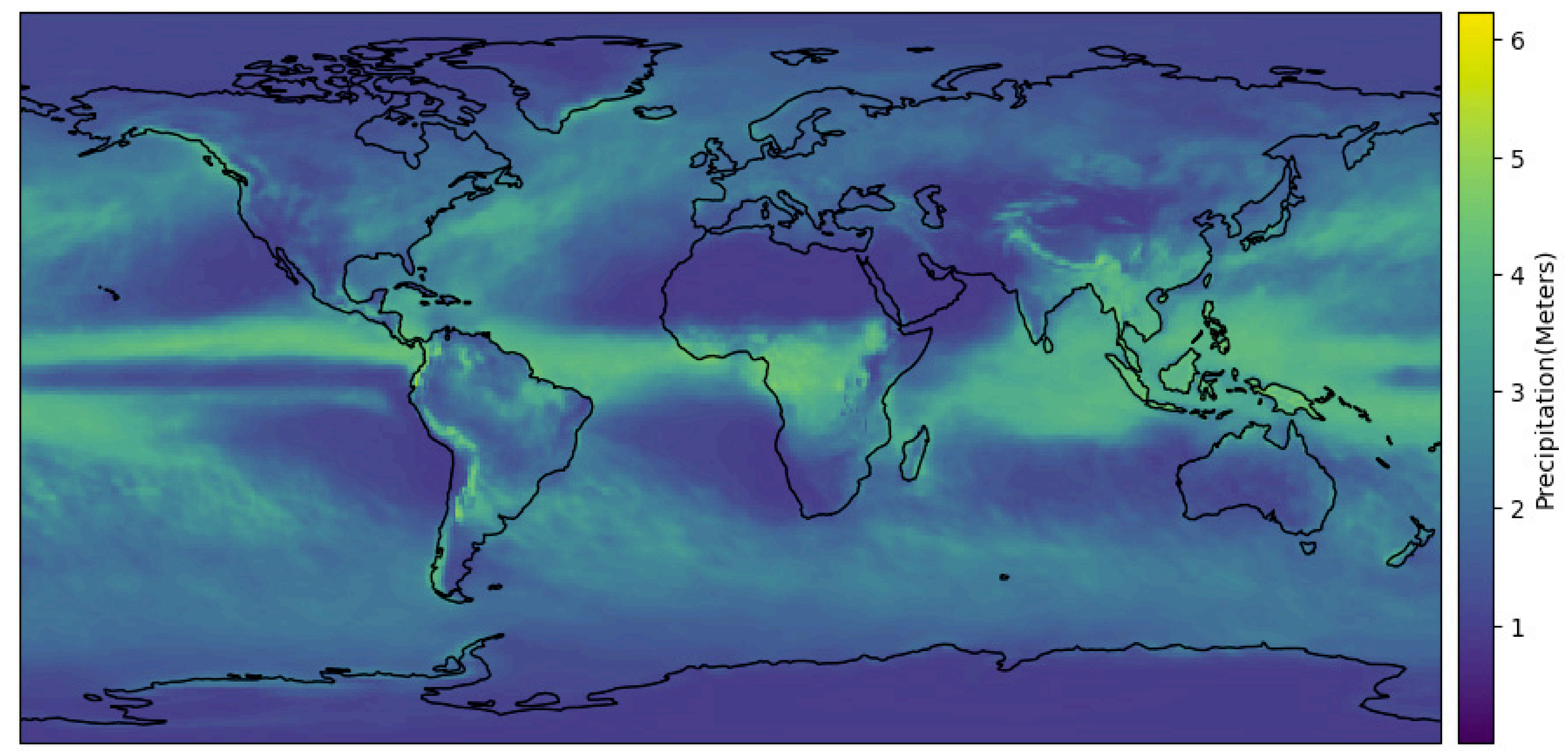


Figure 1. Total *precipitation (meters) in 1984.*

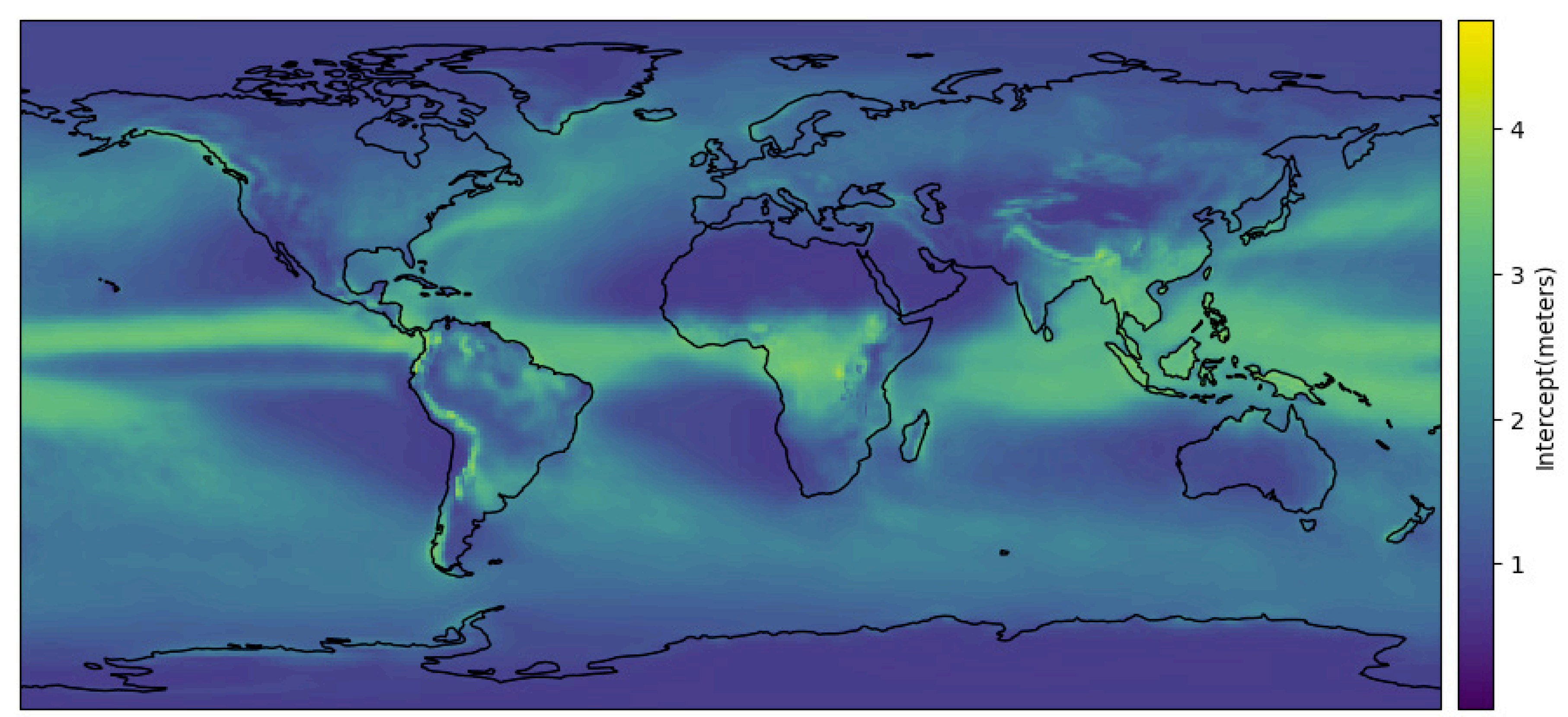


Figure 2. *Precipitation intercept (meters) from linear regression over 34 years.*

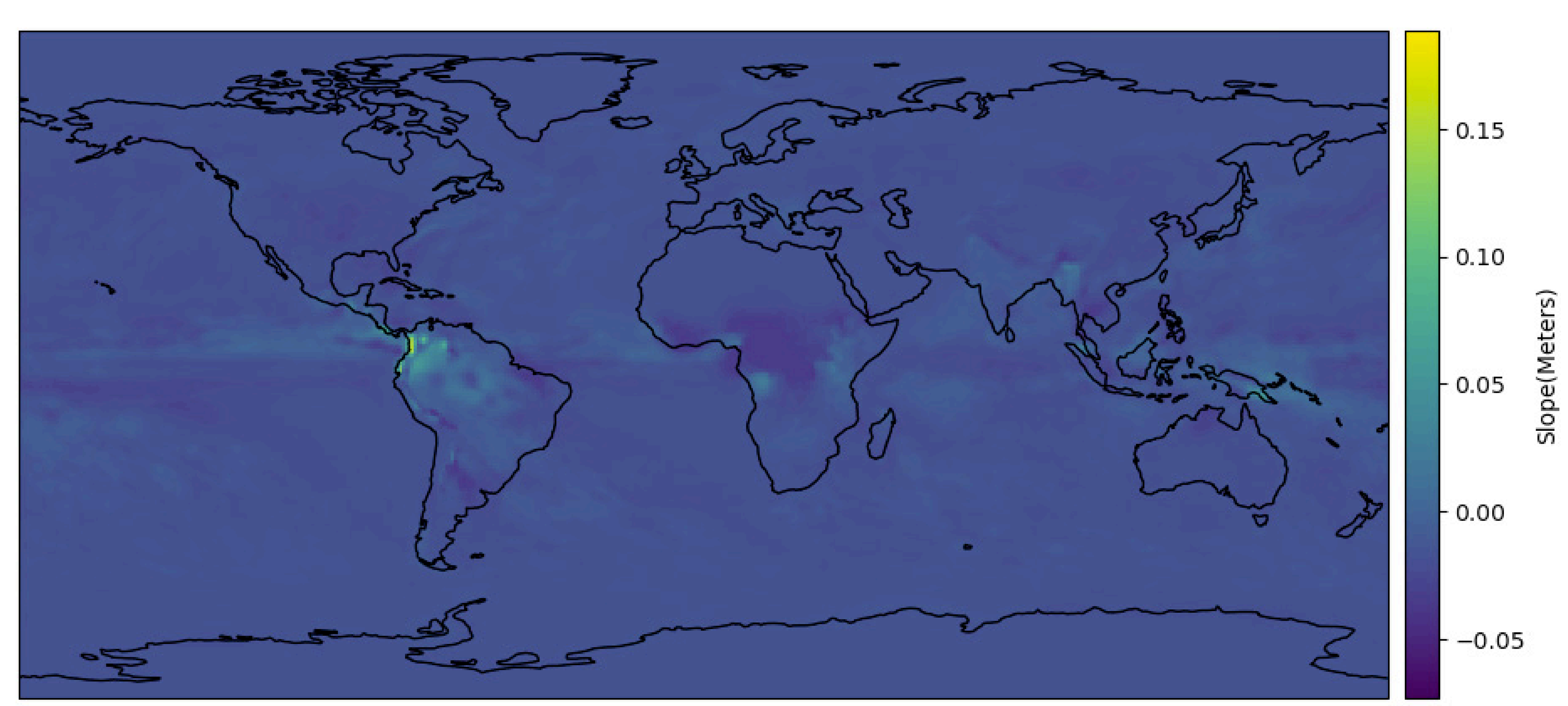


Figure 3. *Rate of change in precipitation (meters per year) over 34 years.*

All Charts, Code, and Poster

Discussion
In Figure 1, high values of precipitation in 1984 are evident along the inter tropical convergence zone (ITCZ) near the equator. Therefore, the equatorial regions have high precipitation. Subtropical high pressure belts explain why areas north and south of the equator don't get as much precipitation. Figure 2 of the intercepts captures the precipitation patterns in Figure 1, as it should. Inspecting Figure 3, we find that the most significant changes in precipitation occur in the equatorial regions.

Conclusions
We find that the equatorial regions have both the highest precipitation amounts and changes. This affects climate, influencing global temperatures, climate change, and natural disasters. In the future, we will investigate in detail precipitation changes across the mid-latitudes and their impacts on regional climate.

Partially related works
The World Meteorological Organization (WMO) leads much of the world in addressing climate change. Author 1 wrote 2 programs that retrieve the latest weather data from all capitals around the world. One is more technical while the other is more high level. They use wget and pandas to produce CSV output files. They're a great introduction to anybody looking to learn pandas and contain in depth explanations for every line of code.

Acknowledgements
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