CS 530 Introduction to Scientific Visualization
Spring 2023 Rashmi Phatak, Chirayu Garg Project Report

Dataset description

We have used multiple datasets:

1. Land Surface Tempearture[Day]:
   https://neo.gsfc.nasa.gov/view.php?datasetId=MOD_LSTD_M
   This map shows the temperature of Earth's lands during the daytime. We have used the data set for every year from 2000 to 2022. We have used the data set for December for every year.

2. Vegetation Index
   https://neo.gsfc.nasa.gov/view.php?datasetId=MOD_NDVI_M
   These vegetation index maps show where and how much green leaf vegetation was growing for the time period shown. We have used the data set for every year from 2000 till 2022. We have used the data set for December for every year.

3. Rainfall
   https://neo.gsfc.nasa.gov/view.php?datasetId=GPM_3IMERGM
   The data show where and how much precipitation fell around the world on the dates shown and how rain and snow move around the planet. The data are from NASA's Global Precipitation Measurement (GPM) mission. We have used the data set for every year from 2000 till 2022. We have used the data set for August for every year.

4. Elevation
   This data is from HW 1. It has the elevation details for the surface of the earth. We use this to visualize the elevation features on the surface of the earth.

Problem Statement

The objective of this project is to visualize different parameters that affect the surface of the earth. We will be looking into the surface temperatures of the land, rainfall, vegetation, and other factors of interest. We will then try to find if there exists a correlation between these factors. We are also trying to see the change in surface temperature and vegetation over a period of time. This will help us in understanding the effect of climate change on the environment.

Methodology

1. Finding datasets that correspond to our problem statement.
   The datasets were collected from https://neo.gsfc.nasa.gov.
2. Explore the data using Paraview and find the important features from the data. Clip the non-essential parts from the data and extract only the essential features.
3. Ensuring that the data sets are in a suitable format. Converting the datasets into the required format.
4. Convert the GeoTIFF data to vti format. A script was needed to be written for the conversion.
5. Understanding the dataset and identifying the data points of interest.
6. Using an appropriate vtk reader to read in the data set and then use the read data to render the features such as temperature, rainfall, vegetation, etc. onto a map.
7. Map surface temperature and vegetation on a sphere.
8. After understanding the rainfall VTI file, represent this data as iso contours.
9. Convert coordinate system data to spherical data since the data is designed for a 2D Coordinate system,
10. Provide an interactive GUI to toggle between different times of year.
11. Provide a toggle to change from land surface temperatures to vegetation.
12. Provide a toggle to enable and disable rainfall isocontours.
13. Provide a toggle disable enable elevation.
14. Determine methods such as the use of iso-counters to find a correlation between interesting features such as vegetation and temperature and rainfall and elevation.

Results

We were able to visualize the different data sets to get outputs of rain data on the globe. We also have the data set of the temperature and the vegetation index and hence we try to correlate the rain data with the temperature and the vegetation index. We also have a slider for year and hence we also seek to understand how the temperature, vegetation and rainfall has changed over the last 20 years.

We have included a few images from our project below. Our code can be found on GitHub to run and have a full view of the render.

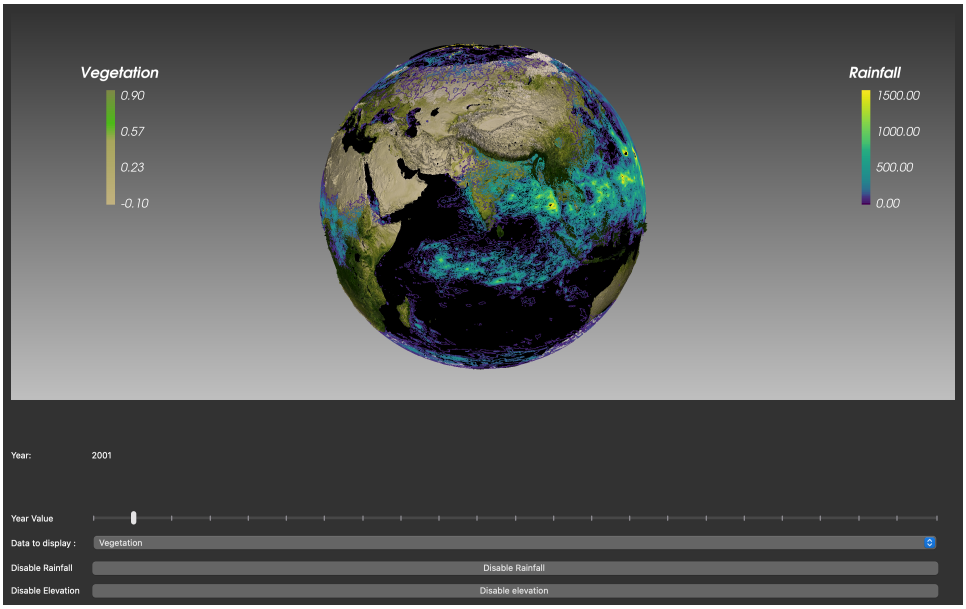

Figure 1: 2001 Vegetation Index

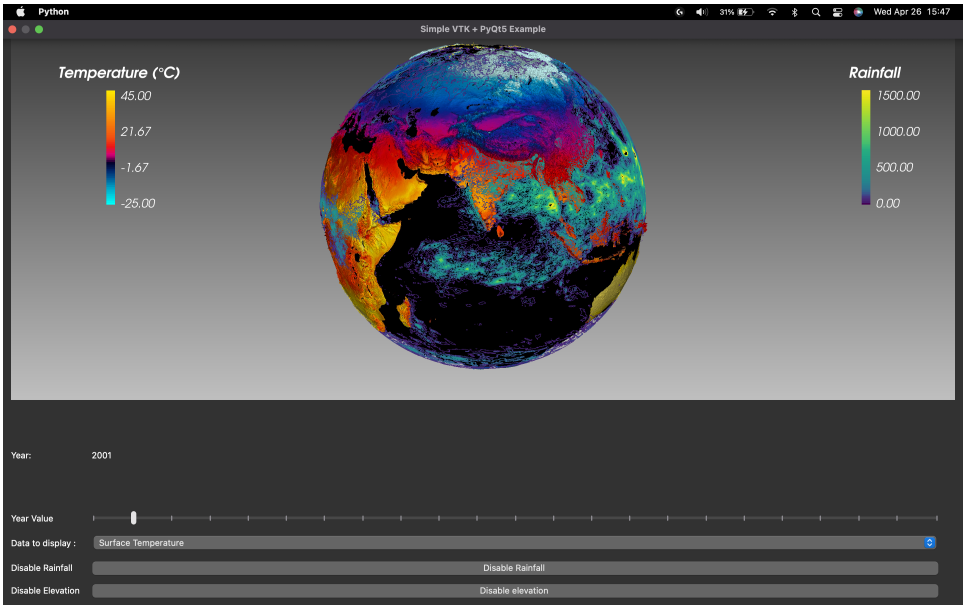

Figure 2: 2001 Temperature

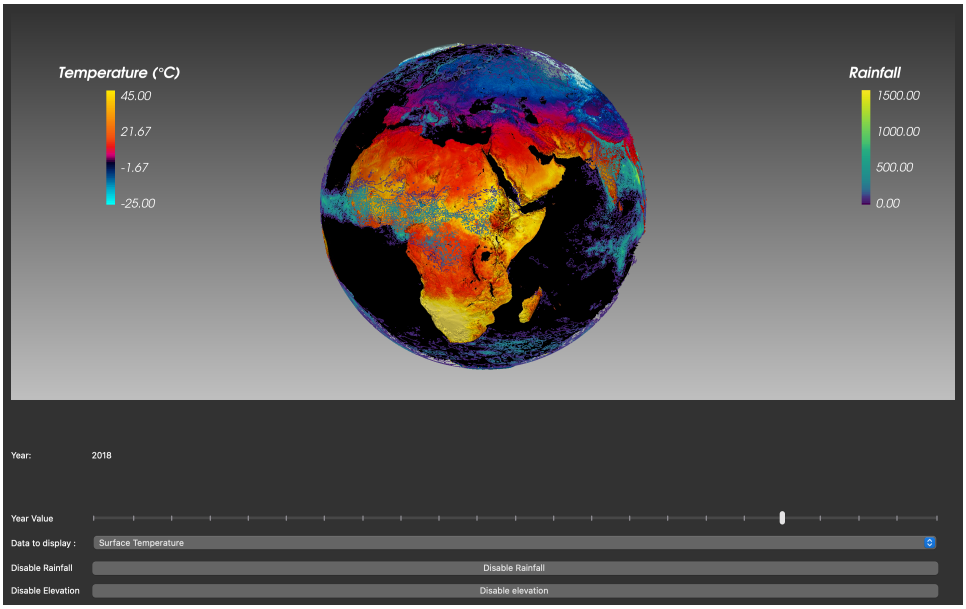

Figure 3: 2018 Temperature Africa

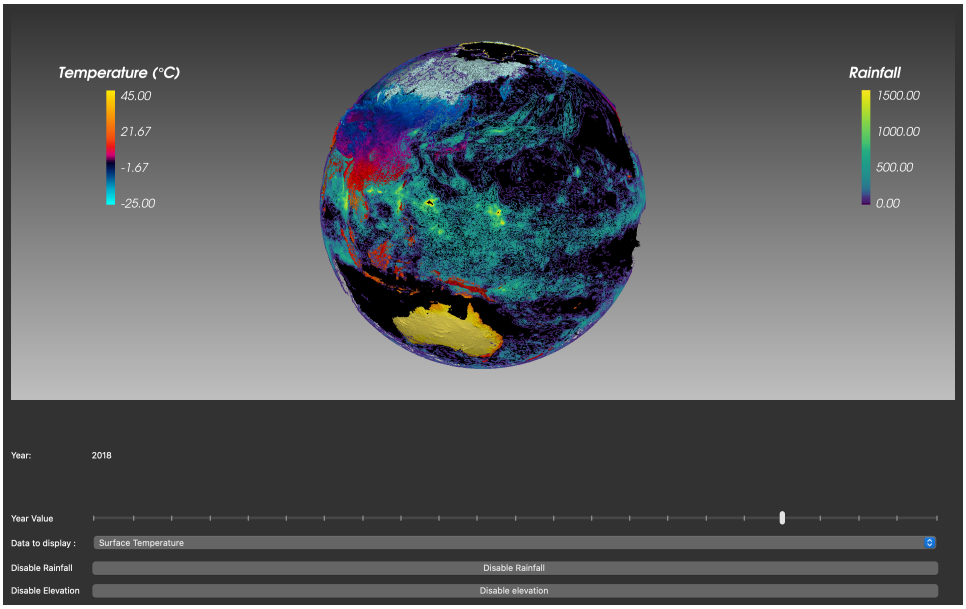

Figure 4: 2018 Temperature Pacific

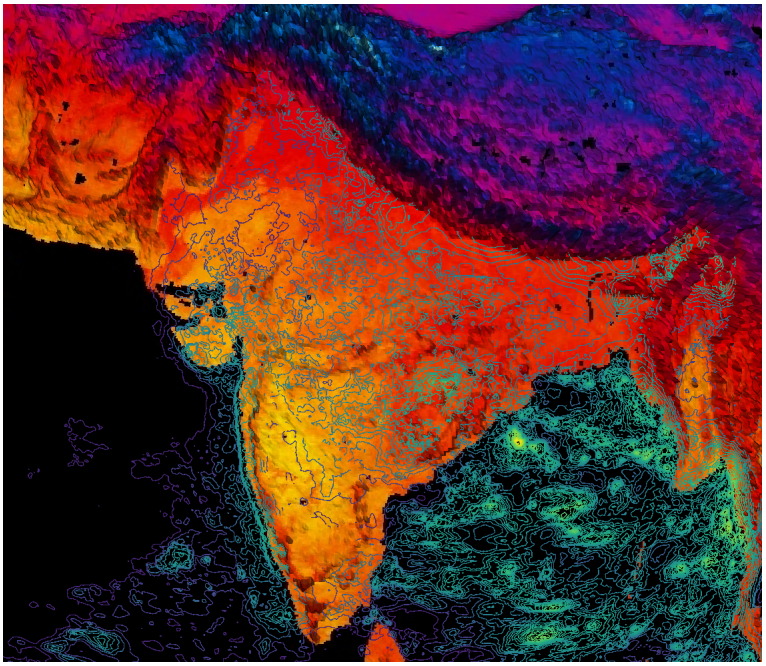

Figure 5: 2003 India Temperature

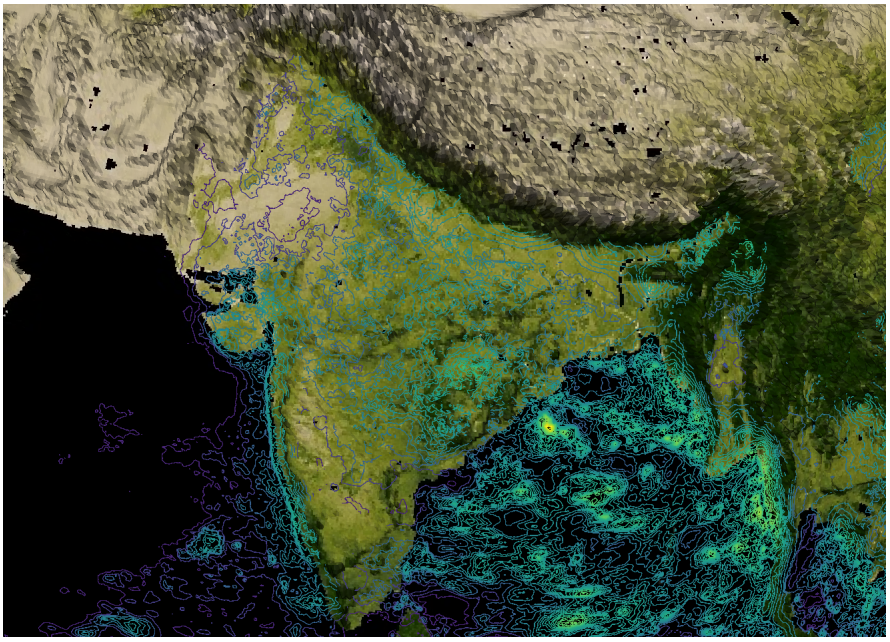

Figure 6: 2003 India Vegetation Index

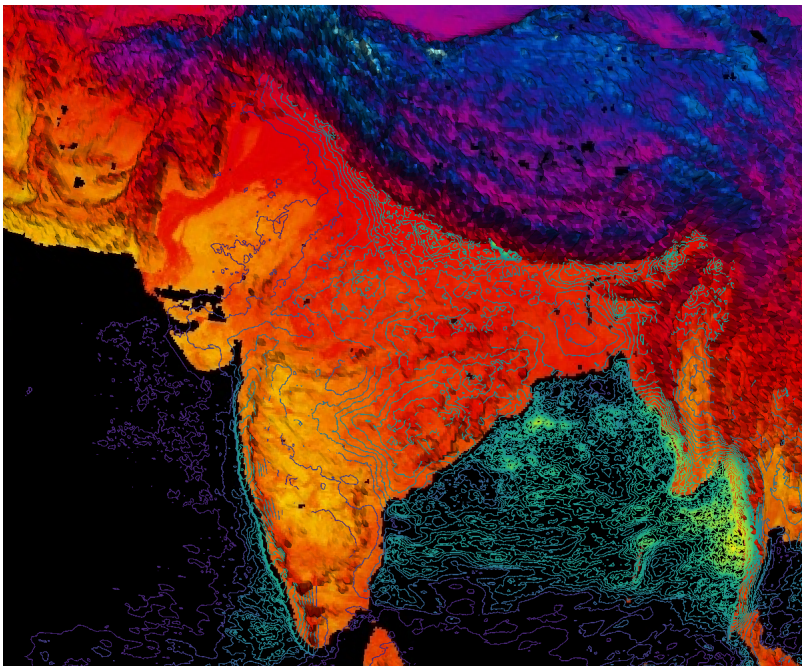

Figure 7: 2018 India Temperature

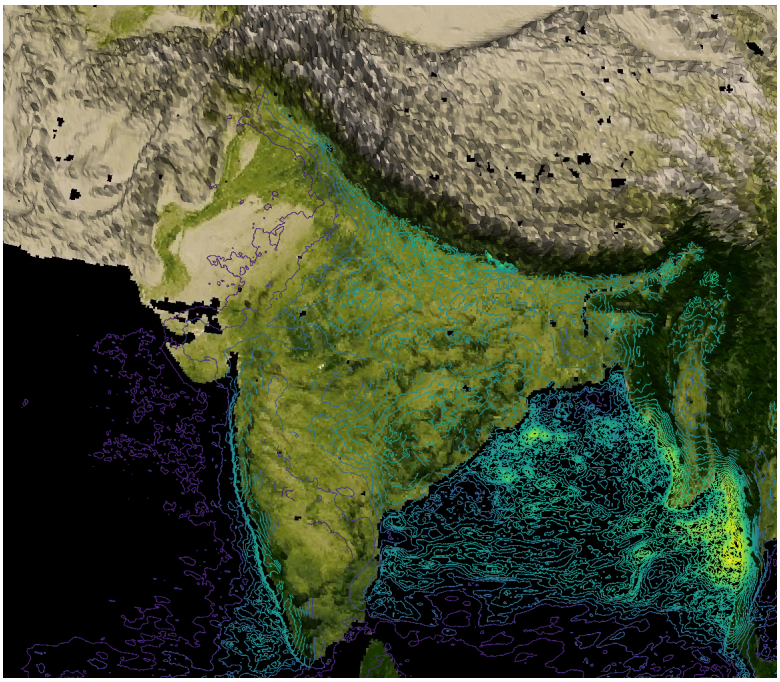

Figure 8: 2018 India Vegetation

Discussion

Correlation

Evaluating regions of the earth like coastal areas, a specific country or rain shadow areas will provide a better insight into the correlation of different parameters that we have. Following are the few key observations:

1. High vegetation can be seen in areas with greater rainfall. Areas with rainfall of 1500 have a vegetation index of 0.9. This can be seen around areas like the northern side of Australia, and east India.
2. Coastal areas receive greater rainfall as compared to land. We can see this along the Indian Ocean region where the density of isocontours is high.
3. Areas with high elevation have less temperature. This can be clearly seen around the Himalayan region.
4. As the rainfall decreases, the temperature also decreases. This can be observed near the Sahara desert region.
5. It can also be observed that, as we change the years, the vegetation in some areas is increasing (eg. India) while in some areas the vegetation is decreasing. This can be due to the change in the amount of rainfall received and the effect of climate change.
6. Similarly, the surface temperature increases as the years are changed from 2000 to 2022. The surface temperature decreases as we go towards the northern hemisphere and southern hemisphere while it is high along the equator.

Problems Faced

The first problem we ran into was understanding and interpreting the dataset. Since we had always used .vti or .vtk files in class, understanding the TIFF files proved to be difficult. The data files we got from NASA were in TIFF(raster) and TIFF(floating) format. This led us to first read and convert the files to .vti format so we can move forward. However, the files were in a different endianness and hence we had to revert the endianness also.

The second problem was to get understand which format of the file - raster or floating point to use. After printing out the point data and analysing it we realized that we will need to use TIFF(floating) file.

Since we were visualizing the data on a globe and our data was for a 2D map, we had to convert the data points point by point o map it to the Globe. Since we had the data points by latitude and longitude, we were able to do so by converting the 2D points to corresponding 3D points using the radius of our globe

Future Scope

The project has a lot of future scope. I think incorporating data like Monsoon winds is something that we wished we could have done with this project as that will give us a better correlation between the rainfall, elevation and the winds. NASA has a lot of data corresponding to the atmosphere, temperature, life and other important aspects of life on Earth. This project can further be developed as a means to visualize these aspects to find the correlation between these aspects, to analyze different parameters that affect the earth to identify patterns which can help in the prediction of future anomalies using other scientific data and knowledge.