

**Team Name: Team 3**

**Team members:** Daniel Brunell, Brett Nielsen, Katelynn Call

## Final Project

### Overview and goals of your project.

This project is meant to show how weather has changed over time and how events potentially affect each other. We wanted to find out how climate has changed over time globally, and how a change in one area may cause similar or opposite changes in other places. We also wanted to see if there are specific trends in locations where they may have a specific weather abnormality in similar time frames.

In order to accomplish this, we created a project that allows the user to compare weather data at different time frames. To do this, we planned to create a Graphical User Interface (GUI). The GUI would have options for different weather metrics and timeframes.

### Background. What books, papers and websites did you learn from?

We learned from different websites that taught about different libraries needed. The following list contains different resources used to learn topics needed for this project:

- Cartopy - <https://scitools.org.uk/cartopy/docs/latest/>
- Xarray - <http://xarray.pydata.org/en/stable/index.html>
- ecCodes - <https://confluence.ecmwf.int/display/ECC/ecCodes+Home>
- PySimpleGUI - <https://realpython.com/pysimplegui-python/>
- Climate Data - <https://cds.climate.copernicus.eu/>

### Provide a description of your project. What data did you use? What scientific questions did you answer? Describe any new questions that arose throughout the project.

Our project aimed to provide meaningful visualizations of vegetation levels around the globe. Our goal was to provide an interface that allowed users to compare different data points at the same time. This allows for comparison of vegetation levels with soil temperature and soil water level. We also aimed to provide visualizations of different time frames to show how these three categories change over time.

We used weather data provided by Copernicus Weather Data Store (<https://cds.climate.copernicus.eu/>). This data was in the format of GRIB. The GRIB files contain data for the three categories chosen over time and by latitude and longitude. We

aimed to answer scientific questions concerning climate change by observing the change of vegetation, soil temperature, and soil water level.

### **Discuss the implementation details of your project.**

To implement this project, we first built a simple Jupyter notebook with visualizations using matplotlib. We started by using an API provided by Copernicus Weather Data Store to download the data.

We initially had a bit of difficulty figuring out how to display the GRIB data for our project. We had difficulty integrating it with VTK as we had initially planned, so we decided that it may be better to find another way to show the data. A library called Xarray provided the needed functionality to read and manipulate GRIB data. Xarray also provided functions that create visualizations with matplotlib. In order to create visualizations with a map, we used the Cartopy library.

After we created a Jupyter notebook, we created a GUI that allowed for a simple interface to interact with the data. We used PySimpleGUI to create the GUI. The interface gives the user the ability to choose the two data points that they want to compare and at what year. They could then click a button that would generate the visualizations.

Along with the programs created for this project, we also created visualizations in Paraview. We once again had difficulty with the GRIB file type of the data, but we were ultimately able to get a NetCDF version of the data from the source for each individual area of data which we were able to use with Paraview. These visualizations were beneficial in understanding the data we were working with. We incorporated these visualizations in our GUI by allowing the user to display screenshots from our Paraview visualizations.

### **Outline what you learned from doing this project.**

This project taught us a lot about visualizations of weather data. We had to learn how to manipulate GRIB data and create a visualization with a map. Learning how to use Cartopy was necessary to give meaning to the visualizations. We also learned how to build simple user interfaces in Python. We also learned the importance of knowing how to create visualizations of large datasets. Weather data is extremely large in size and visualizations take a long time to generate.

On the less technical side, we learned a bit about deciding when to keep going with an idea, and when to move on and try something else. This was important in figuring out how to display our data for the project. While VTK was something we were more comfortable in using because of our experience with it in class, after trying a number of

ideas we were still unable to display the data well, and decided that finding something else to display the data would ultimately be a more beneficial use of our time.

**If you have not accomplished all the goals of your project, or if you have exceeded them, describe how the finished project differs from the description in your initial project plan.**

We accomplished our goal of creating meaningful visualizations of weather data in Python. We originally proposed using VTK for our visualizations. We instead decided to use Cartopy in place of VTK because this library allowed for us to provide visualizations over a map.

**Evaluate your project: how successful do you think it was? What are the strengths and weaknesses of your project?**

We believe that we completed a successful project. We provided a useful interface to compare weather data and see changes over time. One weakness of our project is that we did not provide the ability to interact with the data once the visualizations were created. Another weakness in our project is that our GUI is more difficult to run on Windows OS and requires the use of Anaconda in order to install everything needed. The libraries needed to process GRIB files do not have the ability to run directly on Windows.

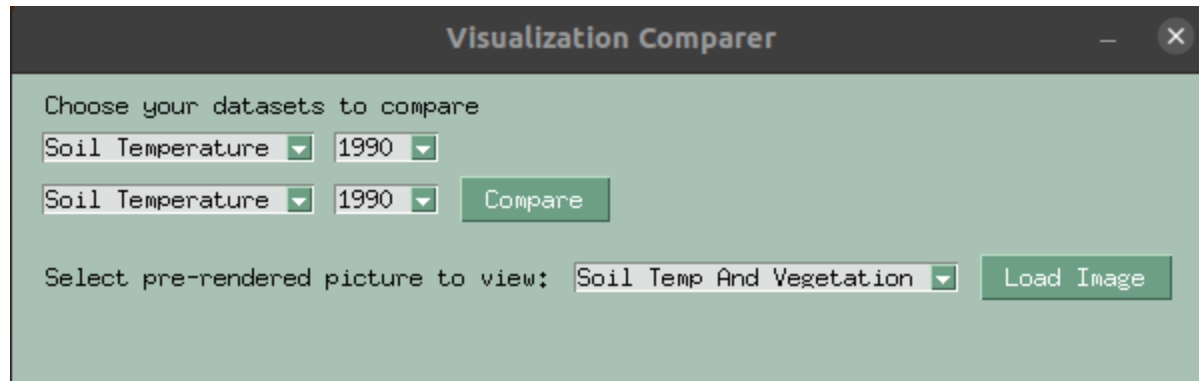
Some of the strengths of our project include being able to view and pull up the data side by side for multiple types of data and years for easy comparison. Since we are able to see a flattened view of the world as well through using Cartopy, we are able to easily look between the data for a side by side comparison.

**Describe how you distributed the work among the members of your team.**

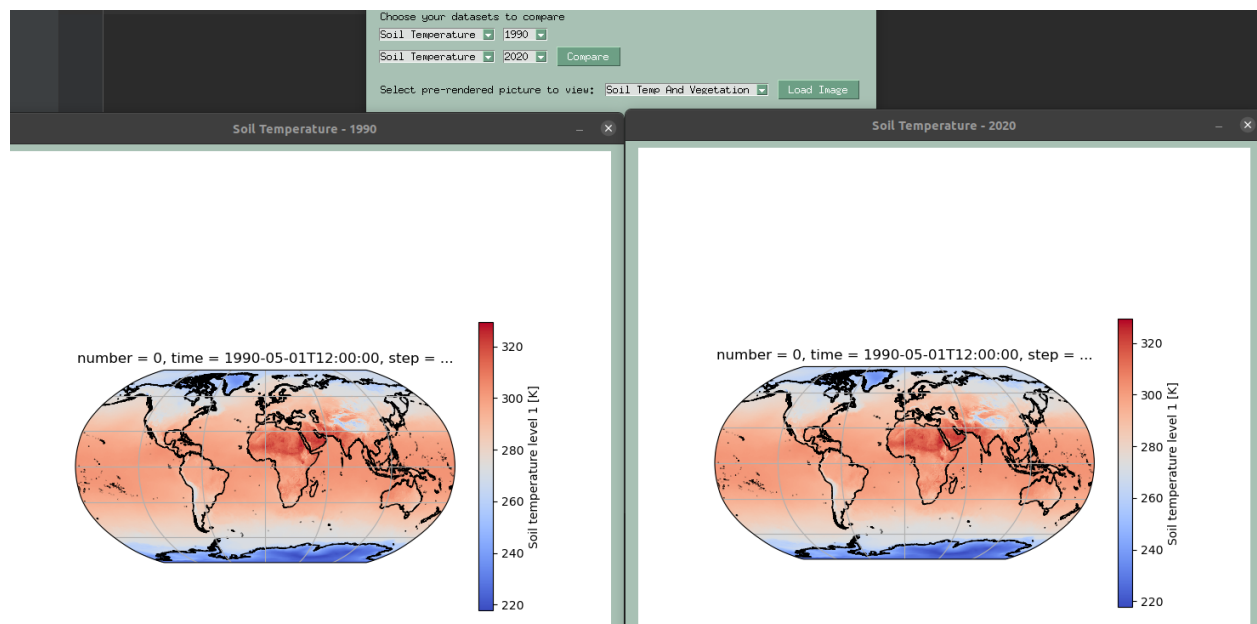
All work was distributed evenly between team members. Brett worked mostly with Cartopy and turning the data into visualizations, Daniel worked on the GUI as well as some paraview visualizations, and Katelynn worked a lot on paraview visualizations as well as conda implementation. Every team member put forth equal effort in creating this project.

**Provide additional comments useful in evaluating your project.**

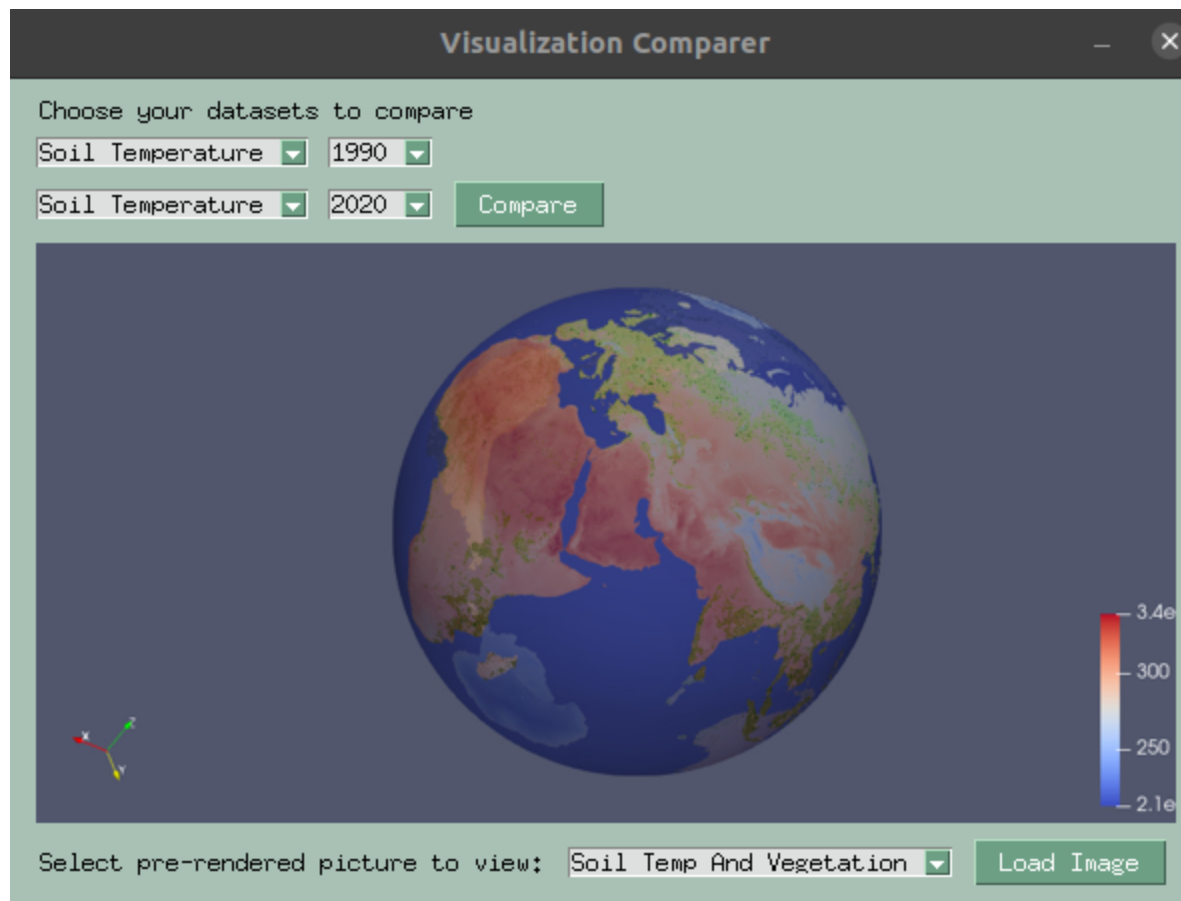
Below are screenshots of our project:



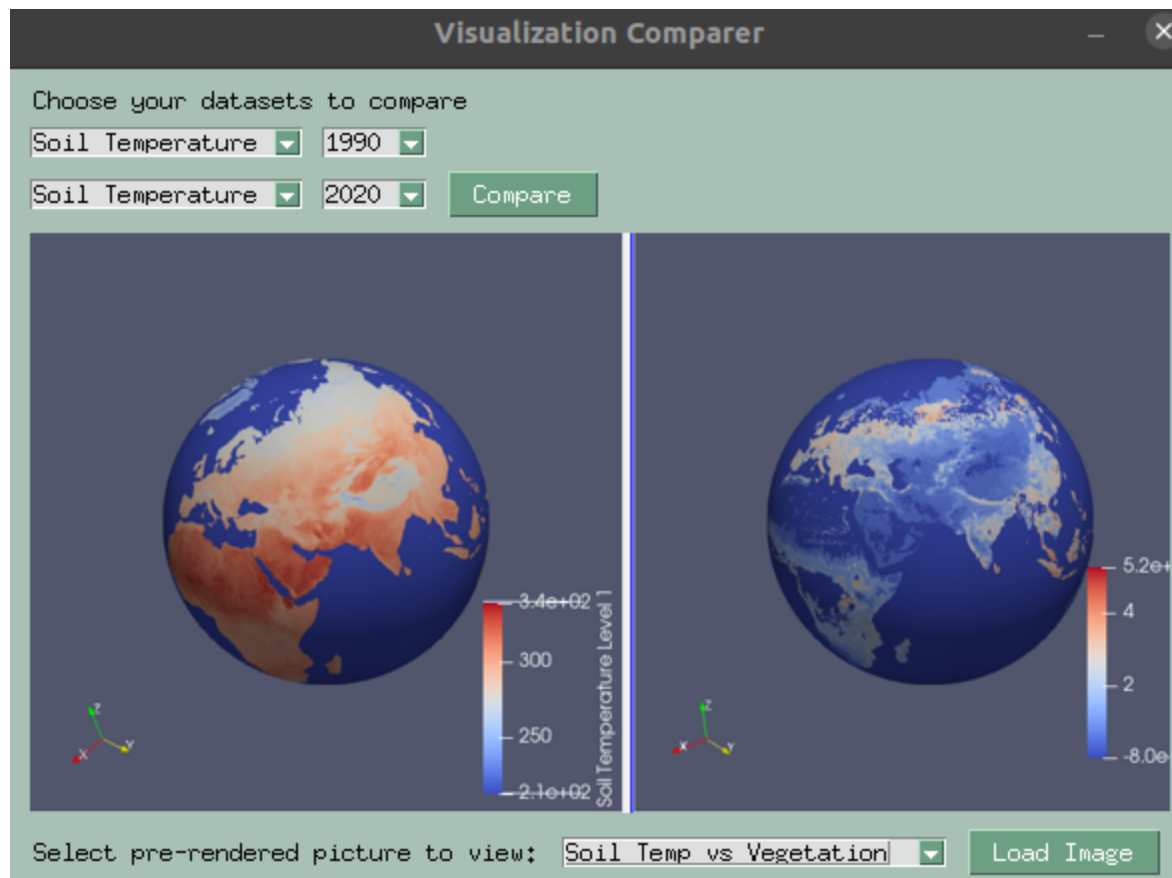
This screenshot is the starting page of our GUI. It presents different options for the user.



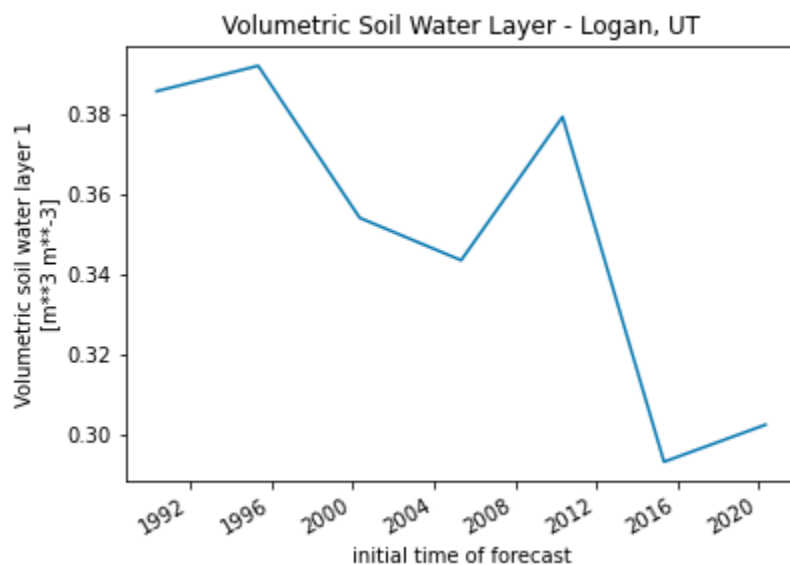
This screenshot shows the visualizations presented when doing a comparison.



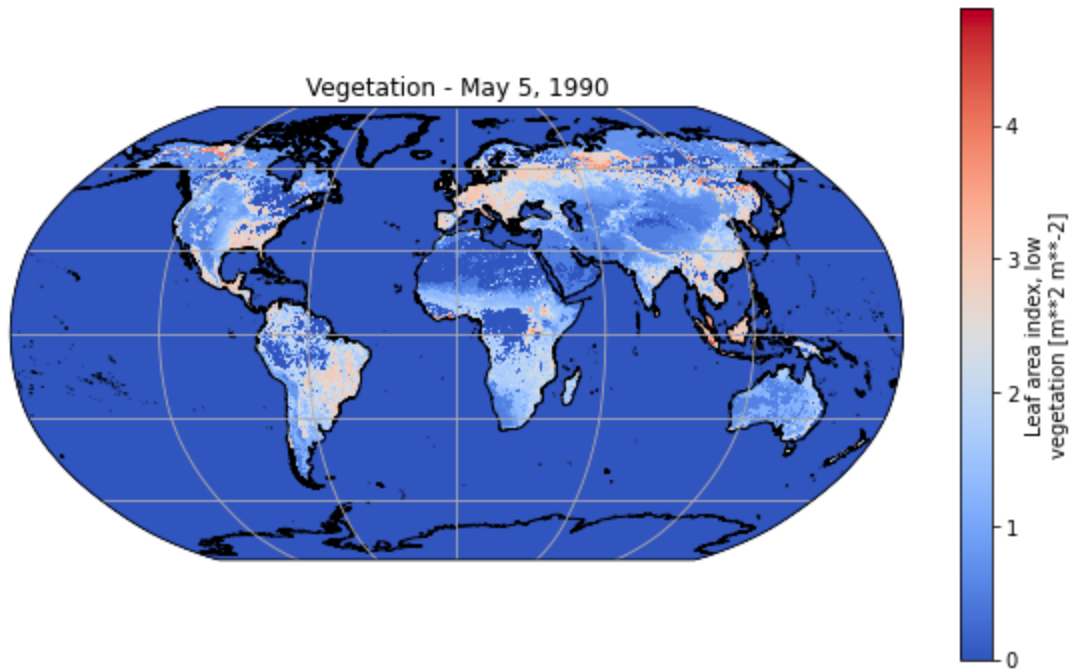
This is an example of a prerendered visualization from Paraview that is accessible from the GUI.



This is another example of a Paraview image that can be viewed in the GUI.



This is an example plot done in the Jupyter notebook when first starting the project. This shows soil water levels in Logan, Utah.



This image was generated in the Jupyter notebook using Cartopy.