CD 732: Data Visualization
Report for Datathon-1

Swasti Shreya Mishra (IMT2017043)
International Institute of
Information Technology Bangalore
Email: SwastiShreya.Mishra@iiitb.org

1. Introduction

We are given the data of India Ocean, generated by the ocean model MOM, run by Indian National Center for Ocean Information Services, INCOIS, Hyderabad. The data values are 5-day moving average of the following variables:

1) Sea Surface Salinity (SSS)
2) Sea Surface Temperature (SST)
3) Sea Surface Height Anomaly (SSHA)
4) Meridional current
5) Zonal current

Our main aim is to effectively visualize the above data to find interesting underlying patterns of the Indian Ocean. We would like to study the effect spatial and temporal patterns of Indian Ocean has on the monsoons of India. Since we have the data around the time of the Tsunami of December 2004, we will also look at the visualizations to infer the impact of the tsunami on the above mentioned variables.

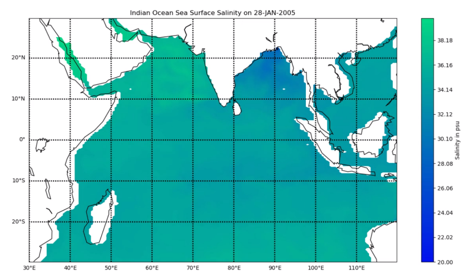

Figure 1. Indian Ocean Sea Surface Salinity

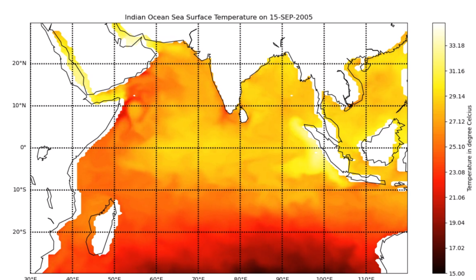

Figure 2. Indian Ocean Sea Surface Temperature

2. Methods

We have visualized all the data using *matplotlib* and have used additional matplotlib packages like *basemap* to visualize the world map and *manimation* for creating a movie of the visualized variables on an increasing time step basis.

2.1. Scalar Field Visualization

We use the *contourf()* function to generate the plots. The color mapping has been chosen to best reflect the information the data wants to portray. It varies for different variables as mentioned in the following subsections. The minimum and maximum value of the *colormaps* have been fixed by taking the minimum and maximum value of the corresponding variable across all data files. In all the plots the latitudes and longitudes have been plotted for better visualization of the data.

2.1.1. Sea Surface Salinity. Here, the data is visualized over a period of a 2 years. This includes the year when the Tsunami of 26 December 2004 occurred. The *colormap* chosen for this plot was the *Sequential (2) winter* colormap. This seemed to capture the information of the sea salinity the best to us, the value being sequential. An example is shown in figure 1.

2.1.2. Sea Surface Temperature. Here, the data is visualized over a period of a year. The *colormap* chosen for this plot was the *Sequential (2) hot* colormap. This is because it emulates the blackbody radiation from an object at increasing temperatures and therefore is a good colormap to visualize temperature based data. An example is shown in figure 2. But, another point to note over here is that, the white-colored portion of the land is not to be confused with the white value of the colormap. Since, it is already mentioned that the data is only being plotted for the ocean region, the assumption made appears to be sensible.

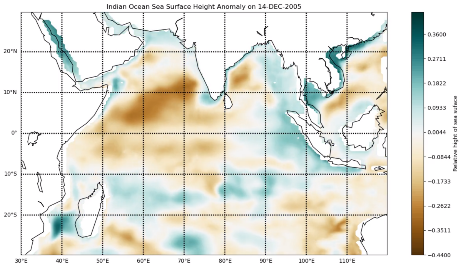

Figure 3. Indian Ocean Sea Surface Height Anomaly

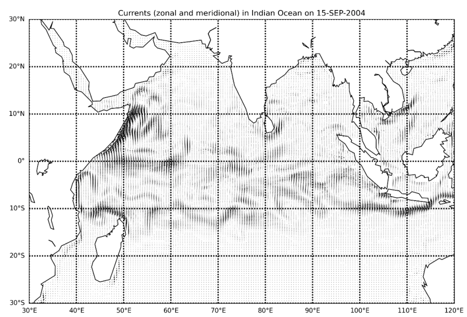

Figure 4. Current pattern in Indian Ocean

2.1.3. Sea Surface Height Anomaly. A sea surface height anomaly is the difference between the long-term average for different regions of the ocean compared to what is actually observed by satellites. We have visualized this data over a period of 2 years. Since, the average value is regarded as the zero value and anomaly is measured as either a positive or negative difference from this average value. We felt that the *diverging colormap* suited best for this variable. For the same reason, the range of *colorbar* has also been evenly distributed from (-0.44,0.44). An example is shown in figure 3. This variable also resembled to an elevation of sorts, but, after plotting it using *matplotlib mplot3d* the corresponding elevation map did not look informative enough. We felt that for an ocean, looking at one particular section of the elevation at a time might not be very useful.

2.2. Vector Field Visualization

We use the *quiver()* function to generate the plots. The data used over here is **meridional current** and **zonal current**. The zonal current value corresponds to the zonal current speed from east-to-west along the latitude. Whereas, the meridional current value corresponds to the meridional current speed from north-to-south along the longitude. After reading the values, they have been multiplied with -1 to make zonal and meridional current along x and y axis respectively. For better visualization of the currents, the quiver plots were plotted in the following ways:

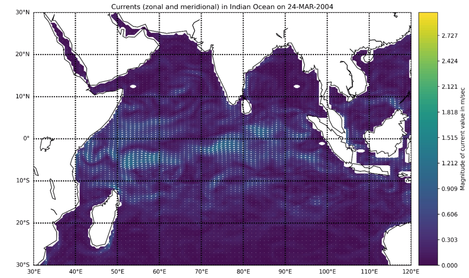

Figure 5. Current pattern with magnitude in Indian Ocean

- **Basic quiver plot:** Here the currents are visualized using arrows of the quiver plot with adjustment to the arrow size. This is done so that the arrows can be interpreted conveniently. The pattern of current is shown in figure 4.
- **Quiver + Contour plot:** Here the current is plotted using quiver arrows. The magnitude of the current at each point is plotted using the *contourf()* function. This plot helps us to explicitly visualize the magnitude of current at each point. An example is shown in figure 5.

3. Results

The visualized variables can be used to infer a lot of results. But, we focus more on the time around which the Tsunami of 24 December 2004 happened. We also look at the current and sea surface temperature patterns to see the seasonal variation it brings on India.

- Sea Surface Salinity: The Sea Surface Salinity appears to have increased a bit after the occurrence of tsunami. Even though the change is not drastic, it seems to remain high until January-February. This is also consistent with the inferences made in this paper [1].
- Sea Surface Temperature: The Sea Surface Temperature is closely linked with the current patterns visible over the Indian Ocean (The correlation between these two variables can be seen in this figure 8). This is due to the pressure differences cause by the temperature difference. This is further elaborated in the following point.
- Meridional and Zonal currents: The Indian subcontinent receives continuous and widespread rains due to the monsoon (meaning seasonal change of wind direction) during the months of June-September. The phenomena in summer takes place due to the cross hemispheric reversal of winds bringing in considerable amount of water vapour from the high pressure regions over the relatively colder Indian and Pacific oceans and the Arabian sea to the low pressure system over heated land mass areas [2]. Even the quiver plots can be seen to show this phenomena.

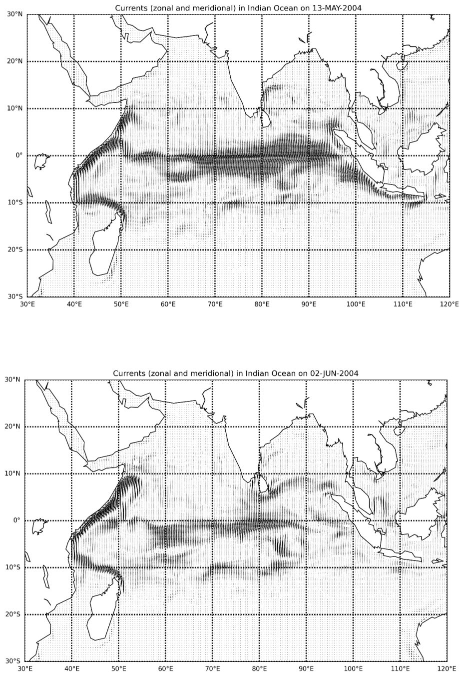

Figure 6. Advancement of monsoons over the Indian subcontinent

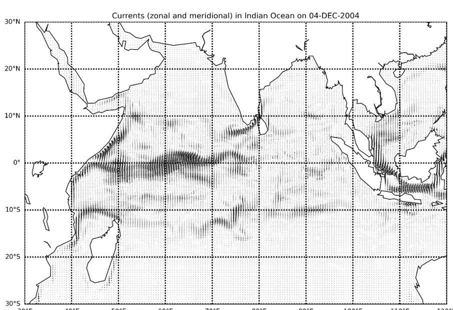

Figure 7. Return monsoon phenomena

The advancement of monsoons over the Indian subcontinent can be seen in this figure 6. The return monsoon over the winter can be observed in figure 7 over the southern part of India.

4. Conclusion

The possibilities of interpretations of the data visualized we have visualized is very large. We have only been able to look at a few of them but they provide us with a lot of information. Due to our limitation of knowledge and the time constraint we are only able to infer the results mentioned above. I would like to thank Prof. Jaya Nair for giving us the opportunity to work with this dataset as well

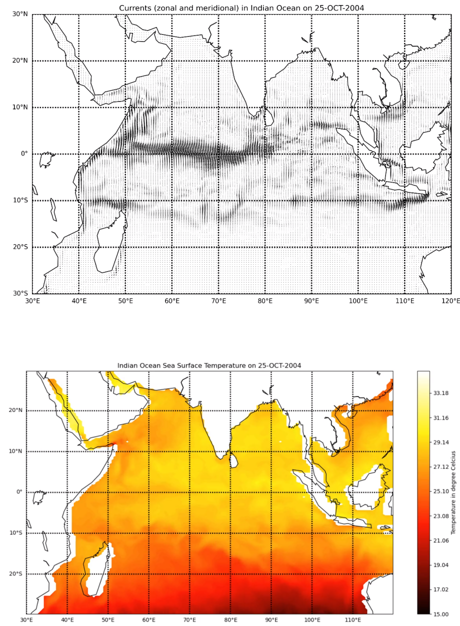

Figure 8. Correlation between Sea Surface Temperature and the sea currents

as teaching us the concepts that were needed to visualize and analyse it.

References

[1] Maged Marghany. Simulation of tsunami impact on sea surface salinity along banda aceh coastal waters, indonesia. In Maged Marghany, editor, *Advanced Geoscience Remote Sensing*, chapter 3. IntechOpen, Rijeka, 2014.

[2] S. C. Chakravarty. Sea surface temperature (sst) and the indian summer monsoon. In Emilson Pereira Leite, editor, *Scientific and Engineering Applications Using MATLAB*, chapter 3. IntechOpen, Rijeka, 2011.