DATATHON 1 : INDIAN OCEAN

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***Abstract*—Data visualizations for various ocean specific variables namely, sea surface salinity (SSS), sea surface temperature (SST), sea surface height anomaly (SSHA), and zonal and meridional currents.**
Through these visualizations we keep forward few changes observed in the above mentioned variables over the time frame of December 2003 to december 2005.

I. Introduction

The Indian Ocean is the third-largest of the world's oceanic divisions, covering 70,560,000 km2 (27,240,000 sq mi) or 19.8% of the water on Earth's surface.[5] It is bounded by Asia to the north, Africa to the west and Australia to the east. To the south it is bounded by the Southern Ocean or Antarctica, depending on the definition in use.[6] Along its core, the Indian Ocean has some large marginal or regional seas such as the Arabian Sea, the Laccadive Sea, the Somali Sea, Bay of Bengal, and the Andaman Sea.
At times the ocean shows very different unexpected results and events. At times it results in loss of a life and property like in the 2004 Indian Ocean Tsunami or the dequent cyclones along the coast of India.
Through visualizations we try to see if we can predict any of such events or if we can see the impact these events left behind.

II. Problem Statement

Given the 3 scalar field variables (SSS, SST, SSHA) generate visualizations using contour mapping, color mapping and elevation mapping.

For the given vector variables (zonal and meridional currents) generate visualizations for using quiver plots.

III. Data

The data has been computed of Indian Ocean from the ocean model MOM, run by the Indian Ocean National Center for Ocean Information Services, INCOIS, Hyderabad.

The data consists of 5 variables:

- Sea Surface Salinity (SSS)
- Sea Surface Temperature (SST)
- Sea Surface Height Anomaly (SSHA)
- Zonal currents
- Meridional currents

The data is a five-day moving average of values, starting from December, 2003 to December, 2005, with a total of 147 timestamps.
The scalar values (SSS, SST, SSHA) have longitude values ranging from [29.8892W, 119.8237W] and latitude values randing from [29.7511S, 29.7511N].
For vector variables (zonal and meriodionial currents) the longitudes range in [30W,120W] and latitudes ranges in [30.0005S, 30.0005N].

IV. Methodology

The scalar variables consists of 188 latitudes [29.7511S, 29.7511N] and 187 longitudes [29.8892W, 119.8237W] contributing to 35156 data points for each scalar variables.
For vector variables, the data consisted of 189 latitudes [30.0005S, 30.0005N] and 181 longitudes[30W, 120W] contributing the 34209 data points each for zonal currents and meriodionial currents.For the purpose of visualization the data was normalized with the local maxima and local minima of each corresponding variable. The preference for local maxima and minima over global maxima and minima was the aim visualization was to be conducted for the trend in the Indian ocean and not to be compared with other oceans and water boadies.

V. Visualizations

We plot the contour maps for the scalar variables (SSS, SST, SSHA) as it gives the observer the different levels of values over the whole dataset. Tried out other methods as well such as contour without filling but those hard to understand and very informative.

A. Sea Surface Salinity (SSS)

Fig 1. below gives us one the visualizations of SSS (date: 29th Decemeber 2004). The data has. The actual range of values are [18.6981,40.5171].
The salinity is observed to be comparatively higher in the Arabian Sea compared to the other parts of the data. A large part of Bay of Bengal and the whole sea itself shows to have low salinity. The reason behind the the observation could be rivers of the Indian sub-continent as majority of them fall into Bay of Bengal.

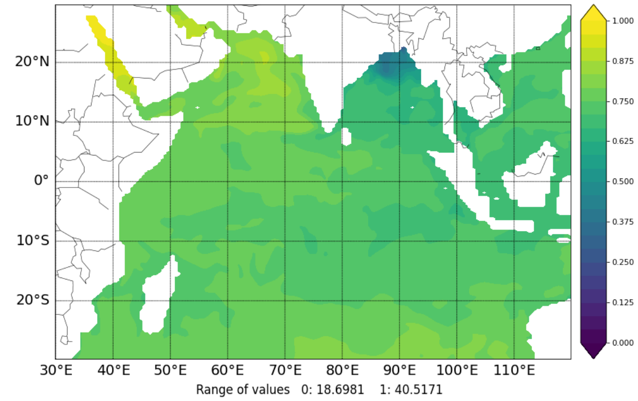

Fig. 1: Sea Surface Salinity (29th Decemeber 2004)

Over the whole time frame (December 2003 to December 2005) the sea level salinity is observed to be increasing overall.

B. Sea Surface Temperature (SST)

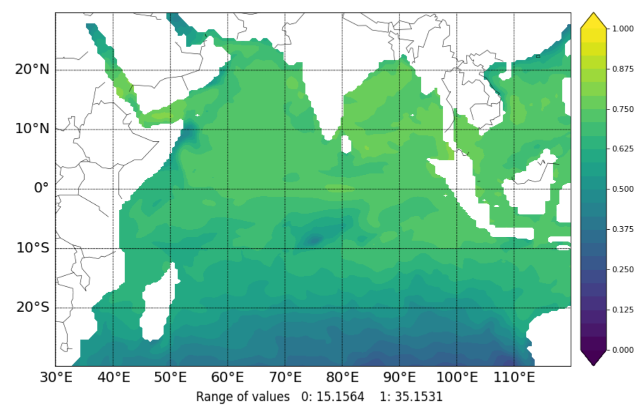

Fig. 2: Sea Surface Temprature (13th May, 2004)

Fig 2. is a visualization of the temperature of the surface of the sea. The range of values varies between [15.1564,35.1531]. The trend viewed for the two year time frame was close to expectation. The value along the equator remained close to constant as it receives direct sun rays throughout the year.
During the period of February to July the temperature in the northern hemisphere starts to increase, which is expected as the northern hemisphere experiences summer during this period. The contrast is observed for the southern hemisphere which shows temperature drop during the this period as. Fig 2. helps in the the above observation.

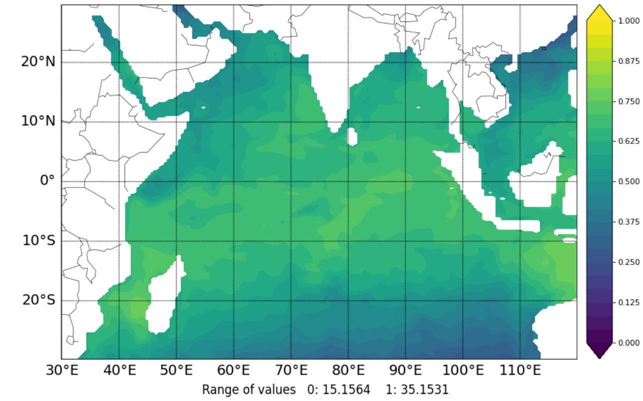

Fig. 3: Sea Surface Temperature (29th December, 2004)

Fig 3. shows the data for the time stamp of December 29th 2004, where the northern hemisphere observes the winter season, and we observe that the temperature has dropped as compared to the previous time stamp (Fig 2.). As expected the southern hemisphere shows a slight increase in temperature during its summer season.

The values observed at a particular period of the year in 2004 were observed to repeat for the year 2005 aswell.

C. Sea Surface Height Anomaly (SSHA)

Fig 4. is the visualization for the variable of sea surface height. The range of values for the variable is very low. The values ranges between [-0.57153,0.457858].
Fig 4. depicts a particular observation perceived during the two year time frame where a spike in the sea level is observed along the western coast of south eastern Asian countries.

Excluding this event the sea surface height remained to be constant with value being slightly higher observed in the sea long the southern eastern Asian countries than the sea along the coast of Africa.

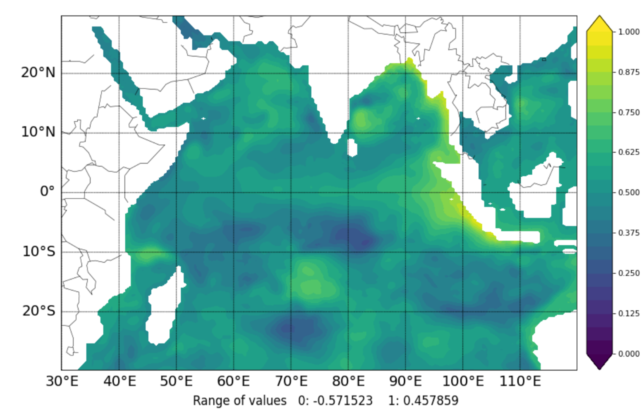

Fig. 4: Sea Surface Height Anomaly (18th May, 2004)

A major event occurred in the history of Indian Ocean during the given time frame, the 2004 tsunami which took place on 26th December 2004. The affect of the same were expected to be visible in the sea level but the data, as mentioned in the data section, is a five day average which does not include the particular date when the tsunami occurred so no unusual data was recorded during that time.

For the vector variables we plot quiver maps for visualization of the direction of the vector in the 2D image as well.

D. Zonal and Meridional Currents

Fig 5. is a quiver visualization for the given time frame. The general trend of the currents observed was that the currents are seen to originate the west coast of the southern eastern Asian countries and move towards west along which they gain a lot of velocity in the middle and hit the eastern coast of Africa. After hitting the eastern coast of Africa the currents lose velocity and constantly change direction in a clockwise pattern.
Fig 5. depicts the data as in 4th March 2005 where we observe a spike in the current's velocity along the eastern coast of India. This observation is important because the coast is prone to frequent cyclones. The similar trend is observed the previous year as well during the same time of the year.

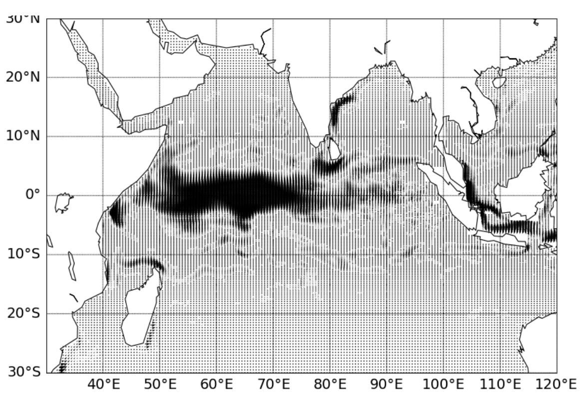

Fig. 5: Zonal and Meridional Currents (4th March, 2005)

We observe a similar spike in current velocity along the current southern eastern coast, yet another area prone to cyclones. The event is recorded on 9th Decemeber 2004 and visualized in Fig 6. The similar spike is again observed the subsequent year at the same time of the year.

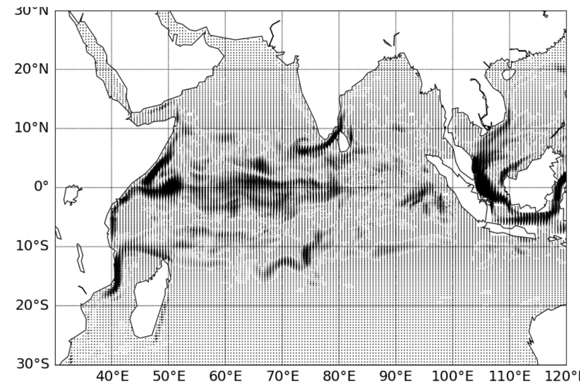

Fig. 6: Zonal and Meridional Currents (9th December, 2004)

VI. Implementation

The implementation of the whole task was done using python as the programming language.
The data was present in the form of text file and the was converted to numpy arrays to be used for visualizations. For reading the file and converting the data to usable form the libraries used were: os, numpy.

For the purpose of creating the visualizations the numpy arrays were feeded to matplotlib APIs. For getting the background of the map basemap library of matplotlib was used. For scalar variables a contour fill plot was plotted, whereas for vector variables a quiver plot was plotted. Libraries used for visualization were: matplotlib, basemap, animations.

VII. Other Inferences

Other than mentioned events there a few of the observations were tried to be observed or predicted.

A. 2004 Tsunami

The data for the particular date, 26th December 2004 was not available and no unexpected or abnormal behaviour in the data of the variables was observed before or after the event.

B. 2005 Mumbai Floods

The heavy rainfall that left not so good memory for Mumbai occurred on 26th July 2005. The exact data for the same date was not included and no unexpected currents pattern was observed.