**Sea surface temperatures forecasting analysis**

1. **Introduction**

This document reports a data analysis that investigates sea surface temperature (SST) trends in the North Atlantic and Indian oceans. This study will aid in understanding the impacts of climate change by isolating the key seasonal trends governing SST changes and providing a forecast that suggests how the two oceanic regions will be affected by climate change in the coming years.

1. **Data and Adjustments**

Data is sourced from the ERA5 Reanalysis project, which can be viewed here: <https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels?tab=overview>

The data frames used for the analysis can be viewed at:

* <https://github.com/joeyuy/Climate-Change/blob/d4f21b538838d3cebee282d90b334f01710ff252/north_atlantic.csv>
* <https://github.com/joeyuy/Climate-Change/blob/d4f21b538838d3cebee282d90b334f01710ff252/indian.csv>

1. **Analysis Methodology**

To identify key trends, the data is decomposed using Fourier transformation. Plotting the resulting Fourier series on a spectrogram reveals which Fourier components cause spiking, and therefore are major governing trends in SST changes. Applying a bandpass filter on these trends is done to construct a trend-focused approximate Fourier series for each ocean that is used for further analysis.

The resulting trends are passed through the Prophet model to create a forecast for future SST’s. These forecasts are then fitted with a regression line to quantify how the SST in each oceanic region is expected to change in the coming years.

1. **Results**
2. Bandpass-filtered Fourier Series

A graph of a data

Description automatically generated with medium confidenceA graph showing a bandpass filter

Description automatically generated

The diagram shows the bandpass-filtered Fourier series for the North Atlantic ocean (left) and Indian ocean (right). Both series approximate the raw data well and validate the conclusion that the identified trends are major determinants of SST changes. The identified trends have periods of 1 year, 1/2 year, and 1/3 year.

1. Regression Results

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Description automatically generated with medium confidence

Above is a diagram that displays the prophet model forecast and its fitted regression line for the North Atlantic ocean (left) and Indian ocean (left). The analysis suggests that both oceans will experience temperature changes as time goes on, but in different ways. The regression line slopes predict SST’s to increase for the North Atlantic ocean and for SST’s to decrease for the Indian ocean, with the Indian ocean experiencing larger overall SST movement.

1. **Conclusion**

Three main trends are identified with periodicities of 1 year, 1/2 year, and 1/3 year. The first trend can be explained by the earth’s annual rotation about the sun. The half year trend can be accounted for by the Autumnal and Vernal equinox cycles, where the earth is exposed to more or less sunlight due to fluctuations in the earth’s axis. The 1/3 year trend does not have an immediately apparent explanation, though it is worth noting that in the spectral analysis, the 1/3 year trends had much smaller magnitudes compared to the one year and half year trends for both oceans. As such, the 1/3 year trend could be more related to random noise visible in the data.

The implications of regression analysis noted in part IV support the conclusions:

1. Indian ocean countries could suffer more in the short term due to more accelerated temperature changes, though the North Atlantic region would also suffer with temperatures continuing to rise.
2. North Atlantic countries will suffer more in the medium term as the cooling off in Indian ocean SST’s will gradually bring down temperatures to similar levels as pre-climate crisis times.
3. Both regions will suffer long term as neither look to have stable long term SST outlooks.