Effect of Hurricanes on Phytoplankton

Plankton Alpha Squad 4.0

Introduction - Overview & Data

- Plankton part of important food chain (fish, whales and large aquatic animals)
- Plankton refers to both aero plankton (airborne plankton) and marine plankton -> this study strictly refers to marine plankton
- Effects of hurricanes on the production of plankton
- Used quantities of chlorophyll as a measure for plankton
- According to MET Office, hurricane season starts mid-August - mid-October (peak in September)
- Collected data from Brighton and looked specifically into the effects of hurricane Ophelia in Brighton

Introduction - Model

- What kind of models we use?

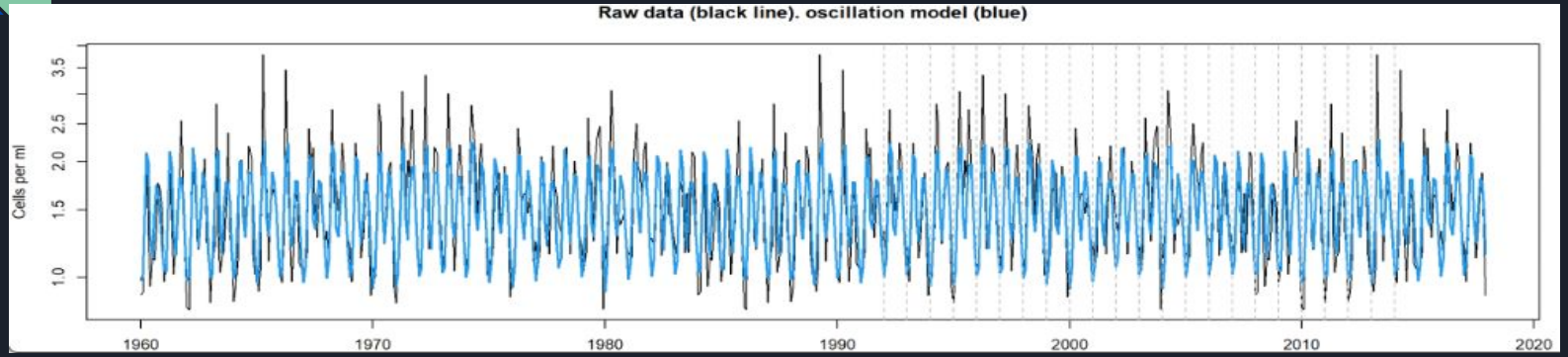
- ARIMA (1,0)-- The model is used to understand past data or predict future data in a series.
- ARIMAX — a widely used algorithm for efficiently computing the discrete Fourier transform (DFT) of a sequence.

- What we could get from the model?

- This model has been developed by taking into account the resonances (cos and sin functions) 6 months, 12 months, 4 months, and 3 months ago, thereby providing a comprehensive analysis of the plankton population density changes over time.

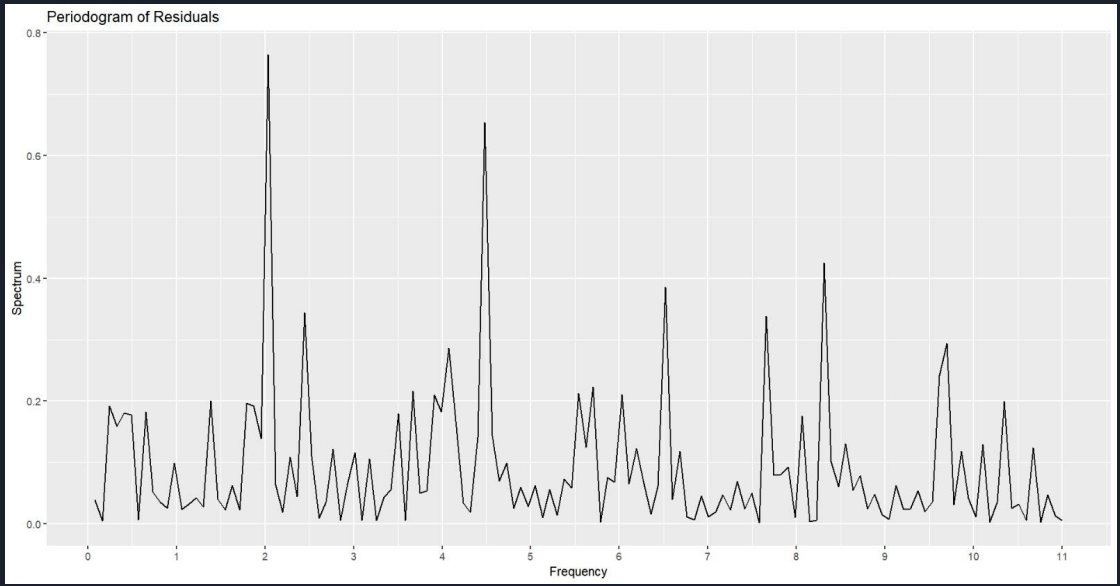
- The response variable is the population density of plankton, expressed in the unit per milliliter of plankton in the container.

Fitting the Model



- This figure compares the raw and fitted data of plankton population density from 1960-2017. The black line represents the raw data, and the blue line represents the fitted model. The y-axis is the number of plankton cells per milliliter, while the x-axis is the year.
- We can find that the time series model simulates the changing trend and relative quantity of the population in almost every year. However, it can be observed that the model doesn't have enough variance to cover some of the residuals. This is because there are many factors such as pollution that haven't been covered by the model.
- If we need to look at the plankton density for a particular year, we can identify it by adding vertical lines to the years.

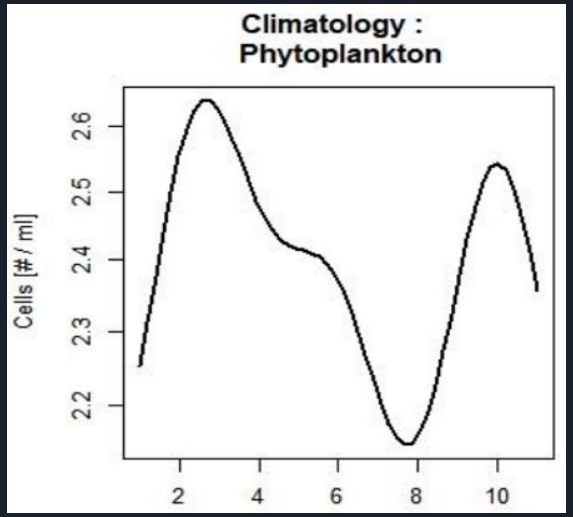
Periodogram of Residuals

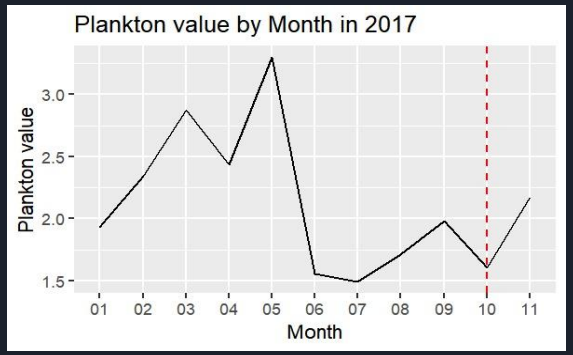


- This plot shows the annual trend of plankton throughout the years. In other words this plot shows the aggregate of residuals about the mean for plankton population, considering data from 1960 to 2017.
- We can observe that the residuals vary from 0.6 to 0.8, however, most residuals lie in the range of 0.1 and 0.4, and there are 2 outliers that can be observed in the months of February and April. This shows that there is a higher plankton density in these months compared to the others.

Analysis- Hurricane Ophelia

- The first plot shows the cumulative trend of Plankton density around Brighton, and in particular, it exhibits the seasonality of the rise and fall of phytoplankton population.
- The second plot is similar to the first one, but is specific to 2017, when the Hurricane Ophelia hit Brighton. The red dotted line marks the month when Ophelia impacted Brighton.
- It can be observed that the the phytoplankton shows a similar trend in 2017, when compared to the overall trend. However, it lacks the second harmonic spike expected towards the end of the year, and in October. When the hurricane impacted Brighton, the plankton density can be observed to increase again. This suggests a positive effect of the hurricane on the plankton density.





Conclusion and Limitations

Conclusion

- Upon analysing 2017's data, the rise in plankton density in response to the hurricane suggests a positive relationship between the two.
- In absence of natural calamities, the production of phytoplankton has a harmonic effect, peaking twice a year. For the area of Brighton, based on data from 1960 to 2017, the phytoplankton density was observed to be the highest in the months of March and October.

Limitations

- The study is only limited to hurricanes, and has not considered other natural calamities that occured in the time period.
- The data and study is limited to only the area around Brighton, and there is special focus on Hurricane Ophelia as a case study.
- The study ignores all forms of pollution, oil spills or contamination that occurred in the area.
- The model failed to capture the variance in the data and hence was unable to explain extreme residuals.

THANK YOU!