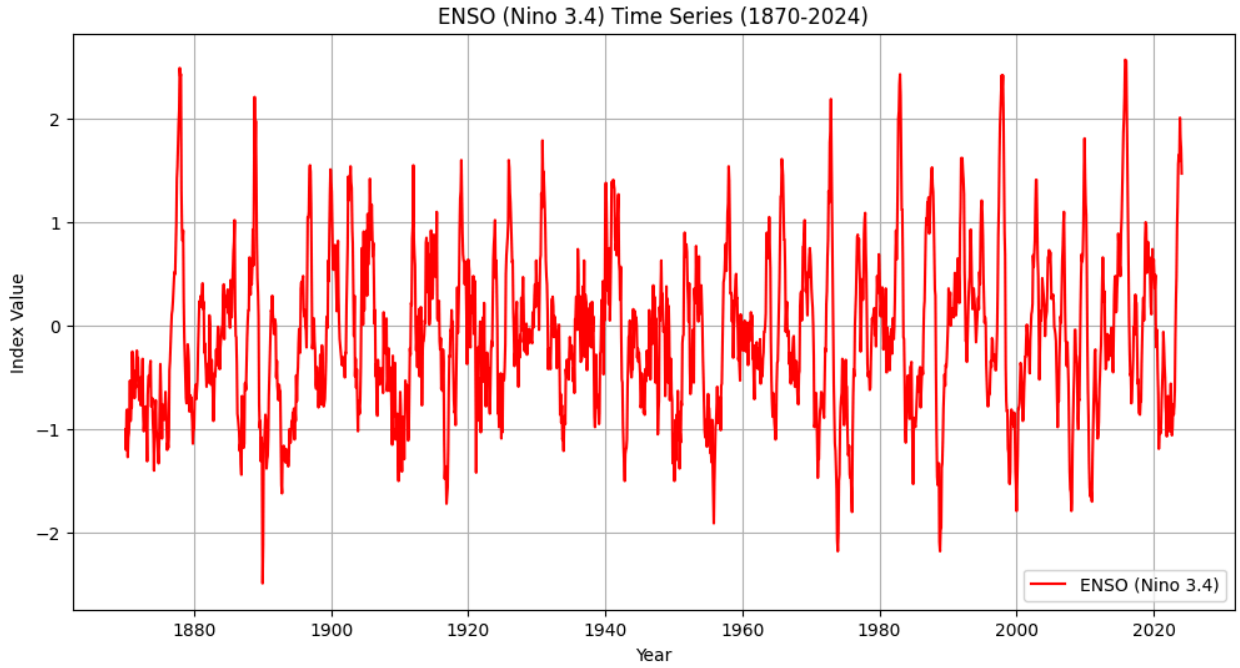
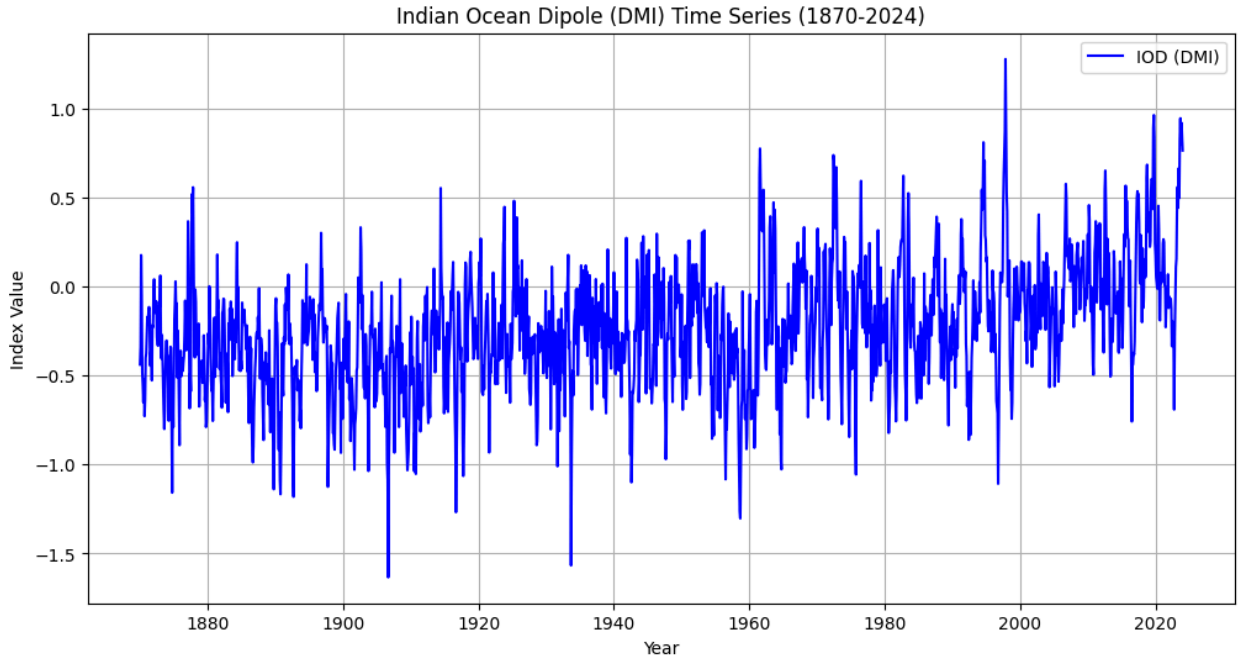
In this assignment, we analyzed several key climate indices and their relationships with each other using monthly time series data and correlation coefficients.

In Q1, we began by plotting the El Niño-Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) indices, highlighting their variations over time.





In Q2, we found a correlation coefficient of 0.3092464809719055 ≈ 0.31. This indicates a moderate positive correlation between two variables.

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Correlation Coefficient between ENSO and IOD: 0.3092464809719055
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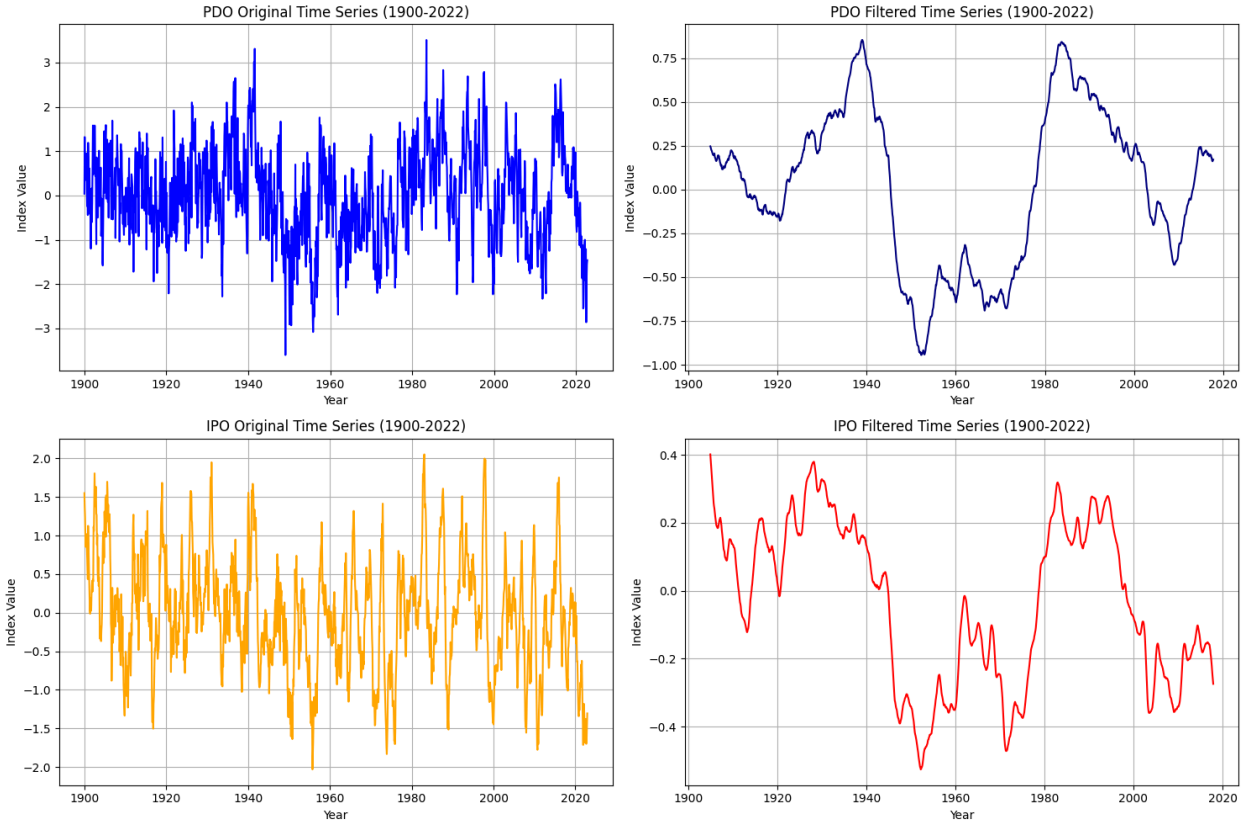
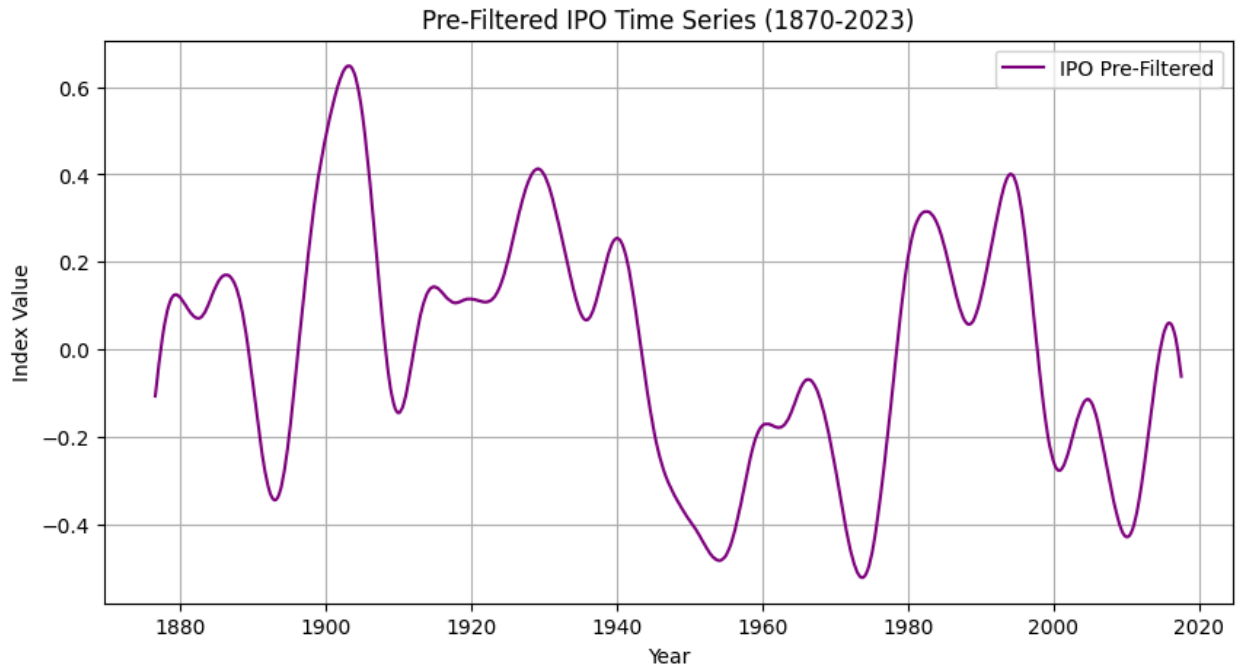
ENSO and IOD are both climatic phenomena that influence global weather patterns, particularly in the tropical Pacific and Indian Ocean regions. Other factors such as regional atmospheric circulation and oceanic processes can also influence these indices independently, contributing to the observed variability.

In Q3, we plotted and filtered the data for Pacific Decadal Oscillation (PDO) and Inter-decadal Pacific Ocean (IPO) time series from Jan-1900 to Dec-2023.



In Q4, we plotted the filtered time series of IPO from the following data source for Jan-1900 to Dec-2023.



We also computed the correlation coefficient between the filtered time series from Q3 and Q4. We found a correlation coefficient of 0.913672896759951 ≈ 0.91. This suggests a strong positive correlation and very little variability between the two variables.

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Correlation coefficient between Q3 and Q4:  0.913672896759951
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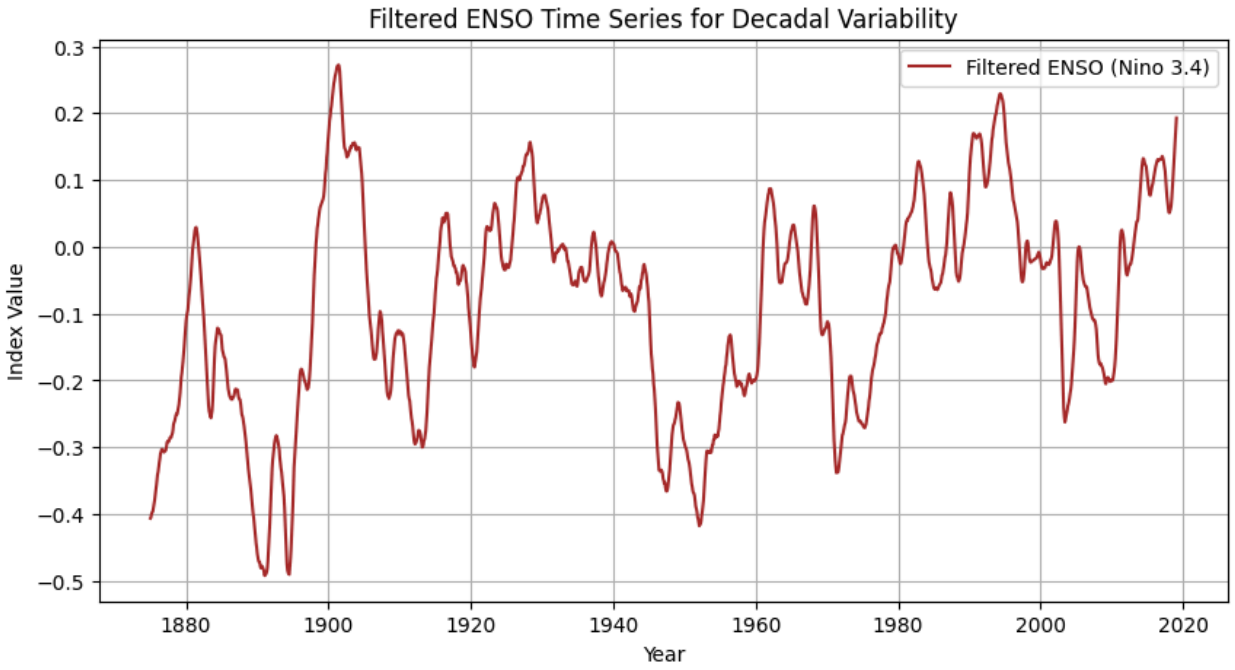
In Q5, we filtered the time series of ENSO from the original time series of ENSO and computed the correlation coefficient with the filtered ENSO/IPO/PDO time series.



Correlation Coefficient between Filtered ENSO and Filtered PDO: 0.6353618969650023 ≈ 0.66
Correlation Coefficient between Filtered ENSO and Filtered IPO: 0.7258021884016923 ≈ 0.73

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Correlation Coefficient between Filtered ENSO and Filtered PDO: 0.6353618969650023
Correlation Coefficient between Filtered ENSO and Filtered IPO: 0.7258021884016923
```

This indicates a moderately positive correlation between the Filtered ENSO and Filtered PDO data and a slightly stronger positive correlation between the Filtered ENSO and Filtered IPO.

In Q6, we subtracted the filtered time series of ENSO from the original time series of ENSO and computed the correlation coefficient with the filtered ENSO/IPO/PDO time series.
ENSO with Filtered ENSO: 0.0241779061710032 ≈ 0.024
ENSO with Filtered IPO: 0.004058216920286711 ≈ 0.004
ENSO with Filtered PDO: 0.005028095681873126 ≈ 0.005

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Non-Decadal ENSO with Filtered ENSO:  0.0241779061710032
Non-Decadal ENSO with Filtered IPO:  0.004058216920286711
Non-Decadal ENSO with Filtered PDO:  0.005028095681873126
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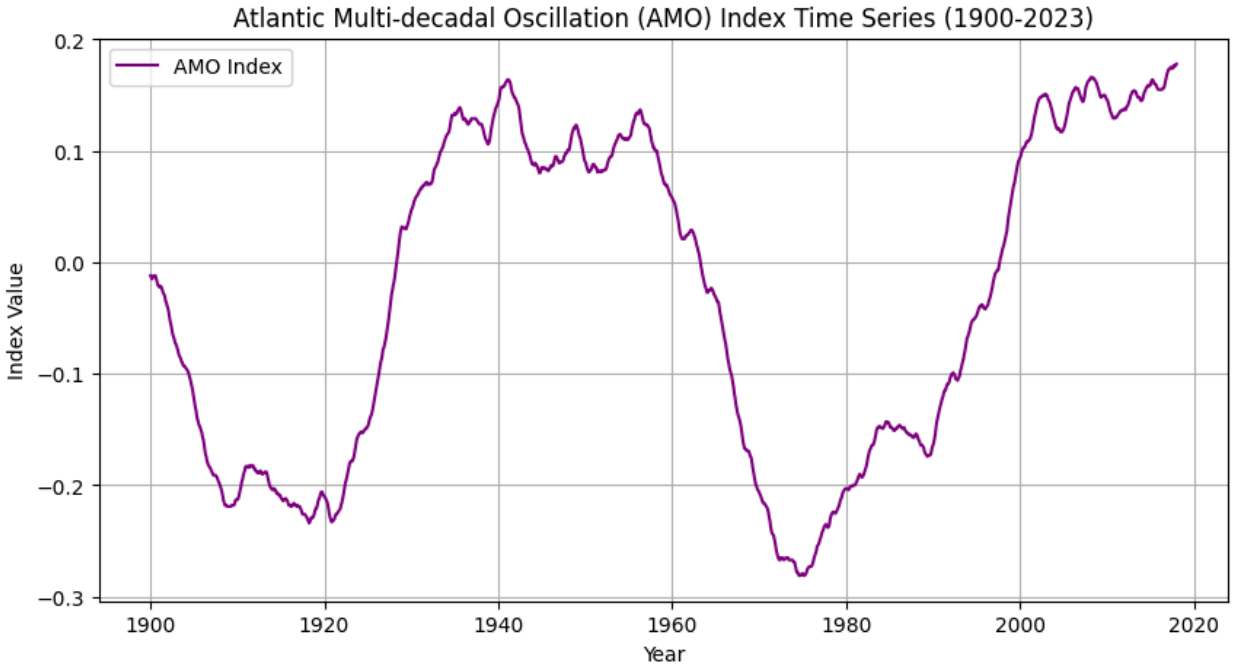
There is an extremely weak positive correlation of ENSO with all of the filtered ENSO/IPO/PDO data.

In Q7, we plotted the Atlantic Multi-decadal Oscillation index (AMO) time series.



In Q8, we computed the following correlation coefficients:
AMO and ENSO (Q1): 0.019259224605013166 ≈ 0.02
AMO and IPO (Q4): -0.21976520899819713 ≈ -0.22

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Correlation coefficient between AMO and ENSO (Q1):  0.019259224605013166
Correlation coefficient between AMO and IPO (Q4):  -0.21976520899819713
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This means an extremely weak positive correlation between AMO and unfiltered ENSO indicating that there is almost no linear relationship between the variables. There is a weak negative correlation between AMO and filtered IPO data meaning there is a slight tendency for the variables to move in opposite directions, but the correlation is not significant.

The Atlantic and Pacific Ocean basins operate largely independently in terms of climate variability.

The codes for the graphs -
https://drive.google.com/drive/folders/1sk6YOqA0nY0nUrO2LwZ6jdHj0TccMYJN?usp=sharing