



ENSO Data Visualizations and Analysis

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Datasets:

- **Weekly (starting Sept-2-1981) observed sea surface temperatures and sea surface temperature anomalies for the following ENSO regions:**
 - **Nino 1+2**
 - **Nino 3**
 - **Nino 3.4**
 - **Nino 4**

*** The sea surface temperature anomalies (SSTA) over ENSO 3.4 were the focus of this exercise*

- **The Meteostat library was used to aggregate historical observational weather data over various station locations.**

Data Visualizations: Time Series Analysis

1) Time Series Analysis - Full Period, Unfiltered Data

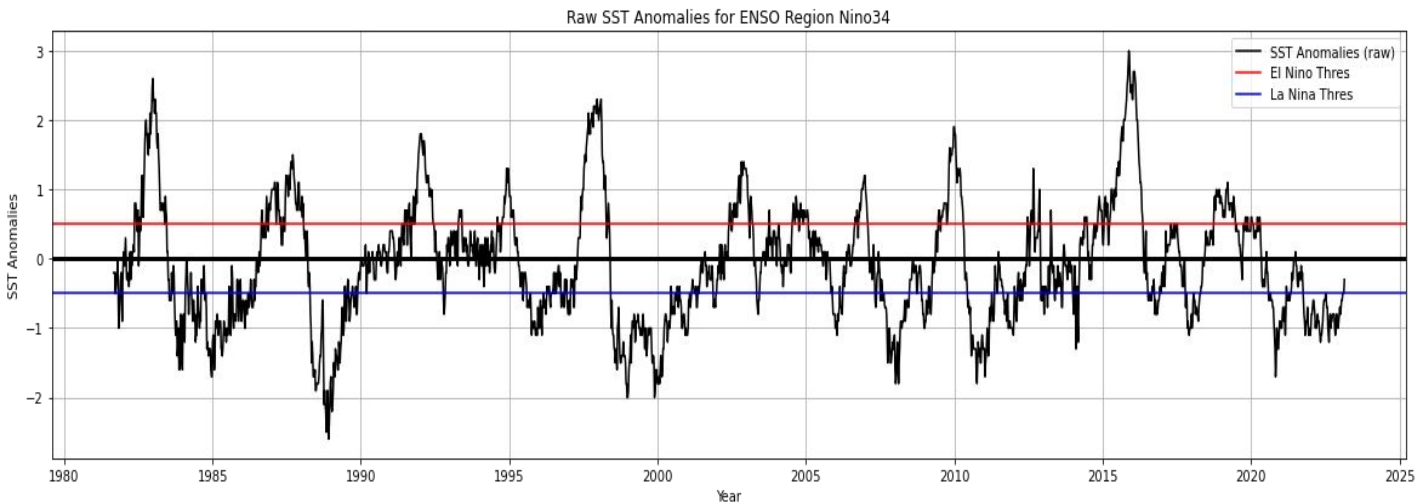
- Weekly SSTA data is plotted for the full dataset (unfiltered).
- $+0.5$ / -0.5 SSTA thresholds are provided to indicate potential ENSO events.

2) Time Series Analysis - Full Period, Filtered Data

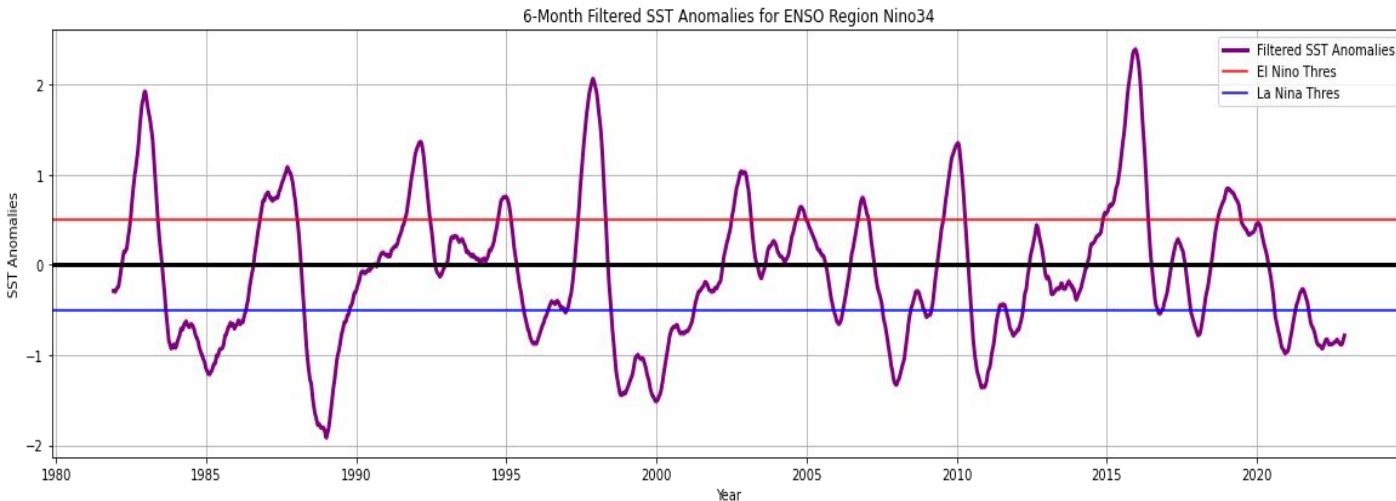
- Same as above, but a filter is provided using a monthly, 3-month, or 6-month running means to smooth the data. This helps more clearly identify potential ENSO events.

3) Time Series Analysis - Selected Period

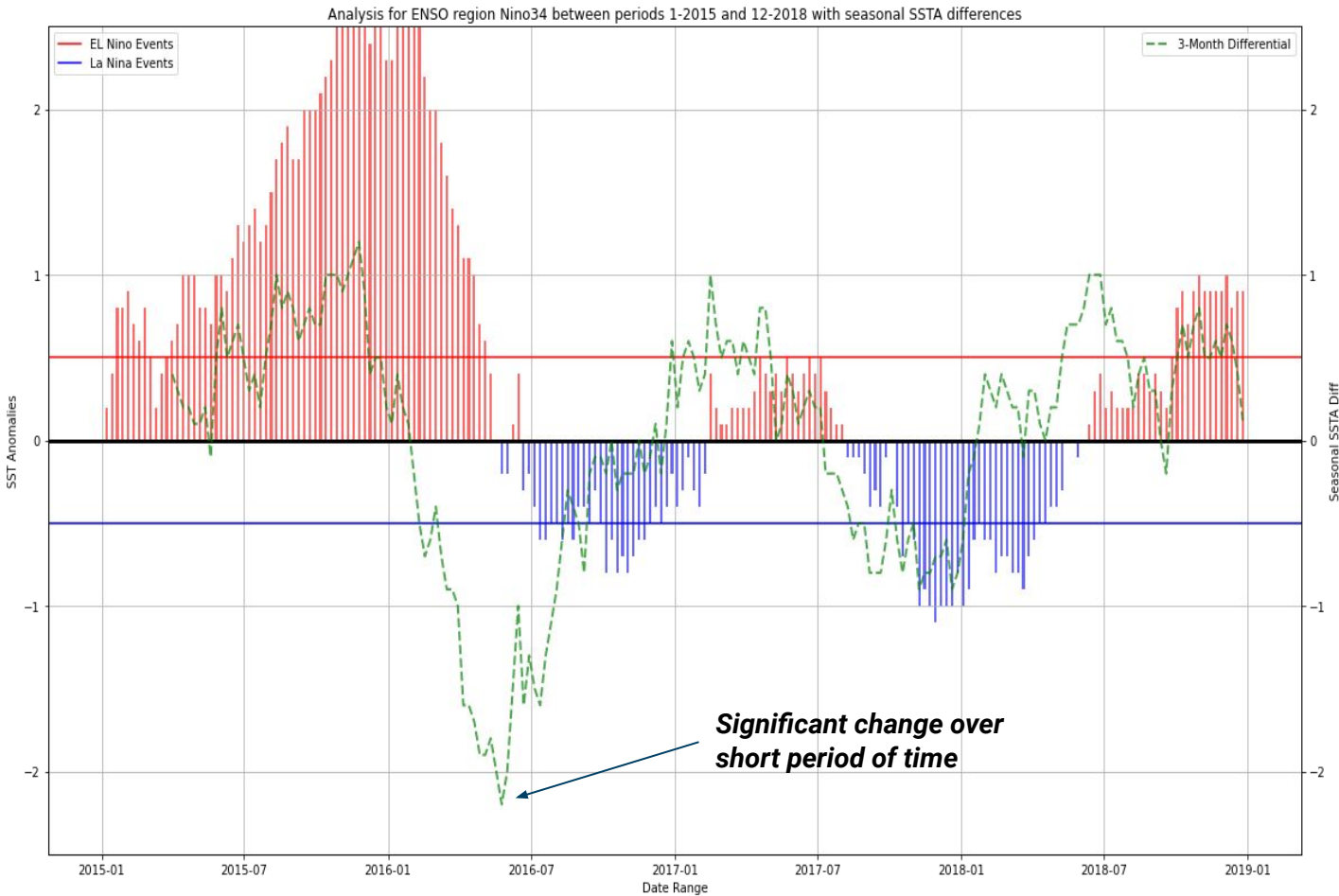
- The user selects a specific time period (start: yyyy/mm, end: yyyy/mm) to visually indicate potential ENSO events using a vertical bar chart. An additional 3-month (seasonal) diff command is applied to identify significant ENSO SSTA delta values from season to season.



1) Raw SSTA data for full period (1981-2023) for Nino 3.4 region.



2) 6-month filtered SSTA data for full period (1981-2023) for Nino 3.4 region. Red and blue horizontal lines help to indicate potential ENSO events.



3) ENSO 3.4 SSTA for period extending from Jan. 2015 to Dec. 2018.

Green dashed lines indicate seasonal differentials (SSTA delta) from season to season (3-month intervals). This helps to identify sudden and significant changes to SSTAs over a region.

Data Visualizations: Mapping Tools

1) Composite Map - All ENSO Regions

- Cartopy is used to plot ENSO SSTA values for a user selected period (monthly, seasonally, annually) which are averaged based on input.
- Boxes are used to represent each ENSO region and are color-coded based on observed amplitude of SSTA over that region.

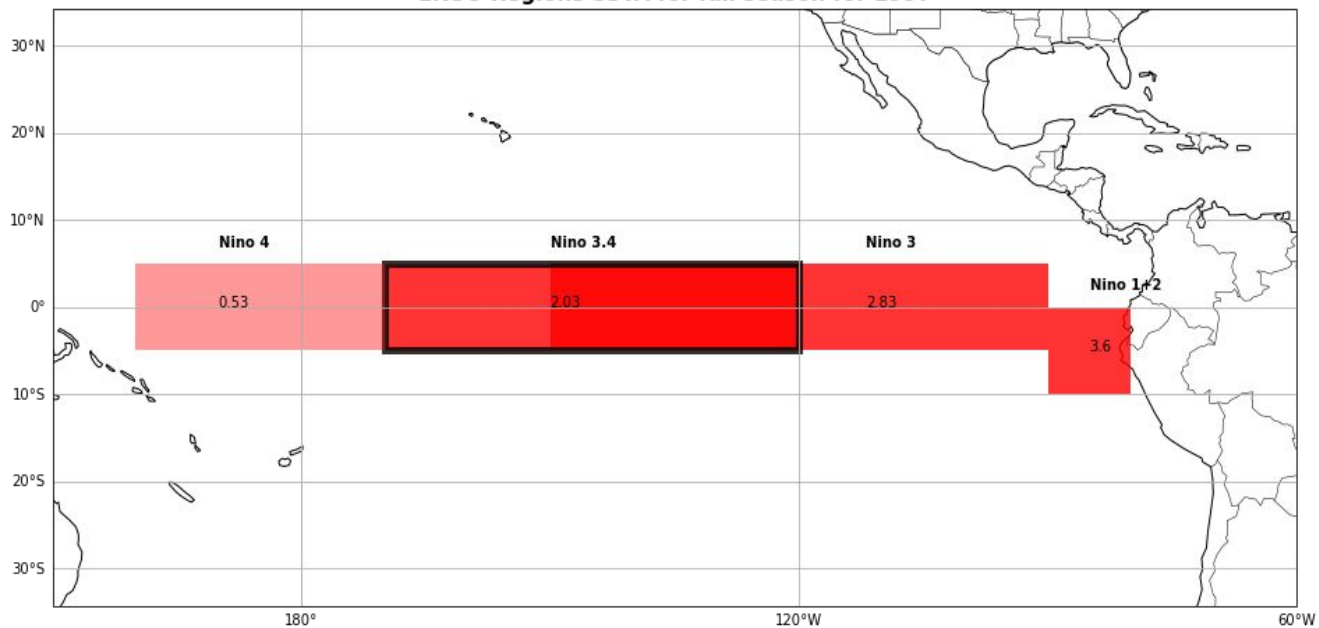
2) Composite Map - Subplot for Individual ENSO Regions

- Same as above, but a subplot is created to show individual SSTA maps for each region.

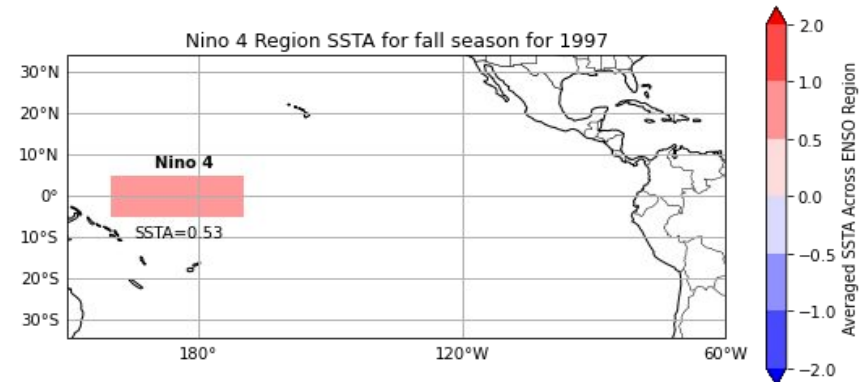
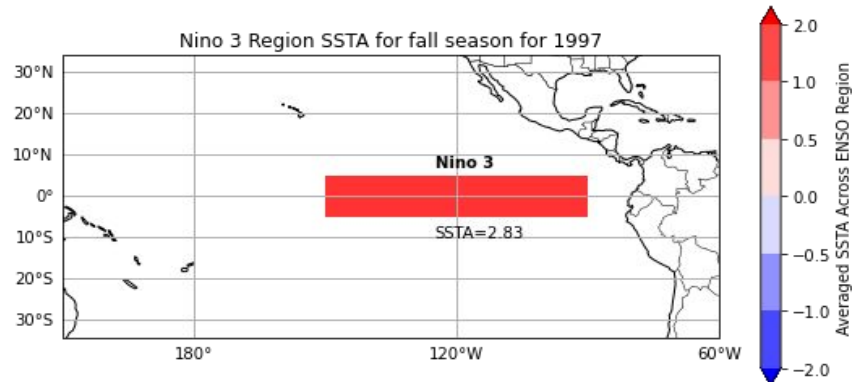
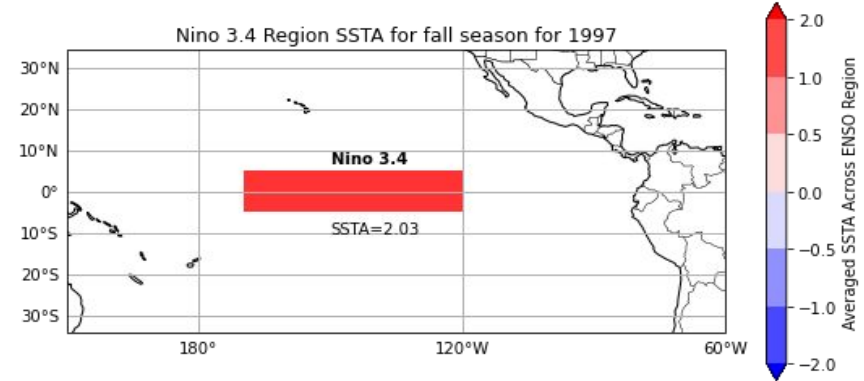
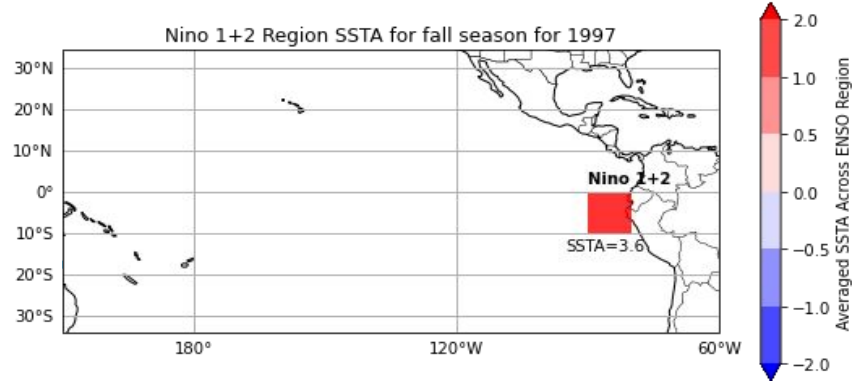
3) Animated Map - Specified Period

- Same as above, but user selects the period and ENSO region. An animated plot is generated to show the SSTA for each time frame within the selected period.

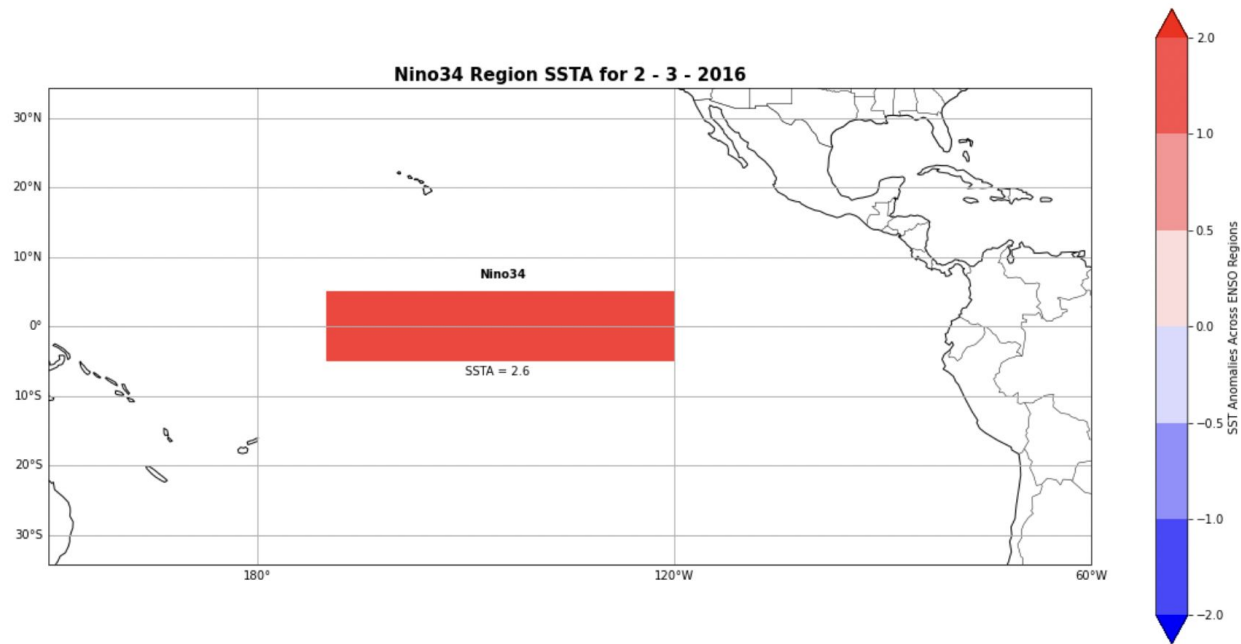
ENSO Regions SSTA for fall season for 1997



1) Composite ENSO map showing SSTAs over each region averaged seasonally for Fall (Sept. - Nov.) during 1997.



2) Subplot map showing seasonally averaged SSTA for each individual ENSO region for the Fall season 1997 (this can be directly compared to the map in the previous slide).



3) Animation of SSTAs from ENSO region 3.4 spanning Feb. 2016 to Sept. 2016. The animation can be accessed after running the script in the Jupyter Notebook.



Data Visualizations: Correlation Plots

1) Pairplots

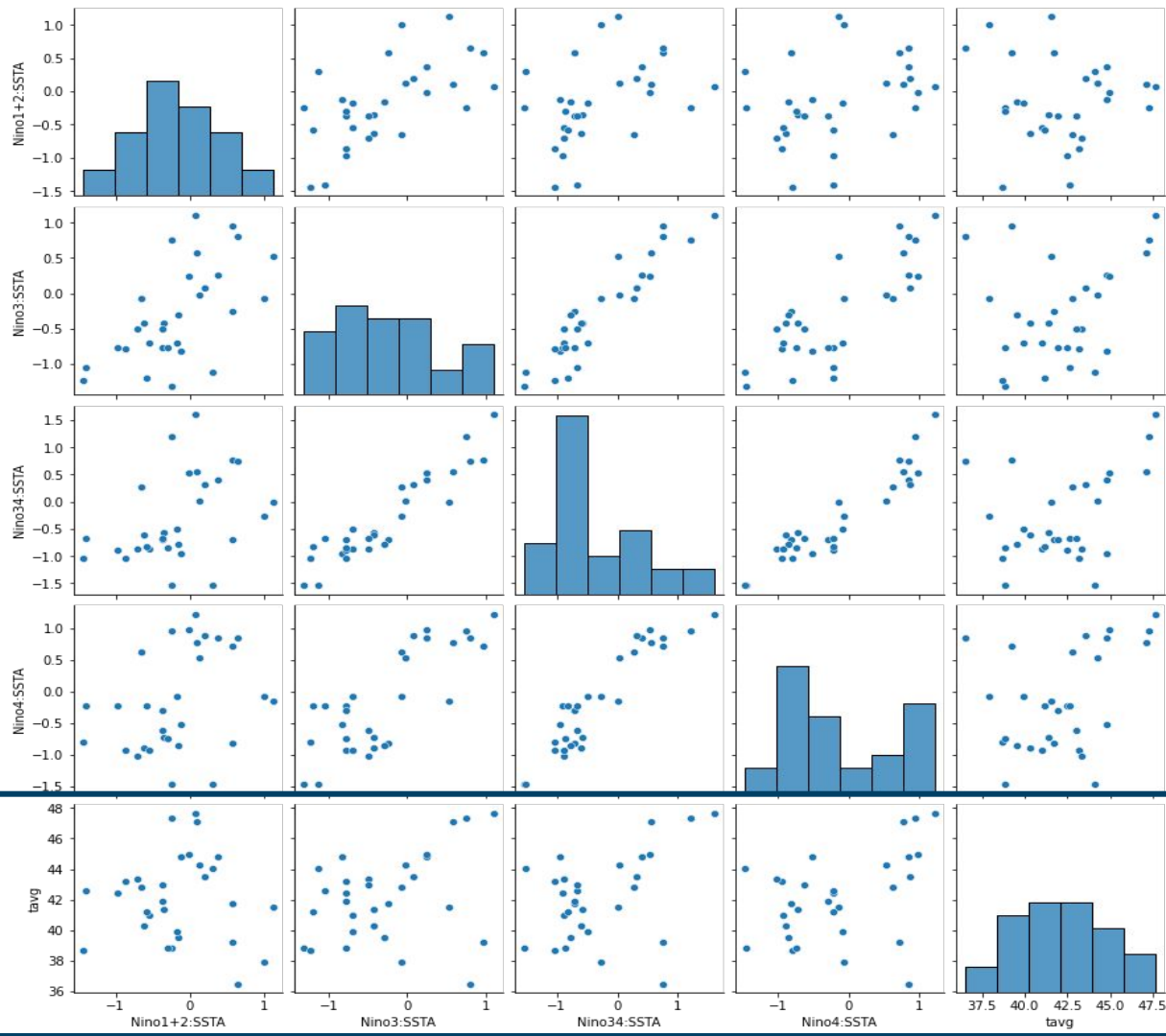
- The Meteostat library was utilized to aggregate observational data over a specific location. This data was then merged with the ENSO SSTA data for comparison. A pairplot, or scatter plot, was generated to show any potential relationships between the ENSO SSTAs and surface temperatures.

2) Correlation Heat Map

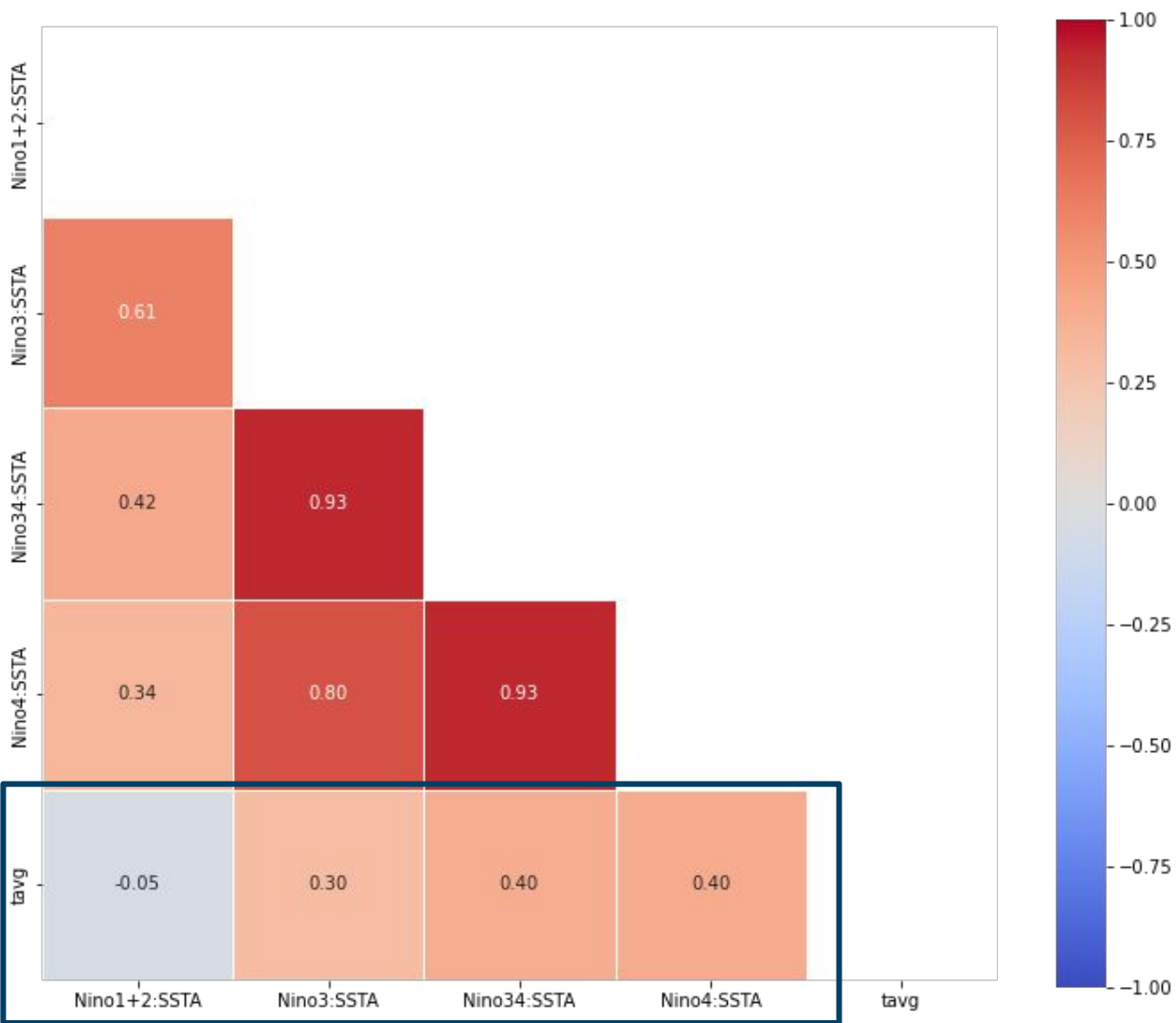
- These relationships were then correlated. A heat map was generated to identify correlations between the SSTAs and surface temperatures.

3) Lagged Correlation Plot

- A lagged correlation was calculated between the SSTA and the surface temperatures (+/- 12 months). This was used to determine if there is a lag between observed SSTAs and potential impacts to surface temperatures.

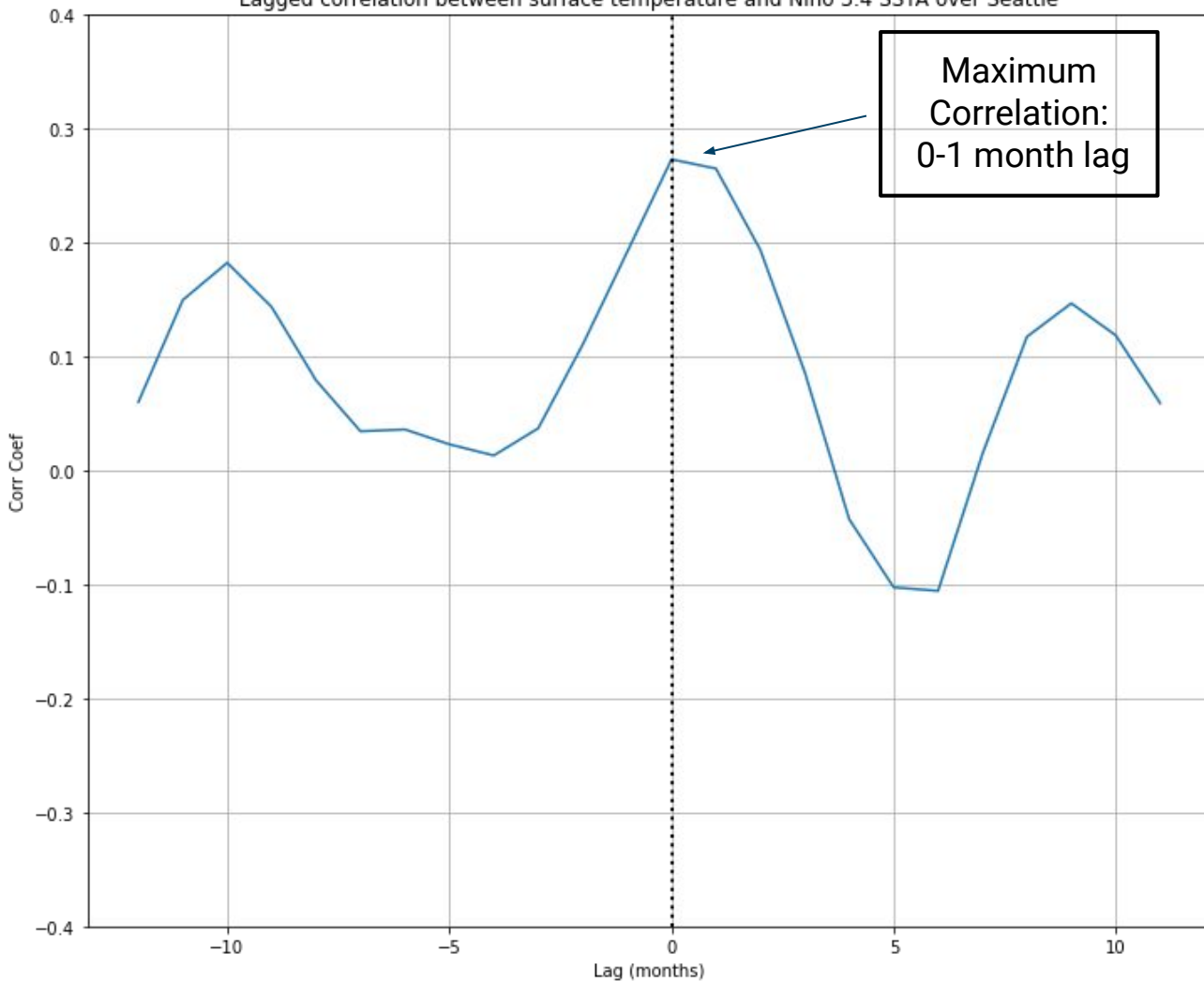


1) Pairplots (scatter plots) between SSTAs associated with each of the ENSO regions and surface temperatures near Seattle for winter (DJF).



2) Heat map showing correlation values between each of the ENSO regions and surface temperatures near Seattle for winter (DJF).

Lagged correlation between surface temperature and Nino 3.4 SSTA over Seattle



3) Lagged correlations (+/- 12 months) between surface temperatures and ENSO SSTAs over the 3.4 region.

This chart is constructed using SSTA and surface temperature data for the full period (1981-2023).

Contact Information

If you have questions regarding any of the work presented in this presentation or the data script itself, please feel free to contact me using my contact information listed below.

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