Investigating the Impact of Climate Variability and Change on the California Current System using a Pacific Pacemaker Experiment

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1. Motivation: The CCLME & ENSO

Figure 1: *The CCLME along the US West Coast.*

- The California Current Large Marine Ecosystem (CCLME) is a primary upwelling region
- Strong coastal upwelling of deep, cold, nutrient-rich water supports high productivity and valuable living marine resources
- Tropical Pacific SST anomalies associated with El Niño-Southern Oscillation (ENSO) have global impacts through oceanic and atmospheric teleconnections that dampen upwelling in the CCLME during positive ENSO events
- Short observational records create uncertainty in the relationship between ENSO and CCLME physical and biogeochemical (BGC) properties

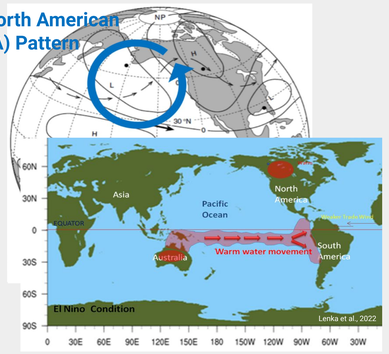


Figure 2: *Teleconnections associated with ENSO include the deepening of the PNA Pattern (top) and the propagation of warm water along the equator leading to coastally-trapped Kelvin waves (bottom).*

2. Methodology: Pacific Pacemaker & FOSI

Pacemaker (PM) Model

- 10 ensemble members of CESM2, 1° resolution
- ERSSTv5 SST anomalies in wedge-shaped restoring region
- 1880-2019, monthly output
- POP2 Ocean & MARBL BGC Model

FOSI Model

- Forced Ocean-Sea Ice (FOSI) configuration of CESM1.1, 1° resolution
- Forced with historical CORE data
- 1958-2019, monthly output
- POP2 Ocean & BEC BGC Model

Seasonal climatology was removed and a second-order polynomial fit was used to detrend anomalies for both models

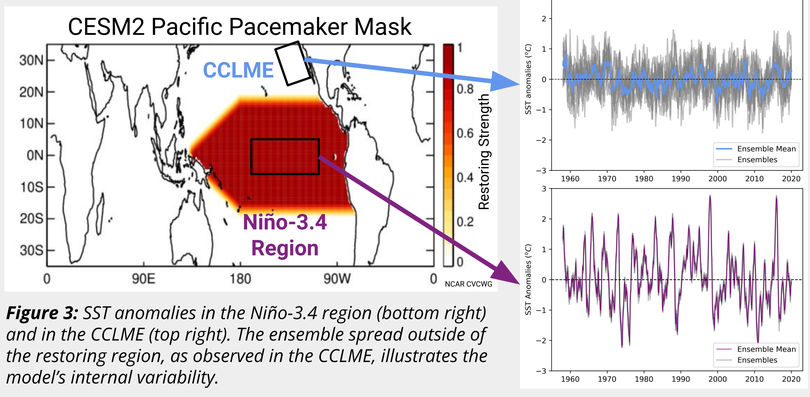
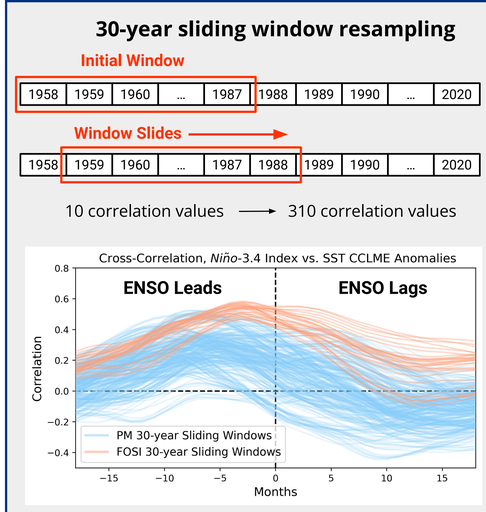


Figure 3: *SST anomalies in the Niño-3.4 region (bottom right) and in the CCLME (top right). The ensemble spread outside of the restoring region, as observed in the CCLME, illustrates the model's internal variability.*

3. Results: Spread in Lagged Correlation



- A spread can be seen in both the lag time and the maximum correlation values over each of the 30-year windows and over the Pacemaker model ensemble members

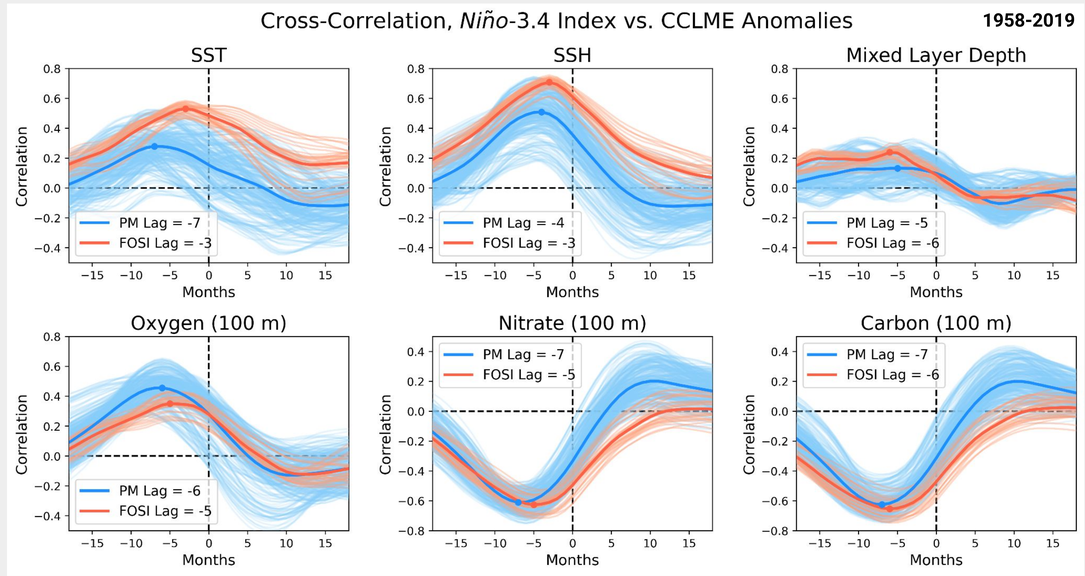


Figure 4: *Lagged cross-correlation of the Niño 3.4 Index and CCLME anomalies over 31 30-year sliding windows, for the FOSI model and for the 10 ensemble members of the Pacemaker model. The mean cross correlation across all of the windows is indicated with a bold line and the lag time with the maximum correlation for the mean line is indicated with a dot.*

4. Results: Spread in Correlation Values

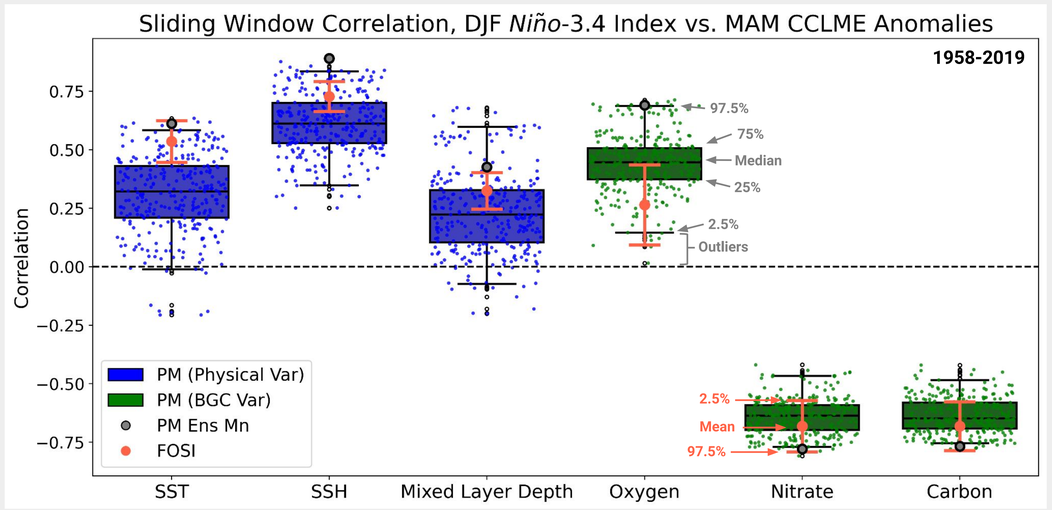


Figure 5: *The correlation between the winter (DJF) Niño-3.4 index and the subsequent spring (MAM) CCLME anomalies for all 30-year sliding windows with 95% confidence intervals using boxplots for the Pacemaker model and dots for the FOSI model.*

- ENSO events tend to peak in the winter and the expected lag time of teleconnections is about one season; the spring is also an important time in the upwelling season
- A spread can be observed in the possible correlation between the Niño-3.4 index and CCLME properties based on the Pacemaker output, which captures the historical correlation shown in the FOSI model

5. Summary & Future Work

- We quantify the spread in both the lag time and the possible correlation between the Niño-3.4 Index and CCLME variables shown in the Pacemaker model and compare to the FOSI model with historical forcing
- We plan to compare wind data of the Pacemaker and FOSI models to explore SST lag and correlation differences
- We plan to calculate upwelling indices including CUTI and BEUTI and analyze their correlation with the Niño-3.4 index
- We plan to conduct a case study of a major El Niño Event (ie. 1997-98)

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