

Quantifying Historical F_{CO_2} Timeseries

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Abstract

Thus far, the study has focused on understanding the residuals of F_{CO_2} , by removing the CESM-LENS ensemble mean from each individual simulation. It has been assumed that these residuals exactly represent the natural flux of carbon. However, embedded in the ensemble mean is a seasonal cycle that might very well contain some of the natural CO_2 fluxes. I am backtracking in this phase of the project to be confident in our definition of these residuals. In the process, I will also quantify various aspects of the historical ‘mean state’ of each system.

1 What exactly are our residuals and seasonal cycle representing?

It isn’t immediately clear what our ensemble mean and residuals represent in the case of F_{CO_2} over the historical period in the CESM-LENS. We can assume that the ensemble mean trend represents the growing anthropogenic CO_2 sink in the ocean, but what about the seasonal cycle? Surely the seasonal cycle cannot be purely due to anthropogenic forcing, but rather it is the seasonal cycle that all members share in common. How much of that seasonal cycle is anthropogenic versus natural, and what controls it?

Figure 1 displays the issue with understanding what each component of the time series represents. We can assume that any trend in the forced signal (red line) is due to the invasion of anthropogenic carbon. However, the seasonal cycle (the black curve) must at least partially represent natural carbon. So are the grey lines (residuals) just truthfully the natural variability of CO_2 ? Do these residuals include any anthropogenic carbon?

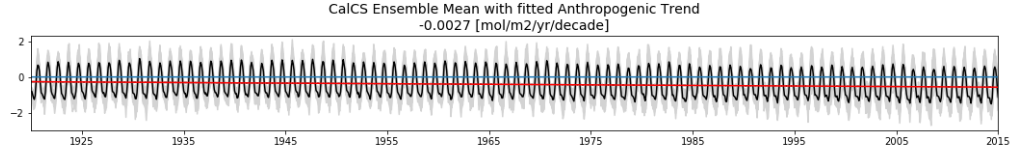


Figure 1: Historical time series of F_{CO_2} in the California Current across the CESM-LENS. The black line represents the ensemble mean, the red line a linear trend, and the grey the residuals.

We can explore this question by using the FG_ALT_CO2 output from the CESM-LENS. This output represents the CO_2 flux when run from 1920-2100 with pre-industrial emissions. Thus, there is no anthropogenic carbon involved in this simulation. The difference between F_{CO_2} and FG_ALT_CO2 is then anthropogenic carbon. (See [Lovenduski et al., 2007] for more details)

This is a test sentence [Brady et al., 2017].

References

- Riley X. Brady, Michael A. Alexander, Nicole S. Lovenduski, and Ryan R. Rykaczewski. Emergent anthropogenic trends in California Current upwelling. *Geophys. Res. Lett.*, 44(10):2017GL072945, May 2017. ISSN 1944-8007. doi: 10.1002/2017GL072945. URL <http://onlinelibrary.wiley.com/doi/10.1002/2017GL072945/abstract>.
- Nicole S. Lovenduski, Nicolas Gruber, Scott C. Doney, and Ivan D. Lima. Enhanced CO₂ outgassing in the Southern Ocean from a positive phase of the Southern Annular Mode. *Global Biogeochem. Cycles*, 21(2):GB2026, June 2007. ISSN 1944-9224. doi: 10.1029/2006GB002900. URL <http://onlinelibrary.wiley.com/doi/10.1029/2006GB002900/abstract>.