Evaluating the Skill of Linear Models of Salinity and $\delta^{18}O_{SW}$ Using Isotope-Enabled Climate Models

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INTRODUCTION

Isotopic coral data serves as a proxy for tropical hydroclimate. In particular, the stable oxygen isotope in coral aragonite ($\delta^{18}O_c$) is related to both temperature and stable oxygen isotope presence in surrounding sea water ($\delta^{18}O_{SW}$) at the time of calcification, the latter being strongly correlated with sea-surface salinity. This results in a simple linear model between $\delta^{18}O_c$, temperature, and salinity (S). This relationship makes $\delta^{18}O_c$ a powerful proxy for inferring past variability in tropical climate. While the direct relationship between temperature and $\delta^{18}O_c$ is often reduced to a constant coefficient, the relationship between S and $\delta^{18}O_c$ varies in both space and time. In order to effectively deduce the relationship between S and $\delta^{18}O_c$, we must first account for the relationship between S and $\delta^{18}O_{SW}$.

KEY GOALS

- Before beginning the formal analysis of the relationship between S and $\delta^{18}O_{SW}$, we aim to recreate Figure 8(b) from Brady et al. – 2019, for scientific consistency.
- Once the figure is recreated, we can proceed with the study by subsampling iCESM data according to an existing observational dataset (Conroy et al. – 2017), splitting the pseudo-observations into two groups and then analyzing the relationship between S and $\delta^{18}O_{SW}$ within each group.

METHODS

- Plotted $\delta^{18}O_{SW}$ mean from 1850 – 2005 using iCESM data (Figure 1)
- Created 6 datasets including coordinates and time period according to the Conroy et al. – 2017 (Conroy) data
- Subsampled iCESM data from 2002 – 2005 and the last millennium at the coordinates obtained from the Conroy dataset, and plotted their respective S and $\delta^{18}O_{SW}$ relationships against each other (Figures 2 & 3)

RESULTS

Our results illustrate a widely consistent relationship between S and $\delta^{18}O_{SW}$ across all the datasets except for Kiritimati Spatial, where the training data did not have adequate distributional coverage for us to compare to the testing data.

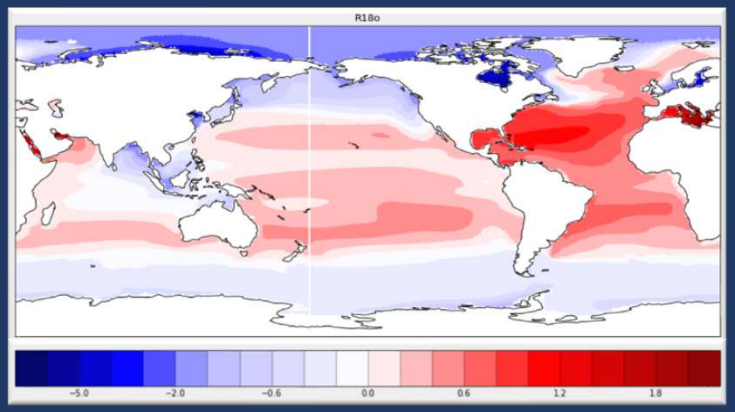

Figure 1) Brady et al. – 2019 Figure 8(b) recreation by calculating the mean $\delta^{18}O_{SW}$ from 1850 – 2005

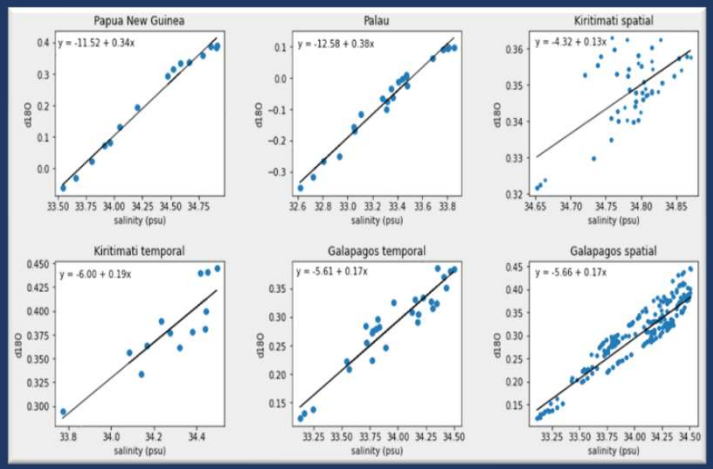

Figure 2) 2002-2005 pseudo-observation relationship between S and $\delta^{18}O_{SW}$ in each of the six datasets using linear regression

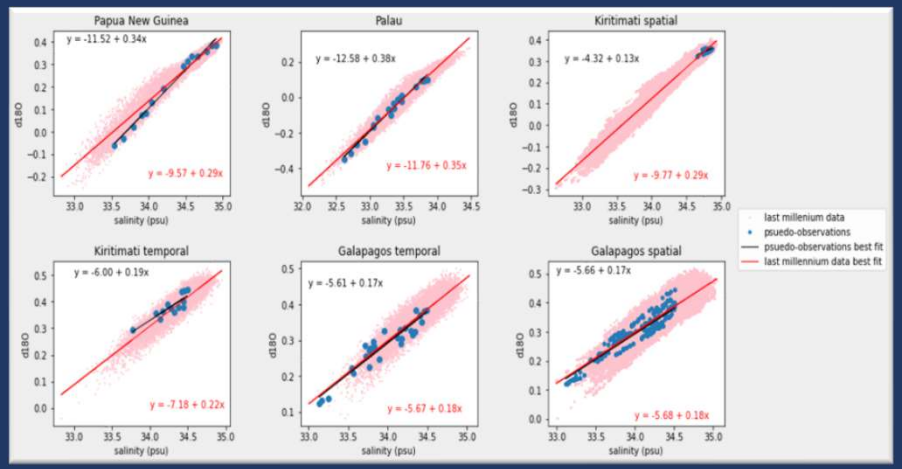

Figure 3) The relationship from Figure 2 plotted with the same relationship but with a testing dataset that spans across the last millennium, with both sets of scatterplots and best fit lines being plotted

CONCLUSIONS & NEXT STEPS

Based on our results, we can conclude that there is a strong and consistent relationship between the two variables in question, but we need to diversify our analysis. The next step is to expand this study to the LeGrande and Schmidt – 2006 dataset. Our goal will be to subsample the iCESM according to observations from Figure 1(a) in the paper. We will then create a smoothed plot for global $\delta^{18}O_{SW}$ for both our training and testing datasets. Using these smoothed plots, we will calculate the residuals between our figures and Figure 1(b) from the same paper. This will develop our understanding of how our two datasets compare to observational data, and how much the relationship varies over space and time.