Introduction: Paragraphs 1-3

Multiple studies have confirmed the relationship between the Atlantic Nino/Nina and the Pacific ENSO (El Nino Southern Oscillation), that an Atlantic Nina is able to cause a Pacific Nino, and vice-versa. The causes of this relationship have been thoroughly studied, but in brief, warm waters caused by an Atlantic Nina triggers a loop of circulating air over the Americas. This loop has descending section over the Pacific Ocean, strengthening the Easterly trade winds, and triggering a Pacific La Nina event. Scientists discovered a peak in the Atlantic-Pacific connection in the 1970’s. This connection is very important to the prediction of strong Pacific ENSO events, as many of the strongest ENSO events were preceded by Atlantic Niños/Niñas. This study aims to analyze the loss of predictability of ENSO caused by global warming.

Methodology and Results: Paragraphs 4-22

The authors of the study use two main types of data, sea temperature observations from pre-collected datasets, and simulations of past (1900-1999) and future (2000-2999) climates. The researchers used a statistical tool called Empirical Orthogonal Function (EOF) analysis, which detects patterns in data by calculating the principal components of data on a map. A principal component is a line which describes data on a scatter plot by showing the location of the most variance of the dataset. They applied EOF analysis to records of sea surface temperature (SST) in the Equatorial Atlantic and identified the principal component that captures the time variability and progression of the Atlantic Nino/Nina. The time principal component was referred to as the Atl-EOF index.

The researchers then measured the impact on the Pacific Ocean by correlating the Pacific SST anomaly with the Atl-EOF index. However, given that the ENSO does not significantly impact the entire Equatorial pacific, they averaged only the data on the map where the correlation to the Atl-EOF index was statistically significant. They also only averaged those points whose sign (negative or positive) agrees with the sign of the entire region. This prevented the correlation coefficients from cancelling out. The change in the average of the correlation coefficients indicates that the Atlantic-Pacific connection was strongest around the 1970’s and then began to weaken.

The next step in their experiment was to set up the CMIP5 models to represent the Atlantic-Pacific connection, and then observe the connection’s change in future climate. They identified a set of CMIP5 models that were able to accurately simulate the observed Atlantic-Pacific connection by keeping only those models that produced a statistically significant correlation between the Atlantic Nino and the Pacific. They ran the 17 chosen CMIP5 models over the period from 2000-2999. The average of the correlation coefficients for the statistically significant points was reduced for 13 of the 17 models. The average reduction across all models was 47.8%. The researchers confirmed this value’s statistical significance using the bootstrap method. The bootstrap method involves randomly picking out new samples from a dataset (that is a sample, not the population), with replacement. This effectively creates a new set of samples, that more closely follows a normal curve and is easier to analyze.

The researchers determined that this loss of connection is caused by an increasingly stable troposphere. Most (14/17) of the CMIP5 models showed a weakening of the vertical winds induced by an Atlantic Nino/Nina. Under greenhouse warming, the vertical temperature gradient is reduced as the upper troposphere warms faster than the lower levels. They confirmed these results by running a set of weather simulations. They ran some in the present-day atmosphere and others in an atmosphere with 4 times the current level of carbon dioxide. They observed a significant reduction in the summer vertical temperature gradient and vertical wind speeds.

Discussion: Paragraph 14

Their hypothesis was supported, as there is a statistically significant reduction of correlation between Atlantic Niños and the Pacific in future climates. Although there is bias in the CMIP5 models, the results indicate no significant connection observed bias and changes in their results. Their results show that forecasting Pacific ENSO events will become more difficult in future climates.

Jia, F., Cai, W., Wu, L., Gan, B., Wang, G., Kucharski, F., . . . Keenlyside, N. (2019). Weakening Atlantic Niño-Pacific connection under greenhouse warming. Science Advances, 1-9.

Questions:

1. What would you suggest to improve the accuracy of forecasting El Nino/La Nina?
2. Why did you use a bootstrap test to determine the statistical significance of the reduction of predictability?
3. What future studies would you recommend to further study the impact of global warming on El Nino/La Nina?