Mid-Pliocene warmth changed tropical rainfall variability

Hana Kawashima[1], Shineng Hu[1] [1]Nicholas School of the Environment, Duke University, Durham

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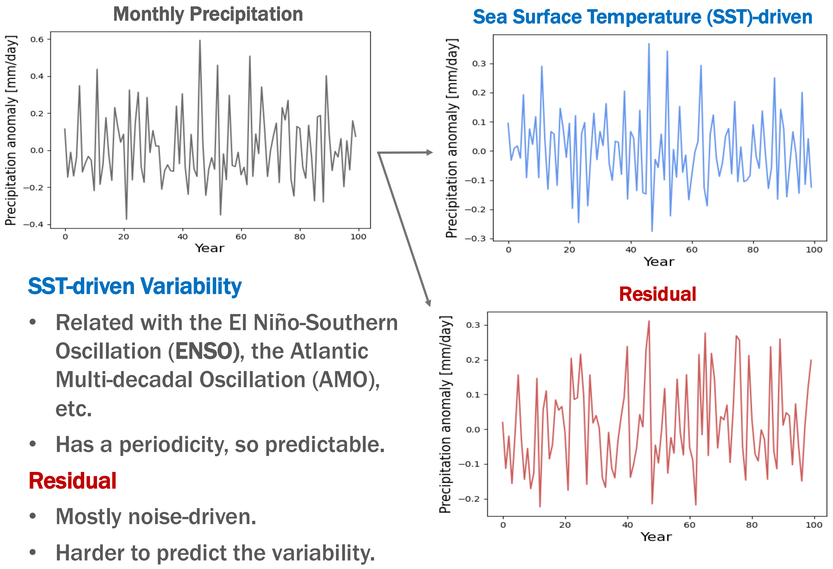
Keys of this study

- Total precipitation can be decomposed into SST-driven and residual precipitation variabilities.
- Residual precipitation variability showed a stronger correlation with mean precipitation than SST-driven variability.
- Residual precipitation variability is likely to be related to noise-induced precipitation, so its increase may affect the ENSO predictability.

How will rainfall variabilities change under warmer climate conditions?



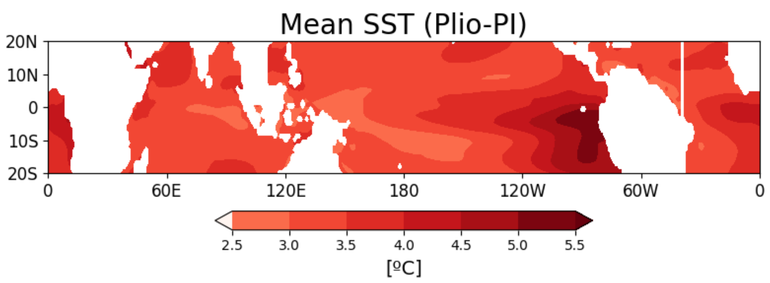
SST-driven Variability

- Related with the El Niño-Southern Oscillation (**ENSO**), the Atlantic Multi-decadal Oscillation (AMO), etc.
- Has a periodicity, so predictable.

Residual

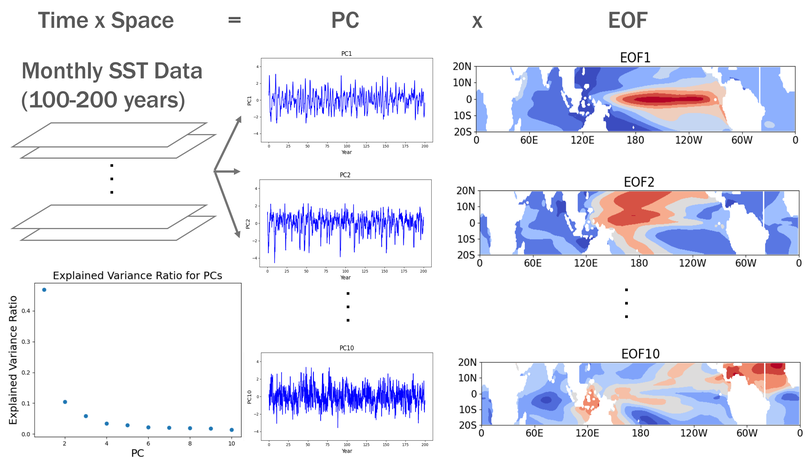
- Mostly noise-driven.
- Harder to predict the variability.

Mean SST was higher during the mid-Pliocene, but the increase varies in regions.



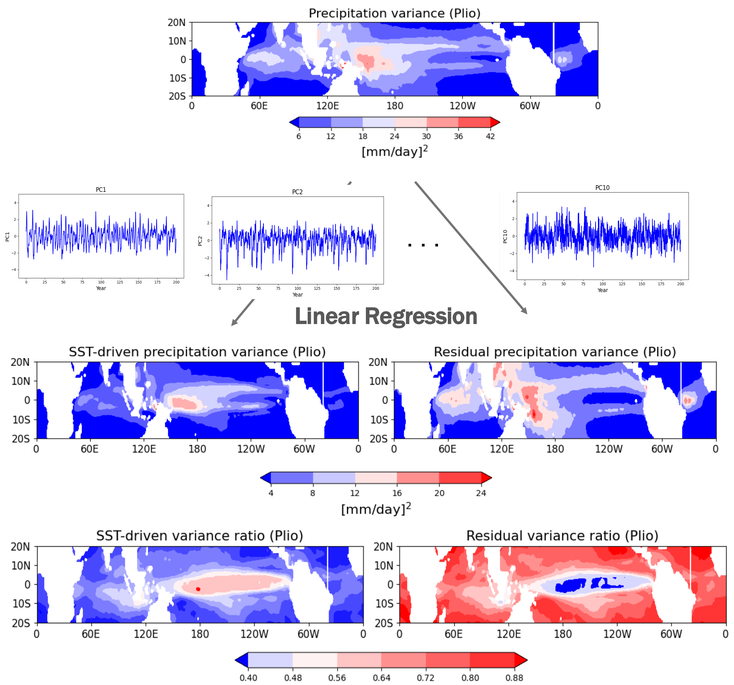
- For the mid-Pliocene climate simulations, the CO_2 level was set at **400** ppm while it was 280 ppm in the pre-industrial period (PI) simulations.
- Mean surface temperature was **2-3 ºC** warmer on average and larger warming was seen in the eastern Pacific Ocean.
- The mean temperature change varies between different climate models.

Empirical Orthogonal Function Analysis (EOF)



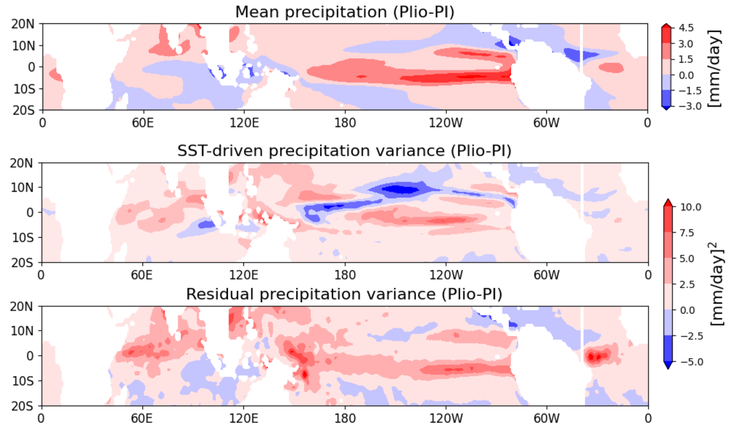
- Temporal and spatial patterns were extracted from SST data, which contains information on both time and space.
- PC1 has an ENSO-like SST pattern and explains almost half of the entire oscillations.
- The explained variance ratio decays exponentially.

SST-driven rainfall variability dominates in the equatorial Pacific Ocean, while residual variability is dominant in the other regions.



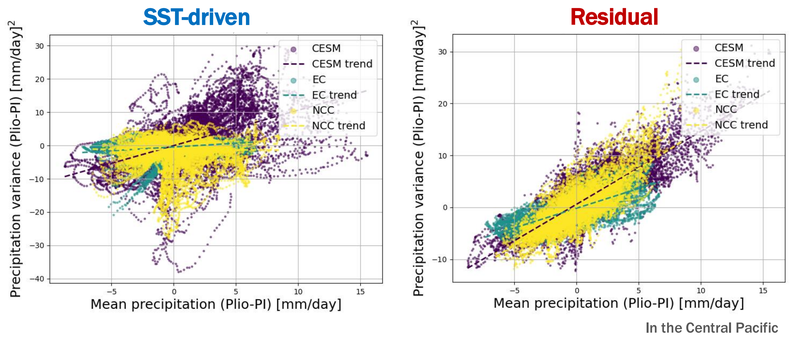
- The leading 10 PCs were used for the decomposition.
- The middle two figures exhibit SST-driven and residual precipitation variances, and the bottom two are those divided by the total variance.

Changes in mean precipitation and residual precipitation variance demonstrate a similar spatial distribution.



- Changes in mean precipitation and decomposed precipitation variances from the CESM simulation.
- Changes in annual mean precipitation and annual residual precipitation variance have more similar spatial patterns.

Stronger residual precipitation variability may be accompanied by mean precipitation increase.



- CESM, EC, and NCC represent three different climate models.
- Stronger positive correlations between mean precipitation and residual precipitation variability, and the mean R-value is about 0.25 for SST-driven variance and about 0.8 for residual variance.
- The slope varies between different climate models.

- **Precipitation can be decomposed into residual and SST-driven variability.**
- **Changes in mean precipitation and residual precipitation variability exhibit a strong positive correlation, implying a control by the Clausius-Clapeyron relation. Their sensitivity is model-dependent.**
- **The change in SST variability may significantly influence the change in SST-driven precipitation variability.**
- **The increase in residual precipitation variability may affect ENSO dynamics and predictability.**