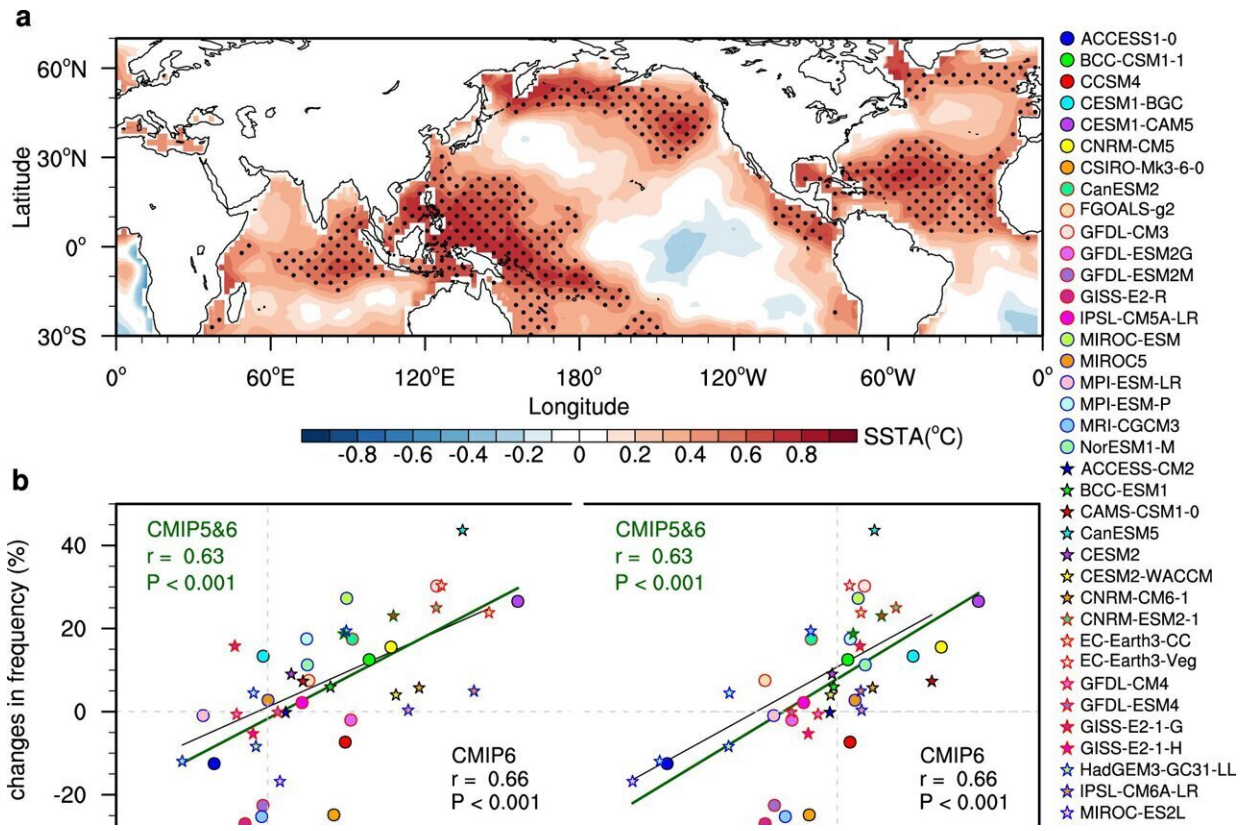
Greenhouse warming and internal variability synergistically increase extreme and central Pacific El Niño frequency

January 30 2023, by Li Yuan



The relationship between the Atlantic Multidecadal Oscillation (AMO) and El Niño types. a The correlation between the internal variability (IV) induced zonal sea surface temperature (SST) anomaly gradient and the residual SST anomaly (SSTA) field. The black stippling indicates statistically significant correlations at the 0.05 level. The merged SST from 1871 to 2017 was used. b Inter-model relationship between the changes in the 21-year running mean western Pacific

(WP) SSTA (130°E–170°E) /Zonal SST gradient [WP SST (155°E–175°W) minus central Pacific SST (115°W–145°W)] (x-axis, units: °C) and the frequency changes in the extreme/ Central Pacific (CP) El Niño events (y-axis, units: %) and for AMO positive state (AMO-positive state) minus AMO-negative state. Due to the model's bias in simulating the evolution of El Niño, we use the El Niño onset phase (April to August) averaged WP SSTA > 0 °C to roughly distinguish the extreme/CP from Eastern Pacific (EP) events. 20 CMIP5 and 23 CMIP6 pre-industrial control simulations were used. c The 21-year sliding frequency of extreme El Niño events (black solid line)/CP El Niño events (red solid line) in the reconstruction and the normalized 21-year running mean AMO reconstruction index. The 21-year sliding frequency is defined by counting extreme/CP El Niño events during the 21 years. The CP El Niño events in the reconstruction are according to ref. The extreme El Niño events are defined by Niño-3.4 reconstruction index >1.2 standard deviations. Credit: *Nature Communications* (2023). DOI: 10.1038/s41467-023-36053-7

Researchers from the Institute of Atmospheric Physics (IAP) of the Chinese Academy of Sciences and their collaborators have investigated past changes in El Niño diversity and quantified the contribution of anthropogenic forcing and internal variability to the recently observed El Niño diversity. They found that greenhouse warming and internal variability synergistically increased extreme and Central Pacific El Niño frequency since 1980.

The study was published in *Nature Communications* on Jan. 24. It is based on multiple pieces of evidence, including multiple long-term observations and the outputs from sixth phases of the Coupled Model Intercomparison Project (CMIP6).

The researchers revealed another extreme El Niño and Central Pacific El Niño epoch around the year 1900, with similar spatial and temporal evolution, dynamic processes, and climate impacts as those that occurred

in the last 40 years. They also found that the frequent occurrence of extreme El Niño events and Central Pacific El Niño events since 1980 was caused by the combination of anthropogenic forcing and internal variability associated with the Atlantic Multidecadal Oscillation.

"A positive Atlantic Multidecadal Oscillation enhances the zonal sea surface temperature gradient in the Central Pacific, which strengthens zonal advective feedback, favoring extreme and Central Pacific El Niño development," said Prof. Huang Gang, corresponding author of the study.

Moreover, using a statistical model, the researchers quantified the contribution of anthropogenic forcing and internal variability to the recently observed El Niño diversity.

"How El Niño will change in the future is a crucial issue, yet model projections remain large uncertainty. Understanding the observed variation of El Niño may help more accurately project El Niño's future change," said Prof. Huang.

More information: Ruyu Gan et al, Greenhouse warming and internal variability increase extreme and central Pacific El Niño frequency since 1980, *Nature Communications* (2023). DOI: 10.1038/s41467-023-36053-7

Provided by Chinese Academy of Sciences