Current climate models misrepresent El Nino

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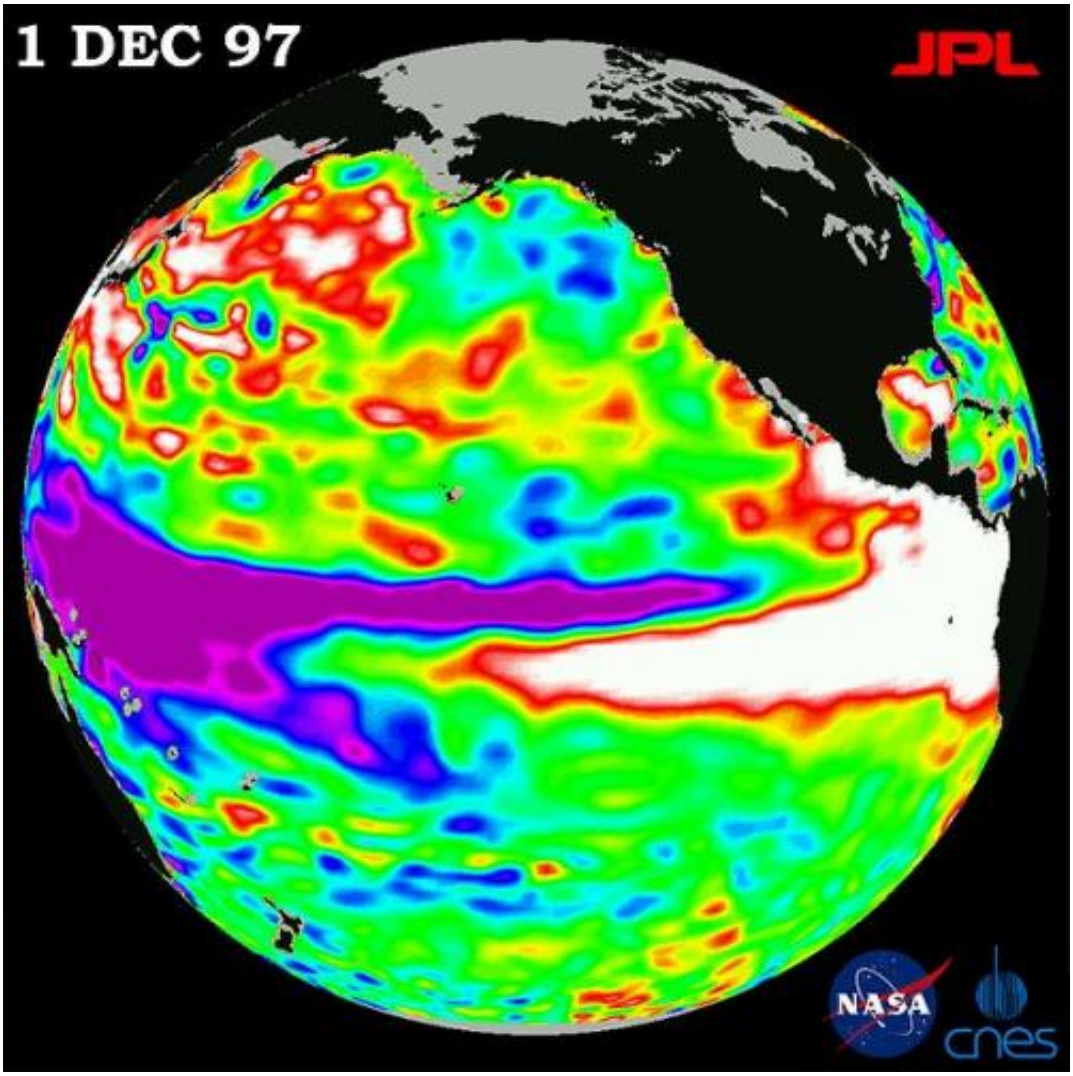

The 1997 El Nino seen by TOPEX/Poseidon. Credit: NASA

An analysis of fossil corals and mollusk shells from the Pacific Ocean

reveals there is no link between the strength of seasonal differences and El Niño, a complex but irregular climate pattern with large impacts on weather, agriculture, fisheries, tourism, and air quality worldwide.

The finding contradicts the top nine climate models in use today, which associate exceptionally hot summers and cold winters with weak El Niños, and vice versa.

"The idea behind this link is based on very well-established physics, so it's appealing to think that nature works this way. But our analysis shows that it's not that simple," said Julien Emile-Geay, lead author of a study contradicting the models and assistant professor of Earth Sciences at the USC Dornsife College of Letters, Arts and Sciences.

His study was published on December 14 in the journal *Nature Geoscience*.

Emile-Geay checked the models against data collected by his coauthors on shells and fossil corals spanning the Holocene period - the last 10,000 years of Earth's history. The period had similar geography, amounts of ice and levels of greenhouse gases in the atmosphere, making it a good analogue for today's climate.

Because shells form by crystalizing calcium carbonate taken from the surrounding water, they record information about the temperature and salinity of that water. For example, the shells capture the prevalence of various isotopes of oxygen, which vary based on sea-surface temperature.

Analyzing the composition of nearly 60 specimens through their thickness, the team was able to reconstruct a detailed history of climate in the tropical Pacific. The corals and clams were taken from various locations throughout the Pacific Ocean, creating a spatially and time-

distributed data set that offered insight into both the amplitude of seasons and the intensity of El Niño via snapshots spanning the past 10,000 years.

He then compared this dataset to the predictions of nine state-of-the-art climate models, and found a mismatch: the models generally fail to simulate lengthy periods of subdued El Niños like the one that occurred 3,000 to 5,000 years ago; the ones that came close did so by relying on an Earth-Sun configuration that ran contrary to observed conditions.

"The causes for prolonged periods of weak El Niño are either beyond the current models, or we're missing an important piece of the puzzle" Emile-Geay said. "This points to deficiencies in the way these models simulate various aspects of tropical Pacific climate, from average conditions, to the march of seasons, to El Niño itself."

Emile-Geay said he hopes his findings will be used to refine climate models further, making them ever more accurate.

"Building climate models is like building a ladder to the Moon," Emile-Geay said. "They are not perfect but they are reaching for the heavens. It's a long process, and one in which the paleoclimate record can teach us a lot about the inner workings of the climate system."

More information: J. Emile-Geay et al. Links between tropical Pacific seasonal, interannual and orbital variability during the Holocene, *Nature Geoscience* (2015). DOI: 10.1038/ngeo2608

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