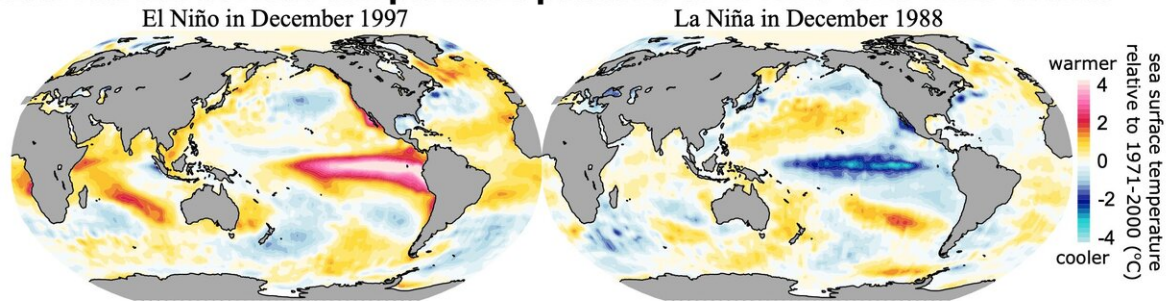


# Fidelity of El Niño simulation matters for predicting future climate

August 28 2020

## Observed sea surface temperature patterns of El Niño & La Niña events



Sea surface temperature patterns during El Niño (warmer water (red) in the eastern tropical Pacific) and La Niña (cooler water (blue) in the eastern tropical Pacific) events. Credit: NOAA data

A new study led by University of Hawai'i at Mānoa researchers, published in the journal *Nature Communications* this week, revealed that correctly simulating ocean current variations hundreds of feet below the ocean surface—the so-called Pacific Equatorial Undercurrent—during El Niño events is key in reducing the uncertainty of predictions of future warming in the eastern tropical Pacific.

Trade winds and the temperatures in the tropical Pacific Ocean experience large changes from year to year due to the El Niño-Southern Oscillation (ENSO), affecting weather patterns across the globe. For

instance, if the tropical Pacific is warmer and trade winds are weaker than usual—an El Niño event -flooding in California typically occurs and monsoon failures in India and East Asia are detrimental to local rice production. In contrast, during a La Niña the global weather patterns reverse with cooler temperatures and stronger trade winds in the tropical Pacific. These natural [climate](#) swings affect ecosystems, fisheries, agriculture, and many other aspects of human society.

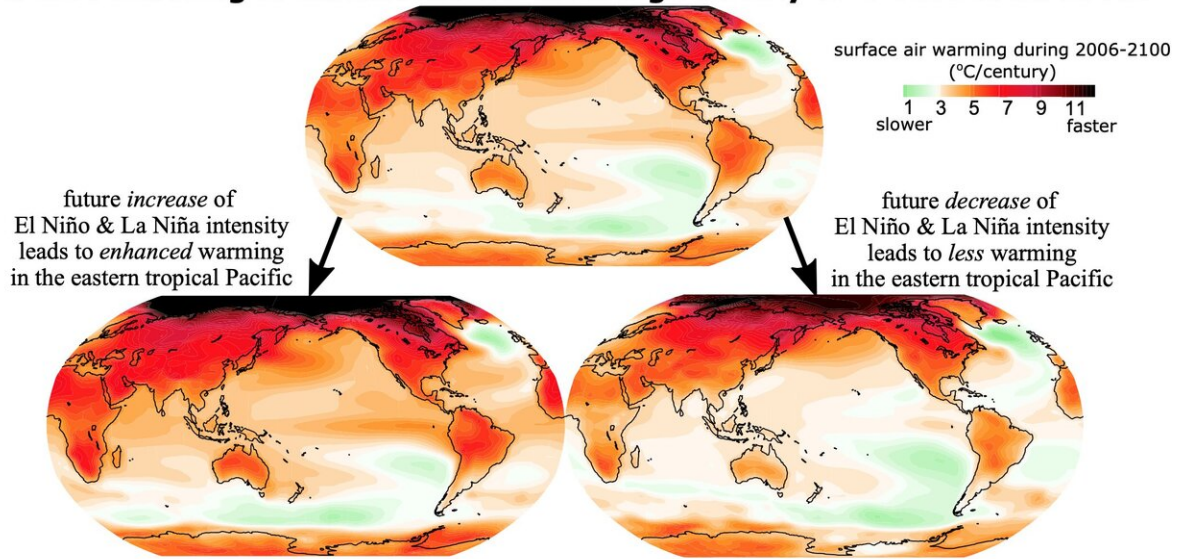
Computer models that are used for projecting future climate correctly predict [global warming](#) due to increasing [greenhouse gas emissions](#) as well as short-term year-to-year natural climate variations associated with El Niño and La Niña.

"There is, however, some model discrepancy on how much the tropical Pacific will warm," said Malte Stuecker, co-author and assistant professor in the Department of Oceanography and International Pacific Research Center at UH Mānoa. "The largest differences are seen in the eastern part of the tropical Pacific, a region that is home to sensitive ecosystems such as the Galapagos Islands. How much the eastern tropical Pacific warms in the future will not only affect fish and wildlife locally but also future weather patterns in other parts of the world."

Researchers have been working for decades to reduce the persistent model uncertainties in tropical Pacific warming projections.

Many climate models simulate El Niño and La Niña events of similar intensity. In nature, however, the warming associated with El Niño events tends to be stronger than the cooling associated with La Niña. In other words, while in most models El Niño and La Niña are symmetric, they are asymmetric in nature.

**Surface warming in climate models with high fidelity of El Niño simulations**



Future increase of El Niño and La Niña intensity leads to enhanced warming in the eastern tropical Pacific (left). Future decrease of El Niño and La Niña intensity leads to less warming in the eastern tropical Pacific (right). Credit: Data from NOAA.

In this new study, the scientists analyzed observational data and numerous climate [model](#) simulations and found that when the models simulate the subsurface ocean current variations more accurately, the simulated asymmetry between El Niño and La Niña increases—becoming more like what is seen in nature.

"Identifying the models that simulate these processes associated with El Niño and La Niña correctly in the current climate can help us reduce the uncertainty of future climate projections," said corresponding lead author Michiya Hayashi, a research associate at the National Institute for Environmental Studies, Japan, and a former postdoctoral researcher at UH Mānoa supported by the Japan Society for the Promotion of Science (JSPS) Overseas Research Fellowships. "Only one-third of all climate

models can reproduce the strength of the subsurface current and associated ocean temperature variations realistically."

"Remarkably, in these models we see a very close relationship between the change of future El Niño and La Niña intensity and the projected tropical warming pattern due to greenhouse warming," noted Stuecker.

That is, the models within the group that simulate a future increase of El Niño and La Niña intensity show also an enhanced warming trend in the eastern tropical Pacific due to greenhouse warming. In contrast, the models that simulate a future decrease of El Niño and La Niña intensity show less greenhouse gas-induced warming in the eastern part of the basin. The presence of that relationship indicates that those models are capturing a mechanism known to impact climate—signifying that those models are more reliable. This relationship totally disappears in the two-thirds of climate models that cannot simulate the subsurface ocean current variations correctly.

"Correctly simulating El Niño and La Niña is crucial for projecting climate change in the tropics and beyond. More research needs to be conducted to reduce the biases in the interactions between wind and ocean so that climate models can generate El Niño—La Niña asymmetry realistically," added Fei-Fei Jin, co-author and professor in the Department of Atmospheric Sciences at UH Mānoa.

"The high uncertainty in the intensity change of El Niño and La Niña in response to greenhouse [warming](#) is another remaining issue," said Stuecker. "A better understanding of Earth's natural climate swings such as El Niño and La Niña will result in reducing uncertainty in future climate change in the tropics and beyond."

**More information:** *Nature Communications* (2020). [DOI: 10.1038/s41467-020-17983-y](https://doi.org/10.1038/s41467-020-17983-y)

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