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Extending climate predictability beyond El Niño

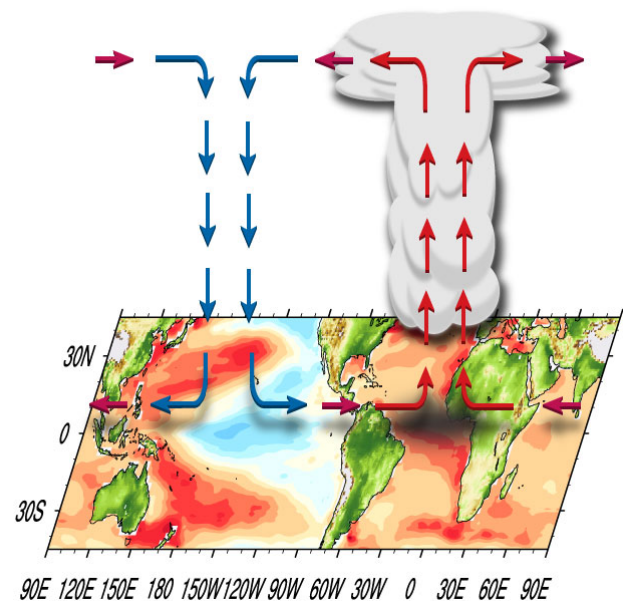
Tropical Pacific climate variations and their global weather impacts may be predicted much further in advance than previously thought, according to research by an international team of climate scientists from the USA, Australia, and Japan. The source of this predictability lies in the tight interactions between the ocean and the atmosphere and among the Atlantic, the Pacific and the Indian Oceans. Such long-term tropical climate forecasts are useful to the public and policy makers.

At present, computer simulations can predict the occurrence of an El Niño event at best three seasons in advance. Climate modeling centers worldwide generate and disseminate these forecasts on an operational basis. Scientists have assumed that the skill and reliability of such tropical climate forecasts drop rapidly for lead times longer than one year.

The new findings of predictable climate variations up to three years in advance are based on a series of hindcast computer modeling experiments, which included observed ocean temperature and salinity data. The results are presented in the April 21, 2015, online issue of *Nature Communications*.

“We found that, even three to four years after starting the prediction, the model was still tracking the observations well,” says Yoshimitsu Chikamoto at the University of Hawaii at Manoa International Pacific Research Center and lead author of the study. “This implies that central Pacific climate conditions can be predicted over several years ahead.”

“The mechanism is simple,” states co-author Shang-Ping Xie from the University of California San Diego. “Warmer water in the Atlantic heats up the atmosphere. Rising air and increased precipitation drive a large atmospheric circulation cell, which then sinks over the Central Pacific. The relatively dry air feeds surface winds back into the Atlantic and the Indian Ocean. These winds cool the Central Pacific leading to conditions, which are similar to a La Niña Modoki event. The central Pacific cooling then strengthens the global atmospheric circulation anomalies.”



This image shows inter-basin coupling as a cause of multi-year tropical Pacific climate predictability: Impact of Atlantic warming on the global atmospheric Walker circulation (arrows). Rising air over the Atlantic subsides over the equatorial Pacific causing central Pacific sea surface cooling, which in turn reinforces the large-scale wind anomalies.

“Our results present a paradigm shift,” explains co-author Axel Timmermann, climate scientist and professor at the University of Hawaii. “Whereas the Pacific was previously considered the main driver of tropical climate variability and the Atlantic and Indian Ocean its slaves, our results document a much more active role for the Atlantic Ocean in determining conditions in the other two ocean basins. The coupling between the oceans is established by a massive reorganization of the atmospheric circulation.”

The impacts of the findings are wide-ranging. “Central Pacific temperature changes have a remote effect on rainfall in California and Australia. Seeing the Atlantic as an important contributor to these rainfall shifts, which happen as far away as Australia, came to us as a great surprise. It highlights the fact that on multi-year timescales we have to view climate variability in a global perspective, rather than through a basin-wide lens,” says Jing-Jia Luo, co-author of the study and climate scientist at the Bureau of Meteorology in Australia.

“Our study fills the gap between the well-established seasonal predictions and internationally ongoing decadal forecasting efforts. We anticipate that the main results will soon be corroborated by other climate computer models,” concludes co-author Masahide Kimoto from the University of Tokyo, Japan.

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