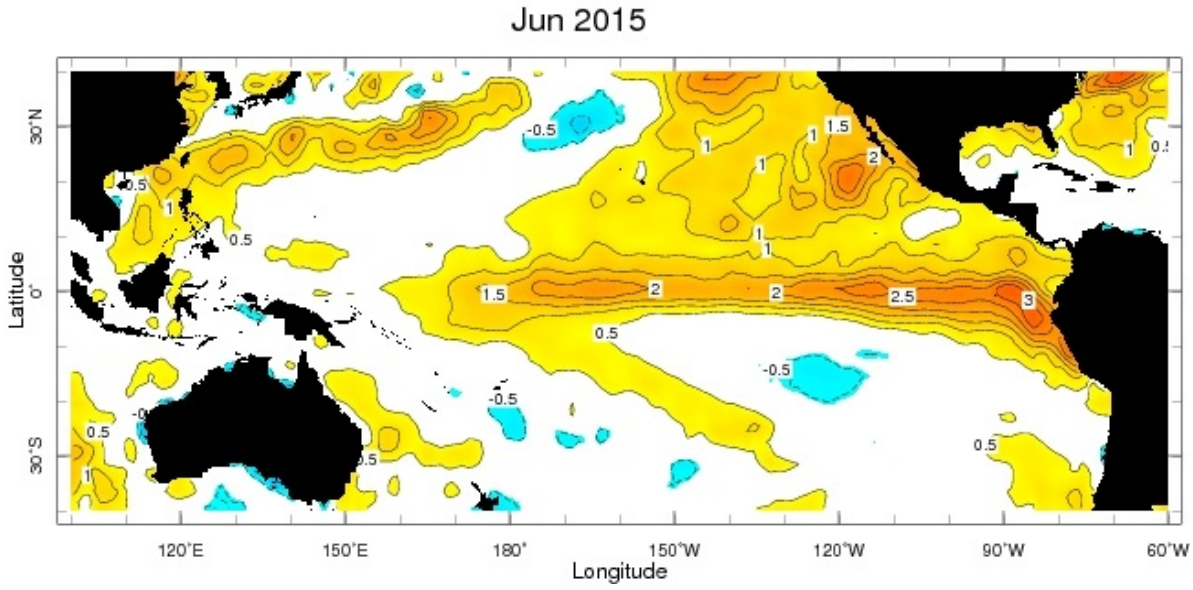
The extreme Pacific climate now

July 15 2015, by Adam Sobel Earth Institute, Columbia University



Sea surface temperature anomaly map for June 2015 — how far the temperature varies from average, in degrees C.

The climate over the tropical Pacific is in an extreme state at the moment. That explains some of the extreme anomalies affecting the United States right now. It also gives us a window through which we can glimpse how even more dramatic and long-term climates of the distant past might have worked, and – in the most radical scenarios, unlikely but impossible to rule out entirely – how much more extreme future climate changes could occur.

Now that Typhoon Chan-Hom has blown over Shanghai, then past Seoul before fizzling out, and Typhoon Nangka now heads north towards Japan, there are four other tropical cyclones further east in the Pacific. None of them is particularly powerful yet, but there's time. Two of the current storms are in the Central North Pacific, in the general vicinity of Hawaii, where another one, Ela, has just fizzled out. This is an incredibly strong burst of tropical cyclone activity for the Central Pacific, and unprecedented for how early in the season it has come.

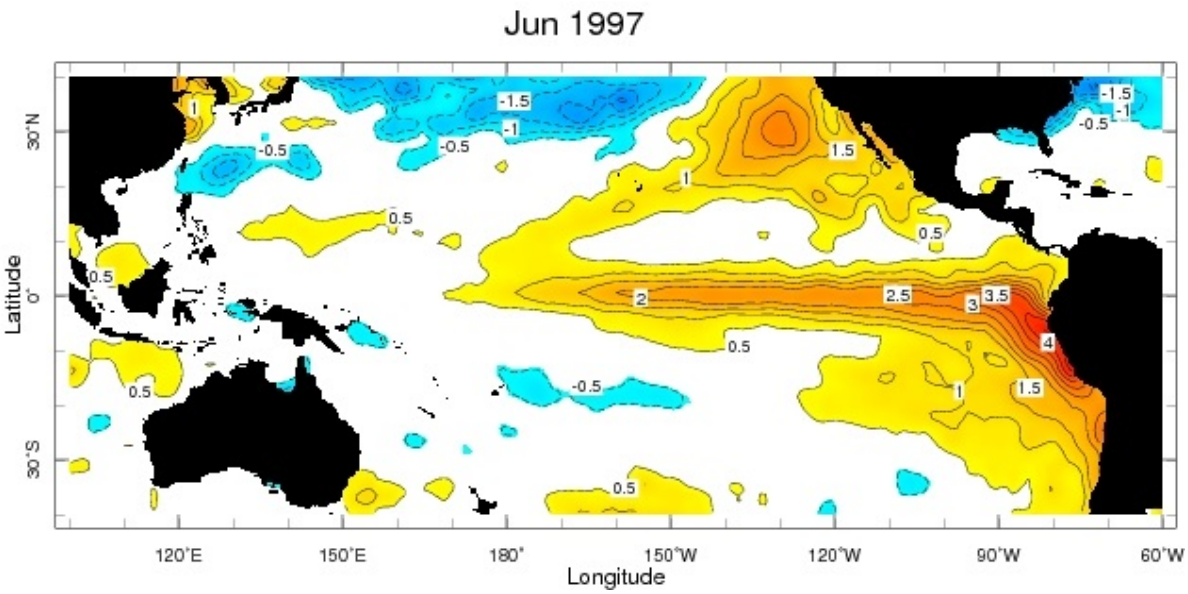
What is going on? The El Niño event currently ongoing in the eastern and Central Pacific is strengthening. The only question is whether it will be just a significant event, or a huge one. While those of us who were in New York City for the blizzard of late January 2015 have learned that we shouldn't apply the word "historic" to weather or climate events before they actually happen, this El Niño has at least the potential to become the biggest one since the onset of modern records. It's already at least competitive with the current record holder, the "super El Niño" of 1997-1998. Strong tropical cyclone seasons in the Central and Eastern Pacific often occur during El Niño events, when the ocean surface becomes anomalously warm along the equator there. That pattern is firmly in place now.

Around a week ago, the most commonly used indicator of the Madden-Julian oscillation (MJO) reached a value in excess of four standard deviations, breaking the record since the start of modern observations in the 1970s. The MJO is the most important atmospheric phenomenon you've never heard of, a tropical weather disturbance with global ramifications broadly similar to those El Niño, except that the MJO evolves faster, over a month or two, while El Niño takes months to years. The current extreme MJO happened as its disturbed weather conditions temporarily locked into phase with the anomalously high sea surface temperatures and rainy weather already in place in the Central Pacific due to the El Niño. The combination of the two helped to spawn the

current flock of tropical cyclones there.

The upside of the El Niño is that it is suppressing hurricanes in the Atlantic. Indeed conditions in the normal tropical Atlantic hurricane breeding ground, close to the equator, are about as hostile as can be. Tropical storm Claudette has nonetheless managed to put itself together off the mid-Atlantic coast, but it won't be a threat to anyone. In the longer term, the other potential benefit of the El Niño is that if it holds together into the winter—as is very likely—there is good reason to hope it could deliver some heavy rain events to California. This would have the potential to make a dent in the severe and protracted drought there, though unlikely enough to end it entirely.

On the other hand, it's not good news for the Pacific Northwest, where El Niños tend to lead to warm, dry winters. Oregon, Washington and British Columbia are already experiencing serious drought and wildfire, after a winter where precipitation fell as rain even in the high mountains, leaving no snowpack to provide summer's water supply. This is being followed by an extended heat wave to rival the near-simultaneous one that just broke records all over Europe. Most ominous in the short term, the fire season is still young.



The monthly sea surface temperature anomaly map from June 1997 — the year of the most extreme El Nino in the modern observational record.

Could this event get any more extreme? In theory, yes.

The equatorial atmosphere could switch to a state of permanent super-rotation, leading to a sudden shift to climate conditions last seen 50 million years ago, when alligators lived at the poles.

That's a climate scientist's nerdy joke – sort of. It's based on serious research, and the real events of the moment do bear some connection to it.

El Niño and MJO events are both associated with acceleration of the total atmospheric angular momentum. Meaning the whole atmosphere, on average, starts moving a little faster around the earth's axis, in the same direction as the earth's natural rotation, west to east. The word "super-rotation" refers to when the winds at the equator move on average

faster in that direction than the earth itself.

The science of geophysical fluid dynamics tells us that super-rotation can only happen due to the action of giant wave disturbances in the atmosphere. These are the so-called "Rossby waves." These waves are pumped out of the tropics especially strongly when there are El Niño and MJO events. The rippling of these waves to higher latitudes causes excessive California rain, Pacific Northwest drought, and other typical El Niño consequences in the U.S.

Similar waves have been distorting the jet stream to create highly anomalous weather patterns such as we've seen in the last two winters in the U.S., with a bitterly cold East next to a hot, dry West. These seasons appear to have been due in part to a Pacific ocean surface temperature pattern somewhat different than those associated with El Niños, but that pattern, too, has been in an extreme state.

In climate models, one can create a state where the Rossby waves and the east-west winds interact with each so that the tropical winds switch direction to blow west-to-east. That's super-rotation, and it radically alters the entire planet's climate when it happens.

In some models, this happens in warm climates because the MJO strengthens, creating more Rossby waves. The resulting dynamics lock the climate into a state where the poles are dramatically warmer. Some researchers have argued that such a state may have actually occurred in the Eocene, around 50 million years ago, when fossils indeed show that alligators lived above the Arctic circle. To the extent these simulations are credible – still a matter of debate, but these models do an entirely plausible job at simulating today's climate – they suggest that the same thing could eventually happen due to human-induced climate change. If this were to happen, it would lead to a sudden and dramatic increase in global warming, beyond that which the greenhouse gases would have

already caused on their own.

This is an outside risk, a doomsday scenario that isn't likely to occur in this century, if ever. But it's an example of a low-probability, high-impact event that we can't entirely rule out. As we look at the relatively extreme state of the Pacific now, it's a reminder that the climate system has the potential to deliver conditions beyond any we have seen before.

More information: "Spontaneous transition to superrotation in warm climates simulated by CAM3": docs.lib.purdue.edu/cgi/viewco … 1031&context=easpubs

Provided by Earth Institute, Columbia University