# Corals unravel the history of El Niño and its changes

*The pattern of El Niño has changed dramatically in recent years, according to the first seasonal record distinguishing different types of El Niño events over the last 400 years. A new category of El Niño has become far more prevalent in the last few decades than at any time in the past four centuries. Over the same period, traditional El Niño events have become more intense.*

El Niño events influence the lives of millions of people around the world. The almost one year-long warming events in the tropical Pacific are so extreme and powerful that their impacts are felt around the globe. Many rainfall and temperature extremes as well as droughts are often associated with El Niño conditions. At the same time, some of the hottest years on record coincide with El Niño events. Over the past decades, considerable effort has been invested to study, describe and predict these El Niño events. However, El Niño has changed dramatically in recent years, so future changes on how El Niño will behave with climate change remains open.

A limitation that hinders our understanding of El Niño events is by the fact that El Niño events happen only every 2-7 years. So during our lifetime we could observe only a handful of events. This isn’t enough to really understand El Niño events and changing patterns. That’s why we started to look at corals from the tropical Pacific. The corals started growing decades to centuries before we began routinely measuring the climate with instruments. The corals are an excellent archive of changes in water conditions they experience as they grow, including ocean changes related to El Niño. We combined the information from a network of coral records that preserve seasonal histories.

At a seasonal timescale, we can see the characteristic patterns of past El Niño events in the chemistry of the corals. These patterns tell us when and where El Niño events occurred over the last 400 years. It is in this continuous picture of past El Niños obtained from coral archives that we found a clear picture of an unusual recent change in the Pacific’s El Niño.

El Niño events usually occur in the waters of the eastern tropical Pacific close to the South American coast. The warmer ocean during these events disrupt or even reverse the normal atmospheric circulation, called the Walker circulation, that moves air along the equator across the tropical Pacific. As a consequence, major weather systems are displaced so that Australia and parts of Asia often receive much less rainfall than during normal years. The opposite applies to the western parts of North and South America, where the stronger rising motion over unusually warm ocean waters often results in heavy rainfall, causing massive floods.

More recently a new type of El Niño has been frequently observed that is characterised by warm ocean temperatures in the Central Pacific, rather than the more typical warming in the far Eastern Pacific near the South American coast. Although not as strong as the Eastern Pacific version, the Central Pacific El Niño is clearly observed in recent decades, including in 2014-15 and most recently in 2018-19, and can differ enormously in terms of weather impacts from its stronger counterpart. By combing the information derived from long-living coral records with recent observations, we found that over most of the last 400 years, El Niño events happened roughly at the same rate in the Central and Eastern Pacific. By the end of the 20th century, though, our research shows a sudden change: a sharp increase of Central Pacific El Niño events becomes evident. At the same time, the number of conventional Eastern Pacific events stayed relatively low, but the three most recent Eastern-type events (in 1982-83, 1997-98 and 2015-16) were unusually strong.

This new finding will arguably alter our understanding of the El Niño phenomenon. Changes to El Niño will influence patterns of precipitation and temperature extremes in Australia, Southeast Asia and the Americas and opens a door to understanding past changes of El Niño, with implications for the future too. Knowing how the different types of El Niño have unfolded in the past will mean we are better able to model, predict and plan for future El Niños and their widespread impacts.