Rare Coral Archives Confirm Weaker El Niño During Colder, Abrupt Climate Events

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Extreme El Niño events, the warm phase of the El Niño–Southern Oscillation (ENSO), have increased in frequency since the late 20th century, making them a critical focus for understanding large-scale climate variability in a warming world. Climate model simulations show more frequent El Niño events due to anthropogenic forcing, fewer El Niño events when the earth was colder, and a consistent mechanism to explain the changes depicted in the model across time. New model-based analysis distinguishes total interannual variability from the fraction explained by ENSO, revealing that detectable changes across the tropical Pacific in ENSO-driven variability occur primarily during older periods of abrupt climate change—however no continuous records of past climate exist to evaluate the model when it simulates a weaker El Niño activity ~12 - 15,000 years ago. Here we present, for the first time, deglacial and Holocene coral oxygen isotope records from Vanuatu and compare them with previously published coral data, as well as existing and new climate model simulations, to analyze ENSO responses during colder abrupt climate events. Results show reduced ENSO strength and extreme El Niño frequency 12–15,000 years ago in both the model and corals, even during abrupt climate events which act to strengthen ENSO. Contrasts between past and future changes suggest anthropogenic forcing will amplify extreme El Niño impacts across the tropical Pacific and potentially far beyond, with global-scale consequences.

Keywords: El Niño, ENSO, Coral, Abrupt Climate Events