

Predicting how El Niño/Southern Oscillation (ENSO) will change with global warming is of enormous importance to society. ENSO exhibits considerable natural variability at interdecadal-centennial time scales. Instrumental records are too short to determine whether ENSO has changed while existing reconstructions are often contaminated by mid-latitude variability. Here we present a seven-century long ENSO reconstruction based on 2222 tree-ring chronologies from both the tropics and mid-latitudes in both hemispheres. The inclusion of tropical records enables us to achieve unprecedented accuracy, as attested by high correlation with equatorial Pacific corals and coherent modulation of global teleconnection that is consistent with an independent Northern Hemisphere temperature reconstruction. Our data indicate that ENSO activity in the late twentieth century is anomalously high over the past seven centuries, suggestive of a response to ongoing global warming. Climate models disagree on the ENSO response to global warming, suggesting that many models underestimate the sensitivity to radiative perturbations. Illustrating the radiative effect, our reconstruction reveals robust ENSO response to volcanic eruptions in unprecedented detail: Tropical volcanism forces the Pacific first into a La Niña state, followed by El Niño one year after; while extratropical eruptions induce La Niña in the second year. Our observations provide crucial constraints for improving climate models and their future projection.