GC44C-05 The frequency and intensity of El Niño events reconstructed from 3 independent sedimentary sequences

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Abstract

Continuous archives of the El Niño Southern Oscillation (ENSO) spanning multiple millennia are rare, as few geologic records faithfully preserve evidence of sub-decadal climate variability over long timescales. Different proxy archive types –such as lake sediments, foraminifera, tree-rings, and corals—have their own unique sensitivities to the climate system and can thus be difficult to intercompare. The sedimentary sequence from Laguna Pallcacocha, Ecuador, represents one of the most widely cited Holocene-scale ENSO reconstructions. Hundreds of mineral-rich flood laminae result from eastern Pacific El Niño events, when convective rainstorms drive erosion and terrigenous sediment transport in the Laguna Pallcacocha watershed. This reconstruction, however, is tangibly different from other ENSO proxy records as well as flood stratigraphies from proximal lakes. The watersheds of these nearby lakes have markedly different landscape characteristics, suggesting that the intensity of storms which generate flood deposits differ between each watershed. Thus, an integrated analysis of these three separate records helps constrain the frequency of paleo-ENSO events of different magnitudes. While moderate El Niño events may have been most frequent approximately 1000 years BP, particularly intense El Niño's occur more frequently during the subsequent Little Ice Age (1450-1850 CE), consistent with tree-ring based reconstructions of ENSO amplitude and foraminiferal records of high-intensity eastern Pacific warming. A widely reported minima in El Niño frequency between approximately 7-4 kyr BP is a prominent feature in Laguna Pallcacocha record. This minima is not present, however, in the high-intensity flood

stratigraphies from the other two lakes, which align more closely with ENSO amplitude records derived from speleothems and corals. These findings highlight the value of integrating evidence from multiple paleoclimate archives in ENSO reconstructions.

Plain-language Summary

The El Niño Southern Oscillation (ENSO) is a dominant driver of climate on interannual timescales. However, interannual climate variability is not often preserved in the geologic record, hindering our understanding how ENSO changes in different background climate states. Intense flooding associated with El Niño events have left sedimentary deposits preserved in some lake sediment records from the Ecuadorian Andes, but the magnitude of a flood which produces a measurable layer changes from lake to lake. Here, we analyze the frequency of flood deposits from three different lakes which differ in their sensitivity to El Niño events. This allows us to reconstruct both the frequency and intensity of El Niños over thousands of years. Recognizing some stratigraphic sequences as sensitive to ENSO frequency and others as primarily sensitive to particularly intense events helps resolve lingering discrepancies between lake sediment records of ENSO and those derived from other sources, such as corals, cave deposits, and marine organisms.

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