Could past changes in El Niño inform its future?

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Paleoclimate records show pronounced changes in the El Niño/Southern Oscillation (ENSO) phenomenon over past climatic intervals, but the application of these results to understand future changes is not straightforward. To address this issue we propose the following mechanism controlling ENSO variability across altered climate states. Numerical simulations show that extreme El Niño – the warm phase of ENSO – could become more frequent in climatic states with a shallower ocean mixed layer, as predicted for the future, and extremely infrequent under climatic states with a deeper mixed layer, typical of glacial intervals. Wind fluctuations involved in the onset of El Niño transfer momentum more efficiently over a thinner ocean mixed layer, thus favoring stronger ocean currents and faster warming during the event. The robustness of this momentum coupling mechanism across climatic states, together with the evidence that ENSO was weaker under glacial conditions, increases our confidence in model predictions of more frequent extreme El Niño under greenhouse warming.