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Prominent precession-band variance in El Niño–Southern Oscillation Intensity over the last 300,000 years

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It remains unclear how El Niño–Southern Oscillation (ENSO)—the prominent interannual anomalous climate mode—varied during the full glacial cycles. We study the evolution of ENSO of the last 300,000 years using continuous fully-coupled climate model simulations. How the slow time□varying changes in insolation, greenhouse gases concentration, and continental ice sheets could influence the behaviours of El Niño are taken into account. The simulated ENSO variance and the tropical eastern Pacific annual cycle (AC) amplitude change in phase, and both have pronounced precession-band variance (~21,000 years) rather than the obliquity-band (~40,000 years). The precession□modulated slow (orbital time scales) ENSO evolution is determined linearly by the change of the coupled ocean□atmosphere instability, notably the Ekman upwelling feedback and thermocline feedback. In contrast, the greenhouse gases and ice sheet forcings (~100,000□year cycles with sawtooth shapes) are opposed to each other as they influence ENSO variability through changes in AC amplitude via a common nonlinear frequency entrainment mechanism. The relatively long simulations which involve pronounced glacial□interglacial forcing effects gives us more confidence in understanding ENSO forcing mechanisms, so they may shed light on ENSO dynamics and how ENSO will change in the future.