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Trans-timescale global cooling by weakened Pacific Sverdrup transport

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Proxy records of Earth's Pleistocene climate indicate significant periodicity in both Milankovitch 40-100 thousand year (kry) and millennial 1-2 kyr bands. But the physical mechanism(s) that drive these changes are not yet established. While present research generally addresses these disparate timescales as separate problems, in reality they share the same Earth system with inter-annual change. A premise of trans-timescale relatedness provides the logical structure of simultaneous equations. Here I propose that weakened northward Sverdrup transport in the equatorial Pacific is a workable trans-timescale mechanism of global cooling. In classical Sverdrup theory, northward Sverdrup transport depends upon both conservation of potential vorticity and the pattern of wind curl distribution in northward intertropical convergence zone (ITCZ) displacement. Weakened Sverdrup transport allows the North Equatorial Countercurrent to merge into the Equatorial Undercurrent at the equator. The resulting reduction in zonal shear area initially triggers eastward advection at El Niño onset. Countercurrent consolidation that continues after western warm pool depletion then results in a distinct mode of equatorially symmetric La Niña (ESLN). In ESLN, cold countercurrent water surfaces near 140^{o}W, as occurred in July 1998, forming a winter monsoon cell (descending cold dry air) that divides and depowers the rising branch of the Hadley cell. This reduces global water vapor production, the dominant greenhouse gas. Past research recognizes the hydrologic similarity of the La Niña mode and ice age climate. In inter-annual timescales, observed extreme semidiurnal thermocline heave (up to 100 meters in 12 hours) in sporadic internal tide resonance is a plausible mechanism of relative vorticity dissipation, as occurred at 0^{o}N 165^{o}E and 2^{o}N 165^{o}E immediately prior to El Niño onset in 1997, 2002, and 2006. The North Equatorial Countercurrent is never present during El Niño onset. Some observed temperature maxima coincide with local meridian passage of the sun and moon (e.g. 16-21 February 1997), so it is implausible that this phenomenon is forced by westerly wind bursts. Millennial cycles in the strength of tides may leverage the above mechanism of tidal ESLN forcing. Though peak tide forcing is ephemeral, the consequence of lost vorticity is not. A 586 year cycle in the frequency of extreme central eclipses that minimize lunar distance by a perturbation in the moon's orbit corresponds with Bond Cycles 1-3, the Little Ice Age and a centennial La Niña proxy. For example, in the 50 year interval 1700-1749 (Little Ice Age) there are 42 such events, while during 1950-1999 there are 8 such events. 2x and 3x multiples of the 586 year cycle are most commensurate with perigee, which yields dual spectral peaks at 1,172 and 1,758 year periods, similar to what is observed in proxy records of millennial change. In Milankovitch timescales, weakened Sverdrup transport may result from the combination of precessional southward ITCZ migration and strengthened low-obliquity equatorial tides. This duality is consistent with the mid-Pleistocene transition to 100 kyr ice ages, when the ratio between obliquity and precession periods changed from 1:2 to 2:5 or 3:5. Accordingly, all of the 11 major glacial onsets in the past 1 million years occurred when September-March perihelion coincides with obliquity less than 23.5^{o}. This hypothesis correlates with global cooling in all timescales, and provides a framework for future work demonstrating causation. Accurate prediction of future climate change requires an understanding of the mechanism(s) of past change.