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The North Pacific pacemaker effect on historical ENSO and its mechanisms

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Recent studies have indicated that North Pacific sea surface temperature (SST) variability can significantly modulate the evolution of the El Niño-Southern Oscillation (ENSO), but there has been little effort to put these extratropical-tropical interactions into the context of ENSO events in the historical record. To quantify the role of the North Pacific in pacing the timing and magnitude of historical ENSO events, we use a fully-coupled climate model to produce the first ensemble of North Pacific Ocean-Global Atmosphere (nPOGA) SST pacemaker simulations. In nPOGA, SST anomalies in the North Pacific (>15˚N) are restored back to observations, but are free to evolve throughout the rest of the globe. We find that North Pacific SST variability has significantly influenced the observed trajectory of ENSO in the historical record, accounting for approximately 15% of the total variance in boreal fall and winter. The interaction between the North and tropical Pacific is primarily the result of two distinct physical pathways: 1. A Wind-Evaporation-SST propagating mechanism in boreal spring, and 2. A convection driven response associated with the Seasonal Footprinting Mechanism in boreal fall. The latter can account for 25% of the observed zonal wind variability around the equatorial dateline. On an event-by-event basis, nPOGA most closely reproduces the failed 2014-2015 El Niño and the extreme 2015-2016 El Niño. In particular, we show that the 2015 Pacific Meridional Mode event increased wind forcing along the equator by 20% in boreal fall, potentially contributing to the extreme nature of the 2015-2016 El Niño. Our results illustrate the significant role of extratropical noise in pacing the initiation and magnitude of ENSO events and may improve the predictability of ENSO on seasonal timescales.