

Press Release

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El Niño and the Tropical Eastern Pacific Annual Cycle Run to the Same Beat

Phase synchronization is a phenomenon in which separate oscillatory systems develop joint coherent behavior by some nonlinear mechanism. First described in 1673 by Dutch scientist Christiaan Huygens, this phenomenon occurs for instance when an applauding audience suddenly starts to clap in unison or when human breathing patterns lock to multiples of the heart beat.

Two climate modes dominate the temperature variability in the eastern equatorial Pacific. Generated through air-sea interactions, the El Niño-Southern Oscillation is the tropical Pacific climate mode that disrupts weather patterns world wide about every 2 to 7 years. The seasonal cycle of temperatures off Ecuador and the Galapagos Islands emerges through coupled air-sea interactions in response to off-equatorial solar radiation and can vary substantially from year-to-year in amplitude and phase with respect to the calendar, depending on the state of the El Niño system.



The interaction between El Niño events and the seasonal cycle of sea surface temperatures in the eastern equatorial Pacific can be described through such a nonlinear phase synchronization mechanism, according to a study published in the September issue of *Physical Review Letters* by University of Hawai'i Manoa (UHM) PhD student Karl Stein and by Axel Timmermann and Niklas Schneider, professors at the International Pacific Research Center and the Department of Oceanography, UHM.

The team of climate scientists analyzed decades of temperature observations to detect evidence for phase synchronization among these two dominant tropical climate modes. Their extensive and complex mathematical computations showed that El Niño events and the annual temperature cycle in the eastern equatorial Pacific synchronize their common dynamics in what scientists call a “2:1 Arnold Tongue,” after the famous Russian mathematician Vladimir Arnold (1937-2010). This partial synchronization indicates that at certain times El Niño and the annual cycle run according to the same beat, while at other times the phases of the two climate modes “slip past” each other.

The newly discovered sporadic phase-locking behavior of El Niño and the annual cycle will have significant impacts on current understanding of the seasonal predictability of large El Niño events. The scientists are eager to test how well state-of-the art climate models reproduce the nonlinear interaction between these two dominant modes of climate variability.

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The International Pacific Research Center (IPRC) at the School of Ocean and Earth Science and Technology (SOEST), University of Hawaii at Manoa, is a climate research center founded to gain greater understanding of the climate system and the nature and causes of climate variation in the Asia-Pacific region and how global climate changes may affect the region. Established under the "U.S.-Japan Common Agenda for Cooperation in Global Perspective" in October 1997, the IPRC is a collaborative effort between agencies in Japan and the United States.