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The El Niño Southern Oscillation (ENSO) recharge oscillator conceptual model : past achievements, future prospects.

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The Recharge Oscillator (RO) is a simple mathematical model of the El Niño Southern Oscillation (ENSO). It is based on two ordinary differential equations that describe the evolution of eastern Pacific sea surface temperature and western Pacific oceanic heat content. These equations are based on physical principles that operate in nature: (i) the air-sea interaction loop known as the Bjerknes feedback, (ii) a delayed negative feedback arising from the slow oceanic response to near-equatorial winds, (iii) state-dependent stochastic forcing from intraseasonal wind variations known as Westerly Wind Events, and (iv) nonlinearities such as those related to deep atmospheric convection and oceanic advection. These elements can be combined in different levels of RO complexity. The RO reproduces the ENSO key properties in observations and climate models: its amplitude, dominant timescale, seasonality, warm/cold phases asymmetries, and the seasonal predictability decrease known as the “spring barrier”. We then discuss the RO in view of timely research questions. First, the RO can be extended to account for pattern ENSO diversity (with events that either peak in the central or eastern Pacific). Second, the core RO hypothesis that ENSO is governed by tropical Pacific dynamics is discussed under the perspective of research suggesting an influence from other basins. Finally, we discuss the RO relevance for studying ENSO response to climate change, and underline that accounting for diversity and better linking the RO parameters to the long term mean state are important research avenues. We end by proposing a list of ten important RO-based research problems.

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