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A possible mechanism of "spring predictability barrier" for El Nino-Southern Oscillation events

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Abstract Within a simple theoretical coupled model of ENSO context, conditional nonlinear optimal perturbation (CNOP) is used to investigate the "spring predictability barrier" caused by initial errors of ENSO events. It is found that the potential for error growth in the coupled model, measured in terms of the growth of norm magnitude of CNOP, varies seasonally. During an El Nino event, its error growth is largest during boreal spring. While during a La Nina event, the error growth is not optimal during spring and even tends to be attenuation. Physically we find that the spring largest growth of error of El Nino is associated with the aggressively strong spring ocean-atmosphere coupled instability (including mean and anomalous): the largest temperature differences between east and west Pacific basins and between surface and subsurface water of equatorial eastern Pacific Ocean (as well as the weakest easterly wind stress and equatorial upwelling). This kind of instability is most favorable for the El Nino error to grow. During the La Nina event, the coupled instability is quite stable and suppresses the error growth, which results in a small error growth or an error attenuation of La Nina. Additionally we emphasize the nonlinear effect of temperature advection process on the error growth of ENSO. Based on the dynamic behaviors of the errors of ENSO, the nonlinear mechanism of error growth is discussed. The results suggest that the nonlinearity of WF96 model enhances the error growth of El Nino during spring and increases the uncertainties of El Nino forecast bestriding spring. Although the error growth of La Nina is also strengthened by the nonlinear term in WF96 model, the amplitude is trivial and negligible.All these indicate that El Nino may be less predictable than La Nina.