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A nonlinear characteristic of El Niño-Southern Oscillation events

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We use the approach of conditional nonlinear optimal perturbation (CNOP) to investigate the optimal precursory disturbances in a theoretical El Niño-Southern Oscillation (ENSO) model and then an intermediate model. By exploring the dynamical behaviors of the El Niño events caused by these CNOP-type precursors, a characteristic for this kind of theoretical El Niño events is shown, i.e., the stronger El Niño events tend to decay faster and have shorter durations of the decaying phase. By examining the observed El Niño events, it is found that the Niño-3.4 SSTA are more potential than the Niño-3 SSTA in illustrating the decaying characteristic of the theoretical El Niño events. In particular, it is the Niño-3.4 indices for the strong El Niño events during 1981-2007 that roughly show the decaying characteristic. Based on the physics of the theoretical model, the mechanism responsible for the above decaying characteristic of strong El Niño events is explored. The analysis demonstrates that the property of the stronger El Niño event decaying faster can be realized only through the linear dynamics with the combined effects of the rising of thermocline and the mean upwelling, but that of the stronger El Niño event having a shorter duration of the decaying phase results from a nonlinear mechanism. It is shown that the nonlinearity related to the anomalous temperature advection in the tropical Pacific shortens the duration of the decaying phase for El Niño event. The stronger the El Niño event, the stronger the nonlinearity, then the more considerable the suppressing of the nonlinearity on the duration of the decaying phase for El Niño event. This explains why the stronger El Niño events have shorter durations of the decaying phase. Also, this sheds light on why the observed strong El Niño events are more likely to show this characteristic.