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Comparison of the initial errors most likely to cause a spring predictability barrier for two types of El Niño events

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In this paper, the spring predictability barrier (SPB) problem for two types of El Niño events is investigated. This is enabled by tracing the evolution of a conditional nonlinear optimal perturbation (CNOP) that acts as the initial error with the biggest negative effect on the El Niño predictions. We show that the CNOP-type errors for Central Pacific-El Niño (CP-El Niño) events can be classified into two types: the first are CP-type-1 errors possessing a sea surface temperature anomaly (SSTA) pattern with negative anomalies in the equatorial central western Pacific, positive anomalies in the equatorial eastern Pacific, and accompanied by a thermocline depth anomaly pattern with positive anomalies along the equator. The second are, CP-type-2 errors presenting an SSTA pattern in the central eastern equatorial Pacific, with a dipole structure of negative anomalies in the east and positive anomalies in the west, and a thermocline depth anomaly pattern with a slight deepening along the equator. CP-type-1 errors grow in a manner similar to an Eastern Pacific-El Niño (EP-El Niño) event and grow significantly during boreal spring, leading to a significant SPB for the CP-El Niño. CP-type-2 errors initially present as a process similar to a La Niña-like decay, prior to transitioning into a growth phase of an EP-El Niño-like event; but they fail to cause a SPB. For the EP-El Niño events, the CNOP-type errors are also classified into two types: EP-type-1 errors and 2 errors. The former is similar to a CP-type-1 error, while the latter presents with an almost opposite pattern. Both EP-type-1 and 2 errors yield a significant SPB for EP-El Niño events. For both CP- and EP-El Niño, their CNOP-type errors that cause a prominent SPB are concentrated in the central and eastern tropical Pacific. This may indicate that the prediction uncertainties of both types of El Niño events are sensitive to the initial errors in this region. The region may represent a common sensitive area for the targeted observation of the two types of El Niño events.