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Contribution of the location and spatial pattern of initial error to uncertainties in El Nino predictions

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The contribution of the location and spatial pattern of initial error in sea surface temperature anomalies (SSTA) to uncertainty in El Nino predictions is investigated using an approach based on conditional nonlinear optimal perturbation (CNOP), which seeks to find the initial error (i.e. the CNOP error) that satisfies a given constraint and that causes the largest prediction error at the prediction time. The computed CNOP error has a dipole pattern in the equatorial central and eastern Pacific. Only when initial errors with a dipole pattern are located in this region, rather than other regions, do they evolve into non-negligible prediction errors. The location of the initial error plays an important role in the error evolution because of the contribution of annual mean states; e.g., the shallow annual mean thermocline in the eastern Pacific favors feedback between the thermocline and sea surface temperature. In contrast, random error in the equatorial central and eastern Pacific, with the same magnitude as the CNOP error, does not evolve significantly over time. Initial errors with a similar spatial pattern to that of the CNOP error give rise to larger prediction errors than in the case of contrasting spatial patterns between the two errors. Consequently, the magnitude of the prediction error at the prediction time depends on the combined effects of the location and spatial pattern of the initial error. If additional observation instruments are deployed to observe sea surface temperature with limited coverage, they should preferentially be deployed in the equatorial central and eastern Pacific.