



Application of conditional nonlinear optimal perturbation method to finding the optimal precursors of Kuroshio large meander

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We use the conditional nonlinear optimal perturbation (CNOP) approach to find optimal precursor of the formation of Kuroshio large meander (LM) path. Three non-large meander (NLM) states are utilized as reference states to calculate the CNOPs. The results demonstrate that the CNOPs can result in the formation of the significant LM path. Simultaneously, we calculate the first singular vector (FSV), which is the linear counterpart of CNOP, and investigate its effects on the Kuroshio path. We found that the FSV with the same amplitude as the CNOP does not trigger a typical Kuroshio LM path. Hence, the CNOP is regarded as an optimal precursor of the formation of the LM path. Furthermore, we analyze the formation processes of the LM path and find that potential vorticity (PV) advection plays an important role in the formation process. The PV advection caused by the FSV perturbation is smaller than that caused by the CNOP perturbation and hence explains why the CNOP is favorable as a precursor over the FSV.