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Application of conditional nonlinear optimal perturbations method to Kuroshio Extension transition

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Some studies have indicated that the Kuroshio Extension(KE) displays bimodal behavior(elongated state and contracted state). These state is found as multiple linearly steady states in a shallow water model. The conditional nonlinear optimal perturbation(CNOP) method is used for investigating the transition behavior between the KE bimodality. The CNOP is calculated with the kinetic energy norm. It is found that when the perturbation is small, the transition can not occur. When the perturbation is increased, the transition may occur. This reflects that the linearly stable state may be nonlinear instable. We study the transition behavior of the KE bimodal mode and find that the anticyclonic eddy in south of KE is strong when the background state is in elongated mode. In contrast, the eddy is weak when the state is contracted. With the weakening of intensity of the eddy, the flow become instable, resulting in the further development of the contracted mode. The CNOP method reveals the important role of the eddy in south of the KE and indicates the importance of the nonlinear effect in transition of the KE bimodal behavior.