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The Optimal Precursor for the EP type of El Nino: results from the GFDL CM2p1 Model

Zeyun Yang

Institute of Oceanology, Chinese Academy of Science, Key Laboratory of Ocean Circulation and Waves, Qingdao, China (yangzeyun@qdio.ac.cn)

In this study, we investigate the nonlinear optimal precursor (OPR) for the EP type of El Nino by using the GFDL CM2p1 model based on the conditional nonlinear optimal perturbation (CNOP) method. CNOP is a type of error with largest nonlinear evolution at the prediction time. It plays an important role in predicting weather and climate. Adjoint model is usually required during the calculation of CNOP. However, for a complicated numerical model such as GFDL CM2p1, constructing an adjoint model is rather difficult and time consuming. In this study, we bypass this problem by applying the principle component analysis (PCA) based Parallel Particle Swarm Optimization (PPSO) algorithm, which is proven by previous studies to be more efficient for obtaining almost the same CNOP as that based on the adjoint algorithm. To find the OPR for the EP type of El Nino, we choose a neutral year in the control run as a reference state. And also, the region 150.5˚W-90.5˚W 20˚N-20˚S is chosen as the target area for the EP type of El Nino. The result shows that the OPR at January for the EP type of El Nino exhibits strong positive sea surface temperature anomalies (SSTA) in the eastern equatorial Pacific, and both the western and central equatorial Pacific show large positive subsurface temperature anomalies. Further analyses indicate that when the OPR is applied upon the reference state at January, strong westerly winds will appear over the western-central equatorial Pacific from February, which is mainly induced by the positive SSTA at the eastern Pacific through reducing the zonal SST gradient and then weakening the Walker circulation. Through down-welling Kelvin waves, the westerly wind anomalies lead the positive subsurface temperature anomalies to propagate to the eastern equatorial Pacific, which deepens the thermocline there. With deeper thermocline the upwelling water in the eastern Pacific is warmer than normal therefore intensifies the positive SSTA there. As a result, the air-sea system of the tropical Pacific evolves into an EP type of El Nino with the peak at December through the Bjerknes positive feedback.