Improving the forecast skill of El Nino diversity: A nonlinear forcing singular vector approach

Lingjiang Tao, Wansuo Duan, and Stephane Vannitsem

1Institute of Atmospheric Physics, State Key Laboratory of Numerical modeling for Atmospheric Sciences and Geophysical Fluid Dynamics, Beijing, China
2Royal Meteorological Institute of Belgium, Brussels 1180, Belgium

Observations indicate that there exist two types of El Niño events: one is the EP-El Niño with a warming center in the eastern tropical Pacific, and the other is the CP-El Niño with large positive SST anomalies in the central tropical Pacific. Most current numerical models show low skills in identifying the El Niño diversity. The present study examines the dynamical properties of the ENSO forecast system NFSV-ICM which combines an intermediate complexity ENSO model (ICM) with a nonlinear forcing singular vector (NFSV)-tendency perturbation forecast model. This system is able to distinguish different types of El Niño in simulations and predictions. It is shown that the NFSV-ICM system is able to capture the horizontal distribution of the SST anomalies and their amplitudes in the mature phase of not only EP-El Niño but also CP-El Niño. At the same time, the NFSV-ICM is able to describe the evolution of SST anomalies associated with the two types of El Niño up to at least two-season lead time, while the corresponding forecasts with the ICM is only limited to at most one-season lead time. These improvements are associated with the modifications of atmospheric and ocean processes described by the ICM through the NFSV-tendency perturbations. In particular, the thermocline and zonal advection feedback are strongly modified and improve the conditions of emergence of both the EP- and CP-El Niño events. The NFSV-ICM therefore provides a useful platform for studying ENSO dynamics and predictability associated with El Niño diversities.