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Seasonal predictability barrier for two types of El Niño events

Meiyi Hou (1), Wansuo Duan (2), and Xiefei Zhi (1)

(1) Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disasters (CIC-FEMD)/ Key Laboratory of Meteorological Disasters, Ministry of Education (KLME), Nanjing University of Information Science & Technology, Nanjing, China (hmyjoyce831@163.com), (2) State Key Laboratory of Atmospheric Sciences and Geophysical Fluid Dynamics (LASG), Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China (duanws@lasg.iap.ac.cn)

The real-time prediction skill for El Niño-Southern Oscillation (ENSO) has not been improved steadily since the 21st century. One important reason is the seasonal predictability barrier (PB), another is because of the pattern diversity of El Niño. In this paper, different PB phenomena of two flavors of El Niño events are investigated by using monthly mean data of the pre-industrial control ("pi-Control") runs from several coupled model outputs in CMIP5 experiments. We found that predictions for Central Pacific El Niño (CP-El Niño) are suffered from summer PB while that for Eastern Pacific El Niño (EP-El Niño) are mainly interfered by spring PB. The results also indicated that not all initial errors tend to have obvious season-dependent evolutions and thus yield spring or summer PB, so we analyze the spatial feature of the PB-related initial errors for two types of El Niño over the whole Pacific Ocean by conducting Empirical Orthogonal Function (EOF) analysis. For CP-El Niño, two patterns of initial errors are classified: the first is CP-type-1, possessing an Ocean temperature anomaly pattern with positive anomalies in the equatorial upper-level central-eastern Pacific, negative anomalies along the upper-level southeastern Pacific, and negative anomalies in the lower-level equatorial western Pacific. This pattern of initial errors first goes through a process similar to a La Niña decaying and then change to a growth phase of an El Niño-like event. The second is CP-type-2, showing large negative Ocean temperature anomalies in upper-level northeastern Pacific near the Alaska region, positive anomalies in the central-north pacific and negative anomalies in the sub tropics near Baja California. This type of errors evolves like an El Niño event from a neutral phase in the equatorial Pacific. Both two types cause under-prediction for CP El Niño events. As for EP El Niño events, PB-related initial errors are also classified into two types: EP-type-1 errors and -2 errors. The former one is similar to a CP-type-1 error. The latter type has an Ocean temperature anomaly pattern with negative anomalies in the upper-level equatorial central-eastern Pacific and negative anomalies in the upper-level northeastern Pacific. EP-type-2 errors evolve like an El Niño event from a weak El Niño phase. Both two types cause under-prediction faults for EP El Niño events. The results indicated that the prediction of different flavors of ENSO is sensitive to the initial status of these areas. And additional observations in the identified sensitive areas may be helpful to improve the ENSO prediction skill.