Investigation of the initial errors that cause spring predictability barrier for El Niño events by using CMIP5 model outputs

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Most ocean-atmosphere coupled models have difficulties in the prediction of El Niño-Southern Oscillation (ENSO) starting from boreal spring seasons. However, the cause of this spring predictability barrier (SPB) phenomenon remains elusive. In this paper, we investigated the effects of initial error patterns related to SPB in El Niño predictions by directly using the monthly mean data of pre-industrial (PI) control runs of CMIP5 experiments.The results indicated that the SPB-related optimal initial errors possessed an SST pattern with positive errors in equatorial central-eastern Pacific and a subsurface sea temperature with positive errors in the upper layers of equatorial eastern Pacific and negative errors in the lower layers of western Pacific. Concerning the evolution of this type of initial errors, the tendency of prediction error of the Niño-3.4 SST for El Niño events from positive phase to negative was mainly induced by the eastward propagation of the negative errors of subsurface sea temperature in the equatorial western Pacific. Therefore, we would regard the subsurface layers of equatorial western Pacific with large negative errors as the first sensitive area of adaptive observation of sea temperature, and the Niño-3.4 region as the second one. That was to say, if additional observations were preferentially deployed in these two regions, it might be able to avoid yielding large prediction errors associated with the SPB-related initial errors and generate a better forecast than observations taken in other regions. Moreover, we also showed that the SPB-related optimal initial errors bear strong resemblance with the optimal precursory disturbance for El Niño and La Niña events. Therefore, the observation network improved by additional observations in these sensitive areas would also be helpful in detecting the signals provided by the precursory disturbance, which might greatly improve the ENSO prediction skill.