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"Summer Predictability Barrier" of the Indian Ocean Dipole Events and Its Error Growth Dynamics

Da Liu (1,2), Wansuo Duan (1,2), Rong Feng (1), and Youmin Tang (3)

(1) Institute of Atmospheric Physics, Chinese Academy of Sciences, LASG, China (april_liuda@126.com), (2) University of Chinese Academy of Sciences, Beijing 100049, China, (3) University of Northern British Columbia, Prince George V2N 4Z9, Canada

The effects of sea temperature errors in both the tropical Pacific and Indian Oceans on the predictability of positive Indian Ocean Dipole (IOD) events is explored by using the Geophysical Fluid Dynamics Laboratory (GFDL) CM2p1 coupled model. By perturbing the sea temperature over the tropical Pacific and Indian Oceans, it is found that the prediction errors of positive IOD events present obvious season-dependent evolution with the considerable error growth in winter and summer, and cause the phenomena of "winter predictability barrier" (WPB) and "summer predictability barrier" (SPB). More is known about the WPB, while less is known about the SPB. The present study focuses on the SPB for IOD and analyzes its error growth dynamics. Results show that two types of initial sea temperature errors are more likely to cause a significant SPB for IOD events. One type presents large sea surface temperature anomalies (SSTAs) in the central-eastern Pacific Ocean, and a dipole mode-structured subsurface sea temperature with negative anomalies in the upper layers of the eastern equatorial Pacific and positive anomalies in the lower layers of the western equatorial Pacific, while the other type shows a pattern almost opposite to the former type. However, both types of initial errors often cause the positive IOD events to be under-predicted with positive SST errors in the east pole of IOD and yield significant SPB for IOD events. By tracking the evolutions of the two types of initial sea temperature errors, it is found that the seasonality of the latent heat flux associated with prediction errors for IOD plays a determining role in the occurrence of SPB; furthermore, such seasonality is closely related to the Pacific Ocean (PO) component of two types of initial errors. In fact, the PO-component of both types of initial errors tends to induce anomalous westerlies occurring in the east pole of the IOD. Then the strongest climatological easterlies and anomalous easterlies of positive IOD events during summer suppress significantly these anomalous westerlies and then hinder the loss of latent heat flux in the east pole of IOD, finally favoring the fastest growth of positive SST error there during summer and causing significant SPB for IOD.