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The dry-to-wet transition of summer precipitation over the Three-River Headwaters' region: the role played by three interdecadal oceanic modes

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Abstract

Summer (June to August) precipitation over the Three-River Headwaters' (TRH) region has experienced a significant dry-to-wet transition during 1979-2020. The transition could have been caused by changed atmospheric circulations, which was modulated by oceanic forcings. This study intends to improve our understanding of the summer precipitation variability over the TRH region under the influence of oceanic modes. The combined effect of three interdecadal oceanic modes [Pacific decadal oscillation (PDO), Atlantic multidecadal oscillation (AMO), and Indian Ocean Basin mode (IOBM)] on the interdecadal dry-to-wet transition was examined, using composite analysis on HadISST and the fifth generation ECMWF reanalysis (ERA5) datasets. The results show that in positive AMO and negative PDO phases, a zonally oriented teleconnection wave train is generated across the Eurasian mid-to-high latitudes, propagating from the North Atlantic to northern East Asia along the westerly jet. This results in a weakened and northward-shifted westerly jet. Furthermore, the enhanced and northward-shifted Western Pacific Subtropical High (WPSH) brings water vapor from the Pacific Ocean, and cyclonic circulation over the Arabian Sea increases the amount of water vapor entering the TRH region. In positive IBOM phases, the warm Indian Ocean induces an anomalous anticyclone over the Bay of Bengal, and anomalous southwesterly delivers abundant water vapor from the Indian Ocean to the TRH region, which overlaps with the vapor transport caused by a positive AMO and PDO. As the Atlantic and Northern Pacific Oceans warm, the enhanced Walker circulation suppresses the ascending motion in the central Pacific and enhances the equatorial easterly, which in turn strengthens the anomalous anticyclone over the Bay of Bengal. As a result, the summer precipitation over the TRH is further increased. The analysis shows that the combined effect of the three oceanic modes played an important role in the dry-to-wet transition.