

The role of the Mexican Plateau in shaping rainfall over Texas

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Spring and summer precipitation over Texas is deemed to be affected by the Mexican Plateau (MP). Satellite observations show possible influences of the MP on the rainfall over Texas during the 2011 Texas drought. The Community Earth System Model version (CESM) 1.0.4 that is an earth system model is used in this study to examine the role of the MP on the hydro-climate over the southern plains and US southwest, providing implications for the linkage between the MP and rainfall over Texas during 2011 Texas drought. A control run and two experiment runs were performed with prescribed sea surface temperatures and sea ice fractions. In experiment I (E1), a warmer MP was produced by setting the albedo of the MP to zero; in experiment II (E2), the topography of the MP was removed.

Results show that when the MP warms, during spring, the warmer air brought by prevailing westerlies to Texas relaxes the vertical temperature gradient. This lapse rate change inhibits convection, decreasing rainfall over Texas. During summer, a warmer MP likes “a moisture pump” that pushes the moist air over the peripheric low elevation areas to the highlands and thus leads to moisture-flux divergence over western Texas. The air divergence is associated with decreased summer rainfall over Texas. Results also show two primary ways by which the topography of the MP affects rainfall over Texas. One way is that the elevations of the MP influences the Bermuda high, which significantly affects the position and strength of the time averaged low-level jet LLJ. At the same time, the LLJ is closely linked to lower troposphere moisture transport that shapes precipitation over Texas. Besides, the elevations of the MP prevents the Gulf of Mexico warm moist air from the southwest US and hence significantly decreases summer precipitation over the southwest.

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