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Complex Role of the Tibetan Plateau and its Surrounding Topography in the Formation of Asian Climate

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The Tibetan Plateau (TP) has undoubtedly played an essential role in the evolution and strengthening of the coupled climate system of the Asian monsoon and inland arid climate since the Cenozoic. However, a growing number of studies have found that regional and relatively smaller scale topography also has significant impact on Asian climate.

By using high resolution atmospheric circulation model, we analyzed the effect of the main body of the TP and its surrounding topography on the evolution of Asian climate. The surrounding topography includes the Yunnan-Guizhou Plateau (YG) at the southeastern margin of the Tibetan Plateau, the Pamir Plateau (Pr) and Tian Shan mountains (TS) at the northern margin and the Mongolian Plateau (MP) further north. The results show that different from the strengthening effect of the main TP, the YG significantly weakens the Indian monsoon. With the uplift of the YG, an anomalous anticyclonic circulation appeared in the lower troposphere over the southwest, resulting in the weakening of monsoon circulation from the Bay of Bengal to the Indian subcontinent and the Arabian sea. The decline in Indian monsoon precipitation caused by the YG accounts for one-third of the total increase in precipitation caused by the entire TP.

For the arid interior Asia, the main TP, YG, Pr and TS, as well as the MP all have reduced the annual precipitation in some extent. However, different from the consistent inhibiting effect of the main TP on the precipitation over the arid interior Asia throughout the year, the decreasing effect of the YG and the MP is mainly effective in boreal winter, which is closely related to the mechanical blocking effect. In addition, the Pr and TS play a key role in the temporal and spatial differentiation of precipitation in the arid interior Asia. Before the appearance of the Pr and TS, the precipitation seasonality over the eastern sub-region was characterized with maximum rainfall in spring and winter and minimum rainfall in summer. With the uplift of Pr and TS, the precipitation over the eastern part decreases in winter and significantly increases in summer, which leads to the change of precipitation seasonality to summer dominated.

The above results indicate that different part of the extensive-third pole have different influences on the Asian monsoon and inland aridity. It suggests that the Asian monsoon-inland arid climate may have undergone complex evolutionary processes on tectonic scale.