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Variation characteristics of temperature and precipitation on the northern slopes of the Himalaya region from 1979 to 2018

Yizhe Han, Yaoming Ma, Zhongyan Wang, and Weiqiang Ma
Qomolangma Atmospheric and Environmental Observation and Research Station, Key Laboratory of Tibetan Environment Changes and Land Surface Processes, Institute of Tibetan Plateau Research, Chinese Academy of Sciences

The northern slopes of Himalaya (NSH) have the highest average elevation in the world. It is difficult to assess how climate change has affected this region because only a few observations are available from the high terrain and harsh environment. This study investigates the long-term characteristics of temperature and precipitation in the NSH. Further, the association of these variations with atmospheric circulation patterns is also investigated. Our results indicated that the warming trend in this region is almost 1.5 times that of the TP region, 2 times that of China, and 3.5 times that of the world. Additionally, the warming rate of the NSH is more obvious than other regions in the Himalayas, which shows that different regions of the Himalayas have different sensitivity to climate change. Although the warming trend in the NSH region does not show obvious seasonal differences like the TP, the temperature increase rate in autumn and winter is still higher than that in spring and summer. The abrupt change point for the temperature increase in summer was about 5 years later than that in other seasons, indicating that the NSH region is more sensitive to climate warming in cooler seasons, which is similar to the western and northwestern Himalaya. Furthermore, the Southern Oscillation Index (SOI) displays significant relationships with the temperature in the NSH, meanwhile, the North Atlantic Oscillation index (NAO) and Western Pacific Subtropical High Intensity Index (WPI) also exist some correlations with seasonal temperature change. This indicating that the atmospheric circulation would also have affected the temperature increase in this region, especially in summer and winter. The changes in precipitation are only affected by the SOI during the monsoon season (June to September), indicating that ENSO influences precipitation changes through water vapor transmission. In contrast, the precipitation in the TP is correlated with NAO, SOI and WPI, which indicating the precipitation of the TP might be affected by multiple circulation systems.