

Recent advances on reconstruction of climate and extreme events in China for the past 2000 year

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The study of regional climate changes for past 2000 year could present spatial pattern of climate variation and various historical analogues for the sensitivity and operation of the climate system (e.g., the modulations of internal variability, feedbacks and teleconnections, abrupt changes and regional extreme events, etc.) from inter-annual to centennial scales and provide the knowledge to predict and project climate in the near future. China is distinguished by a prominent monsoon climate in east, continental arid climate in northwest and high land cold climate in Qinghai-Tibetan Plateau located at southwest. The long history of civilization and the variety of climate in China provides an abundant and well-dated documentary records and a wide range of natural archives (e.g., tree-ring, ice core, stalagmite, varved lake sediment, etc.) for high-resolution paleoclimate reconstruction. This paper presented a review of recent advances on reconstruction of climate and extreme events in China for the past 2000 years. In recent 10 years, there were many new high-resolution paleoclimatic reconstructions reported in China, e.g., the annual and decadal resolution series of temperature and precipitation in eastern China derived from historical documents, in western China derived from tree-ring and other natural archives. These new reconstructions provided more proxies and better spatial coverage to understand the characteristics of climate change over China and the uncertainty of regional reconstructions, as well as to reconstruct the high-resolution temperature series and the spatial pattern of precipitation change for whole China in the past millenniums by synthesizing the multi-proxy together.

The updated results show that, in China, the warm intervals for the past 2000 years were in AD 1–200, AD 551–760, AD 951–1320, and after AD 1921; as well as the cold intervals were in AD 201–350, AD 441–530, AD 781–950, and AD 1321–1920. The extreme cold winters occurred in periods of 1500-1900 were more frequent than that after 1950. The intensity of regional heat wave occurred in the context of recent global warming may not exceed the natural climate variability during the historical times. In the eastern monsoon region of China, the significant cycles of precipitation are 90-100a, 70-80a, 43-48a, 35a, 25-27a and 17-18a in North China Plain; 90-100a, 73-75a, 63-68a, 55a, 45a, 37a and 26a in Jiang-Huai area; and 85-100a, 75-77a, 58-65a, 37-39a, 31a and 26a in Jiang-Nan area; respectively. Whereas, the spatial pattern of drought/flood for all cold periods ensemble mean showed an east to west distribution, but for all warm periods ensemble mean showed a tri-pole pattern with drought in south of 25°N, flood in 25°–30°N, and drought in north of 30°N. The extreme drought events were more frequent at the periods of 301-400, 751-800, 1051-1150, 1501-1550 and 1601-1650, the extreme flood events were more frequent at the periods of 101-150, 251-300, 951-1000, 1701-1750, 1801-1850 and 1901-1950, and for the period of 1551-1600, the coexisting extreme drought and extreme flood events most frequently occurred. In arid area, China, it was characterized by a relatively dry in AD 1000-1350, a wet in AD 1500 to 1850 and tending to moisture in recent decades. In the northeastern Qinghai-Tibetan Plateau, there existed evident centennial oscillations for precipitation during the past 1000 years, with interruption of several multi-decadal severe drought events, which two prominent droughty events centered on AD1480s and AD 1710s. In the Southwest of China, the extreme droughts as severe as in Sichuan and Chongqing in 2006 have also been occurred during the historical times.