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Spatial-temporal analysis on climate variation in early Qing dynasty (17th -18th century) using China's chronological records

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Global climate change in the form of extreme, variation, and short- or mid-term fluctuation is now widely conceived to challenge the survival of the human beings and the societies. Meanwhile, improving present and future climate modeling needs a comprehensive understanding of the past climate patterns. Although historical climate modeling has gained substantive progress in recent years based on the new findings from dynamical meteorology, phenology, or paleobiology, less known are the mid- to short-term variations or lower-frequency variabilities at different temporal scale and their regional expressions.

Enabling accurate historical climate modeling would heavily rely on the robustness of the dataset that could carry specific time, location, and meteorological information in the continuous temporal and spatial chains. This study thus presents an important methodological innovation to reconstruct historical climate modeling at multiple temporal and spatial scales through building a historical climate dataset, based on the Chinese chronicles compiled in a Zhang (2004) edited Compendium of Chinese Meteorological Records of the Last 3,000 Years since Zhou Dynasty (1100BC). The dataset reserves the most delicate meteorological data with accurate time, location, meteorological event, duration, and other phonological, social and economic impact information, and is carefully digitalized, coded, and geo-referenced on the Geographical Information System based maps according to Tan's (1982) historical atlas in China. The research project, beginning in January 2015, is a collaborative work among scholars across meteorology, geography, and historical linguistics disciplines.

The present research findings derived from the early 100+ years of the Qing dynasty include the following. First, the analysis is based on the sampling size, denoted as cities/counties, n=1398 across the Mainland China in the observation period. Second, the frequencies of precipitation, cold-warm temperature, flood and drought with an index of social unrest are counted in an interval of a year, five years, ten years, and twenty years to gain their running mean(s) for every cites/counties to depict their temporal variations. Third, the cities and counties are divided into seven zones based on their meteorological and geographical characteristics, in order to interpret the regional expressions of the climate variations. Finally, the Ordinary Least Square regression model is used to estimate the coefficients among precipitation, temperature, flood and drought. Significantly, it is found that in general all these indices fluctuated in past 100+ years. However, the occurrence of drought and flood all have significant correlation with lower (colder) temperature ($P=0.00$) and also with precipitation ($P<0.05$). This implies that cold temperature tends to have higher meteorological extremes, and both flood and drought can occur approximately in the same year with abundant precipitation at different time. Among seven geographical zones, North China is found more vulnerable to the temperature changes considering these extreme weathers. Temperature change in Central and South China however are less significant. Central China on the other hand is more sensitive to the precipitation that are both correlated with drought and flood.