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Temperature variations as record by tree ring samples from the middle section of the Animaqin Mountains, China

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A well dated 667-year Qilian juniper (Sabina przewalskii Kom.) tree-ring width chronology was developed using samples from the middle section of the Animaqin Mountains using the signal free method. Based on the subsample signal strength, this chronology can be used to infer the climatic variations back to 1380. Correlation analysis for the common period (1960-2014) between the observed climatic data and the ring-width chronology indicated that the radial growth of trees was positively related with temperature variables, in addition to a significant correlation with February precipitation. Specially, the correlation coefficient between the minimum temperatures averaged from August of the prior year to July of the current year and ring-width indices reached 0.767. After the first difference was performed on the data, this correlation coefficient remained statistically significant with a value of 0.583 ($p<0.001$). Using a liner regression equation we reconstructed annual mean minimum temperature calculated from August of the prior year to July of the current year for the past 635 years (AD 1380-2014). Through comparisons with other available nearby mean minimum temperature reconstructions, it was found that our reconstruction contained robust signals of temperature variations. During the past 635 years, the longest cold and warm periods lasted for 17 and 19 years, respectively, based on the mean plus and minus 0.5 standard deviations of the reconstructed series. Specifically, cold periods prevailed during AD 1440-42, 1483-95, 1555-68, 1586-1602, 1676-77, 1679-80, 1686-96, 1840-54, 1856-58, 1866-67, 1869-70, 1872-76, 1893-1901, 1910-20, 1957-59, 1961-68, and 1975-83; while warm intervals occurred in AD 1409-24, 1427-28, 1504-09, 1655-59, 1729-39, 1768-69, 1775-79, 1781-1813, and 1991-2009. We further investigated the relationships between our reconstruction and the possible mechanisms of temperature variation, such as solar activity, large volcanic eruptions, and several air circulation indices including North Atlantic Oscillation (NAO), El Niño-Southern Oscillation, (ENSO), and Pacific Decadal Oscillation (PDO). Results indicated that the trend of our reconstruction was correlated with solar activity; while the decadal and multi-decadal variations are related with NAO and PDO. Additionally, short-term low temperature events in the study area were related to major volcanic eruptions during this period.