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Degree of connectivity in reconstructed precipitation dynamics and extremes for semiarid regions across South Siberia

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ABSTRACT

Tree rings from forest-steppes of temperate continental Asia are useful proxies for the moisture regime reconstructions, encompassing environmental variations such as warming climate, changing frequency and intensity of droughts. Heterogeneity of precipitation leaves open the question of the probability of spatially large-scale droughts in this macro-region. Theoretically, such events could be driven by global tele-connections and/or common astronomic cycles. We have attempted the precipitation reconstructions of two distant (~1000 km) intermountain valleys in South Siberia, based on the tree ring width of *Pinus sylvestris* L. To enhance the quality of the precipitation reconstruction models, networks of existing tree-ring data were expanded and daily precision of instrumental precipitation series was implemented for calibration. Within-region (150–200 km) common signal between local chronologies $r = 0.37–0.90$ ($p < 0.05$) allowed obtaining regional ones, registering precipitation up to annual temporal scale. High correlations of both regional chronologies with annual precipitation were found for period from previous July 22 to current July 21 ($r = 0.71–0.72$). These precipitation series were further reconstructed. Reconstruction models explaining 50–52% of variation were developed for the years 1753–2015 and 1798–2015. Although both valleys do not record many concurrent extreme precipitation events, some common and opposite extremes have been revealed. For both regions, an 11-year and 26–29-year cycles were commonly observed. These were probably associated with the solar activity and Pacific Decadal Oscillation (PDO). However, phase shifts of these cycles were recorded between the regions and with PDO. Stronger impact of oceanic air masses was observed in the eastern one of the two considered territories. Whereas higher significance of frequencies associated with astronomic cycles (solar and lunar-nodal) was found in the western one. *Data availability:* Temperature and precipitation series of climatic stations were obtained from the website of All-Russia Research Institute of Hydrometeorological Information, World Data Centre (RIHMI-WDC, http://meteo.ru/data). Other climatic time series and solar activity series were obtained from the website of The Royal Netherlands Meteorological Institute (KNMI) Climate Explorer (https://climexp.knmi.nl). Used in the study tree-ring width measurements will be submitted to the International Tree-Ring Data Bank (ITRDB; https://www.ncei.noaa.gov/products/paleoclimatology/tree-ring) upon publication of the manuscript and with reference to it.

1. Introduction

The extreme climatic events are likely to increase in their severity and frequency as a consequence of recent warming above the average global trend temperature in the temperate continental Asia (Groisman et al., 2012; AghaKouchak et al., 2020). The impact of extreme events is more predominant than variation in the long term averages of climatic variables (Ummenhofer and Meehl, 2017). This is influencing the continental climate severely where moisture deficit during the vegetation growth season is combined with the extremely wide seasonal range of temperatures (Rivas-Martínez et al., 2011). Such conditions are drivers of persistently emerging stressful growth conditions for the forest ecosystems (Dulamsuren et al., 2009, 2014). Woody plants form a forest-steppe ecotone at the lower and southern boundaries of the

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