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Solar and volcanic fingerprints in tree ring chronologies over the past 2000 years

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The Sun is the main driver of Earth's climate, yet the role of the Sun in decadal-to-centennial climate variations has remained controversial, especially in the context of understanding the components of natural climate forcings underlying the anthropogenic induced global warming during the past few decades. This study statistically explores seventeen near globally distributed, high-resolution tree chronologies in terms of solar forcing (i.e. Total Solar Irradiance; TSI) and climate variability with emphasis on centennial time scales during the past approximately two millennia. Analyses in the frequency domain indicate significant periodicities in the 208-year frequency band, corresponding to the DeVries cycle of solar activity. The association, however, remains weak. Other forcing factors, such as volcanic activity, might mask the solar signal in space and time. To investigate this hypothesis, we attempted a separation of volcanic and other signals in the temperature time series using a statistical approach. Wavelet analysis of the volcanic contribution reveals significant periodicities near the DeVries frequency during the Little Ice Age (LIA), which makes it very difficult to separate volcanic and solar forcing during the LIA. On the other hand, the residual contribution also shows significant periodicities near the DeVries frequency during the entire time period, pointing to a solar imprint and emphasising the need for solar related studies in the absence of strong multi-decadal volcanic forcing. Furthermore, there is no clear Sun-drought linkage distinguishable at centennial time scales in the south-western United States drought records. Nonetheless, the results presented here give indications of a solar-climate relationship, despite some inconclusive findings and justify the continued search for spatial and temporal linkages and mechanisms.