Forum Comment

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Fossil forest reveals sunspot activity in the early Permian

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In their study of tree rings from the Chemnitz Fossil Forest (Germany), Luthardt and Rößler (2017) claim to identify a regular near-11-yr cyclicity in growth, and present that pattern as evidence of the influence of the Schwabe solar cycle (Usokin and Mursula, 2003) on climate and forest productivity during the early Permian. If correctly interpreted, these fossil tree rings would indicate the sunspot cycle was the dominant influence on interannual variability in Earth's climate during this period and that it has been a consistent aspect of our Sun's behavior for at least the past 300 m.y. We argue the fossil tree-ring record from Chemnitz does not constitute reliable evidence of solar activity during the Permian because the individual tree-ring sequences are not correctly aligned (dendrochronologically dated) and, as a result, the mean ring-width composite is not a meaningful estimate of year-to-year variations in tree growth in this ancient forest.

Because the Chemnitz Fossil Forest was killed by a single volcanic eruption (Rößler et al., 2014), the outermost growth rings in each specimen, if intact, would have formed in the same year. Luthardt and Rößler measured tree-ring widths in 43 fossil trees, aligned 19 measurement series so their outermost rings were assigned relative dates that fell within a 19 yr span, and created an index of mean tree-ring width averaged over a subset of their 11 "best fitting" trees. These fossil tree-ring sequences are quite short—the longest has fewer than 80 yr and the median number of rings in their correlated sequences is 52—and attempting to align short tree-ring sequences with limited overlap make dating errors much more likely (Fowler and Bridge, 2017). While Luthardt and Rößler do not report any of the standard metrics used to gauge the quality of the cross-dating (Wigley et al., 1987; Bunn, 2010), it is apparent the overall agreement between individual trees and the index representing mean growth is weak compared to the matches typically reported for modern ring-width data (St. George, 2014). Furthermore, several tree-ring sequences included in their "best-fitting" set would have higher correlations with the ring-width composite if they were shifted earlier or later by 10 or 20 yr. Most importantly, the Chemnitz tree-ring measurements do not show any instances of concurrent wide or narrow rings (Fig. 1), which are the most reliable chronological markers in properly dated tree-ring sequences (Douglass, 1941; Stokes and Smiley, 1968). On the contrary, there are many cases where, during what is supposed to be the same year, very high growth in some trees coincides with very low growth in others. Considering the limited span and overlap of the tree-ring sequences, the poor between-tree correlations, and the total lack of marker rings, it is most likely these trees have not been assigned the correct relative dates. And if the dating are wrong, the composite Chemnitz tree-ring record cannot be interpreted as an indicator of annual fluctuations in either forest growth or climate at this location, let alone periodic variations in solar activity.

In addition, Luthardt and Rößler tested for spectral peaks in the composite record using a null hypothesis based on white noise. However, tree growth exhibits strong biological persistence due to carbohydrate storage and needle retention (Matalas, 1962; Franke et al., 2013), so peaks in the power spectra from ring-width sequences must be compared against results obtained from a random process with memory (red noise). The inherent autocorrelation in the tree-ring composite was further exaggerated by a 3 yr moving average applied by Luthardt and Rößler to individual tree-ring sequences prior to their spectral analysis, which reduced the available degrees of freedom and increased the risk of spurious peaks (Pittock, 1978).

Tree-ring dating was developed partly because Douglass (1927) required long proxy weather records to continue his search for solar influences on drought in the southwestern United States. But in the modern tree-ring width network, which includes data from thousands of forested locations, the very few records that have even modest spectral power near to the Schwabe cycle are scattered geographically, indicating that even these 11 yr peaks arise due to chance (Telford et al., 2015). Because after nearly a century of work we have not been able to identify in living or subfossil trees robust evidence of the sunspot cycle, the prospects for recovering the Sun's fingerprint from fossilized tree rings are likely to remain dim.

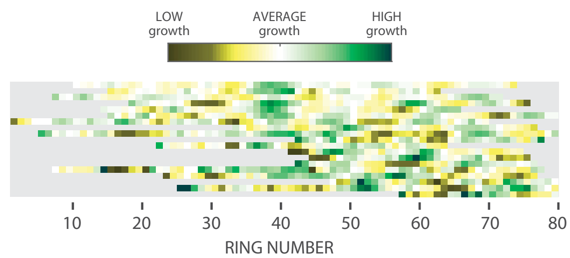

Figure 1. Color plot illustrating the alignment of the Chemnitz fossil tree-ring sequences suggested by Luthardt and Rößler (2017). If the sequences were dated correctly, narrow (brown) and/or wide (green) rings would match (vertically) across most or all trees in the set.

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