Correlation and Return Interval Analysis of Tree Rings Based Temperature and Precipitation Reconstructions

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We analyze tree rings based summer temperature and precipitation reconstructions from Central Europe covering the past 2500y [1], by (i) autocorrelation functions, (ii) detrended fluctuation analysis (DFA2) and (iii) the Haar wavelet technique (WT2). We also study (iv) the PDFs of the return intervals for return periods of 5y, 10y, 20y, and 40y. All results provide evidence that the data cannot be described by an AR1 process, but are long-term correlated with a Hurst exponent H close to 1 for summer temperature data and around 0.9 for summer precipitation. These results, however, are not in agreement with neither observational data of the past two centuries nor millennium simulations with contemporary climate models, which both suggest H close to 0.65 for the temperature data and H close to 0.5 for the precipitation data. In particular the strong contrast in precipitation (highly correlated for the reconstructed data, white noise for the observational and model data) rises concerns on tree rings based climate reconstructions, which will have to be taken into account in future investigations.
[1] Büntgen, U., Tegel, W., Nicolussi, K., McCormick, M., Frank, D., Trouet, V., Kaplan, J.O., Herzig, F., Heussner, K.-U., Wanner, H., Luterbacher, J., and Esper, J., 2011: 2500 Years of European Climate Variability and Human Susceptibility. SCIENCE, 331, 578-582.