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Abrupt Changes of Mean and Variance in an 8000-Year Series Reconstructed From Tree-Rings in the Western USA

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Abstract. An algorithm of scanning t test for detection of multi-time scale abrupt changes in the subseries mean (the first moment) was employed to an 8000 year time series of annual precipitation reconstructed from tree rings in the western USA. The tree ring samples were gathered from eight states in the southwestern USA. Twenty two change points were identified and twenty three relatively wet /normal/dry episodes were partitioned. The episodes span between 133 years and 733 years with an average of 348 years in duration. All of the wet /normal/dry episodes were collaborated by a coherency analysis of abrupt changes in the subseries mean between the tree-ring reconstructed series and the TIC / δ^{18}O records from cored sediments of Pyramid Lake in Nevada, or by comparison with published reports of related studies. In addition, the episodes were also compared with the global climate changes and with the climate changes in China during the same periods. The results suggest that the algorithm of scanning t test and coherency detection has a wide practicality for detection of multi-time scale abrupt changes in a long time series, and that this tree-ring reconstructed series is quite valuable in researches of the climate changes on multi-centurial time-scales in the western USA. Due to the TIC and δ^{18}O record series are sampled in high resolution with unequal intervals between 3 and 14 years, a new computing program was developed to respond the unequal intervals series.

In addition, A scanning F test for detection of abrupt changes in the subseries variance

(the second moment) was also applied to this tree-ring reconstructed series. Thirty three change points were identified and 34 spells of different variance were partitioned to reveal fluctuant stability. A small variance denotes a steady state while large variance indicates an unsteady state. The averages of subseries variance were calculated for each spell, and show a general trend of larger variance in the early years before 4500BC while a smaller variance in the later years after 800BC. Combining the results from the F test with the partition of wet/normal/dry episodes based on the abrupt changes of subseries means, we classified further each wet/ normal/dry episode into a steady (small variance) or an unsteady (large variance) characteristic. All results are summarized in a table.