Analysing the degree of replication of palaeoclimate records

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Palaeoclimate proxy records (such as time series derived from ice cores or stalagmites) from the same or nearby location would be expected to represent similar climate variation. This is called replication of proxy records but is often difficult to achieve, because either the proxies are not reflecting the paleoclimate variation, external factors overprint the climate signal in the proxy record, or chronological uncertainties cause a serious mismatch between the individual records. In order to minimize the later issue and take the chronological uncertainties into account, we combine a Monte Carlo based approach (COPRA) with an ensemble based windowed cross-correlation analysis. This allows the investigation of potential replication of proxy records from a statistical perspective. We demonstrate this approach by comparing two stalagmite $\delta^{18}O$ records from Heshang cave and Sanbao cave, both strongly influenced by the East Asian Summer Monsoon and covering the period between 9000 yr BP and 500 yrBP. We find that both proxy records reproduce well, although not perfectly. Main issues are differences between the records caused by unresolved geochemical processes influencing the U-series system and possibly kinetic fractionation in the oxygen isotope system. Overall, the proposed approach can provide a means to extract a correction function which reduces the uncertainties in the dating procedure. This method is a precursory step towards composite reconstructions that are based on multiple, replicating, time series.