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Correlation estimation of paleoclimate time series of unequal timescales

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Geoscientists are often interested to know the correlation between two paleoclimate time series to evaluate the influences of one time depended variable on another. General properties of paleoclimate data bring in extra challenges to estimate correlation between two time series with realistic confidence intervals. These properties are for example unequal timescale of the two time series, serial dependence, missing data and effects of smoothing.

Here we study usage of two different techniques aimed to deal with the situation of two time series with unequal timescales. One technique is interpolation, which is conventionally used in climatic sciences. However, interpolation affects the autocorrelation of the time series and may therefore bias the correlation estimation. The second technique is the binning correlation estimator (Mudelsee, 2010). There the time-interval is divided into bins of constant lengths, where the selection of the bin length takes into account the persistence times of both processes. The points of each time series within the bin are averaged and assigned to time value. The central binned time series are used to estimate the correlation between the two processes.

We analyse how these two different techniques affect the correlation estimation (Pearson‘s and Spearman’s correlation coefficients). Artificial data are used to test time series of different data size, autocorrelation and time spacing and the two different techniques are used to prepare the artificial time series prior to the estimate calculation. In addition, effects of smoothing the time series before the correlation estimation are analysed. We look at bias, standard error and root-mean-squared error of the correlation estimations to compare the results and evaluate the advantages and drawbacks of the different methods. Finally, the methods are applied to real paleoceanographic data from the Agulhas region south of Africa (GATEWAYS project), spanning the past several hundred thousand years (late Pleistocene).

Mudelsee, M (2010) Climate Time Series Analysis: Classical Statistical and Bootstrap Methods. Springer, Dordrecht Heidelberg London New York, 474 pp. [www.manfredmudelsee.com/book]