ICYESS2013-117
Interdisciplinary Conference of Young Earth System Scientists
Hamburg, Germany, 22 – 25 September 2013

Correlation estimation between two climate time series with improved uncertainty measures

K. B. Olafsdottir (1,2), M. Mudelsee (1), and M. Schulz (2)

(1) Climate Risk Analysis, Schneiderberg 26, 30167 Hannover, Germany (olafsdottir@climate-risk-analysis.com), (2) MARUM, Center for Marine Environmental Sciences, University of Bremen, 28334 Bremen, Germany

Climate time series provide information about the natural system that generated them. Some time series are based on proxy data, used to reconstruct climate fluctuations of the past, output from numerical models which simulate the climate system, or instrumental measurements that cover the most recent time period.
It is often useful to compare two climate time series to gain deeper understanding of the underlying processes that generated them. The most commonly used statistical methods involve estimating the correlation parameter between two time series. The correlation parameter gives information about the influences of one time depended variable on another. The most common method is to estimate the Pearson's correlation coefficient between two time series. Additionally the association can be evaluated in the frequency domain via coherency spectrum, which measures how well the two time series co-vary at different frequencies. In both cases it is necessary to include error estimates and hypothesis testing to evaluate how reliable the estimate is.
It can be challenging task to make accurate error measurements for climate time series as the time series is only one realization of the system aimed to be reconstructed. Information about the natural system that produced the time series may be lacking, for example the statistical distribution behind the data is usually unknown. The number of data points is often limited and may be unevenly spaced in time. In addition, climate time series do usually contain memory as there is natural inertia in the climate system.
Here we present two different methods to give improved estimates of the relationship between two climate time series, where data properties common to climate time series are taken into account. The first method estimates Pearson's correlation coefficient between two time series with accurate calibrated bootstrap confidence interval (Mudelsee, 2010). This method offers robustness against data distribution and takes the memory of both time series into account. The second method estimates coherency spectrum between two unevenly spaced time series, where the level of significant coherency is approximated with Monte Carlo simulations. These methods have been developed and adapted on the basis of existing software, PearsonT (Mudelsee, 2003) and REDFIT (Schulz and Mudelsee, 2002).

Mudelsee M., 2003. Estimating Pearson's correlation coefficient with bootstrap confidence interval from serially dependent time series. Mathematical Geology 35(6), 651-665.
Mudelsee, M., 2010. Climate Time Series Analysis: Classical Statistical and Bootstrap Methods. Springer, Dordrecht, 474 pp.
Schulz, M. and Mudelsee, M., 2002. REDFIT: estimating red-noise spectra directly from unevenly spaced paleoclimatic time series. Computers & Geosciences 28, 421–426.