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Comparison of linear and nonlinear similarity measures for irregularly sampled and age-uncertain time series

Kira Rehfeld (1,2), Jobst Heitzig (1), Norbert Marwan (1), Bedartha Goswami (1,3), Jürgen Kurths (1,2)

(1) Potsdam-Institute for Climate Impact Research, Transdisciplinary Concepts & Methods, Potsdam, Germany (rehfeld@pik-potsdam.de), (2) Department of Physics, Humboldt Universität zu Berlin, Newtonstr. 15, 12489 Berlin, Germany, (3) Department of Physics, Universität Potsdam, Karl-Liebknecht-Str. 24-25, 14476 Potsdam, Germany

Paleoclimate time series are oftentimes sparse and heterogeneously sampled. Furthermore, time itself is a variable that has to be reconstructed prior to analysis, which results in additional – and substantial – uncertainties. Statistical analysis of such time series usually dictates, that they be sampled regularly, a requirement often met by means of linear interpolation. Such interpolation is, however, immediately linked with loss of information on short timescales, and over-estimation of variability on long timescales.

We adapted similarity estimators for Pearson correlation, mutual information and event synchronization that do not require the time series to be sampled regularly. We performed benchmark tests on synthetic data to infer, which estimators are most robust in the presence of irregular sampling, and how they are influenced by additional uncertainty on the time axis.

We compared results for standard estimators, using interpolated time series, and the adapted estimators. We observe that interpolation of the time series results in the largest estimation error for cross correlation estimation, while the event synchronization function and Gaussian-kernel-based correlation estimation show the overall lowest error.