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A correlation estimation algorithm adapted to irregular sampling applied to ice core and speleothem time series

Kira Rehfeld (1,2,3), Norbert Marwan (1), Jürgen Kurths (1,2), Dietmar Wagenbach (3), Susanne Preunkert (4), and Sebastian Breitenbach (5)

(1) Potsdam Institute for Climate Impact Research, PO Box 601203, 14412 Potsdam, Germany, (2) Department of Physics, Humboldt University Berlin, Newtonstr. 15, 12489 Berlin, Germany, (3) Institute of Environmental Physics, Ruprecht-Karls-Universität Heidelberg, Im Neuenheimer Feld 229, 69120 Heidelberg, Germany, (4) Laboratoire de Glaciologie et Géophysique de l'Environnement, CNRS,BP 96, F-38402 St. Martin d'Hères, France, (5) Climate Geology, Dept. of Earth Sciences, Swiss Federal Institute of Science and Technology (ETH), CH-8092, Zürich, Switzerland

Geoscientific time series providing information over timescales from years to centuries are constructed from geoarchives and are prone to errors in time and signal dimension. Sampling is often inherently irregular which for frequency-based analysis requires interpolation prior to analysis or methods adapted to it. Spectral analysis of irregularly sampled data has received much interest especially in the field of astrophysics, but most research has been focussed on power spectrum estimators such as the Lomb-Scargle Periodogram. Cross- and autocorrelation estimation of unequally sampled data has received little attention up to now. However, it offers new possibilities for correlation-based similarity network analysis and we show that our approach can highlight cyclical patterns lost in the interpolation process. This feature can be extremely useful in the chronology building process, where annual lamination can provide restraints for radiometric dates and time horizons as used for the dating of speleothems and ice cores. Here, a correlation estimation algorithm adapted to irregular sampling is presented, validated against common routines for equidistant sampling and its robustness regarding common sampling artifacts is shown. Results of the analysis of a speleothem record and a Mont Blanc summit ice core record are presented.