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Characterization of long-term Climate Change by Dimension Estimates of Multivariate Palaeoclimatic Proxy Data

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Geological data sets usually consist of a number of biological, chemical, physical, or sedimentological parameters obtained along a particular sequence and contain multiple information about past climate variability, which is however often not to be interpreted easily. It is a standard problem in palaeoclimatology to attribute particular variability patterns of such multivariate data sets to changes of particular palaeoclimatic variables like temperature, precipitation, or strength and location of different atmospheric oscillation patterns. For this purpose, one frequently makes use of appropriate transfer functions which may be a potential matter of criticism.

We like to address the problem of extracting climate variability from geological records on a more fundamental level, considering the number of variability patterns that can be derived from the multivariate data and carry significant information from a statistical point of view. For this purpose, we make use of relative dimension estimates recently introduced for describing temporal changes of the correlation structure of multivariate time series. We demonstrate the power of our method by applying it to two different examples of geological records: abundances of different chemical trace elements and relative size-frequency data of grains obtained along a sedimentary sequence. We discuss the particular problems of both kinds of data with respect to our statistical method. The major results and their meaning for palaeoclimatic interpretation are discussed. In particular, we address the sensitivity of our measure to extreme events.