Detecting trends, rythms and transitions during the Late Quaternary in southern Ethiopia using Recurrence Quantification Analyses

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Abstract

This project aims at statistically analyzing the long (~278 m) sediment record of the Chew Bahir basin, as part of the ICDP-funded Hominin Sites and Paleolakes Drilling Project (HSPDP). The aim of the project is (1) to establish a robust age-depth model for the sediment cores, (2) to correlate the Chew Bahir record with other records within and outside HSPDP, (3) to detect trends, rhythms and events in the environmental record of the basin, and (4) identify recurrent, characteristic types of climate transitions in the time series, as compared with the ones of the other HSPDP sites and climate records outside HSPDP. The work presented here is related to (3) and (4) respectively, and will provide an introduction to recurrence plots and their quantification analysis adapted to the Chew Bahir data.
The different aspects of recurrence can help to identify and characterize subtle changes in systems dynamics. Besides the identification of transitions, recurrence methods can help to provide a better understanding of the underlying process of these transitions by statistically describing the dynamical characteristics, e.g. the predictability, determinism and complexity of the dynamical system. For example, the characteristic block structures in the recurrence plot can be used to identify different types of intermittency. In general, changes between different dynamics are visually well expressed in recurrence plots. The introduction of selected recurrence quantifiers (such as recurrence rate, determinism, or laminarity) together with a running window approach has paved the way for a quantitative recurrence analysis of transitions and therefore allow a classification of different transition types. We present first results of such recurrence based classification, analyzing the sediment records of the Chew Bahir basin (CB01 & CHB14).