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Classifying past climate variation in the Chew Bahir basin, southern Ethiopia, using recurrence quantification analysis

Martin H. Trauth (1), Asfawossen Asrat (2), Walter Duesing (1), Verena Foerster (3), Hauke Kraemer (1,5), Henry Lamb (4), Norbert Marwan (5), Mark A. Maslin (6), and Frank Schaebitz (3)

(1) University of Potsdam, Institute for Earth and Environmental Sciences, Potsdam, Germany (trauth@geo.uni-potsdam.de), (2) Addis Ababa University, School of Earth Sciences, Addis Ababa, Ethiopia, (3) University of Cologne, Institute of Geography Education, Cologne, Germany, (4) University of Aberystwyth, Department of Geography and Earth Sciences, UK, (5) Potsdam Institute for Climate Impact Research, Potsdam, Germany, (6) Department of Geography, University College London, London, UK

The Chew Bahir Drilling Project (CBDP) aims to test hypothesized linkages between climate and mammalian (including hominin) evolution in tropical-subtropical eastern Africa by the acquisition and analysis of long (∼280 m) sediment cores that have recorded environmental change in the Chew Bahir basin. In our statistical project, we describe the Chew Bahir paleolake as a dynamical system composed of interacting components, such as the water body, the sediment below the bottom of the (paleo-)lake, and the organisms living in the lake and its surroundings. A common feature of dynamical systems is the property of recurrence, where patterns of recurring states reflect typical system characteristics whose description contribute significantly to understanding its dynamics. In our example it could be a recurrence of changes in the state variables precipitation, evaporation and wind speed, which lead to similar (but not identical) conditions in the lake (e.g., depth and size of the lake, alkalinity and salinity of the lake water, species assemblage in the water body, diagenesis in the sediment). A recurrence plot (RP), first introduced by J.P. Eckmann in 1987, is a graphical display of such recurring states of the system, calculated from the distance (e.g. Euclidean) between all pairs of observations x(t), within a cutoff limit. To complement the visual inspection of recurrence plots, measures of complexity were introduced for their quantitative description to perform the recurrence quantification analysis (RQA). Here we present and discuss preliminary results of a RQA of the ∼550 kyr long environmental record from the Chew Bahir basin.