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Nonlinear detection of paleoclimate-variability transitions possibly related to human evolution

J.F. Donges (1,2), R.V. Donner (1,3), M.H. Trauth (4), N. Marwan (1), H.J. Schellnhuber (1), J. Kurths (1,2,5)

(1) Potsdam Institute for Climate Impact Research, Transdisciplinary concepts and methods, Potsdam, Germany (donges@pik-potsdam.de), (2) Department of Physics, Humboldt University, Berlin, Germany, (3) Institute for Transport and Economics, Dresden University of Technology, Dresden, Germany, (4) Department of Earth and Environmental Sciences, University of Potsdam, Potsdam, Germany, (5) Institute for Complex Systems and Mathematical Biology, University of Aberdeen, Aberdeen, United Kingdom

Potential paleoclimatic driving mechanisms acting on human evolution present an open problem of cross-disciplinary scientific interest. The analysis of paleoclimate archives encoding the environmental variability in East Africa during the last 5 Ma (million years) has triggered an ongoing debate about possible candidate processes and evolutionary mechanisms. In this work, we apply a novel nonlinear statistical technique, recurrence network analysis, to three distinct marine records of terrigenous dust flux. Our method enables us to identify three epochs with transitions between qualitatively different types of environmental variability in North and East Africa during the (i) Mid-Pliocene (3.35-3.15 Ma BP (before present)), (ii) Early Pleistocene (2.25-1.6 Ma BP), and (iii) Mid-Pleistocene (1.1-0.7 Ma BP). A deeper examination of these transition periods reveals potential climatic drivers, including (i) large-scale changes in ocean currents due to a spatial shift of the Indonesian throughflow in combination with an intensification of Northern Hemisphere glaciation, (ii) a global reorganization of the atmospheric Walker circulation induced in the tropical Pacific and Indian Ocean, and (iii) shifts in the dominating temporal variability pattern of glacial activity during the Mid-Pleistocene, respectively. A reexamination of the available fossil record demonstrates statistically significant coincidences between the detected transition periods and major steps in hominin evolution. This suggests that the observed shifts between more regular and more erratic environmental variability may have acted as a trigger for rapid change in the development of humankind in Africa.