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Is the Sahara a tipping element?

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The Sahara, the largest desert on our Earth, has undergone large-scale changes. The last one happened approximately 6000 to 4000 years ago, at the end of the mid-Holocene. Interpretation of some palaeo proxies suggest a tipping point, a rather rapid and persistent termination of the so-called African Humid Period (AHP) and associated expansion of the Sahara from a rather green state to the modern desert during this period of time. Other proxies hint at a more gradual transition. And the discussion continues whether the Sahara has changed abruptly, whether there was a collapse of the green Sahara, or a tipping point, or not. To foster discussion, we suggest quantifying "abruptness". We demonstrate that at the end of the mid-Holocene, the concentration of terrigenous material in marine sediment records which took place over several centuries has changed approximately an order of magnitude faster than the orbital forcing. Analysis of the pollen record from Lake Yoa (NE Chad) reveals equally rapid changes of ecosystem successions from tropical taxa to modern desert conditions whilst the main biomass–producers seem to indicate a gradual change. New transient climate system simulations of the last 8000 years show spatially heterogeneous vegetation dynamics in northern Africa. The fastest increase in simulated desert fraction - some 5 to 7 times faster than orbital forcing – occur in a stripe from approximately 20N in the western part and around 14N in the central and eastern part. Thereby the simulations reconcile the seeming discrepancy between the rather fast changes in desert conditions found in the marine records and the more gradual overall changes seen in the Lake Yoa record. In summary, the mid-Holocene transition of the Sahara was regionally rapid, hence a tipping element, with respect to changes in the driving forcing, but slow with respect to time scales of individual humans (i.e. human life time) and local ecosystems (i.e. growth or decay of Savanna plants). However, the mid-Holocene transition, rapid or gradual depending on the perspective, has led to persistent and long lasting changes that are associated with a tipping point in human civilisations which led to the emergence of new cultures along the Nile.