



On the mechanism of the vegetation collapse in the Sahara/Sahel at the end of the African Humid Period

Sebastian Bathiany (1), Martin Claussen (1,2), and Klaus Fraedrich (2)

(1) Max Planck Institute for Meteorology, KlimaCampus, Hamburg, Germany, (2) Meteorologisches Institut, Universität Hamburg, KlimaCampus, Hamburg, Germany

Many paleoclimatic records indicate a collapse of vegetation in the Western Sahara at the end of the African Humid Period (about 5500 years before present). Modelling studies have shown that this phenomenon may be interpreted as a critical transition that results from a bifurcation in the atmosphere-vegetation system. However, the impact of climate variability must be considered. So far it has been argued that large variability will cause intermittency (a flickering between the deterministic stable states), or even obliterate the deterministic equilibria completely, which would lead to only gradual decline in vegetation cover. In order to explain a vegetation collapse despite strong variability, low frequency variations in precipitation have been suggested.

By coupling the Planet Simulator, an atmosphere model of intermediate complexity, with the simple dynamic vegetation model VECODE, we confirm that the number and nature of steady states depends on the way of coupling. Only if variability is suppressed by passing an averaged climate to the vegetation model (asynchronous coupling), multiple steady states can emerge. However, an abrupt decrease in vegetation cover is still possible in the synchronously coupled model despite strong and uncorrelated atmospheric variability. Because of the nonlinear relation between vegetation dynamics and precipitation the green state is stabilised by the variability. Only when very dry conditions occur, the system cannot escape the desert state anymore because its variability is then also reduced.