Geophysical Research Abstracts, Vol. 9, 08968, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-08968

Modeling the impact of eastern Africa elevation changes during the late Neogene : climate and vegetation responses

P. Sepulchre (1,2), G. Ramstein (1), F. Fluteau (3), M. Schuster (2), J.-J. Tiercelin (4), M. Brunet (2)

1. Laboratoire des Sciences du Climat et de l'Environnement, Gif-sur-Yvette, France (pierre.sepulchre@free.fr)
2. Laboratoire de Géobiologie, Biochronologie et Paléontologie Humaine, Université de Poitiers, France
3. Institut de Physique du Globe de Paris, France
4. InstitutUniversitaire Européen de la Mer, Brest, France

Several phases of aridification punctuated East African environments evolution during late Neogene (8-2 million years ago, hereafter Myr). Isotopic studies on mammals fossils have attributed a first Upper Miocene (8-6 Myr) transition from woodlands to grasslands to atmospheric CO_2 decrease. Paleoclimatologists have invoked Indian ocean Sea Surface Temperatures cooling and onset of glacial-interglacial cycles to explain later Mio-Pliocene (5-3 Myr) spreading of grasslands associated with increased climatic variability. Moreover, dust records off Arabian peninsula revealed an orbitally-linked cyclicity in the climatic patterns. However, the topographic evolution of eastern Africa has not been quantified yet and has not been accounted for as a major climatic forcing.

Nowadays, Eastern African climate is strongly influenced by moisture fluxes linked to Atlantic and Indian monsoons, but also by topography especially with the East African Rift System which is 6,000 kilometers-long, with elevations up to more than 5,000 meters. This system started uplifting by its eastern branch during Eocene-Oligocene times in southern Ethiopia and Turkana depression (northern Kenya) with uplifting reaching a maximum at the Plio-Pleistocene interval. Ethiopia uplift shoulders were superimposed on an older topography due to Oligocene volcanic activity (Ethiopian traps).

The Western branch of the East African Rift System started to develop during middle-late Miocene with initiation of the central Tanganyika Basin at about 12-10 Myr, and with more recent phases of major uplift between 5 and 2 Myr in the Tanganyika and Malawi rifts. Major Tanzanian escarpments were present by 3 Myr. Southward; the Karoo plateau in South Africa (20˚S-32˚S) has been raised during the past 5 million years, reaching a mean elevation of ca. 1,400 m at present.

We used Atmospheric General Circulation and Dynamical Vegetation models to test the potential impact of these topographic features on climate and ultimately on vegetation. Our model provides a resolution of 144 longitude points and 108 latitude points and 19 vertical layers. A zoom is set over Africa to get a ca. 50 km resolution over the central part of the continent. By sensitivity experiments with reduced topography over eastern Africa, we show that reducing drastically the elevation changes temperature contrasts between the continent and Indian ocean as well as it reduces the barrier-effect of the Rift. Large-scale zonal circulation of moisture between the Indian ocean and the continent is enhanced. As a consequence rainfall patterns are strongly modified and a global enhancement of precipitation over eastern Africa is observed. Simulating vegetation response to these changes show that tropical arboreal plant functional types could have covered a large part of eastern Africa when topography was lower. Therefore it seems that tectonics played actually a major role in triggering aridification of eastern Africa. By suggesting the major role played by tectonics in the setting of East African grasslands, these results involve a need of accurate paleoaltitude reconstructions for future studies of late Neogene paleoenvironments.