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From Toumai to Lucy: climate and orographic forcing on Environment and Early Human

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This abstract will present a summary of several studies we conducted at LSCE to understand through modeling simulations how the climate and topography variations may drive the evolution/migration of Early Humans.

Tectonics and orbital forcing are major forcing factors on environment which act at different time scales. African Uplift spans over Millions of years whereas at low latitudes precession cycles will produce drastic hydrologic variations at the pluri millennial time scale. Therefore, in a first step it is necessary to investigate the impact of long term topographic changes on climate and vegetation.

The long term forcing of the African uplift has been first tested and investigated through a set of numerical experiments using different heights for the Rift. We pointed out that this issue was the key factor to explain the dryness of the East part of the Rift associated with the disappearance of the forests when the rift was uplifted during the late Pliocene. Prior to this, much more water penetrates from the Indian Ocean over East Africa and forests can sustain.
Therefore, this pattern of Dry East of the Rift and Wet west of the Rift is driven by the uplift and consistent with the evolution of vegetation.
On the other side, the Mega Lake Chad (MLC) region was not really sensitive to this topographic change but much more to orbital forcing.

Two species of early hominids (Australopithecus bahrelghazali, 3,6 Ma, and Sahelanthropus tchadensis, Toumai, 7 Ma) were found in this region, associated with other vertebrate fossil remains, which seem to be associated to the presence of the Mega Lake Chad. It is thus crucial to understand how it is possible to produce and sustain such a large lake (350 000 km2) at these latitudes.

Through a second series of simulations, we demonstrated that during the Pliocene, occurrences of such megalake episodes were possible (similarly as during most recent Holocene) and may be sustained during half a precession cycle (10 kyr) allowing a vegetation that enabled hominin settings (Australopithecus)

Therefore the orbital parameters, mainly the precession cycle, drives the hydrologic cycle, shifting the ITCZ and the Monsoon to produce oscillations between arid and wet phases. This second mechanism is responsible for the establishment of periodically favorable conditions that enable a large lake in the Chad area which may last several thousand years.

To go a step further, we need to downscale our model results from 50 to 10 km. We need this spatial resolution to better catch the topography and to better compare climate and vegetation outputs to multiproxies.