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African monsoon variations and persistence of the Megalake Chad during the late Pliocene

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Megalake Chad (MLC) occurrences are widely documented for the mid-Holocene period but also for the Mio-Pliocene (Schuster et al., 2009). From 7 to 3 Ma, analysis of sedimentary deposits of the Djurab desert region show desertic to full-lacustrine facies, suggesting an alternance of dry to wet climates (Schuster, 2002, Schuster et al., 2009), lacustrine conditions being associated to fauna dispersal and early hominid presence (e.g. Brunet et al., 1995, 2002). Some studies (e.g. Braconnot and Marti, 2003) suggest a control of precession on monsoon. Using late Pliocene climate simulations and different orbital configurations, can we constrain variations of the Megalake and reach the water volume of 350 000 km^2 proposed by several authors (Ghienne et al., 2002; Leblanc et al., 2006)? Can we propose a timing for the MLC occurrences?

First, in order to better characterize the precession role on Megalake Chad occurrences during the late Pliocene, we use the IPSLCM5A coupled ocean atmosphere climate model forced with four different orbital configurations and mid-Pliocene boundary conditions. The four orbital configurations, all around 3 Ma, correspond to maximum and minimum insolations at 30°N at summer solstice or autumn equinox. We find important increases of precipitation in North Africa, controlled by insolation maxima at 30°N at summer solstice and autumn equinox, i.e. related to an angular precession between 270° and 10°. When used to force a surface routing model (HYDRA, Coe, 2000), these precipitation increases lead to MLC episodes, suggesting the MLC could be sustained during at least 5 kyr of a precession cycle.

However, this method does not account for the lake feedback on climate. Indeed, during wet phases, the MLC becomes an important evaporation source, modifying the climate of the Chad basin. To investigate this aspect, we use the LMDZ4 atmospheric model including an open water surface module (Krinner, 2003). We find that deep convection is suppressed above the MLC surface, and convective activity on the borders of the MLC is enhanced. The climatic outputs are then used to force the HYDRA model, this time, accounting for the lake feedback on climate. The results are presented and the possibility of maintaining a MLC is discussed.