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A continental miocene thermal maximum predates the miocene climate optimum in central europe

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The Miocene Climate Optimum (MCO) is thought to represent the climax in Neogene climate evolution, representing the warmest interval during the last 23 million years (Zachos et al. 2001). However, recent evaluation of continental climate archives from the North Alpine Foreland Basin (NAFB, palaeolatitude $\sim$46° N) provides evidence that a thermal maximum ranged between $\sim$17.7 and $\sim$18.5 Ma[1] (Ottnangian, Late Burdigalian) significantly predate the MCO from 16.7 to 14.2 Ma. This result based on the following palaeontological data:

1. The highest crocodile diversity (three contemporaneous genera; *Diplocynodon*, *Tomistoma*, *Gavialis*) occur around $\sim$18.3 Ma (Baltringen locality; Early to Middle Ottnangian transition)

2. The largest body size ever recorded in European crocodiles, a *Tomistoma* of about 10 m length, is documented around 17.9 Ma (Eggingen-Mittelhart locality, Middle Ottnangian)

3. The largest body size in certain aquatic turtles (*Chelydropsis* 65 to 70 cm carapax length, *Trionyx* 50 cm carapax length) is reached around $\sim$17.8 Ma (Langenau locality; Late Ottnangian)

[1] A refined geochronology of late Early Miocene sediments of the NAFB is still in progress. Ages given for selected localities can vary within in the range of few 0.1 My between authors and due to further magnetobiochronologic studies.

4. A paratropical vegetation is reconstructed for the period around 17.8 Ma (Ortenburger gravel xyloflora, Late Ottnangian, Böhme et al. 2007) giving a mean annual temperature (MAT) of 22.2-24.2°C and a could month temperature (CMT) of 16.7°C, both using the Coexistence Approach

In contrast, the MCO in the NAFB is characterized by a low crocodile diversity (one species), a smaller maximum body size in crocodiles and turtles, and subtropical vegetation, indicating more than 1.7 K (MAT) and over 3.4 K (CMT) cooler temperatures (MAT 17.4–20.5°C and CMT 8.0–13.3°C). The proxy data suggest that the Ottnangian Thermal Maximum shows the highest continental temperatures since about the last 40 million years.

This thermal maximum falls within a period of large (up to 2 per mill) and rapid ($<$100 ka) shifts in benthic foraminiferal δ^{18}O, oceanic bottom water temperatures and East Antarctic ice-volume (Pekar & DeConto 2006). In contrast to the MCO, this suggests a dynamic cryosphere with pronounced glacial-interglacial cyclicity. The time resolution of continental sequences correlate to the Ottnangian is still too low to decide whether the thermal maximum correspond to the entire Ottnangian, or the studied localities represent short but extreme interglacial conditions (dated to 18.4 and 18.2 Ma, Pekar & DeConto 2006). The latter possibility seems likely, since precipitation estimates (bioclimatic analysis of herpetofauna, Böhme et al. 2006) for the pre-MCO (Ottnangian and early Karpatian, $\sim$18.3-16.5 Ma) show several rapid ($\sim$100 ka) humidity shifts from perhumid (160% relative to present day precipitation) to subarid (20% relative to present day precipitation) conditions. With the beginning of the MCO the precipitation increase strongly and remain at relatively constant humid levels until $\sim$14.7 Ma (with the exception of a short decrease at 15 Ma). Toward the end of the MCO the climate shifts again into subhumid conditions. These results suggest a close relationship between Southern Hemisphere glacial-interglacial cycles and Central European humidity evolution.

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