Late Early Miocene Climate in the Turkana Basin, Kenya From Multi-Proxy Records and iCESM Results

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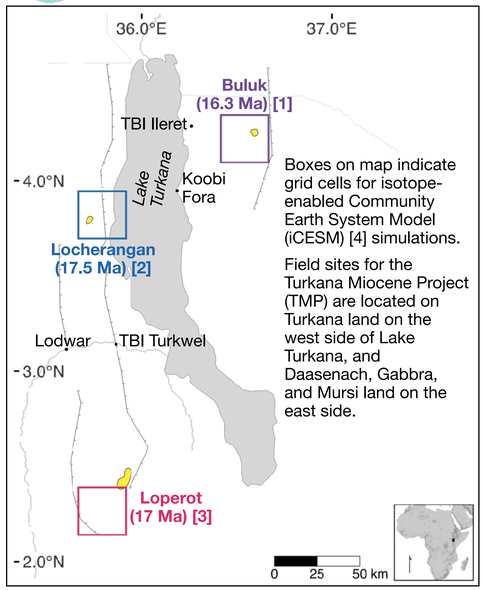
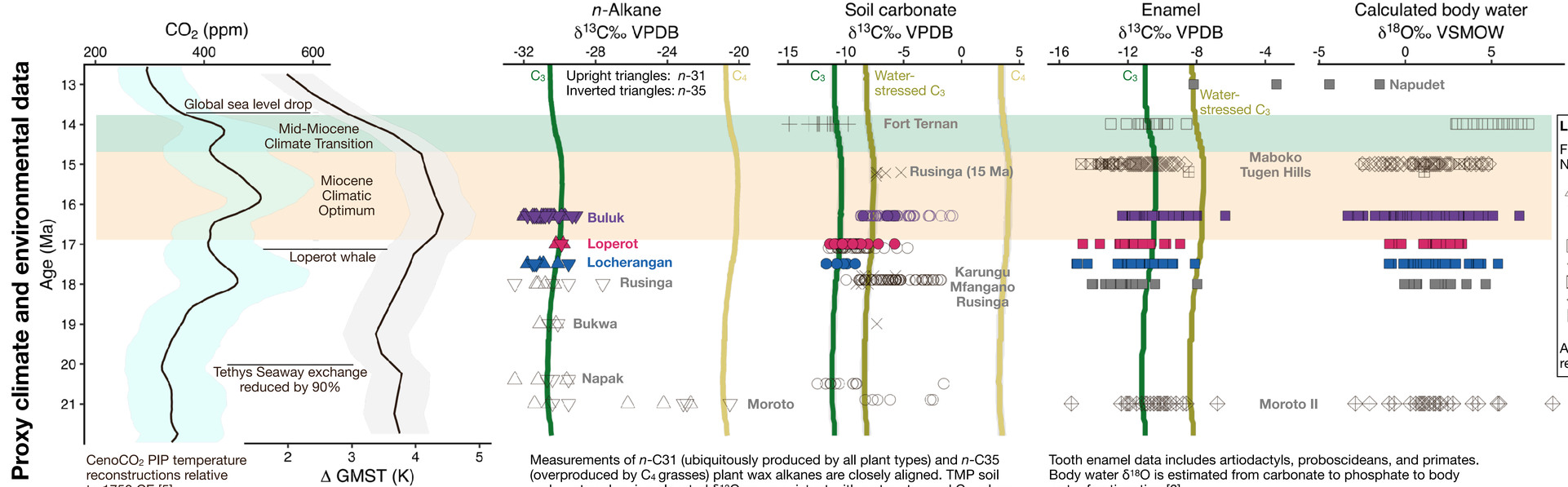
TURKANA MIOCENE PROJECT



Boxes on map indicate grid cells for isotope-enabled Community Earth System Model (iCESM) [4] simulations.

Field sites for the Turkana Miocene Project (TMP) are located on Turkana land on the west side of Lake Turkana, and Daasenach, Gabbra, and Mursi land on the east side.



CenoCO$_2$ PIP temperature reconstructions relative to 1750 CE [5]

Measurements of *n*-C31 (ubiquitously produced by all plant types) and *n*-C35 (overproduced by C$_4$ grasses) plant wax alkanes are closely aligned. TMP soil carbonates showing elevated $\delta^{13}C$ are consistent with water-stressed C$_3$ values.

Tooth enamel data includes artiodactyls, proboscideans, and primates. Body water $\delta^{18}O$ is estimated from carbonate to phosphate to body water fractionation [6].

Summary

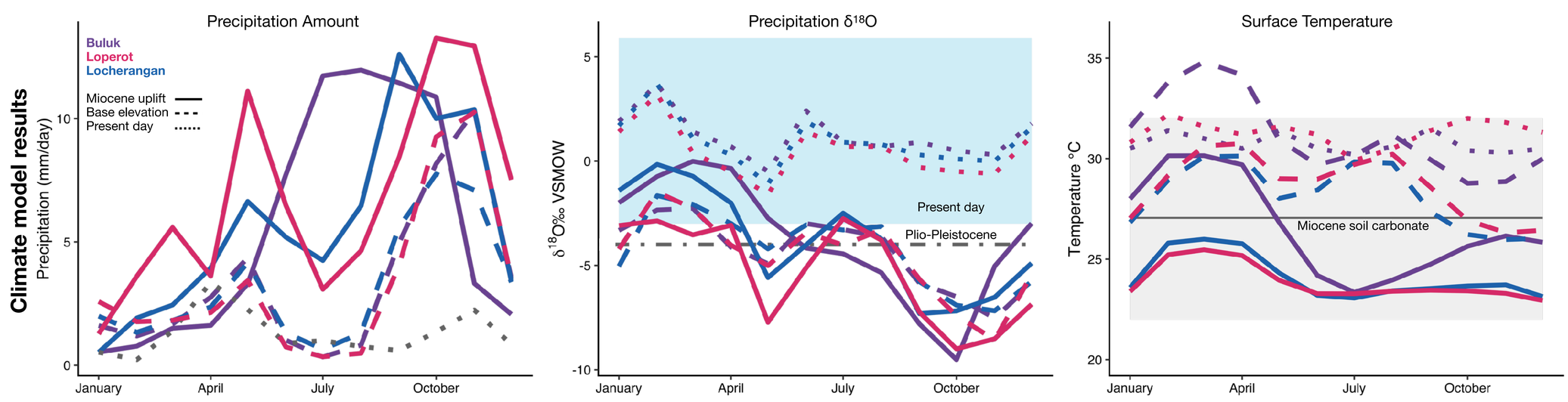
Motivation: Paleoclimate proxies from the Turkana Basin record conditions through a period of topographical, hydrological, and biotic changes just prior to the Miocene Climatic Optimum. We present a new multi-proxy record for three Early Miocene sites along with high-resolution climate model results.

Tectonic uplift and climate feedback: Updated topography of East African Rift System (EARS) uplift is essential for modeling regional climate variability. Precipitation seasonality between sites increases with EARS uplift.

Consistent C$_3$ environments: All proxies for $\delta^{13}C$ indicate wooded ecosystems. Wetter conditions in the Miocene support this interpretation.

Hydrological indicators: Body water and simulated precipitation $\delta^{18}O$ vary across sites due to climatic change over time and/or site-specific characteristics.

Future work: More terrestrial hydroclimate proxy data are needed to compare modeling results. Leaf wax δD measurements and carbonate-derived soil water $\delta^{18}O$ and soil temperature estimates are forthcoming.



Model results from iCESM1.3 use 400 ppm CO_2 and have a horizontal resolution of ~25 km. Miocene uplift topography conditions are adapted from a geodynamic model by TMP colleagues [19]. Base elevation is 25% lower relative to present [20]. Present day precipitation records are from a weather station in Lodwar [21].

For all model output parameters, seasonal variability is amplified with Miocene uplift. Range of measurements from 2016–2021 [22] (shaded region) and values from the Online Isotopes in Precipitation Calculator [23] are elevated relative to all Miocene simulations and Plio-Pleistocene [24].

Shaded region shows soil carbonate clumped isotope temperature range ($T(\Delta_{47})$) for one nodule from Buluk [25]. Present day values are monthly averages from Turkana Basin Institute (TBI) Research Centers at Turkwel (southwest) and Ileret (northeast) 2019–2023 recorded using HOBO pendant loggers.

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References

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