

Distribution of Glycerol Diakyl Glycerol Tetraethers (GDGTs) in surface soils and Crater Lake sediments from Mount.Kenya, East Africa

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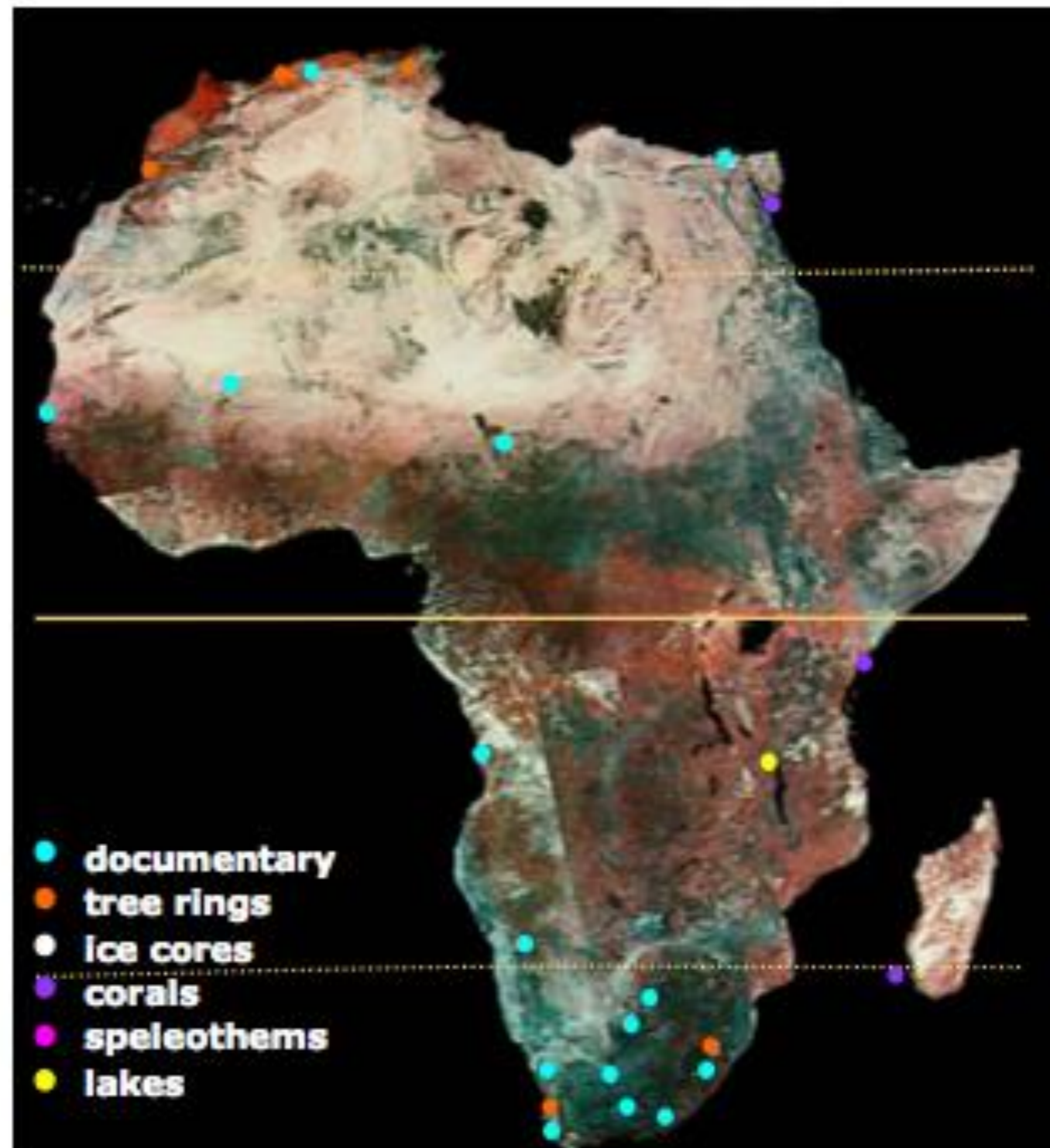
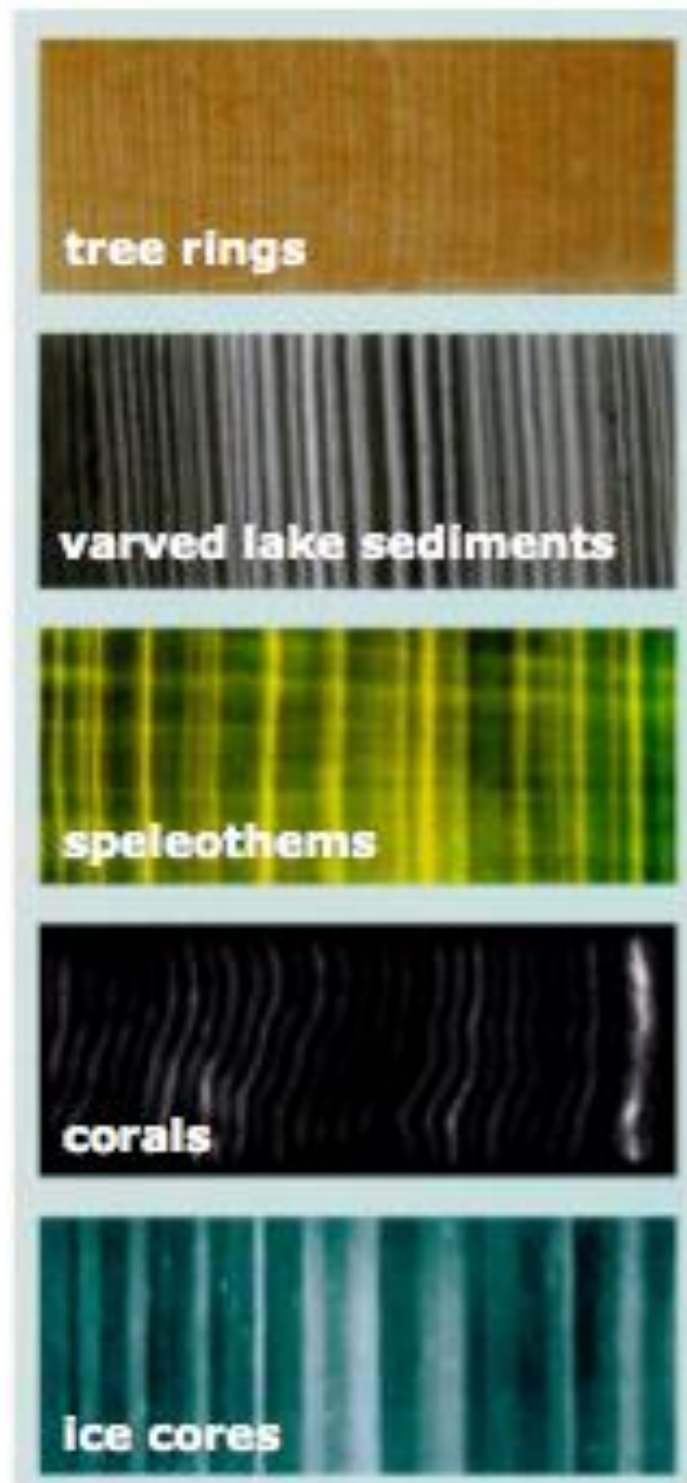
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Outline of Presentation

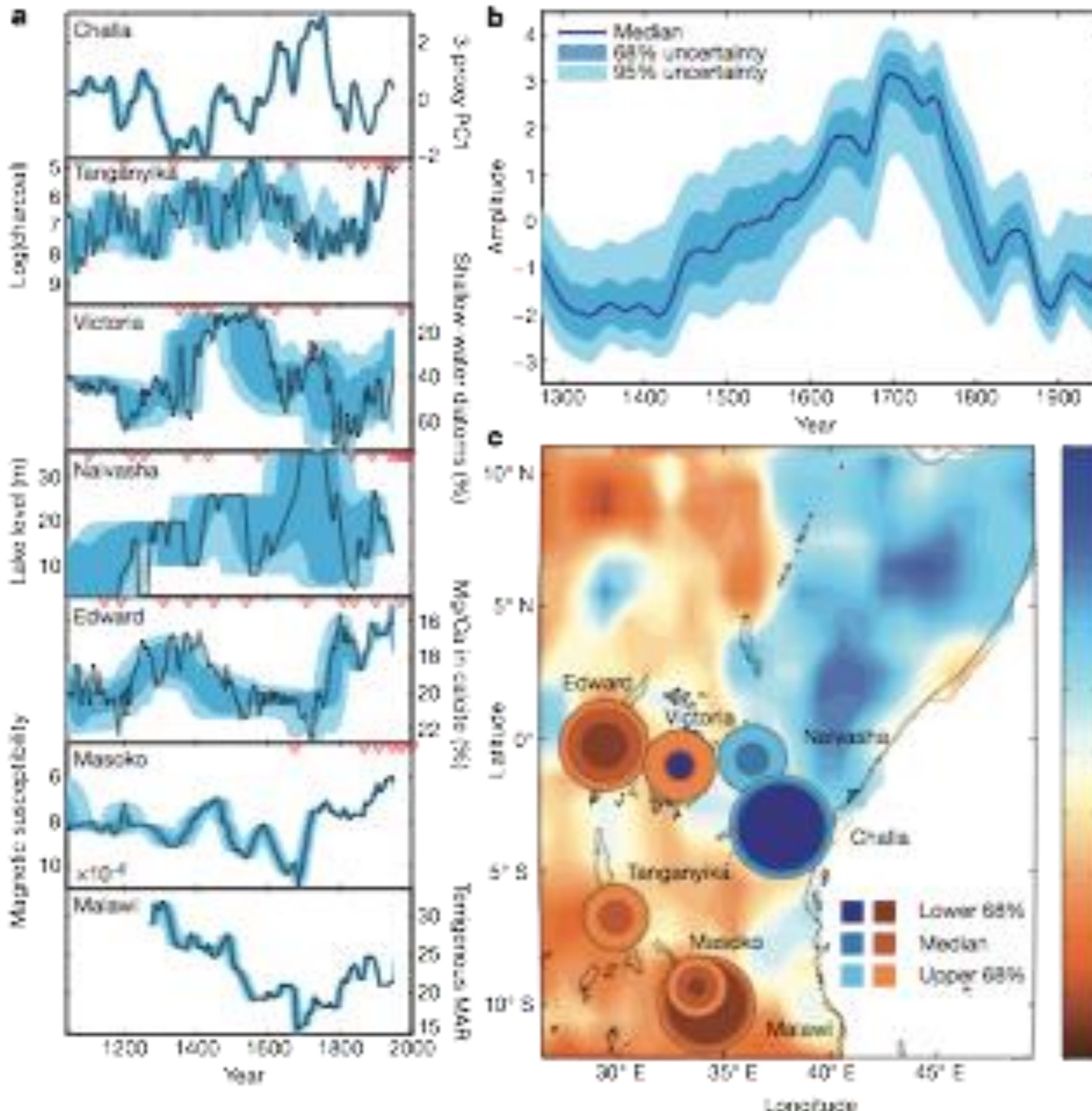
- Background information
- Introduction
- Methods
- Results and Discussion
- Conclusions

Background information

- We read geological materials: Lake sediments, Marine sediments, Peat, Corals, Ground water, Speleothems, tree rings, ice, etc



Multidecadal variability hydroclimatic variability in East Africa



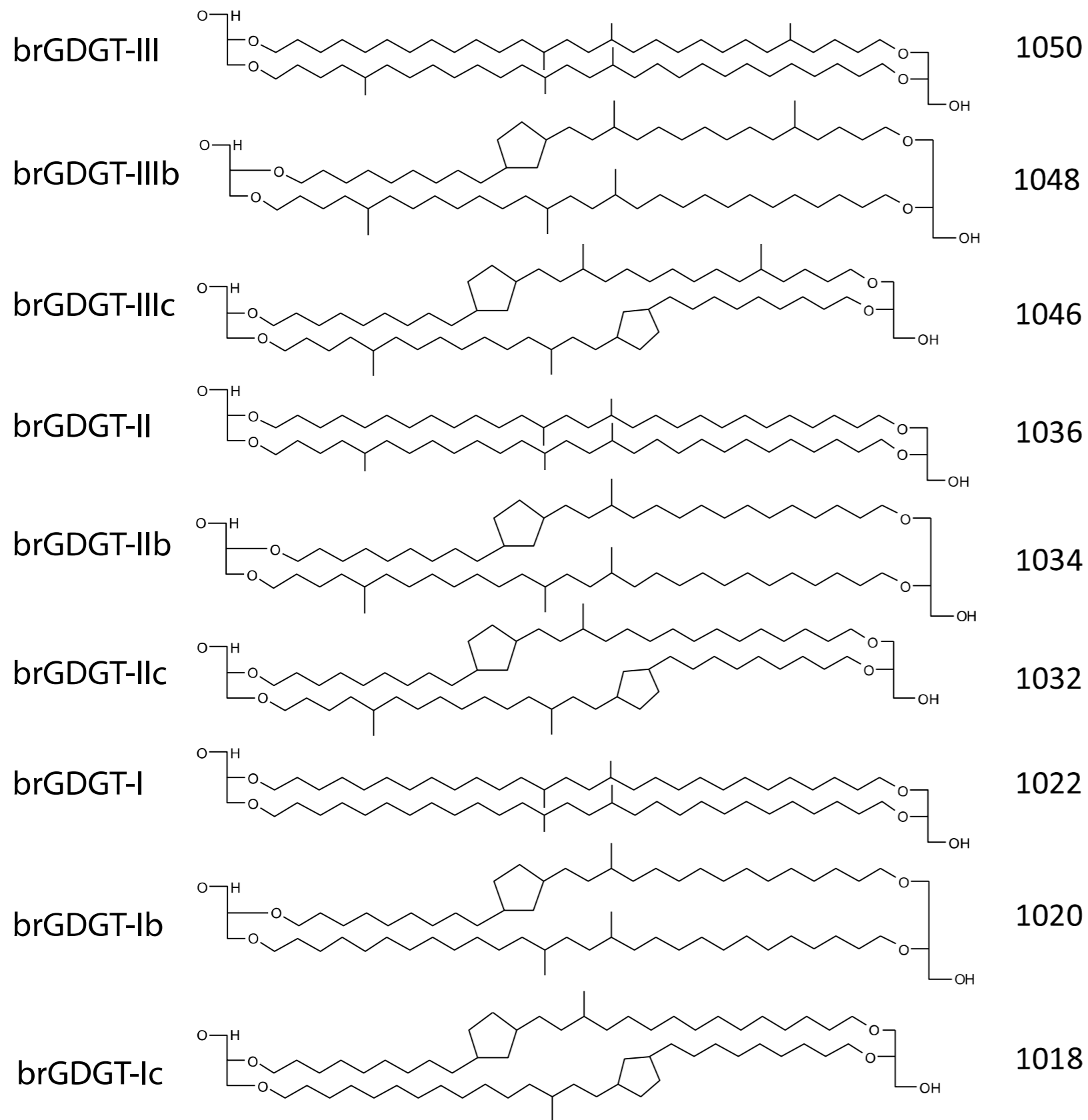
- proxy indicators of relative moisture balance and model simulations

- Indian Ocean drives East African in decadal rainfall variability

The use of GDGTs

- The thermal history of the Quaternary period in tropical Africa is unknown in the current climate models. This has resulted in utilisation of robust proxies suitable for the climatic reconstruction.
- One such proxy is based on the molecules called **Glycerol Diakyl Glycerol Tetraethers (GDGTs)**
- **GDGTs** - core membrane lipids that are synthesised by archea (iGDGTs) and some bacteria (BrGDGTs).
- BrGDGTs - straight or branched alkyl chains linked by ether bonds to the glycerol backbone

Branched GDGTs



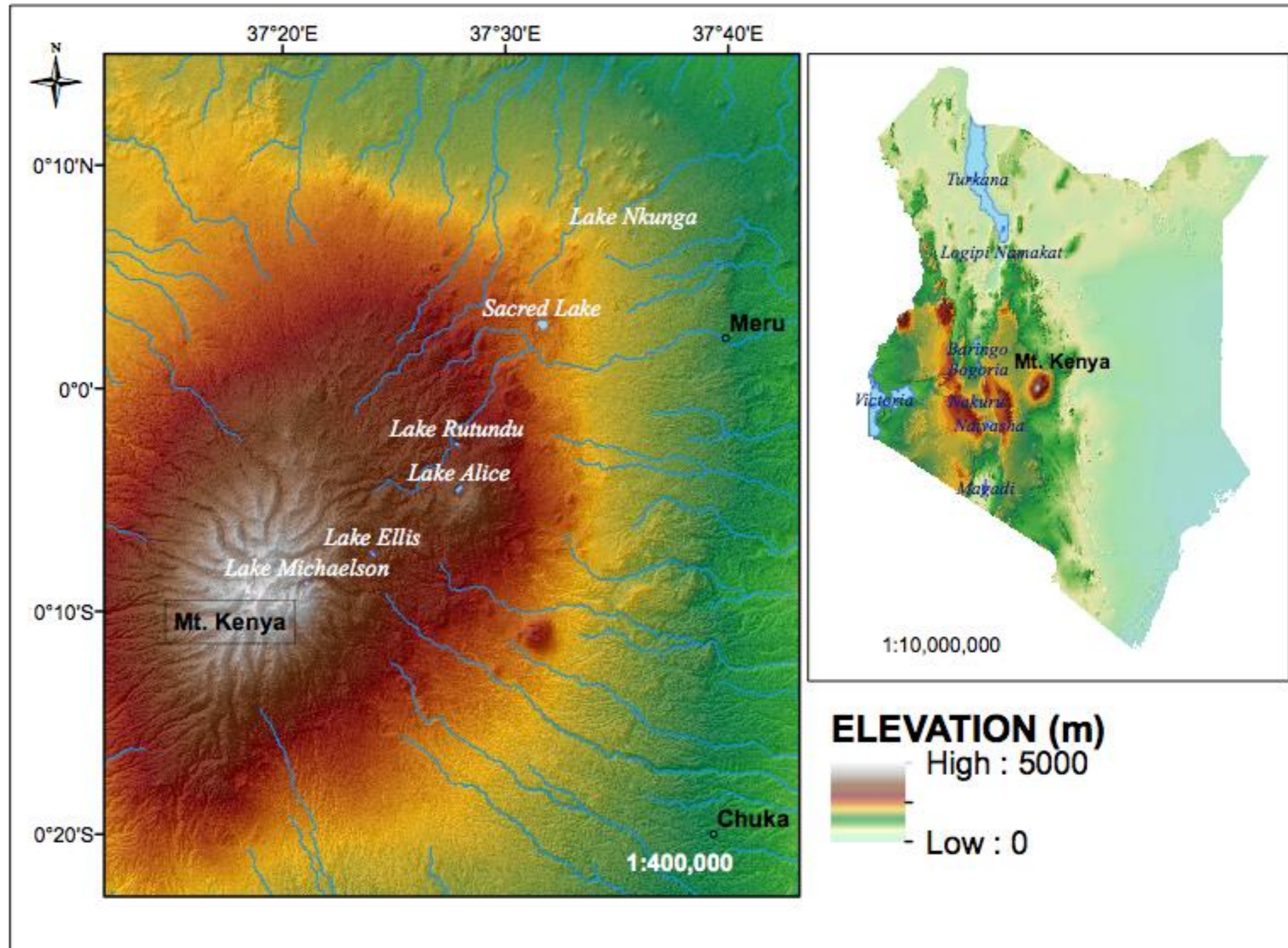
- Variations of the structure as a function of environmental parameters
- Number of cyclopentanes depend on the pH
- Number of Methyl groups correlated with air temperature and to a lesser extent with soil pH

Introduction

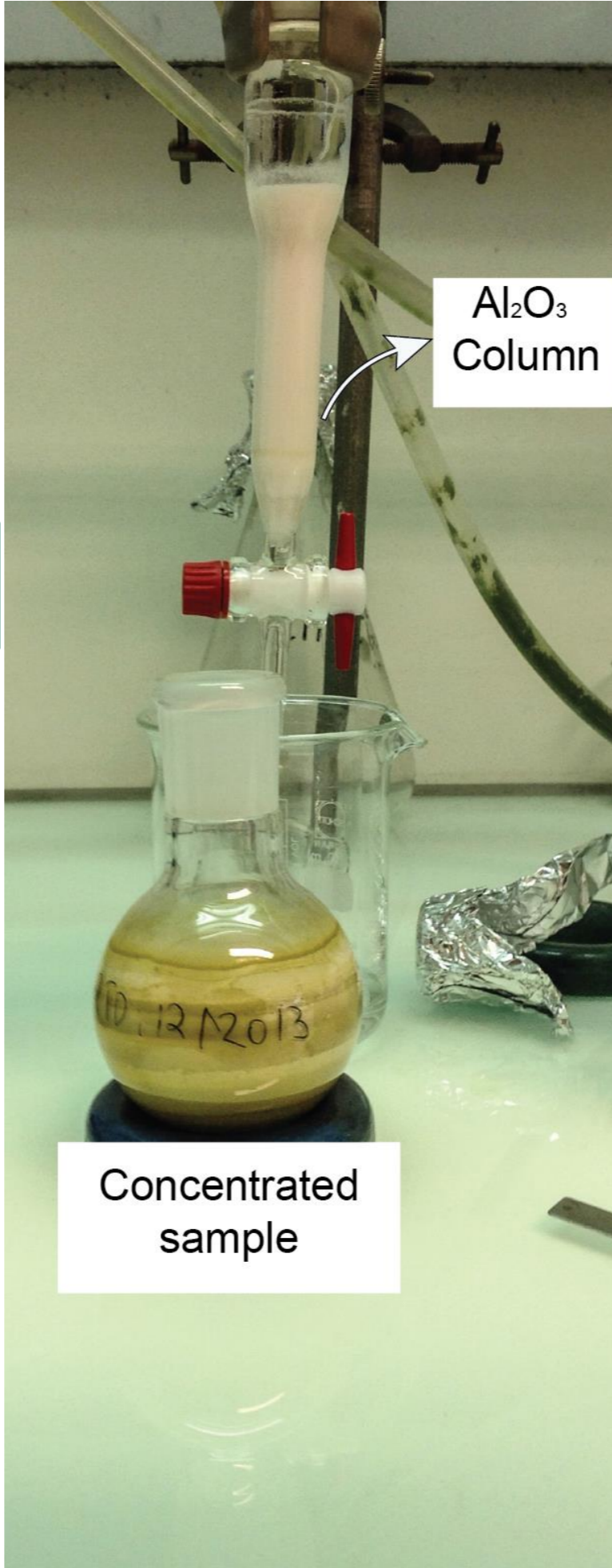
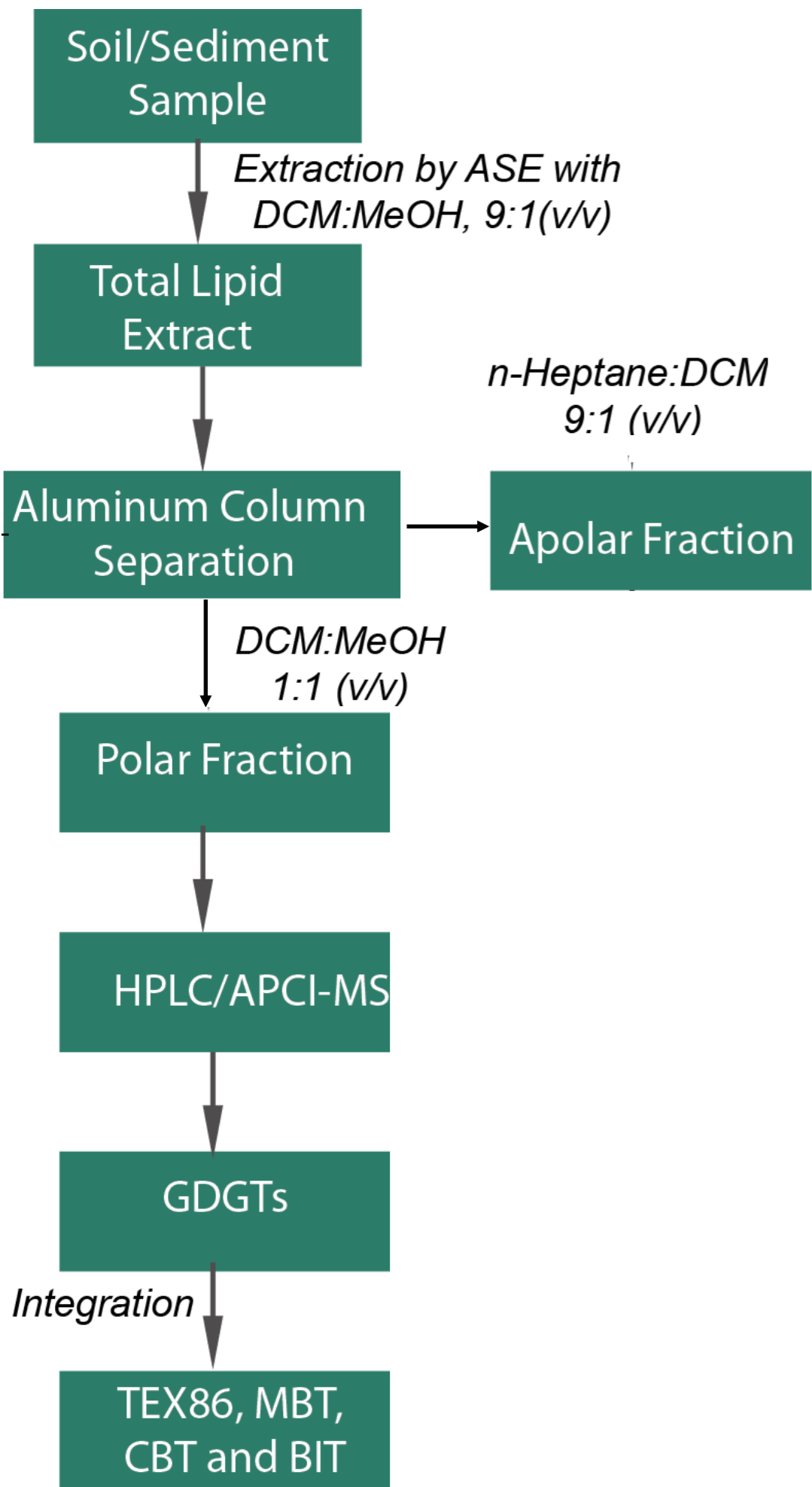
- Why study the GDGT in soils and sediments
 - ubiquitous lipids in aquatic and terrestrial environments (core lipids - higher persistence in the environment)
 - Temperature and pH proxies increasingly used of the reconstruction of past environmental changes
 - Improvement of the current understanding the temperature changes in Mt. Kenya over the Late Holocene

Location

- Eastern side of the EA rift
- Lakes are linearly aligned on the NW slopes of Mt. Kenya

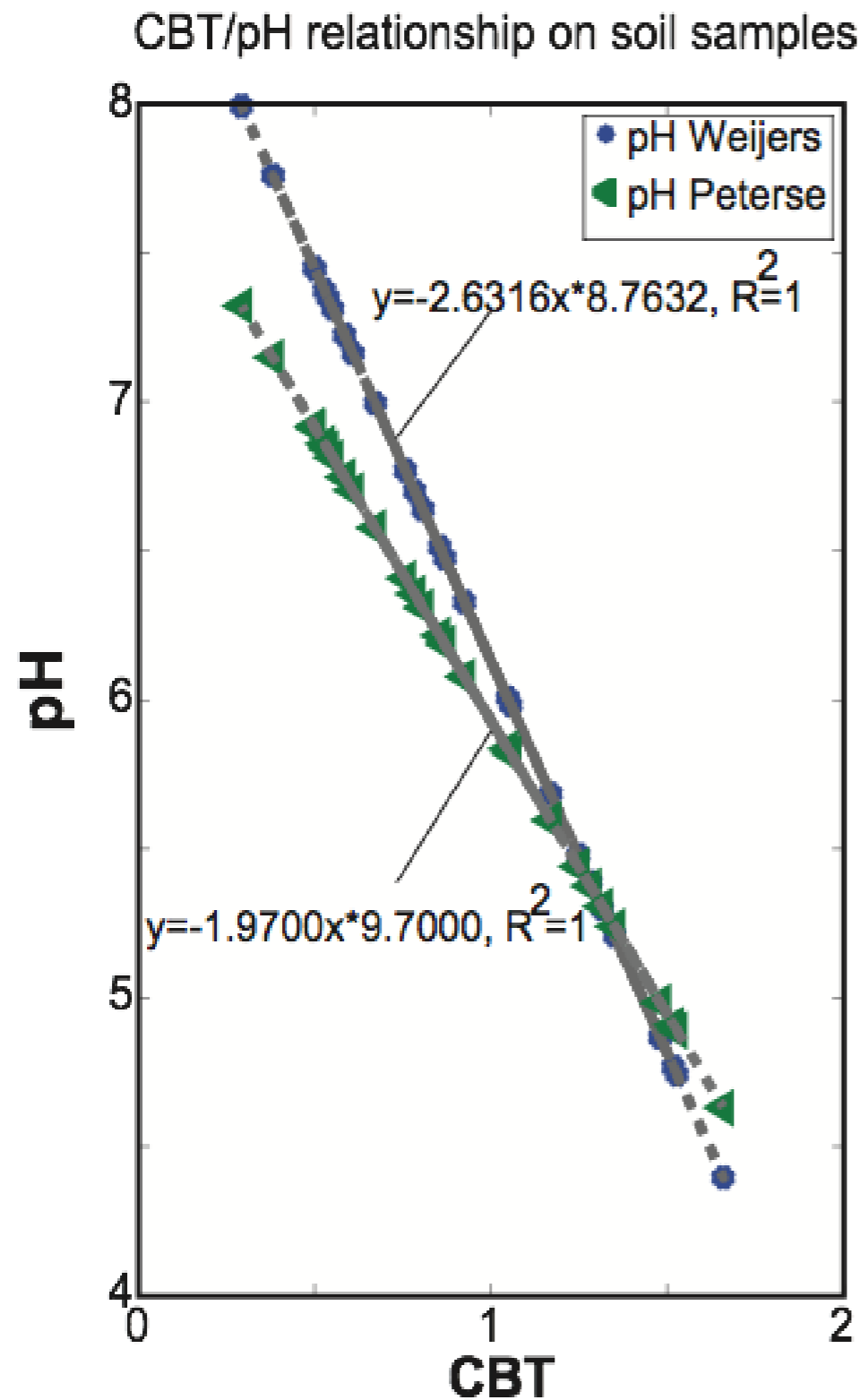


- Lake Nkunga - 1780m asl
- Sacred Lake - 2350m asl
- Lake Rutundu - 3088m asl



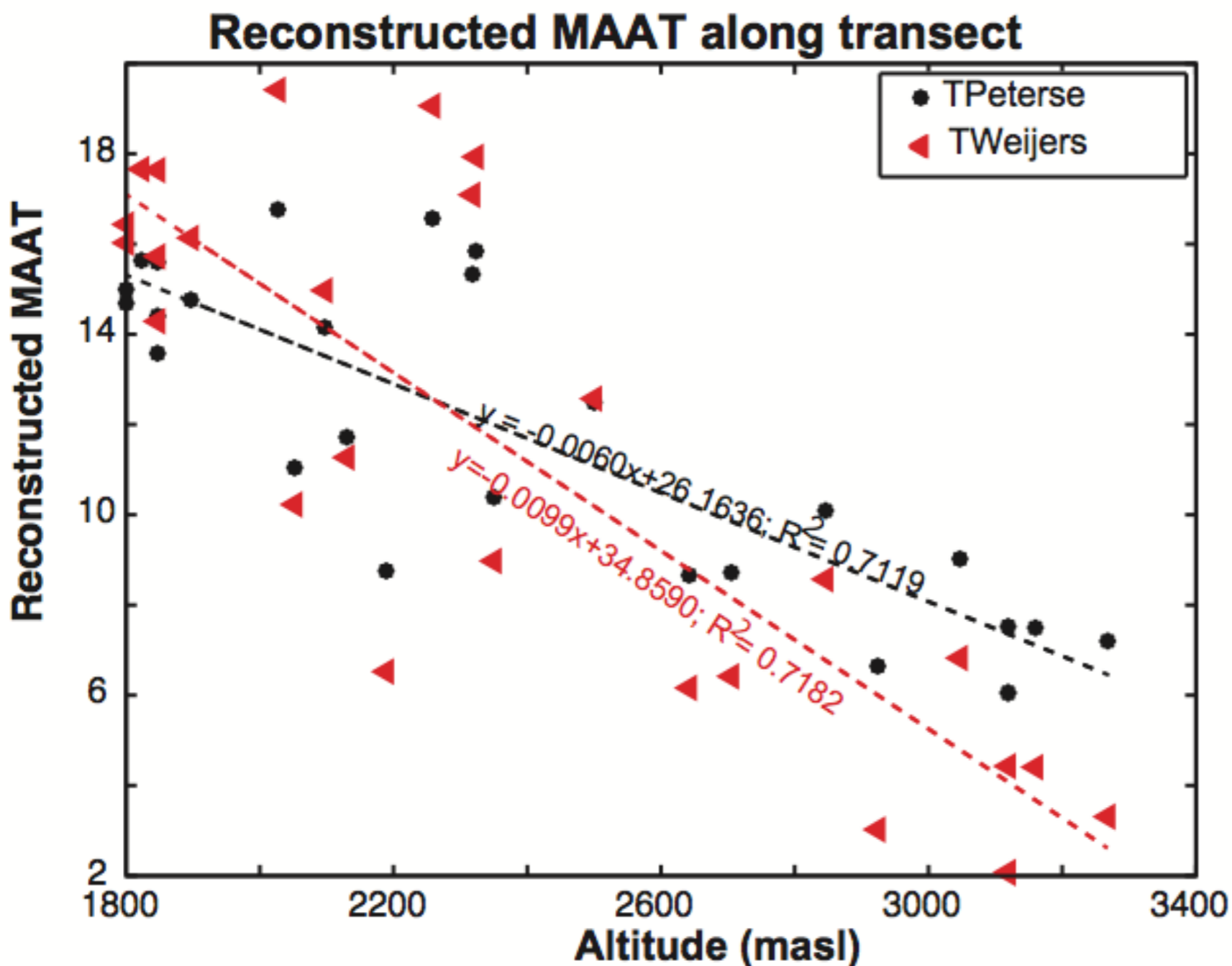
- High performance liquid chromatography/atmospheric pressure chemical ionization-mass spectrometry (HPLC/APCI-MS)

Soil pH relationship with the cyclisation index



- Estimated pH vs CBT = determination coefficient of 1
- Lower CBT = higher pH values

Reconstructed Mean Annual Air Temperature (MAAT)



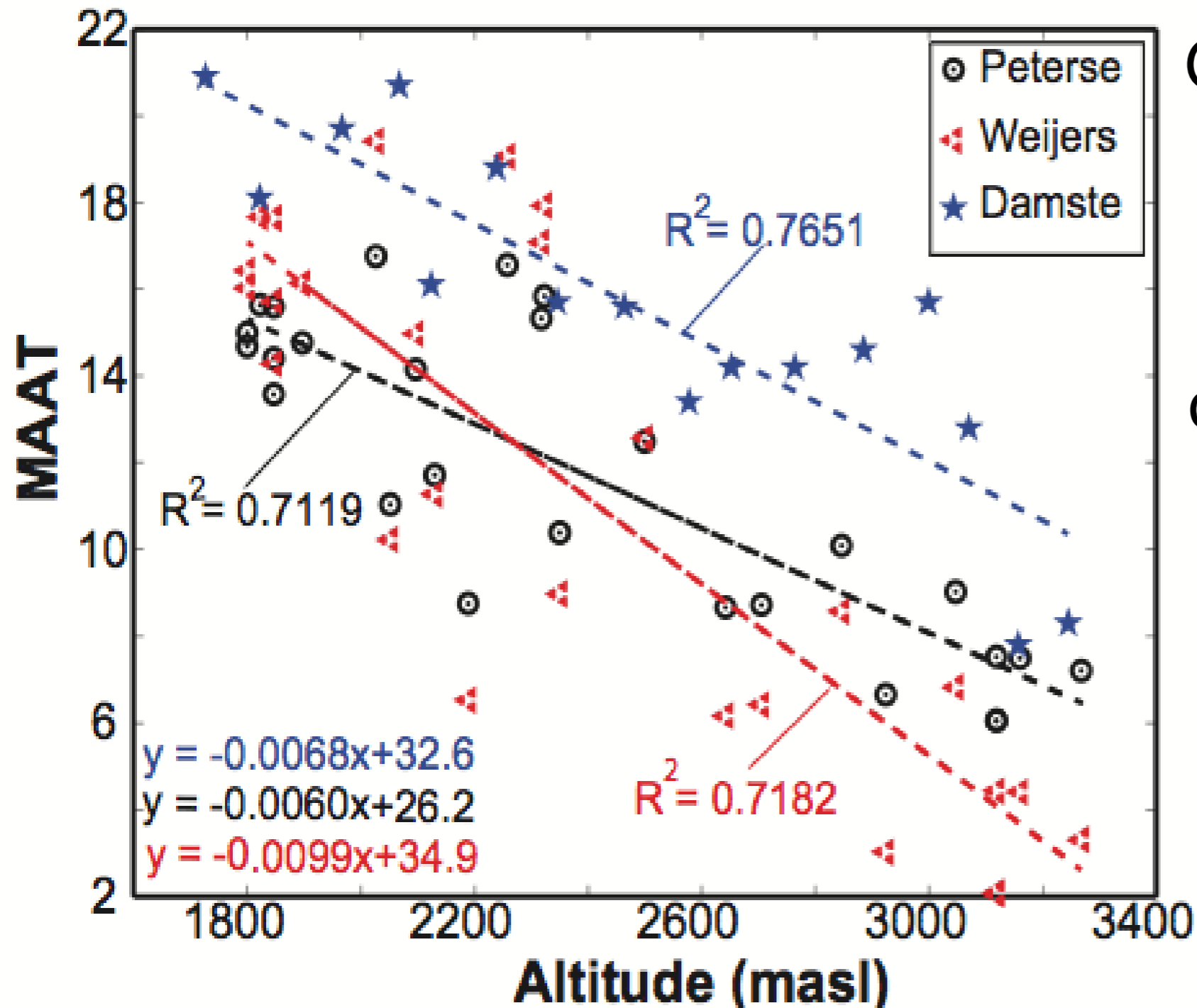
MAAT can be estimate from the Methylation and cyclisation degrees of the GDDTs

Good linear relationship between the reconstructed MAAT and altitude

Lapse rate **0.9°C/100m** and **0.5°C/100m**

Comparison with Mt. Kilimanjaro record

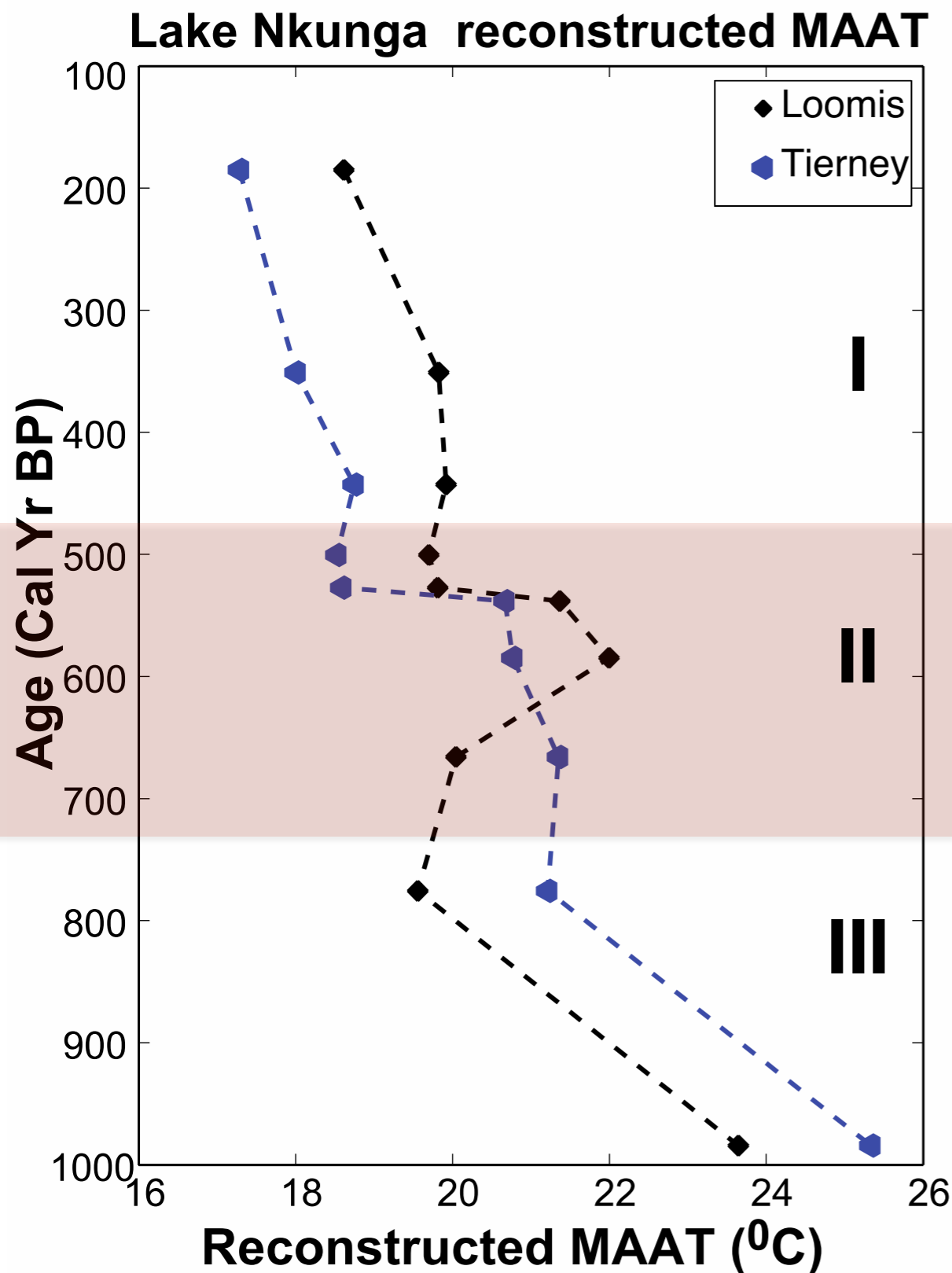
MAAT reconstruction CBT/MBT indices



Good linear relationship

Microclimate and seasonality variations on individual mountains

Lake Nkunga MAAT



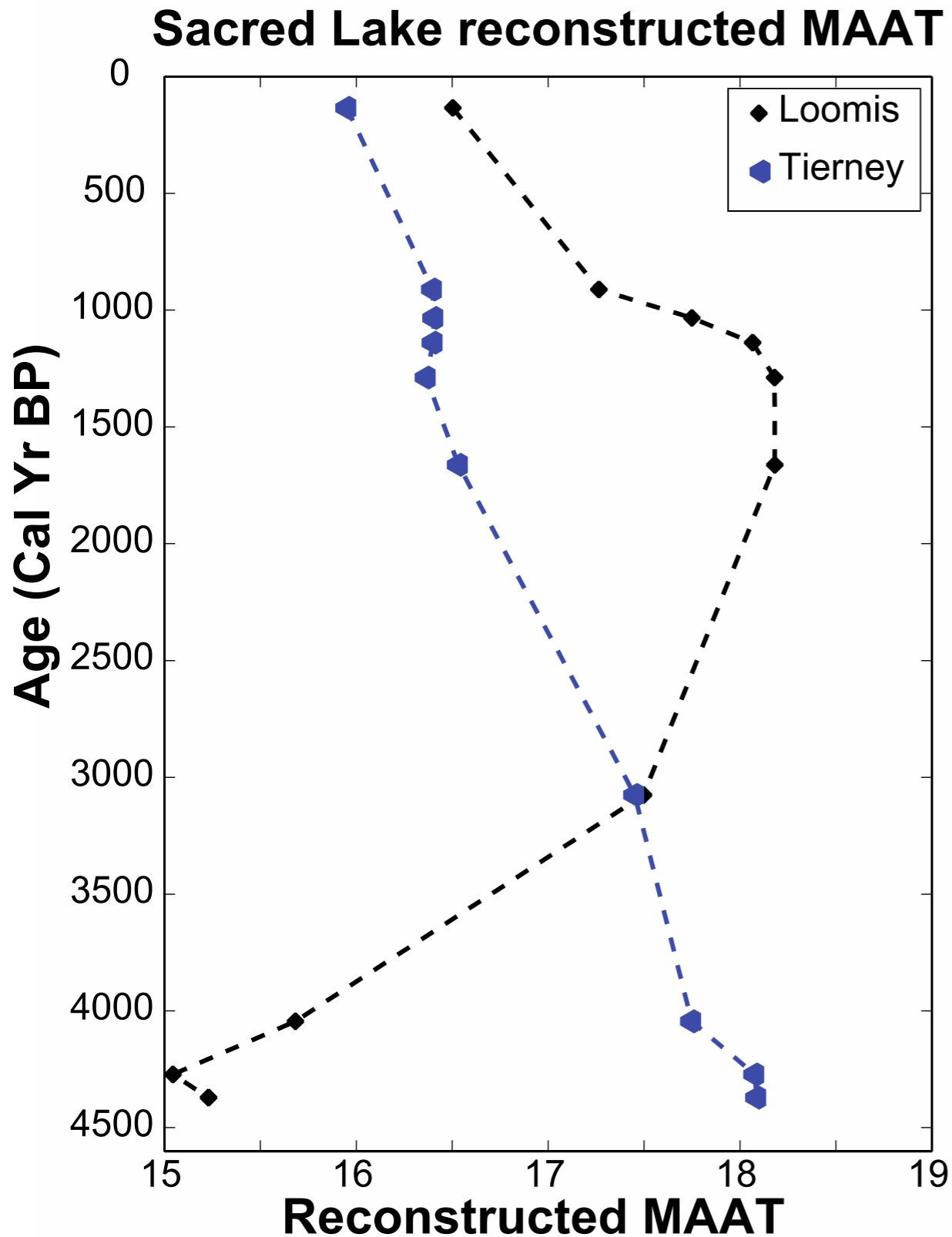
Progressive cooling from ~1100 Cal Yrs BP to present by **8°C** (Tierney et al. 2010) and **5°C** (Loomis et al. 2012)

I : ca. 500 Cal yrs BP- Present

II : ca. 700 - 500 Cal yrs BP
Transitional period
probably aridity transition?

III : ca. 1100 - 700 Cal yrs BP
Medieval Warming Period??

Sacred Lake MAAT

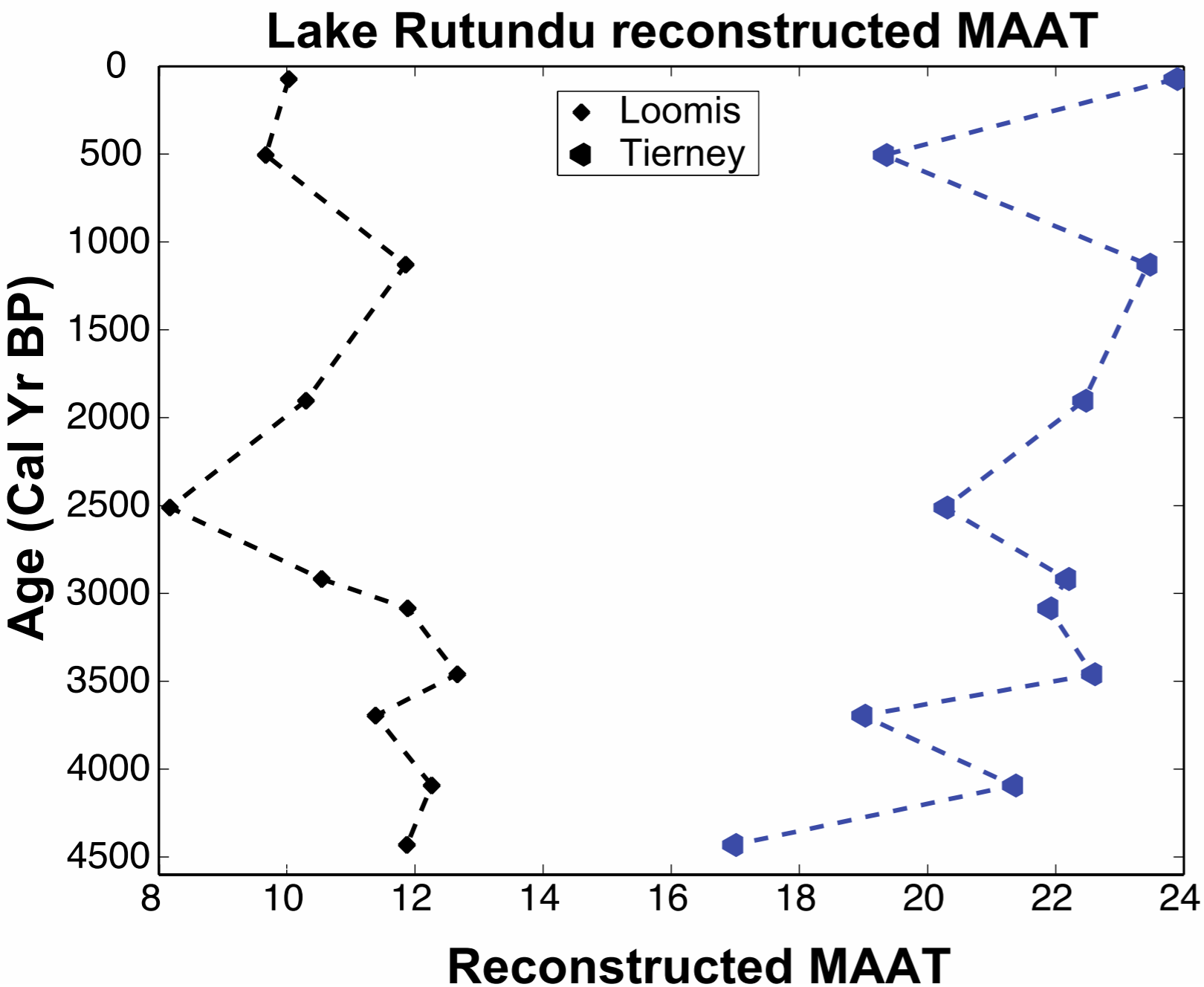


Tierney et al. 2010 calibration
progressive cooling
vs
Loomis et al. 2012 calibration
progressive warming

Other proxies indicate that ca.4500 Cal yrs marks the beginning of the hot and dry conditions in EA due to the suppression of the monsoon

Need to re-examine the results to derive conclusive changes

Lake Rutundu MAAT



- Huge disparity in the values with a 4 – 12°C difference depending on the calibration
- progressive cooling from ~4500 to 2500 Cal yrs BP. followed by progressive warming from ~2500 to 1000 Cal yrs BP and some cooling to Present day (Loomis et al. 2012)

Do these fluctuations represent the late Holocene climate variability pulsed with precipitation and aridity??

Conclusions

- The use of GDGTs as temperature and pH proxies in soils and lake sediments from East African mountains is promising
- The current calibrations give similar trends although they need conform with available instrumental records
- The robustness of the MBT/CBT temperature proxy in equatorial East Africa for a large altitudinal range is evident from the results obtained
- Lake sediment calibrations do not necessarily give the same temperature trends, suggesting that regional calibrations may be needed



Thank you

