



# $\Delta_{47}$ -based Pliocene Indian Ocean SSTs

Martin Ziegler<sup>1</sup>, Anne von der Meer<sup>1</sup>, Margit Simon<sup>2</sup>, Guido van der Molen<sup>1</sup>, Rudolf Moll<sup>1</sup>, Steve Barker<sup>3</sup>, Ian Hall<sup>3</sup>

<sup>1</sup> Utrecht University, Department of Earth Sciences, Princetonlaan 8, Utrecht, The Netherlands

<sup>2</sup> Bergen University, Uni Research Klima, Allegt. 55, Bergen, Norway

<sup>3</sup> Cardiff University, School of Earth and Ocean Sciences, Park Place, Cardiff, UK

## Background

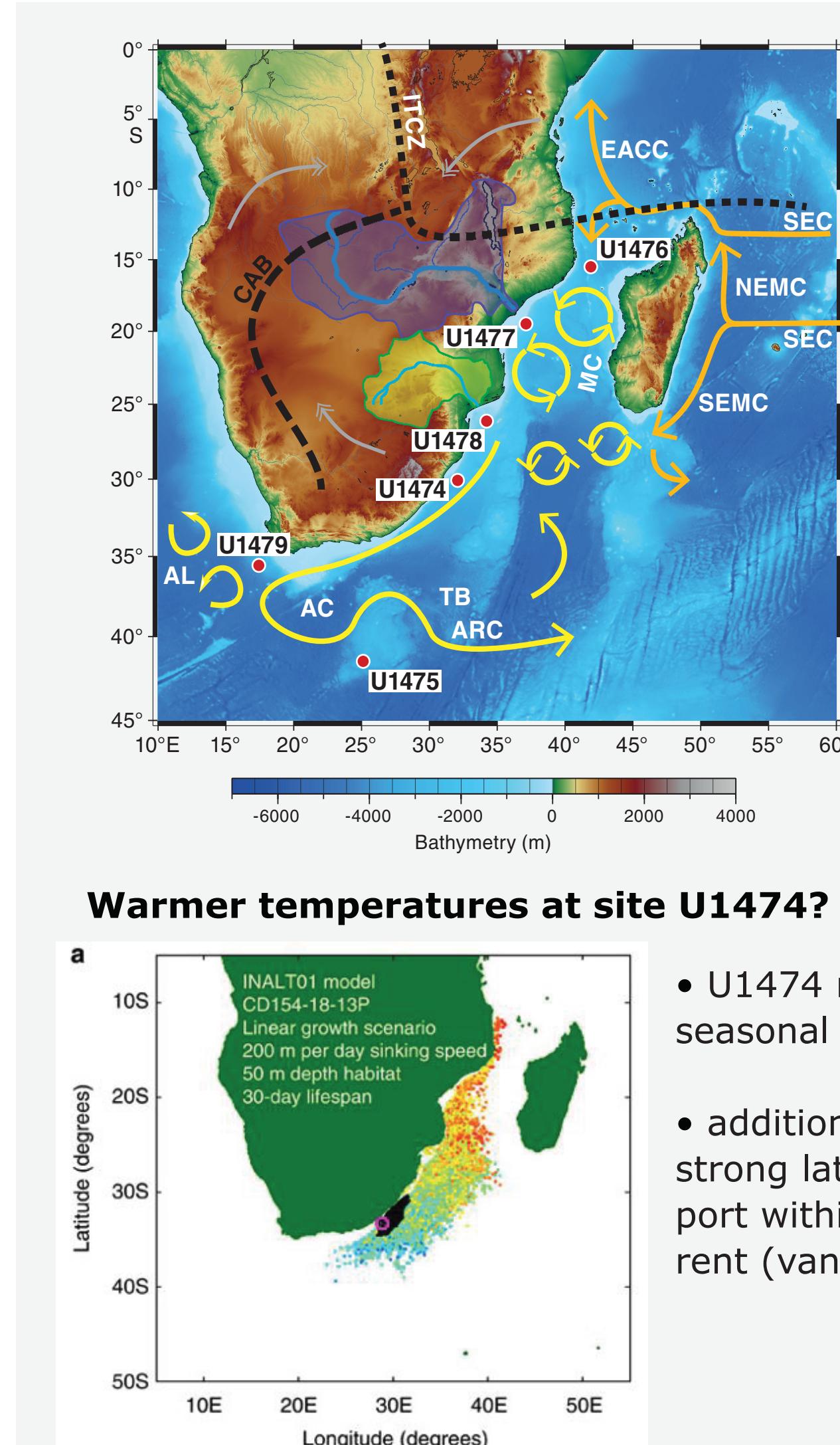
The low latitude warm pools of the oceans are important components of the climate system and are critical sources of heat and moisture. Global mean temperatures are thought to have cooled by 3 to 4 degrees over the Plio-Pleistocene, however the temperature evolution in the tropical warm pools is uncertain, due to discrepancies between different proxy methods. Some proxy reconstructions indicate constant temperatures over the past 4 million years while others indicate a significant cooling trend (e.g. O'Brien et al., 2013).

Temperature reconstructions from the southwestern Indian Ocean for the Pliocene are missing until now. Here we present new SST reconstructions from recently drilled IODP sites U1474 and U1476 based on the planktic foraminifera clumped isotopes.

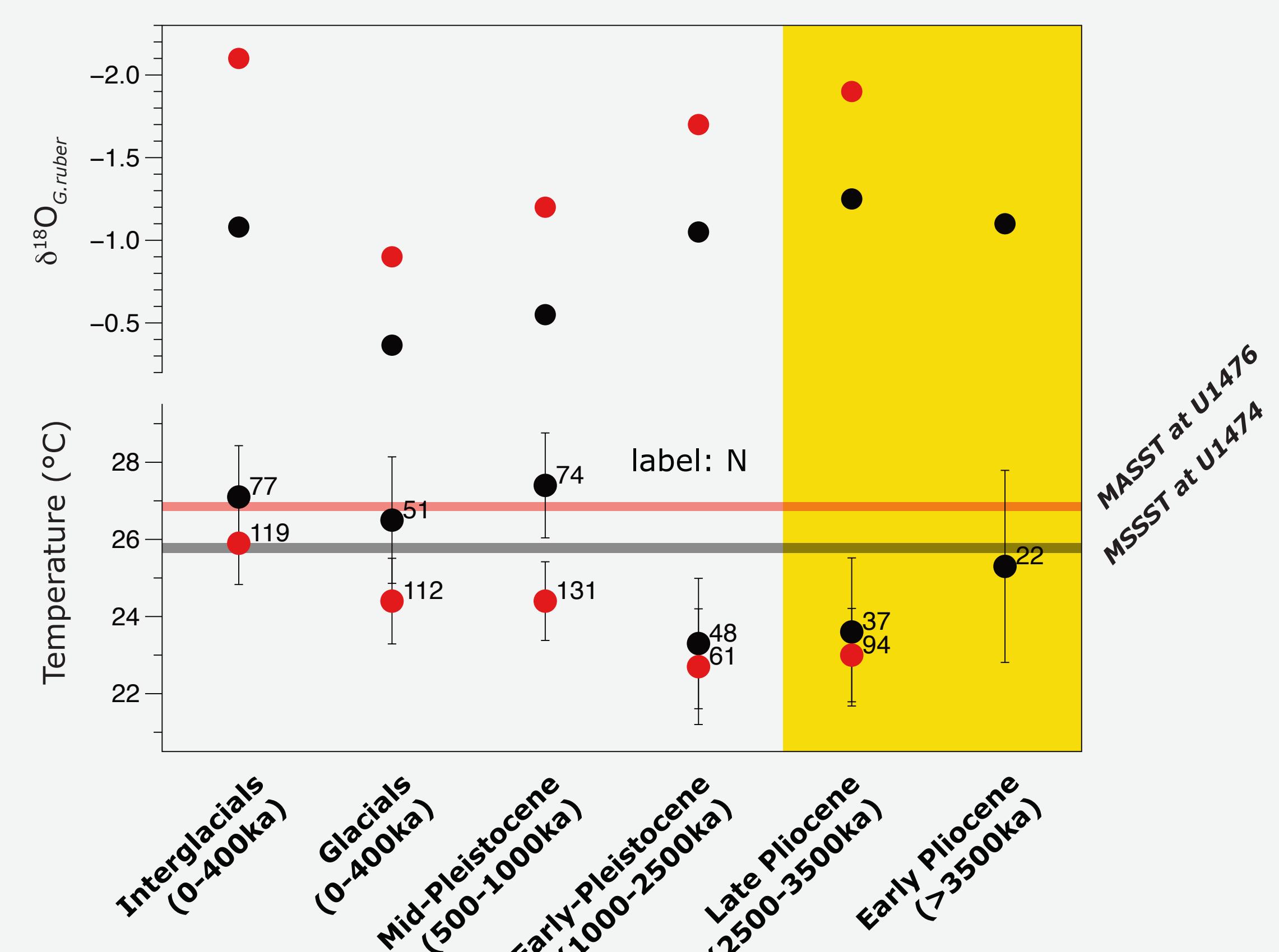
## Conclusion

The southwestern Indian Ocean had relatively stable SSTs over the last 5 Million years (Pliocene possibly even cooler than modern)

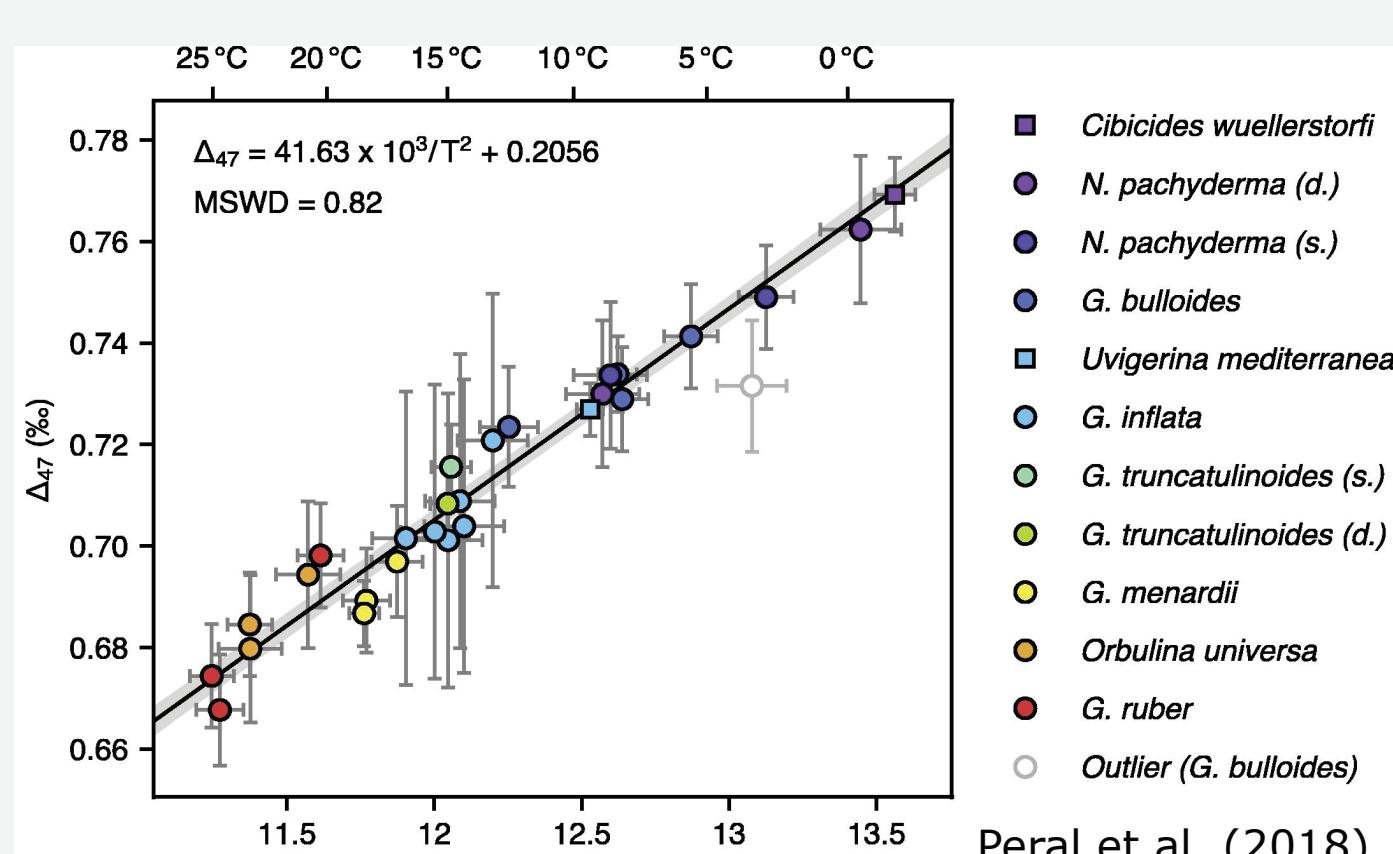
Stable foraminiferal Mg/Ca data indicate stable seawater Mg concentrations over the same time interval.



## Summarized clumped isotope based temperatures



## Carbonate clumped isotope thermometry $\Delta_{47}$



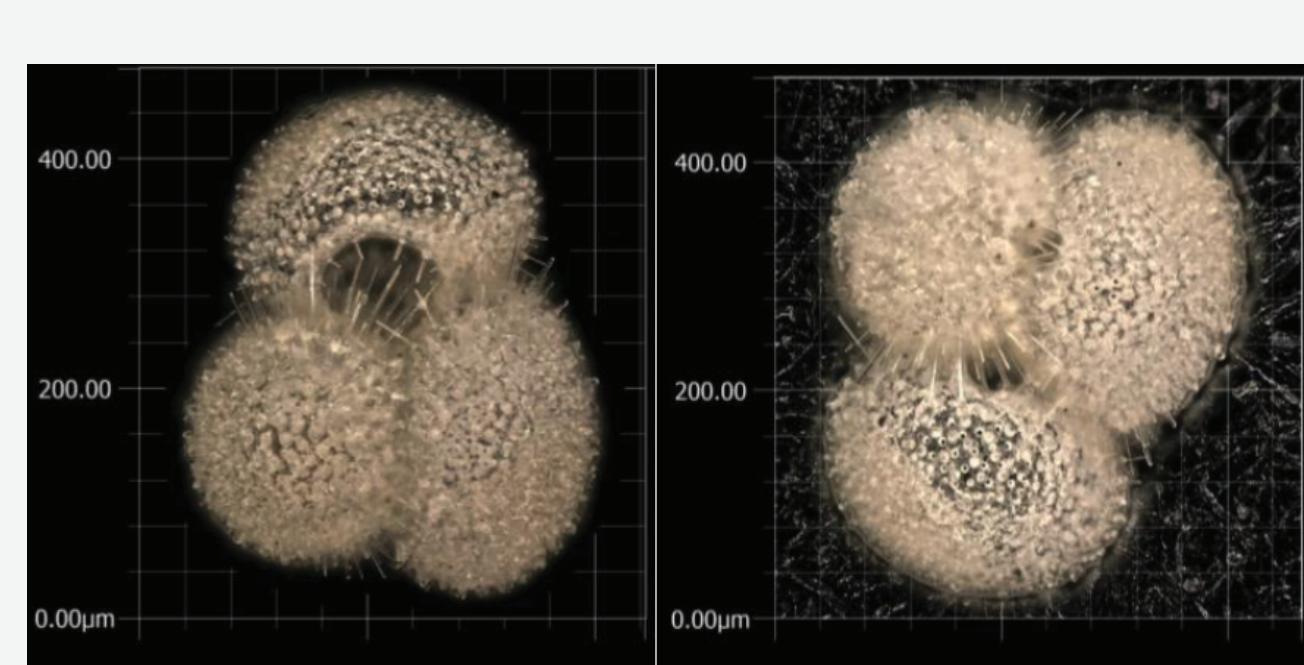
- Degree of clumping of heavy isotopes in carbonates is temperature dependent (independent of fluid composition)
- tested in foraminifera, no vital/species effects detectable
- however, the temperature sensitivity is low (~5ppm/°C) and the analytical target rare <1 permille, hence many replicates necessary

## Utrecht University Clumped Isotope Lab

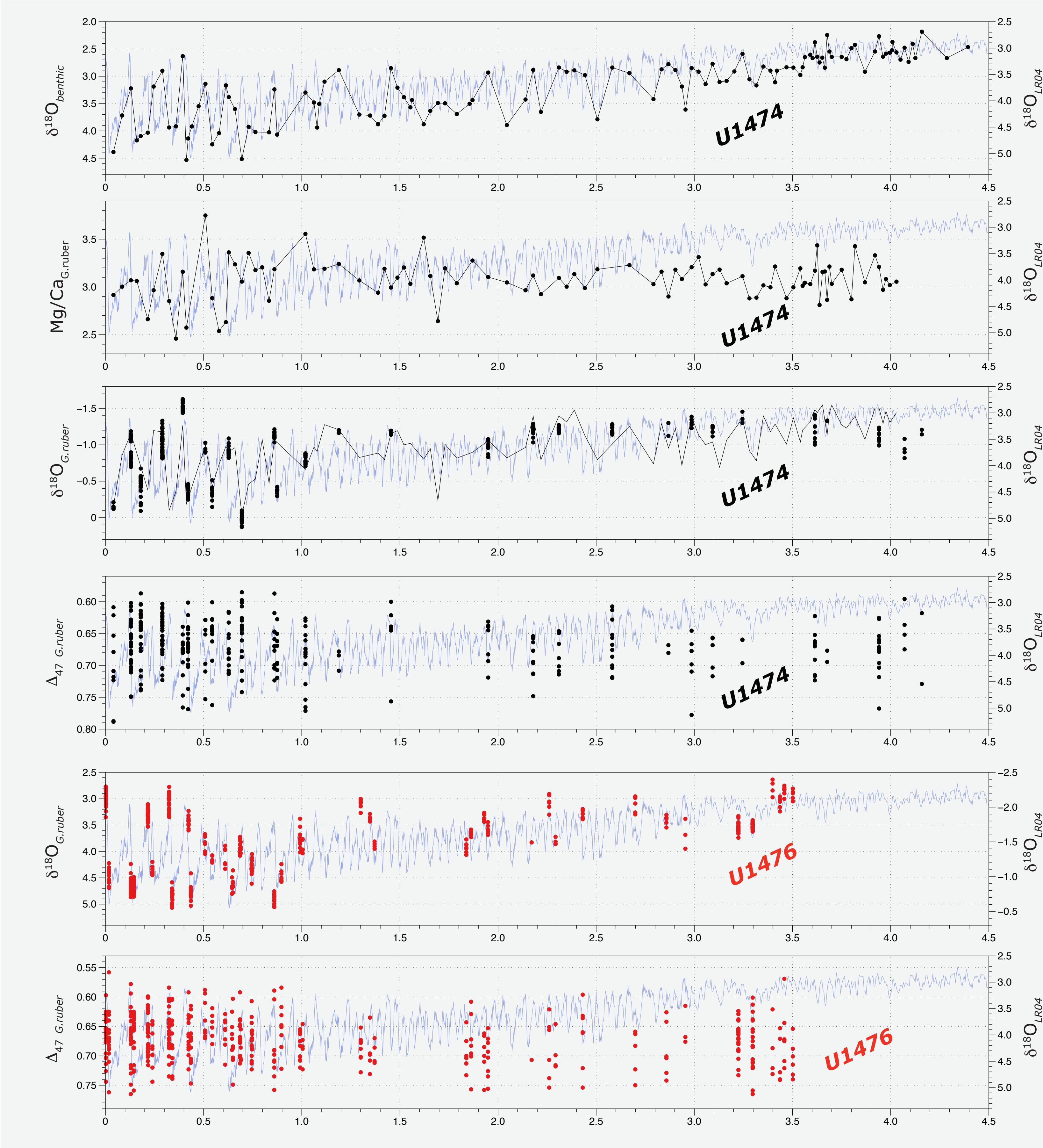


- Thermo 253+ with Kiel-IV device & Thermo 253 with Kiel-IV device (Meckler et al., 2014)
- both equipped with additional porapak unit (LN cooled to -40°C)
- PBL correction via daily scans and m/z 47.5 m cup
- Sample size ~80 µg, Std.dev. ~25-35 ppm in LIDI mode

## Foraminifera - *G.ruber*(s.s.)



- Site U1474 and U1476 contain excellently preserved planktic foraminifera
- no downcore trend in preservation over the study interval visible



## References

- Meckler et al. (2014) Long-term performance of the Kiel carbonate device with a new correction scheme for clumped isotope measurements, RCMS; O'Brien et al. (2013), High sea surface temperatures in tropical warm pools during the Pliocene, *Nature Geoscience*; Peral et al. (2018), Updated calibration of the clumped isotope thermometer in planktonic and benthic foraminifera, *GCA*; van Sebille et al. (2015), Ocean currents generate large footprints in marine palaeoclimate proxies, *Nature Communications*