**University of Leicester PhD studentship**

**Funding Source:** CENTA DTP

**Proposed start date:** 23rd September 2024

**Closing date for applications:** See our web page

**Eligibility:** UK/International

**Department/School:** Geography

**Supervisors:** **PI:** Dr Anna Joy Drury, a.j.drury@ucl.ac.uk

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**Co-I:** Professor Jens Zinke, jz262@leicester.ac.uk

**Project Title:** Late Miocene thermal gradients in the equatorial Pacific during prolonged El Niño- and La Niña-like states.

**Project Description:**

**Project Highlights:**

- Establish Late Miocene equatorial Pacific thermal gradients during shifts from El Niño-like and La Niña-like conditions
- Test changes in sensitivity of sea surface temperatures to astronomical forcing during El Niño- versus La Niña-like conditions.
- Investigate impact of prolonged warm periods on foraminiferal ecology

**Overview:**

Late Miocene (11.63-5.333 Ma) climate was characterised by warmer temperatures and $CO_2$, similar to the 4°C warming and $CO_2$ levels predicted by the IPCC for the year 2100. There has been an ongoing question about whether or not permanent El Niño-like conditions existed during the Late Miocene, with the equatorial Pacific characterised by warm waters spread across the entire region. As the modern El Niño causes significant global climate anomalies, understanding the potential presence and impacts of permanent El Niño-like conditions in the past is important.

There are currently three main hypotheses about which conditions dominated the equatorial Pacific during the Late Miocene: 1) a Late Miocene permanent El Niño-like state (e.g., Ravelo et al., 2014), 2) alternating El Niño-like (9.6-6.5 Ma) and La Niña-like (6.5-6.1 Ma) states (e.g., Nathan and Leckie, 2009; Drury et al., 2018), or 3) modern thermal gradients since ~12 Ma (e.g., Zhang et al., 2014). However, the lack of high-resolution records in the Western Pacific Warm Pool (WPWP) was a hurdle to resolving which hypothesis was more likely. A recent project generated new high-resolution stable oxygen ($\delta^{18}O$) isotope data in the WPWP (Drury, MIONIÑO, 2019-2022), but independent temperature records are nonetheless needed to establish E-W equatorial Pacific temperature gradients, as foraminiferal $\delta^{18}O$ is also influenced seawater $\delta^{18}O$ changes (e.g., global ice volume, salinity), as well as temperature.

This PhD project would focus on generating high-resolution sea surface and thermocline temperature records in the WPWP using planktonic foraminiferal Mg/Ca analysis paired with clumped isotope ($\Delta_{47}$) thermometry on coccolith-rich fine fraction sediment. This would make it possible to reconstruct the WPWP thermocline structure, as well as E-W thermal gradients, to understand the thermal impact of alternations between prolonged El Niño-like and La Niña-like conditions. As the records will be high-resolution, it will make it possible to test whether the sensitivity to astronomical forcing changes between these climate states. The impact of these different climate states and associated thermal shifts on the biosphere will be investigated using multi-species planktonic foraminiferal geochemistry records.

**Methodology:**

The proposed PhD project will focus on generating Mg/Ca major trace element analysis of planktonic mixed layer and thermocline foraminifera to reconstruct upper water column temperatures in the WPWP, using material recovered by the International Ocean Discovery Program (IODP). Clumped isotope $\Delta_{47}$ thermometry on coccolith-rich fine fraction will help constrain long-term temperature changes that may be impacted by changes in seawater Mg/Ca concentration. Scanning electron microscopy to establish specimen preservation and the composition of the isolated sediment fractions. Spectral analysis techniques on the new data will be used to test for any sensitivity changes of sea surface temperatures to astronomical forcing during the changing climate states. Multi-species $\delta^{18}O$ and $\delta^{13}C$ analyses will be used to trace links between ecological and environmental changes during prolonged warm intervals.

**References:**


Drury, A. J., and C. M. John (2016), 'Exploring the potential of clumped isotope thermometry on coccolith- rich sediments as a sea surface temperature proxy', *Geochemistry, Geophysics Geosystems*, *17*(10), pp. 4092-4104, https://doi.org/10.1002/2016GC006459

Drury, A. J., G. P. Lee, W. R. Gray, M. Lyle, T. Westerhold, A. E. Shevenell, and C. M. John (2018), 'Deciphering the State of the Late Miocene to Early Pliocene Equatorial Pacific', *Paleoceanography and Paleoclimatology*, 33(3), pp. 246-263, https://doi.org/10.1002/2017PA003245

Drury, A.J., (no date) 'MIONIÑO - Resolving the debate on a permanent El Niño-like state in the late Miocene'. Available at (accessed 19 September 2023): https://www.ucl.ac.uk/earth-sciences/research/research-groups/micropalaeontology/research/mionino

Nathan, S. a., and R. M. Leckie (2009), 'Early history of the Western Pacific Warm Pool during the middle to late Miocene (~13.2–5.8 Ma): Role of sea-level change and implications for equatorial circulation', *Palaeogeography, Palaeoclimatology, Palaeoecology*, *274*(3–4), pp. 140-159, https://doi.org/10.1016/j.palaeo.2009.01.007

Ravelo, A. C., K. T. Lawrence, A. Fedorov, and H. L. Ford (2014), 'Comment on "A 12-million-year temperature history of the tropical Pacific Ocean', *Science (80)*, *346*(6216), pp. 1467, https://doi.org/10.1126/science.1257618

Zhang, Y. G., M. Pagani, and Z. Liu (2014), 'A 12-Million-Year Temperature History of the Tropical Pacific Ocean', *Science (80)*, *344*(6179), pp. 84-87, https://doi.org/10.1126/science.1246172

**Funding details:**

NERC CENTA studentships are for 3.5 years and are funded by NERC. In addition to the full payment of your tuition fees, you will receive the following financial support:

- Annual stipend, currently set at £18,622 (2023/4 – new figures to be confirmed spring 2024)
- Research training support grant £8,000 (RTSG)

If you are not eligible for UK Fees the University of Leicester will fund the difference between UK and International fees for the duration of your studies

For more details of the CENTA consortium please see the CENTA website: www.centa.org.uk.

**Entry requirements:**
Applicants are required to hold/or expect to obtain a UK Bachelor Degree 2:1 or better in a relevant subject.

The University of Leicester English language requirements apply where applicable.

**Application advice:**

To apply please refer to our web page for further information and read carefully the How to Apply section before submitting your application
https://le.ac.uk/study/research-degrees/funded-opportunities/centa-phd-studentships

In the funding section please specify that you wish to be considered for Ref CENTA2-SGGE8-DRUR

In the proposal section please provide the name of the supervisors and project title (a proposal is not required)

**Project / Funding Enquiries to: CENTA@le.ac.uk or a.j.drury@ucl.ac.uk**

**Application enquiries to pgradmissions@le.ac.uk**