Proposition de sujet de thèse 2026

(A remplir par les équipes d'accueil et à retourner à Isabelle HAMMAD : hammad@cerege.fr

**à renseigner obligatoirement pour la validation du sujet, (1) : A remplir lors de la campagne d'attribution des allocations, à l'issue de la session de juin des Masters*

Sujet de doctorat proposé *: Late Miocene Enigma: Could proxy-carrier ecology changes impact our understanding of the Climate System?

Encadrant(s), *nom, prénom, adresse mail *: CHALK, Thomas, chalk@cerege.fr, SARR Anta-Clarisse sarr@cerege.fr*

Laboratoire *: CEREGE

Tableau récapitulatif du sujet

Candidat(e)(1)	
Nom - Prénom :	
Date de naissance :	
Licence (origine, années, mention) :	
Mention et classement au Master 1 année (Xème sur Y)	
Mention et classement au S3 du Master 2 (Xème sur Y)	
Mention et classement au S4 du Master 2 (Xème sur Y)	
Mention et classement au M2 (année) (Xème sur Y)	
MASTER (nom, université)	
Sujet de doctorat proposé*	Reinterpreting Late Miocene climate records: The role of proxy-carrier ecology in palaeoclimate reconstruction
Encadrants (2 max, indiquer si HDR ou pas)*	Thomas Chalk (CR CN CNRS HDR sept26) Anta-Clarisse Sarr (CR CN CNRS)
Laboratoire*	CEREGE

Programme finançant la recherche (indiqué si obtenu ou envisagé) (1)	Soutien financier de l'ERC ForCry de T Chalk jusqu'à juin 2028, Heure de calcul et stockage pour les simulations via Trés Grand Centre de Calcul du CEA (TGCC) - projet GEN2212 renouvelé annuellement (A-C. Sarr). Projet IODP SPARC 2027 demandé, futurs demandes LEFE/ANR pour l'environnement de thèse 2027–2029.

Sujet de doctorat proposé*

Intitulé* : Reinterpreting Late Miocene climate records: The role of proxy-carrier ecology in palaeoclimate reconstruction

Descriptif *: The Late Miocene (5–11 million years ago) is an enigmatic period where strong climate responses are thought to appear with relatively little change in global climate forcing (e.g. by greenhouse gases; Brown et al. 2022). This time interval witnessed several major and partially interconnected events: cooling in the high latitudes and the tropics, increased upper water column stratification, the Miocene "biogenic bloom", the later stage of the transition to C4 plants, and the Late Miocene Carbon Isotope Shift (LMCIS) in benthic foraminifera $\delta^{13}C$; Steinsthorsdottir et al. 2020). Together, cooling and stratification restructured the water column, creating potential for shifting ecological niches that drove changes to planktic foraminiferal assemblages, including a step increase in shell size (Schmidt et al. 2024) and the appearance of new species occupying deeper habitats (Boscolo-Galazzo et al. 2021) . How changes in stratification, circulation, ecology and what mechanistic links connect global climate forcing with the plethora of Late Miocene climate events is still enigmatic.

The highest resolution CO_2 record across this interval is at a resolution of 1 sample per ~50 thousand years, not sufficient to resolve any orbitally driven changes in carbon dioxide. To further confound the problem, the CO_2 proxy record has been re-interpreted across a large range of absolute values, rendering its quantitative use questionable (Tanner et al., 2025). Additionally, modeling work that could offer insights into the Late Miocene climate dynamics remains limited to very few studies (see MioMIP1, Burls et al., 2021). Those, in addition, show a large discrepancy between simulations and temperature records (which are commonly used to evaluate model performance), pointing to a clear need to re-assess simulations forcing and boundary conditions, but also more in-depth evaluation of the simulated states.

Novel methods in foraminifera sorting, imaging, classification and separation (Miso), geochemistry (ForCry), and a revitalised interest in this interval (MioOcean, etc.) mean that now is the time to tackle some of these outstanding questions. CEREGE hosts ForCry (ERC StG), an ERC project dedicated to improving the throughput and understanding of CO_2 data derived from the $\delta^{11}B$-based pH proxy. Using the advancements from this project, measuring multiple species in the same sample is now achievable, which means that comparative ecology studies can be performed on the same sample material (e.g. by analysing multiple species from the same core). Combined with the automated morphometrics and classification (MiSo) from the MANTA facility (de Garidel-Thoron, Beaufort) a powerful new toolbox is available for more accurate and precise studies of past CO_2. The palaeoecology of proxy carriers is key; for their environmental sensitivity, and for our understanding of the environmental variables that they reconstruct, intrinsically linked to our comparison-with, and assessment-of, climate model simulations. An exceptional synergy

with the recently funded eCO_2-morpH project (MSCA, Jaime Suarez-Ibarra, CEREGE, 2027–2029) is also gained, which will study similar questions in the Miocene Climatic Optimum (MCO, ~16 Ma). The Late Miocene is ideal for the application of these new tools, as many of the same proxy carriers are present in the modern where we have a tangible understanding of their ecology (e.g. Chaabane et al 2023).

This thesis aims to:
i) use morphometric analyses (traditional and geometric morphometrics) combined with geochemical records ($\delta^{18}O$, $\delta^{13}C$, trace elements, $\delta^{11}B$) to characterise the ecology, habitat depth, and calcification behaviour of planktic foraminifera at sub-orbital scale in snapshots across the Late Miocene, aligned between tropical (I)ODP Sites 926 and U1443.
ii) reconstruct sub-orbital scale resolved $\delta^{11}B$-based CO_2 records in snapshots across the Late Miocene from multiple species of planktic foraminifera. Both cores have proven their viability for geochemical records (Martinot et al. 2022, Brown et al 2022). These data will be combined with deep sea records from the same cores, utilising benthic stables isotopes (Wilkens et al., 2017, Bolton et al. 2022) including the generation of B/Ca to interrogate the deep water carbonate system.
iii) compare newly generated proxy-records and compiled data with model outputs to evaluate how climate models reproduce Late Miocene Climate. To do so the student will rely on a Late Miocene simulation ensemble performed with the IPSL-CM5A2 model (Sepulchre et al. 2020) and its marine biogeochemistry component PISCES-v2 (Aumont et al. 2015). This dataset already include simulations with a range of CO_2 levels (Martinot et al. 2022, Pillot et al., 2025), different ice-sheet configurations (Sarr et al., 2022) or states of ocean circulation (Pillot, 2025, unpublished simulations), and can/will be complemented with additional experiments with refined boundary conditions.

Model-Data comparison will focus on ocean structure because it gives information on the ocean dynamics that SST alone does not provide (e.g. vertical gradients, proxy-carrier depth, carbon cycle changes). This part will focus on 1) evaluating persistent model-data discrepancies that will inform either on the limitation with the model/modeling setup or with the proxy interpretation (eg. Sarr et al. 2025) and 2) identifying which simulated states best-fit the data followed by performing further analysis to provide insights into the mechanisms that drove Late Miocene climate change.

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Sarr, A. C., Donnadieu, Y., Bolton, C. T., Ladant, J. B., Licht, A., Fluteau, F, et al. (2022). Neogene South Asian monsoon rainfall and wind histories diverged due to topographic effects. *Nature Geoscience*, *15*(4), 314-319.

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Détail du Programme finançant la recherche* : Soutien financier de l'ERC ForCry de T. Chalk, Heure de calcul et stockage pour les simulations via Trés Grand Centre de Calcul du CEA (TGCC) - projet GEN2212 renouvelé annuellement (A-C. Sarr)
SPARC 2027 demandé, futurs demandes LEFE/ANR pour l'environnement de thèse 2027–2029.

Directeur(s) de thèse proposé(s)*

(limiter au plus à deux personnes principales, dont au moins une titulaire de l'HDR)

Directeur HDR proposé*

Nom - Prénom : Chalk Thomas
Corps : CR CN HDR sept26
Laboratoire (i.e. formation contractualisée de rattachement, éventuellement équipe au sein de cette formation) : CEREGE
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Choix de cinq publications récentes (souligner éventuellement les étudiants dirigés co-signataires) :

Chalk, T.B., Babila, T.L., Henehan, M.J., Jurikova, H., Huang, K.F. and Anagnostou, E., 2025. Perspectives for best practices in boron-based CO_2 reconstruction. *Paleoceanography and Paleoclimatology*, *40*(10), p.e2024PA005057.

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Thèses encadrées ou co-encadrées au cours des quatre dernières années*

Nom : Louisa Slama
Intitulé : Forçages environnementaux sur l'évolution et la production du plancton calcaire dans l'océan Indien intertropical au Quaternaire.
Type d'allocation : bourse ministère
Date de début de l'allocation de doctorat : Octobre 2025
Date de soutenance (si la thèse est soutenue) : en cours – 1ère année
Programme finançant la recherche : INSU AO LEFE
Situation actuelle du docteur (si la thèse est soutenue) :
Pourcentage de participation du directeur à l'encadrement en cas de co-direction : 40%

Nom : Vincent Guarinos
Intitulé : Variabilité en oxygénation en Mer Méditerranée durant les deux dernières périodes interglaciaires
Type d'allocation : bourse ministère
Date de début de l'allocation de doctorat : Octobre 2023
Date de soutenance (si la thèse est soutenue) : Octobre 2026, en cours – 3ème année
Programme finançant la recherche : ANR MedSens
Situation actuelle du docteur (si la thèse est soutenue) : -

Pourcentage de participation du directeur à l'encadrement en cas de co-direction : 30 %

Nom: Rachel M. Brown
Intitulé: The role of CO_2 in the first great ice age.
Type d'allocation : Programme de formation doctorale au Royaume-Uni
Date de début de l'allocation de doctorat : Octobre 2018
Date de soutenance (si la thèse est soutenue) : Mars 2023
Programme finançant la recherche : INSPIRE (ED anglais)
Situation actuelle du docteur (si la thèse est soutenue) : technicienne (IR équivalent) CDD
Pourcentage de participation du directeur à l'encadrement en cas de co-direction : 40 %

Autre directeur proposé (*éventuellement*)*

Nom - Prénom : Sarr Anta-Clarisse
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Choix de cinq publications récentes (souligner éventuellement les étudiants dirigés co-signataires) :

Sarr, A. C., Poulsen, C. J., & Do, E. L. (2025). Revisiting the early Late Cretaceous equable climate problem through a model-data perspective. *Paleoceanography and Paleoclimatology*, *40*(4), e2024PA005002.

Pillot, Q., ***Sarr, A. C.,** Donnadieu, Y., Gramoullé, A., & Suchéras-Marx, B. (2025). Impact of dust and temperature on primary productivity in Late Miocene oceans. *Paleoceanography and Paleoclimatology*, *40*(1), e2023PA004838. (*corresponding author)

Lee, D., **Sarr, A. C.,** Acosta, R. P., & Poulsen, C. J. (2025). Multiple ocean equilibria and decoupling of Miocene atmospheric pCO2 and regional temperatures. *Paleoceanography and Paleoclimatology*, *40*(5), e2025PA005126.

Sarr, A. C., Donnadieu, Y., Bolton, C. T., Ladant, J. B., Licht, A., Fluteau, F, et al. (2022). Neogene South Asian monsoon rainfall and wind histories diverged due to topographic effects. *Nature Geoscience*, *15*(4), 314-319.

Martinot, C., Bolton, C. T., **Sarr, A. C.**, Donnadieu, Y., Garcia, M., Gray, E., & Tachikawa, K. (2022). Drivers of late Miocene tropical sea surface cooling: A new perspective from the equatorial Indian Ocean. *Paleoceanography and Paleoclimatology*, *37*(10), e2021PA004407.

Thèses encadrées ou co-encadrées au cours des quatre dernières années*