

February 19, 2025

Dear Editor,

We are pleased to submit our manuscript, "A nutrient effect on the TEX₈₆ paleotemperature proxy," for consideration in *Geophysical Research Letters*. Our study provides compelling evidence that nutrient stress significantly alters the distribution of archaeal membrane lipids (GDGTs) in marine sediments, leading to elevated TEX₈₆ values independent of temperature.

Using an expanded global core-top database, we demonstrate that TEX₈₆ residuals quantifying deviations from a temperature-based linear fit exhibit a significant negative relationship with surface ocean nitrate concentrations, which we use as a proxy for ammonia oxidation rates. While laboratory studies have shown that nutrient availability influences GDGT cyclization, our study is among the first to systematically reveal that this nutrient effect is preserved in marine sediments.

Beyond the global core-top analysis, we compare TEX₈₆ records with U₃₇^{K'} an independent organic paleotemperature proxy over glacial-interglacial cycles. Our results suggest that nutrient stress likely explains periods when TEX₈₆-based temperature estimates exceed U₃₇^{K'}-based SSTs. These findings underscore the need to account for nutrient effects in TEX₈₆ paleothermometry and offer a pathway to reconcile long-standing discrepancies among paleotemperature proxies.

We believe our study presents novel insights that will enhance the accuracy of TEX₈₆ as a paleotemperature proxy.

Enclosed are the main text (2,954 words, 4 figures) and supplementary materials (supplementary text, 3 figures, 1 table) in PDF format. In compliance with AGU's open research guidelines, all data and code necessary to reproduce our results are archived in Zenodo and GitHub repositories with DOI links. Should the manuscript be accepted for publication, we will ensure these repositories are publicly accessible.

This manuscript is original, has not been published elsewhere, and is not under consideration by any other journal. We appreciate your time and consideration.

Sincerely,

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On behalf of co-authors, Drs. Jessica E. Tierney, and Jordan T. Abell