Response of South China Sea nitrogen fixation to shelf nitrogen loss over glacial cycles

HAOJIA REN1*, DANIEL M. SIGMAN2, ALFREDO MARTÍNEZ-GARCÍA1, ROBERT F. ANDERSON3, MIN-TE CHEN4, MARIETTA STRAUB5, GEORGE T.F. WONG2, GERALD H. HAUG8

1Department of Geosciences, National Taiwan University, Taiwan, abbyren@ntu.edu.tw
2Department of Geosciences, Princeton University, Princeton, U.S., sigman@princeton.edu
3Max Planck Institute for Chemistry (MPIC), Mainz, Germany, a.martinez-garcia@mpic.de
4Lamont-Doherty Earth Observatory, Columbia University, U.S., boba@ldeo.columbia.edu
5Institute of Applied Geophysics, National Taiwan Ocean University, Keelung, Taiwan, mtkchen@ntou.edu.tw
6Institute of Radiation Physics, Lausanne University Hospital, Lausanne, Switzerland, Marietta.Straub@chuv.ch
7Research Center for Environmental Changes, Academia Sinica, Taiwan, gfwong@gate.sinica.edu.tw
8Max Planck Institute for Chemistry (MPIC), Mainz, Germany, gerald.haug@mpic.de

Of the mechanisms by which the ocean loses biologically available nitrogen (“fixed N”), conversion to N₂ in coastal sediments appears to dominate. Due to the disappearance of continental shelves, coastal sedimentary N loss has been hypothesized to decrease during ice ages. This change may have driven a compensating decrease in N fixation, the greatest source of the ocean’s fixed N. Here we reconstruct N fixation changes in the South China Sea over the last 860 kyr (8 glacial cycles) using the δ¹⁵N of foraminifera-bound N (FB-δ¹⁵N). FB-δ¹⁵N is higher during interglacials and lower during interglacials, suggesting an increase in N fixation in the interglacials. Time series analysis indicates that N fixation varied more strongly with sea level than with any other potential influence. This finding is best explained by strong coupling of South China Sea N fixation to ice age reductions in N loss along the western Pacific margin due to the disappearance of currently extensive continental shelves, including the nearby Sunda shelf. If this applied globally, then the ice age ocean hosted lower rates of fixed N input and loss, a longer residence time for fixed N, and less biogeochemically dynamic ocean margins.