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Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Research policies, see Authors & Referees and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed
☐	☒ The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒ The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☐	☒ A description of all covariates tested
☒	☐ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒ For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐ Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Isotopic data measured with the IRMS were collected with MAT 252 Thermo Fisher software.
Data analysis	The data were analysed using Excel and Origin 2018.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

The authors declare that the data supporting the findings of this study are available within the article and its supplementary information file.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	The goal of this study was to assess the impact of ocean acidification on nitrification and N2O production rates.
Research sample	For this study we collected seawater samples from different sampling stations and depths.
Sampling strategy	The samples were collected in different climatic regions and at different depths in the Pacific Ocean (subarctic and subtropical North Pacific see below).
Data collection	Concentrations, isotope and isotopomers ratios of N2O were measured using a slightly modified version of a gas chromatograph-isotope ratio mass spectrometer (GC-IRMS) system described in an earlier publication
Timing and spatial scale	Seawater samples were collected during the MR13-04, KS-16-8 and YK16-16 cruises at three contrasting times-series stations, the subarctic K2 station (47°00'N–160°05'E, 100 m and 175 m, July 23rd 2013), the Kyodo North Pacific Ocean Time series (KNOT) station (44°00'N–155°01'E, 100 m and 175 m, November 19th 2016), and subtropical S1 station (30°00'N–145°00'E, 175 m and 200 m, July 15th 2013) in the western North Pacific (WNP). Moreover, seawater samples were also collected at an intermediate station E1 (41° 15'N–146°43'E, 100 m and 140 m, July 27th 2013) and in the subtropical S2 station (30°00'N–142°36'E, 150 and 200 m, July 8th 2016).
Data exclusions	No data were excluded for the analysis.
Reproducibility	Several samples were collected from each sampling stations and depths.
Randomization	Randomization was not relevant for this study since the sampling, the experiments and the analyses were carried out by the same group of scientists.
Blinding	Blinding was not relevant for this study since the sampling, the experiments and the analyses were carried out by the same group of scientists.

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	The samples were collected under different field conditions (e.g. temperature, wind speed, current) because they were collected at different sampling stations in western north Pacific between 2013 and 2016.
Location	The samples were collected in western north Pacific. The latitude and longitude of the sampling stations are provided in the manuscript (methods). The depths at which the samples were collected are also available in the manuscript .
Access and import/export	All samples were collected using research vessels of the Japan Agency for Marine-Earth Science and Technology and all the samples were analysed in Japan.
Disturbance	To avoid any disturbance of the samples, all vials were quickly sealed with butyl rubber stoppers and were unsealed only for the additions of 15NH4+ (15N atom fraction: 99.3%) or HCl. The samples were incubated in the dark at a temperature close to that at the sampling depth.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology
☒	☐ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging