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Reporting Summary

Nature Portfolio 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 Portfolio policies, see our Editorial Policies 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	LI-8250 Multiplexer user interface, IoniTOF 4.0 DAQ.
Data analysis	IONICON Data Anlyzer (IDA), LI-COR SoilFluxPro V5.3.1, Python (v 3.11.11) within the Spyder IDE (v 6.0.5)

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 and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio 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 description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

The data used in this manuscript are currently being uploaded to the ATTO data portal, and the DOI will be provided as soon as it becomes available

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	Not applicable
Reporting on race, ethnicity, or other socially relevant groupings	Not applicable
Population characteristics	Not applicable
Recruitment	Not applicable
Ethics oversight	Not applicable

Note that full information on the approval of the study protocol must also be provided in the manuscript.

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 Amazon Rainforest plays a dominant role in the global isoprene budget, yet soil isoprene fluxes remain poorly constrained due to the lack of long-term, field-based observations. This study investigated soil-atmosphere isoprene exchange in the central Amazon using three automated dynamic soil flux chambers installed at different soil spots for in-situ measurements. Continuous high-frequency data were collected across five seasons, including the 2023 El Niño dry season, to quantify seasonal and diurnal variability in soil isoprene fluxes and to assess their relationships with key environmental variables such as soil temperature and soil water content.
Research sample	Soil flux measurements were based on the change in gas concentrations in recirculated ambient air within the closed dynamic soil chamber. The sampled air was analysed for isoprene using a proton-transfer-reaction time-of-flight mass spectrometer (PTR-ToF-MS) and for CO_2 using an infrared gas analyser.
Sampling strategy	The sampling strategy consisted of selecting three soil spots within a representative terra firme forest area in the central Amazon. At the beginning of the study, the chambers were placed on three contrasting soil conditions: one organic-rich spot, one spot with an intact litter layer, and one spot where the litter layer was removed. After approximately one year, the chambers were relocated to new undisturbed soil spots with intact litter layers to increase spatial coverage. This approach provided repeated high-frequency measurements across multiple seasons, including the 2023 El Niño dry season, enabling us to assess how soil properties and the presence or absence of the litter layer influenced soil fluxes, as well as to evaluate the long-term seasonal effects of key environmental drivers. No sample size calculation was performed as we sampled as much as we could.
Data collection	Soil flux measurements were conducted by Giovanni Pugliese, and the data were automatically recorded by the acquisition software of the PTR-ToF-MS and the LI-COR soil flux system. Soil temperature and volumetric water content at 5 cm depth were measured by Giovanni Pugliese using Stevens HydraProbe II sensors, with data logged by the LI-COR system. Air temperature and relative humidity were measured by Cléo Quaresma Dias-Júnior and Flávio A. Farias D'Oliveira using a thermohygrometer sensor (IAK I-Series, Galltec +Mela) placed at 26 m height within the canopy on the 80 m walk-up tower. Photosynthetically Active Radiation was measured by Cléo Quaresma Dias-Júnior and Flávio A. Farias D'Oliveira using a PQS1 sensor by Kipp & Zonen installed at 75 m height on the canopy on the same tower. Precipitation was measured at 321 m height of the ATTO tall tower by Christopher Pöhlker using a compact weather station (WS600-UMB, G. Lufft Mess- und Regeltechnik GmbH, Fellbach, Germany).
Timing and spatial scale	Measurements were conducted at the Amazon Tall Tower Observatory (ATTO) research facility in 9 field campaigns: 1) from 02-05-2022 to 16-05-2022; 2) from 08-09-2022 to 19-09-2022; 3) from 17-11-2022 to 30-11-2022; 4) from 01-12-2022 to 08-01-2023; 5) from 31-05-2023 to 19-06-2023; 6) from 30-09-2023 to 27-10-2023; 7) from 11-01-2024 to 18-01-2024; 8) from 29-02-2024 to 08-03-2024; 9) from 26-04-2024 to 14-05-2024. Soil VOC fluxes measurement from one chamber lasted 10 minutes. The chambers were measured consecutively, resulting in a temporal resolution that depended on the number of operational chambers. This timing scale enabled us to resolve both diurnal patterns and seasonal variability in soil fluxes. The measured spots were located within 10 m of each other.
Data exclusions	Data was not excluded

Reproducibility	Because this was a long-term field experiment conducted under naturally varying environmental conditions, the exact conditions of the study cannot be reproduced.
Randomization	Randomization was not applicable to our study because it consisted of long-term on-line measurements at fixed field locations.
Blinding	Blinding is not applicable to our study as it was a long-term field experiment.

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	The measurements were conducted at the Amazon Tall Tower Observatory (ATTO) research facility. The annual average temperature at the site is 27-28 °C, and the annual total precipitation ranges from 2200 to 2400 mm. During the 2023 El Niño dry season, precipitation was markedly reduced and temperatures were elevated relative to typical conditions
Location	The measurements were conducted at the Amazon Tall Tower Observatory (ATTO) research facility, located at S 02°08.752' W 59° 00.335'
Access & import/export	Access to the site was coordinated by ATTO project staff, who provided technical and logistical support. No samples were exported or imported for this study.
Disturbance	The automated soil chambers for soil flux measurements were installed on soil collars that were gently placed on soil surface in order to avoid cutting surface roots, which could generate gas emissions and interfere with soil flux measurements. The collars were sealed from the outside with the surrounding soil. After installation, all measurements were conducted in a way that minimized interference with natural conditions.

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 and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

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

Plants

Seed stocks	Not applicable
Novel plant genotypes	Not applicable
Authentication	Not applicable