

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

Microclimate modelling was conducted using R software (2021) and the mechanistic microclimate model is freely available to use in the microclimf package for R: <https://github.com/ilyamaclean/microclimf>. The full code used here to model microclimate is published online (10.5281/zenodo.8246818) with examples of the open access datasets needed to reproduce the results shown here (those listed in the data availability statement).

Data analysis

Code used for the novelty analysis is published online (10.5281/zenodo.8246818) with examples of the open access datasets needed to reproduce the results shown here (those listed in the data availability statement). Data analysis was conducted using R software (2021).

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](#)

Global hourly climate data is available from <https://cds.climate.copernicus.eu/>. Environmental parameters include: (a) leaf area index & surface reflectance available from <https://www.ncei.noaa.gov/data/avhrr-land-leaf-area-index-and-fapar/>, (b) global habitat types available from <https://www.esa-landcover-cci.org/>, (c) vegetation height available from <https://webmap.ornl.gov/ogc/>, (d) soil types available from <https://www.soilgrids.org>, (e) digital elevation model available from: <https://www.usgs.gov/centers/eros/science/usgs-eros-archive-digital-elevation-shuttle-radar-topography-mission-srtm-1>. The microclimate model is freely available for download and adaptation via a GitHub repository: <https://github.com/ilyamaclean/microclimf>. The global tropical forest monitoring dataset is available from <https://forobs.jrc.ec.europa.eu/TMF>. Temperature records used for validation are available from the global SoilTemp dataset on request: <https://www.soiltempproject.com/the-soiltemp-database/>.

Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

Reporting on sex and gender

Use the terms sex (biological attribute) and gender (shaped by social and cultural circumstances) carefully in order to avoid confusing both terms. Indicate if findings apply to only one sex or gender; describe whether sex and gender were considered in study design whether sex and/or gender was determined based on self-reporting or assigned and methods used. Provide in the source data disaggregated sex and gender data where this information has been collected, and consent has been obtained for sharing of individual-level data; provide overall numbers in this Reporting Summary. Please state if this information has not been collected. Report sex- and gender-based analyses where performed, justify reasons for lack of sex- and gender-based analysis.

Population characteristics

Describe the covariate-relevant population characteristics of the human research participants (e.g. age, genotypic information, past and current diagnosis and treatment categories). If you filled out the behavioural & social sciences study design questions and have nothing to add here, write "See above."

Recruitment

Describe how participants were recruited. Outline any potential self-selection bias or other biases that may be present and how these are likely to impact results.

Ethics oversight

Identify the organization(s) that approved the study protocol.

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](https://www.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

Microclimate modelling of historical climate conditions across global tropical forests to assess recent climate novelty (2005 to 2019), compared to a baseline historical time period (1990 to 2004).

Research sample

Undisturbed tropical forest = 317,809; degraded tropical forest = 56,388; total: 374,197 grid cells. The spatial extent of which is defined by Vancutsem et al., (2021) (as below).

Sampling strategy

To exclude forest where climate change could be amplified by interacting human activities like deforestation, global tropical moist forest which remained undisturbed at the end of 2019 was included in the study and defined by Vancutsem et al., (2021) as all closed forests in the humid tropics including the tropical rainforest and the tropical moist deciduous forest without any observed disturbances (degradation or deforestation) across the full observation period defined by the available Landsat data (1982 - 2019). We also included degraded tropical forest in our analysis which was classified by Vancutsem et al., (2021) as degraded in 2019 (where a visual disturbance or repeated visual disturbances have been observed from space between 1982 and 2019. However, each disturbance event lasted less than 2.5 years and was therefore not classified as deforestation).

Data collection

The microclimate model was run in daily time increments and then hourly temperatures – at 0.05 m above the ground - were derived

Data collection	using the model's interpolation methods, which infer hourly data from daily minima and maxima using the diurnal cycle in the ambient temperatures provided as inputs to the model. Data needed to drive the model is freely available from the databases listed in the data availability statement.
Timing and spatial scale	Microclimate modelling of hourly temperatures between 01.01.1990 to 31.12.2019. Spatial resolution is 5km gridded.
Data exclusions	Deforested locations were excluded form the analyses as they are no longer able to meet the biological requirements of a tropical forest.
Reproducibility	Reproducible code available at: 10.5281/zenodo.8246818. The mechanistic microclimate model is freely available to use in the microclimf package for R: https://github.com/ilyamaclean/microclimf . All data driving the model is open access and freely available from those databases listed in the data availability statement.
Randomization	None
Blinding	None

Did the study involve field work? Yes No

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 | Involvement in the study |
|-------------------------------------|--|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Antibodies |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Eukaryotic cell lines |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Palaeontology and archaeology |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Animals and other organisms |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Clinical data |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Dual use research of concern |

Methods

- | n/a | Involvement in the study |
|-------------------------------------|---|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> ChIP-seq |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Flow cytometry |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> MRI-based neuroimaging |