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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	No software was used.
Data analysis	All statistical analyses were performed using the SPSS 18.0 for Windows (SPSS Inc., Chicago, Illinois, USA). The map was drawn by ArcGIS 10.3 for Desktop (Environmental Systems Research Institute, Inc., RedLands, California, USA).

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

All data generated or analysed during this study are included in this manuscript and its supplementary information files.

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

We demonstrated how tree-ring width growth is closely linked to litterfall dynamics and how litterfall-enhanced nitrogen recycling supports a sustained effect of CO2 fertilization on tree-ring growth, based on our 10-year observed data at two alpine treeline sites.

Research sample

This study was conducted on the north-facing and south-facing slopes of a U-shaped valley at the peak of the Sergyemla Mountains (29°36′N, 94°36′E) in southeast Tibet. Dominant tree species of both treelines are Abies georgei var. smithii on the north-facing slope and Juniperus saltuaria on the south-facing slope. Along both slopes the vegetation changes from sub-alpine and treeline forests (tree height > 4 m and canopy coverage >40%) to open mosaic of alpine shrublands and grasslands. In August 2005, two long-term observing plots (50 × 50 m) were established in both treeline forests.

Sampling strategy

We conducted 10-year observations (2007-2017) of seasonal stem radial increment, canopy litterfall and its induced nitrogen return and resorption, as well as climate factors at two alpine treelines in southeast Tibet. We also investigated the variation of tree-ring width growth over a longer time period (1986-2017) across the two treeline species (Abies georgei var. smithii and Juniperus saltuaria). The time series data (1986-2017) of monthly climatic factors and atmospheric CO2 concentration were obtained from the Nyingchi weather station in southeast Tibet (ca. 10 km from our study sites) and the Mauna Loa Observatory, Hawaii, respectively.

Data collection

Four automatic weather stations were installed in the two treeline forests and above both treelines (hourly records). In each of both treeline forests, five 1.5m×0.5m litterfall traps were randomly installed to monthly collect the litterfall. Eight mature, healthy trees at each of the two treeline sites were selected and mounted with automatic dendrometers at breast height to continuously monitor stem radial growth (hourly records). In 2016-2017, 2 tree-ring cores at breast height were sampled with an increment borer for each of 30 trees (including the 8 monitored trees with dendrometers) in each of both treeline species, and annual ring width was measured with a resolution of 0.01 mm.

Timing and spatial scale

We aim to examine three key issues: 1) whether seasonal and annual stem increments typically show a lagged positive relationship to litterfall, N-return and N-resorption across the two treeline stands; 2) whether annual tree-ring width, litterfall, N-return and N-resorption all have a higher sensitivity to eCO2 than to the variability of temperature, precipitation and solar radiation during 2007-2017; and if so, 3) whether similar patterns are found in longer time series of tree-ring width index during 1986-2017. To test the scalability of our observed patterns, we further examined the literature data of tree-ring width for 6 other tree species at 11 treeline sites on the Tibetan Plateau.

Data exclusions

No data were excluded from the analyses.

Reproducibility

Annual tree-ring width, annual litterfall, and annual nitrogen return and resorption all showed an increasing trend during 2007-2017, and most of the variations were explained by elevated atmospheric CO2 rather than climate change. Similar patterns were found in longer time series of tree-ring width index during 1986-2017. The scalability of our observed patterns was confirmed by the literature data of 6 other tree species at 11 treeline sites over the Tibetan Plateau.

Randomization

In each of both treeline forests, five 1.5m×0.5m litterfall traps were randomly installed to monthly collect the litterfall. The 8 monitored trees with dendrometers at each of the two treeline sites were selected to represent different sizes of tree diameter.

Blinding

Blinding was not relevant to our long-term located observations and measurements with automatic instruments.

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions

Two alpine treeline forests at 4300-4400 m, with annual mean air temperature of 0.6 °C - 1.1 °C, the world highest timberline.

Location

At the peak of the Sergyemla Mountains (29°36′N, 94°36′E, 4300-4400 m) in southeast Tibet, China.

Access & import/export

We are free to make 10-year observations/measurements of stem radial increment, canopy litterfall and its induced nitrogen return and resorption in two alpine treeline forests on the Tibetan Plateau.

Disturbance

No disturbance

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
☒	☐ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

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