

Supplementary Information

Supplementary Figure 1 PRISMA flowchart outlining the search strategy and number of studies excluded at each stage.

Supplementary Figure 2 Comparisons of the responses of plant β -diversity to global change factors using data from studies that employed different analytical methods. Source data are provided as a Source Data file.

Supplementary Figure 3 The effect size (ln RR) of GCFs on the three dimensions of plant β -diversity—taxonomic (TB), functional (FB), and phylogenetic (PB)—varies across different GCFs, hotspot status, hotspots, regions, elevations, realms, and climate zones (left panel), as well as across ecosystems, floristic realms, plant life forms, taxa types, abundance status, data sources, and study design aspects such as temporal extent and spatial extent (right panel). Source data are provided as a Source Data file.

Supplementary Figure 4 The effect size (ln RR) of GCFs on the five GCFs—biological invasion (BI), climate change (CC), land use change (LUC); LM, land management (LM) and multiple factors (MF)—varies across different GCFs, hotspot status, hotspots, regions, elevations, realms, and climate zones (left panel), as well as across ecosystems, floristic realms, plant life forms, taxa types, abundance status, data sources, and study design aspects such as temporal extent and spatial extent (right panel). Source data are provided as a Source Data file.

Supplementary Figure 5 Comparisons of the responses of TB, FB, and PB to five GCFs, categorized by hotspot status, hotspots, regions, elevations, realms, and climate zones (left panel), as well as by ecosystems, floristic realms, plant life forms, taxa types, abundance status, data sources, and study design factors such as temporal and spatial extent (right panel). Source data are provided as a Source Data file.

Supplementary Figure 6 Relative contribution of environmental factors and study design to the ln RR of plant β -diversity under the impacts of GCFs in the random forest models. Source data are provided as a Source Data file.

Supplementary Figure 7 Diagnostic plots for meta-regression models assessing the effects of continuous moderators on ln RR. Source data are provided as a Source Data file.

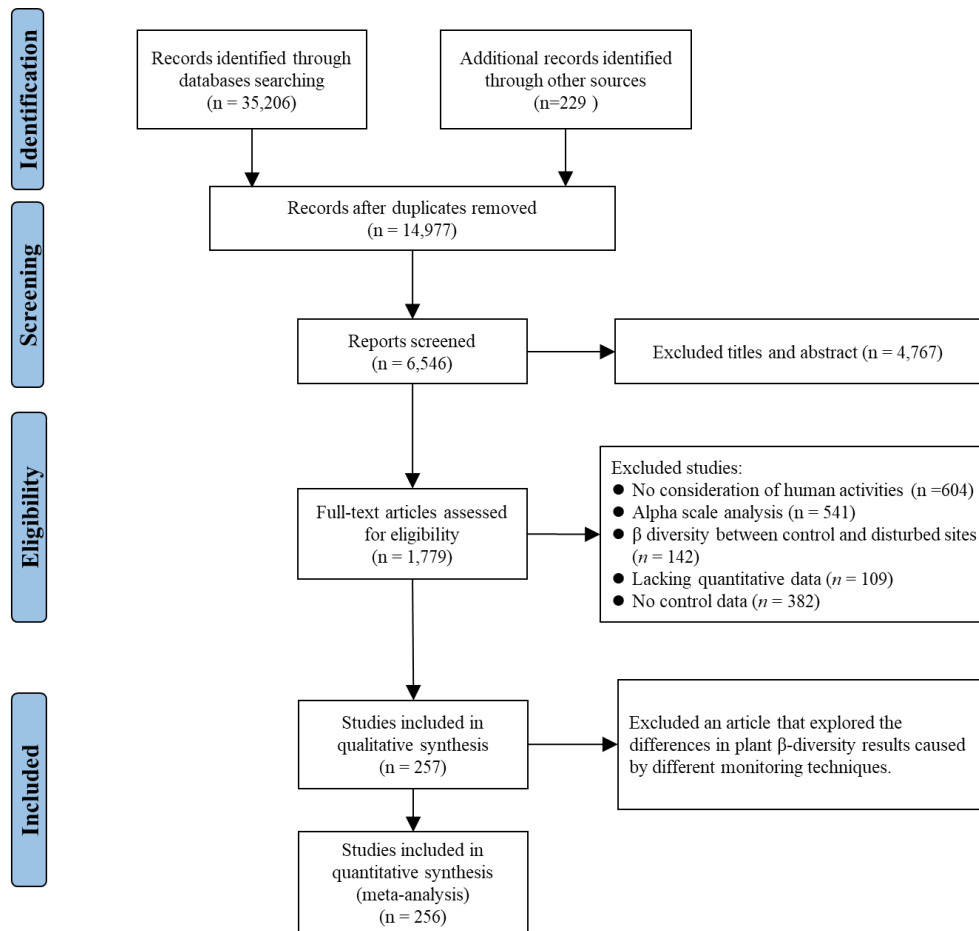
Supplementary Figure 8 Relationship between GCFs effect sizes on response ratios for plant β diversity and mean annual temperature (MAT), mean annual precipitation (MAP), latitude, longitude, elevation, sampling size, spatial extent and temporal extent. Source data are provided as a Source Data file.

Supplementary Table 1 Quality criteria for reviewed studies.

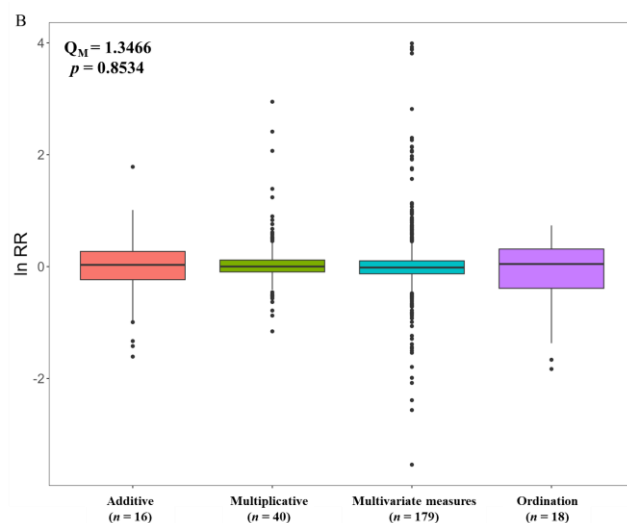
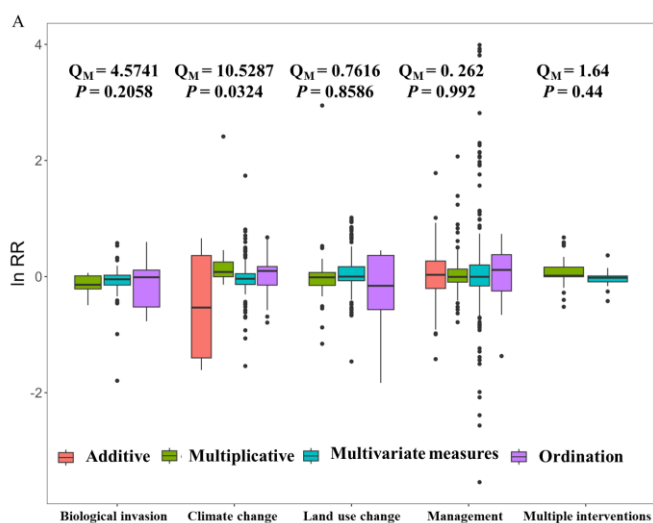
Supplementary Table 2 Summary of publication bias analyses regarding plant β -

diversity response in global-level.

Supplementary Table 3 Summary of publication bias analyses regarding plant β -diversity responses to specific GCFs.

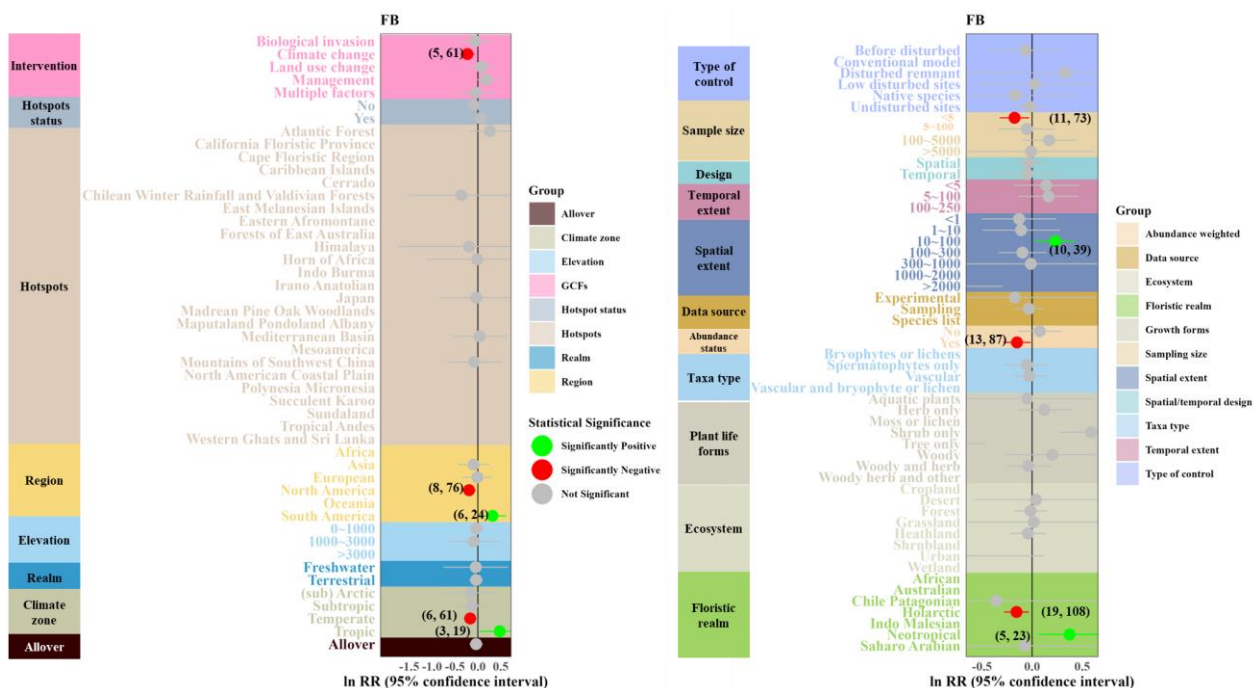


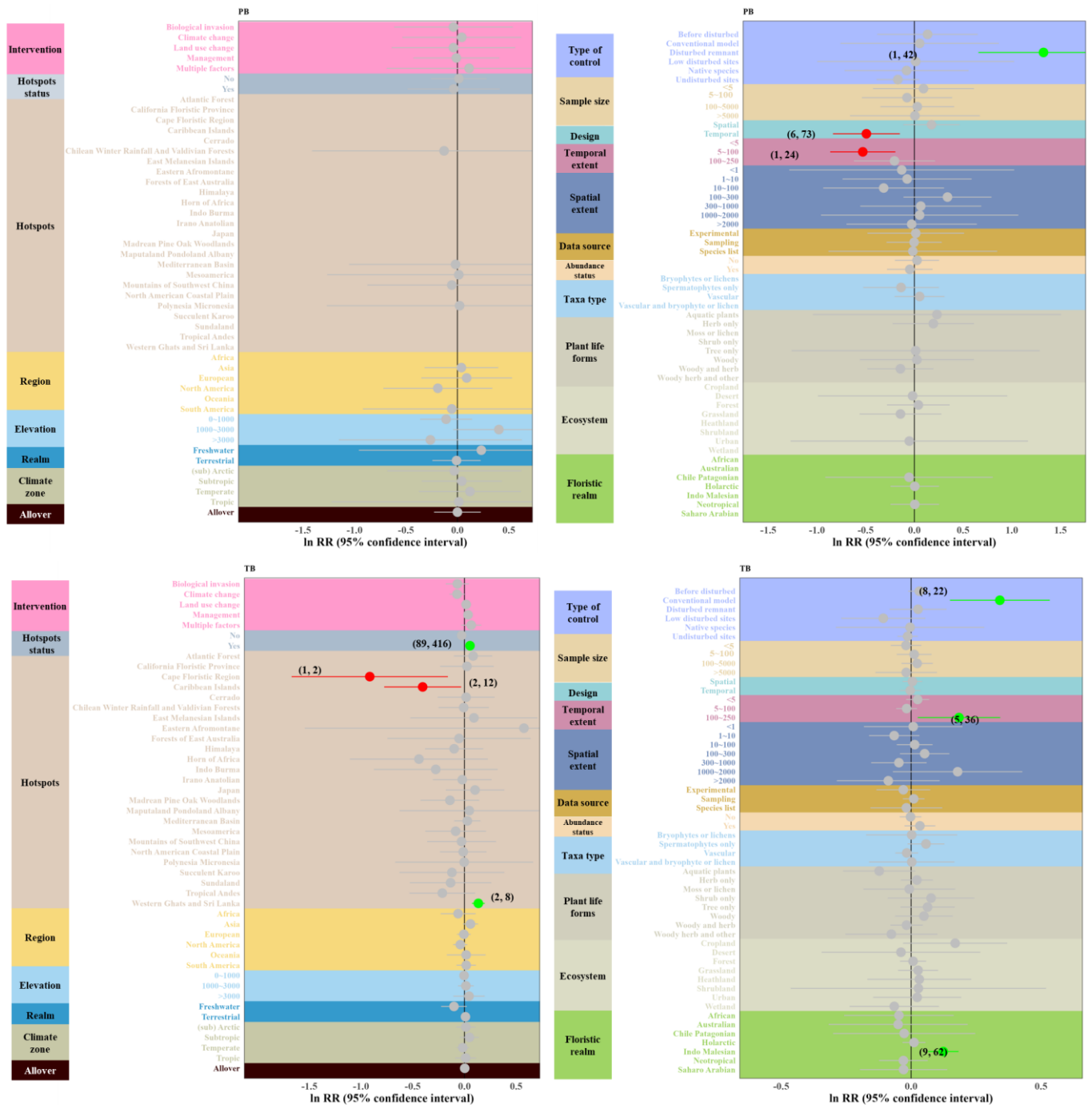
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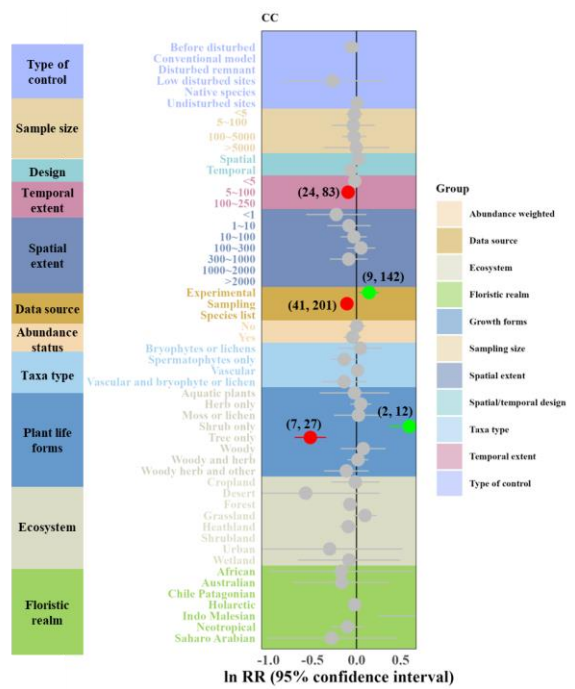
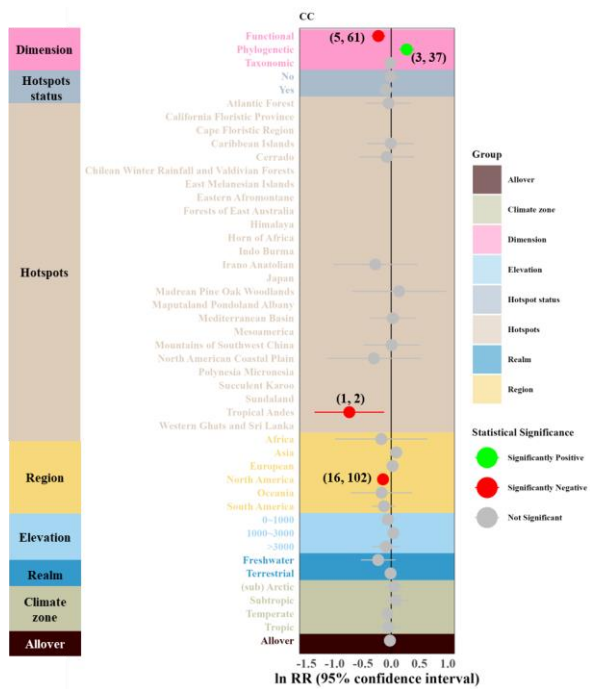
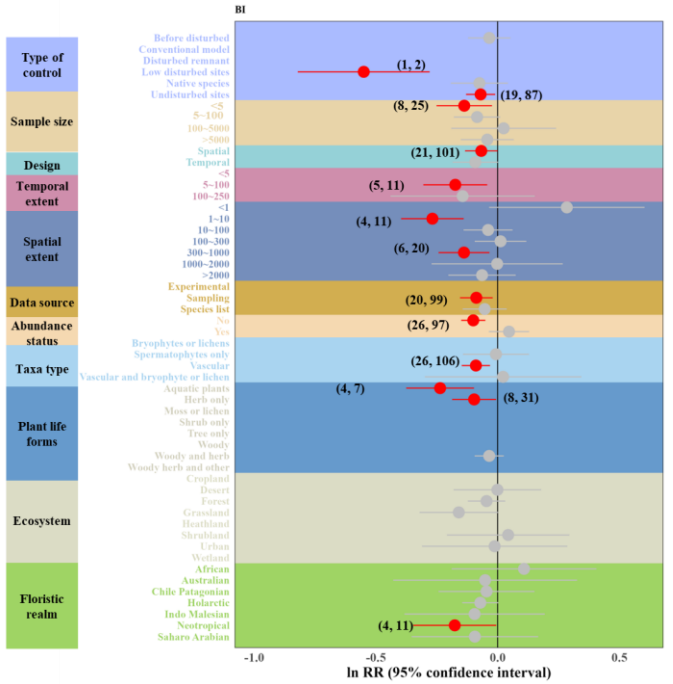
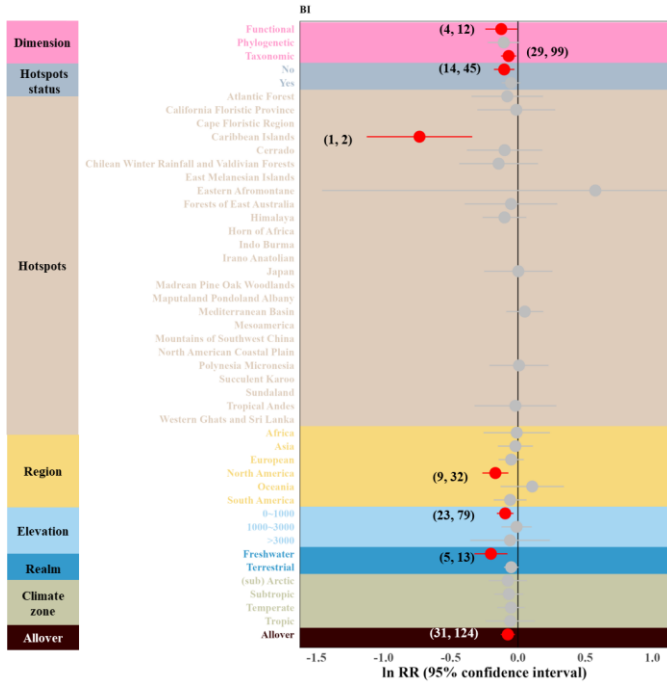


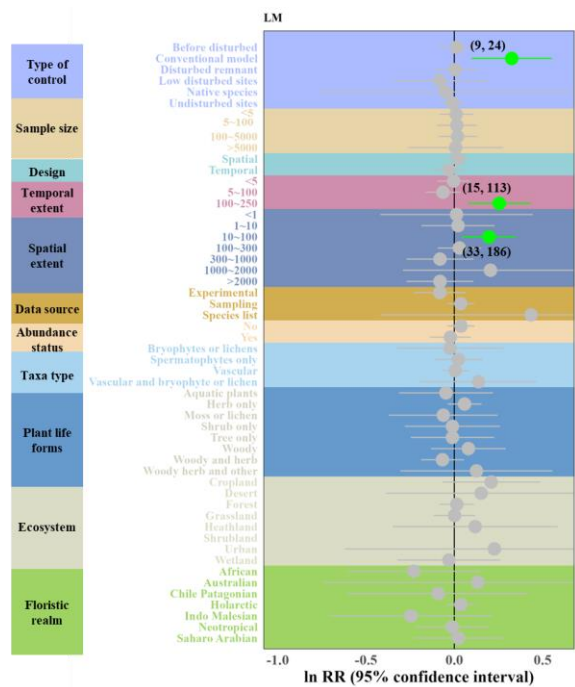
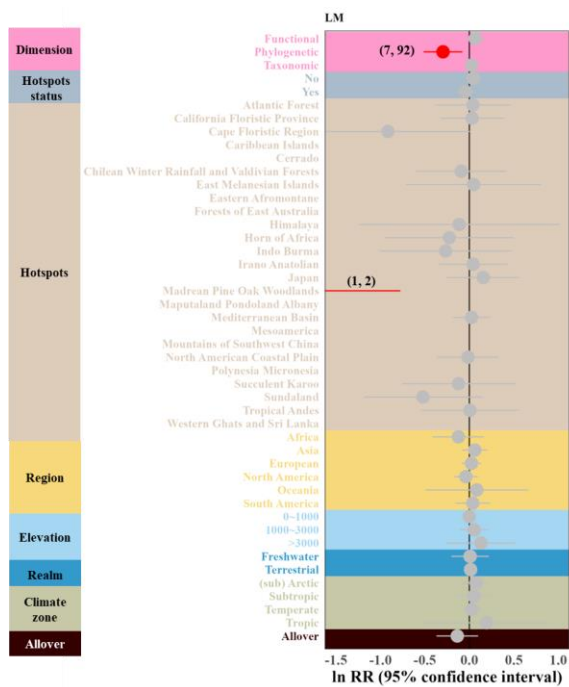
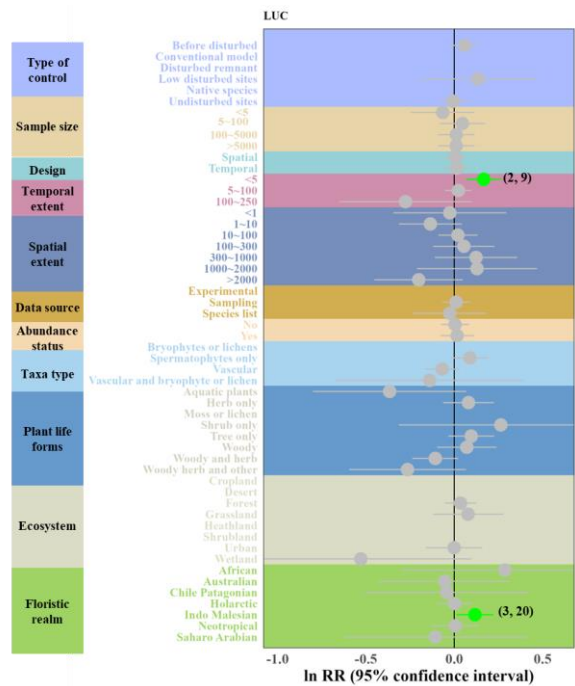
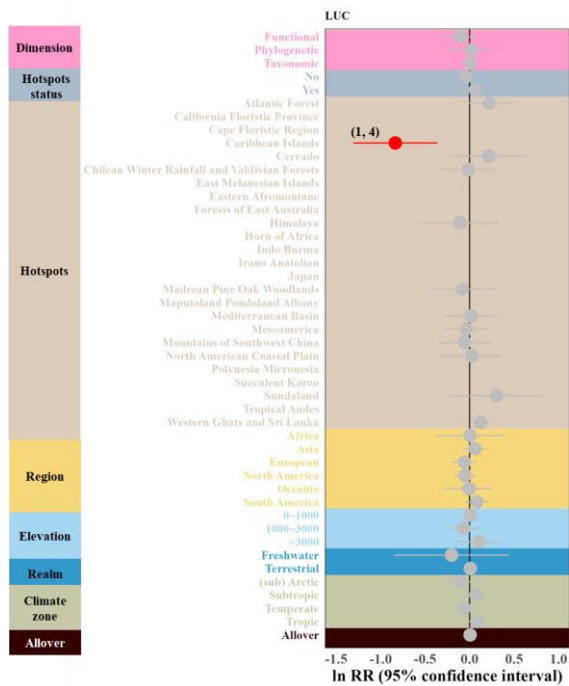
1 **Supplementary Figure 2** Comparisons of the responses of plant β -diversity to global
2 change factors using data from studies that employed different analytical methods.
3 Source data are provided as a Source Data file.

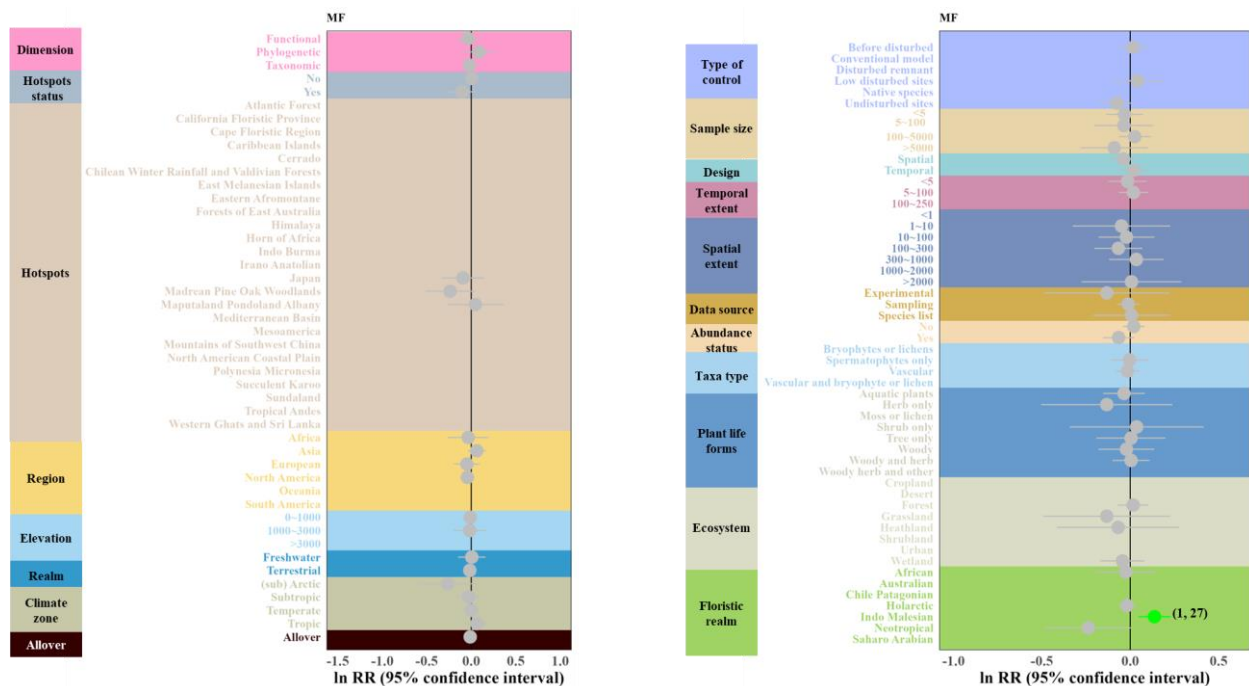
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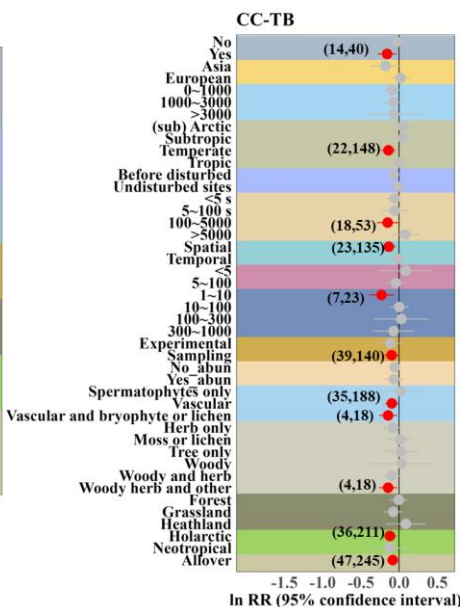
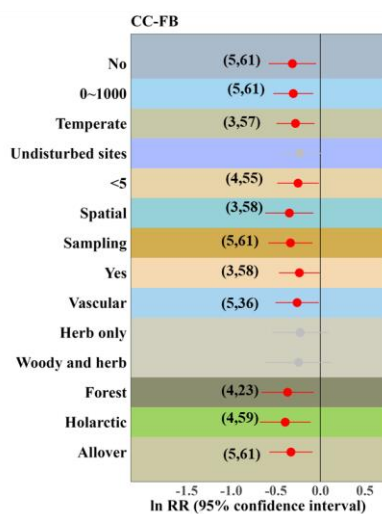
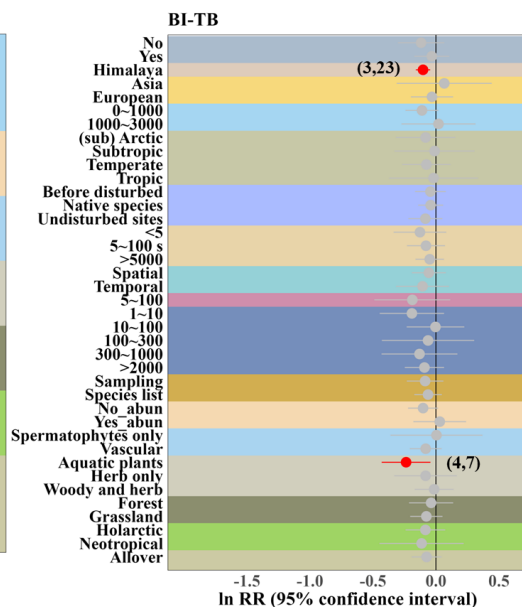
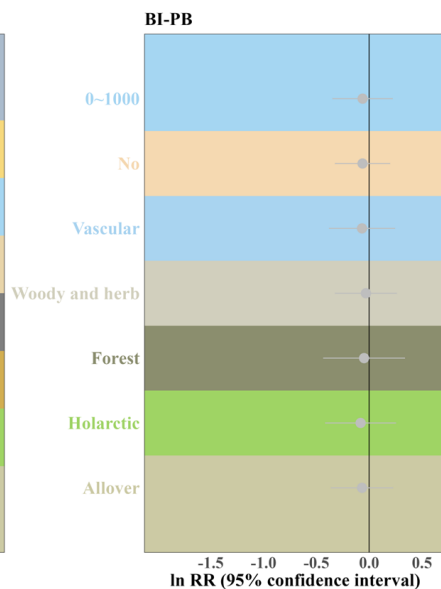
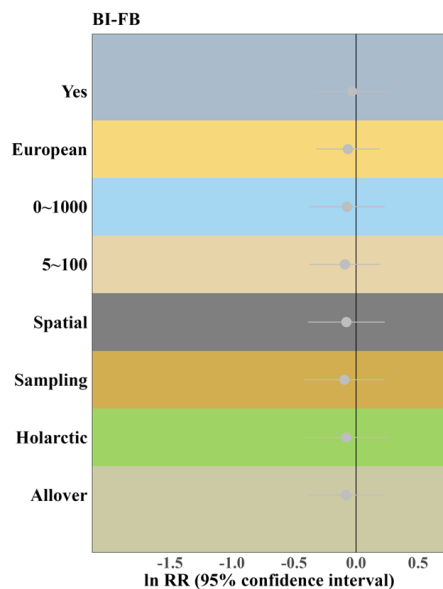


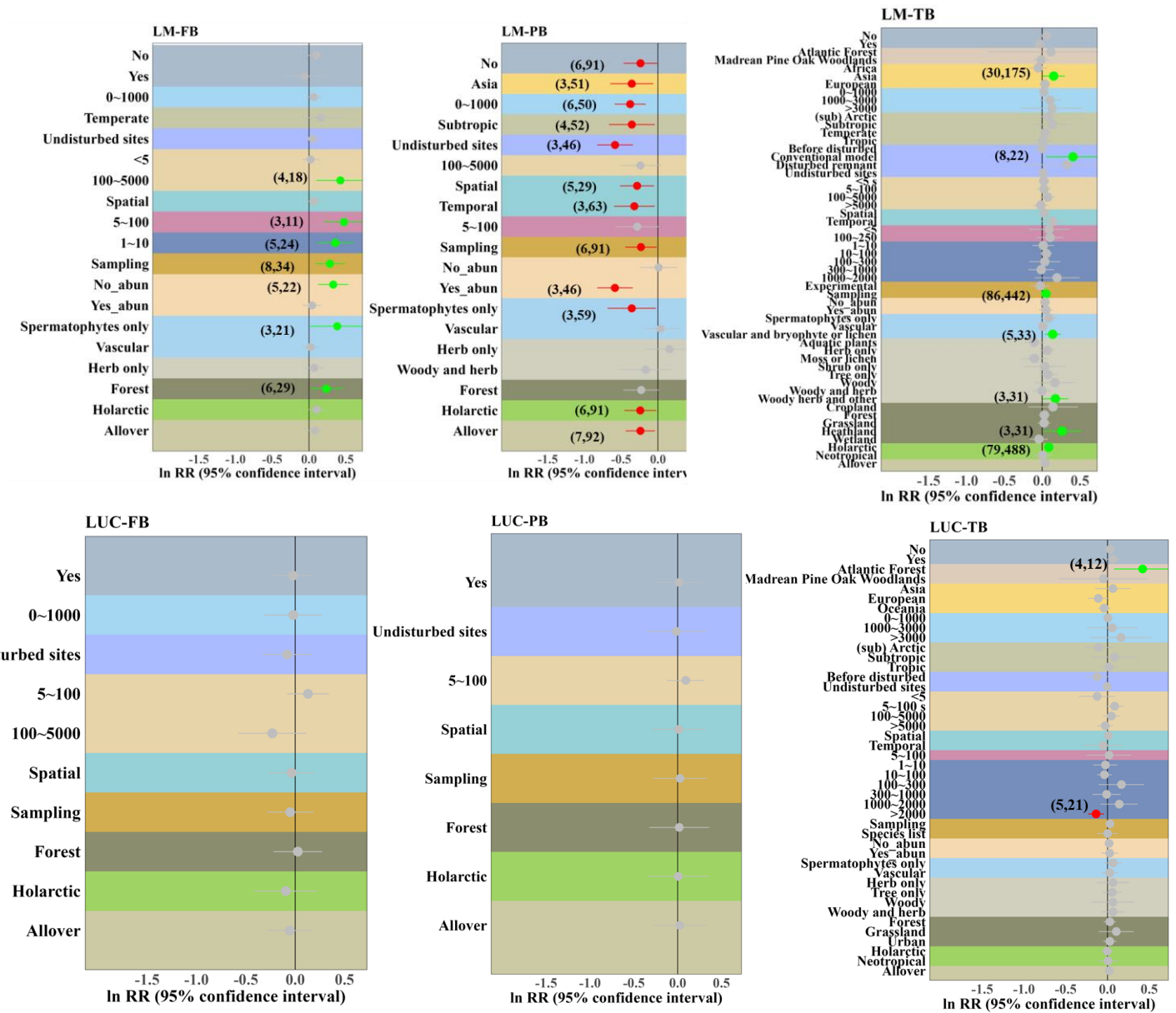


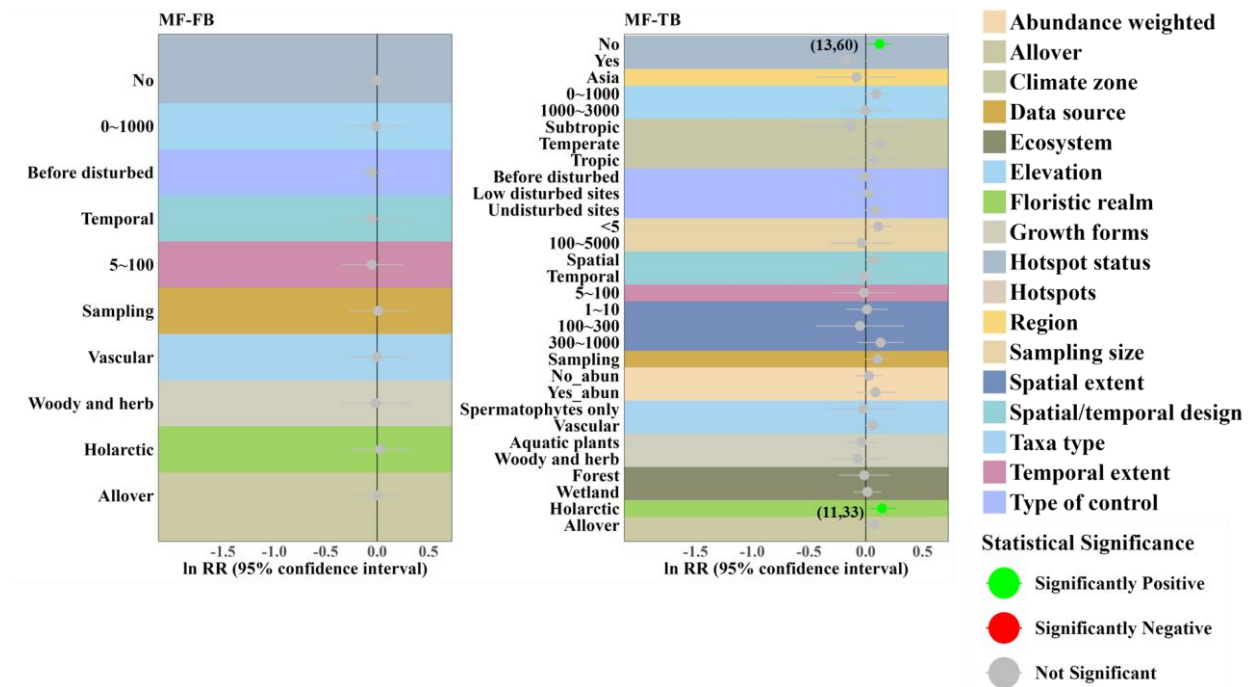




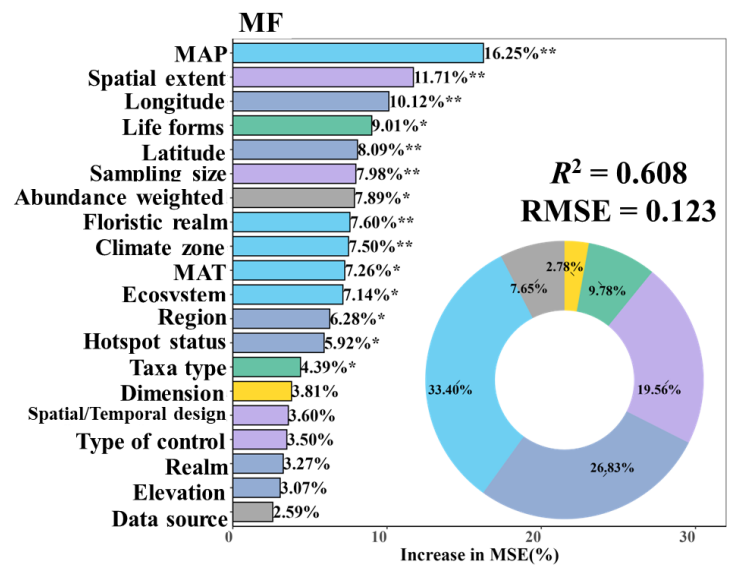
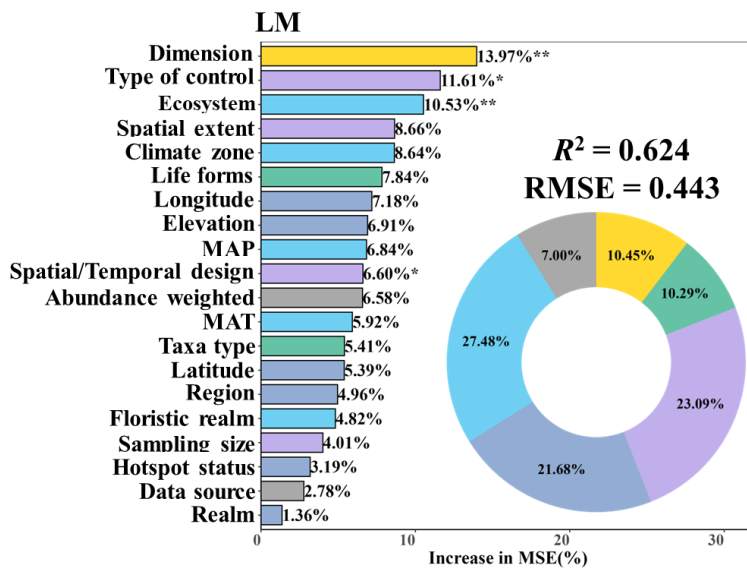
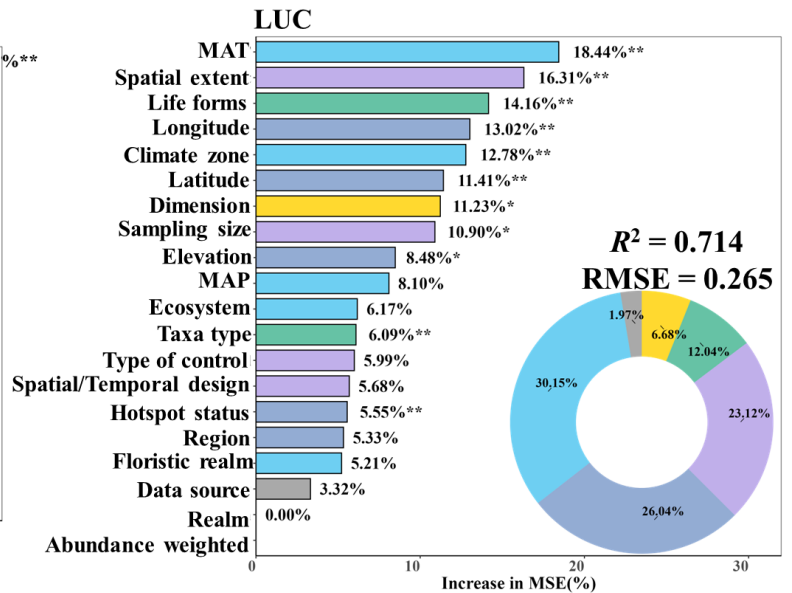
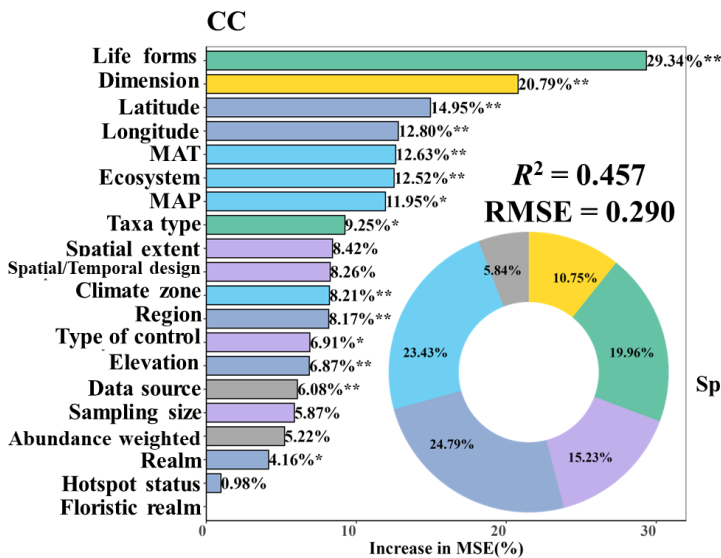
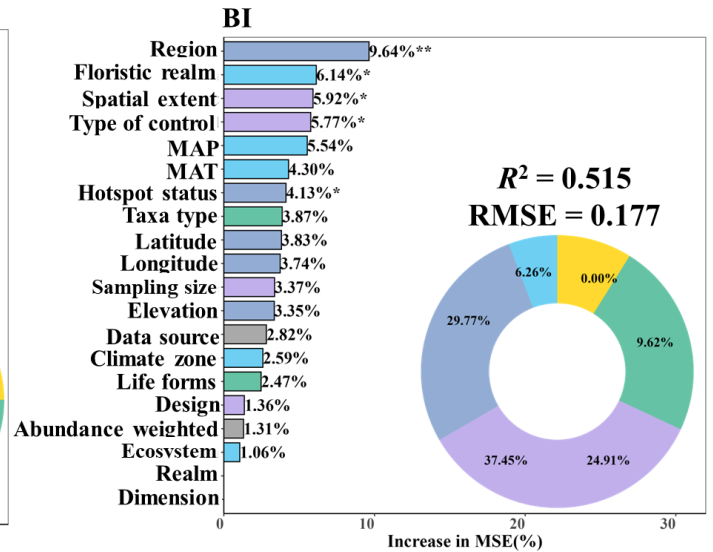
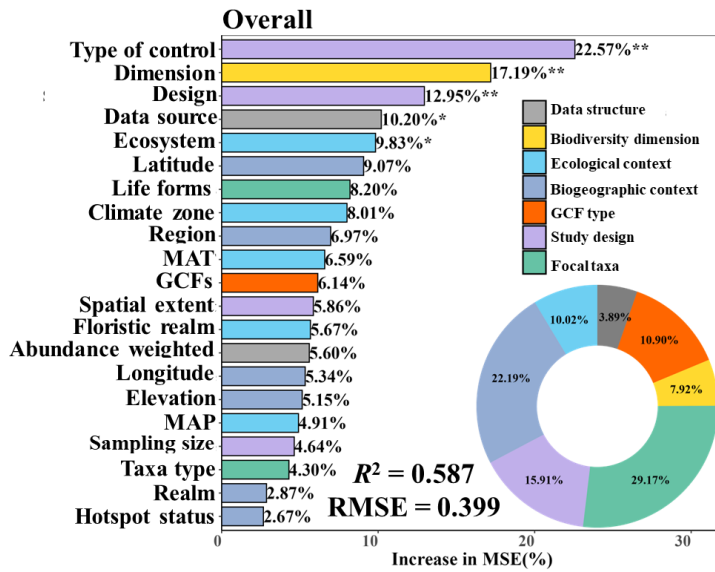
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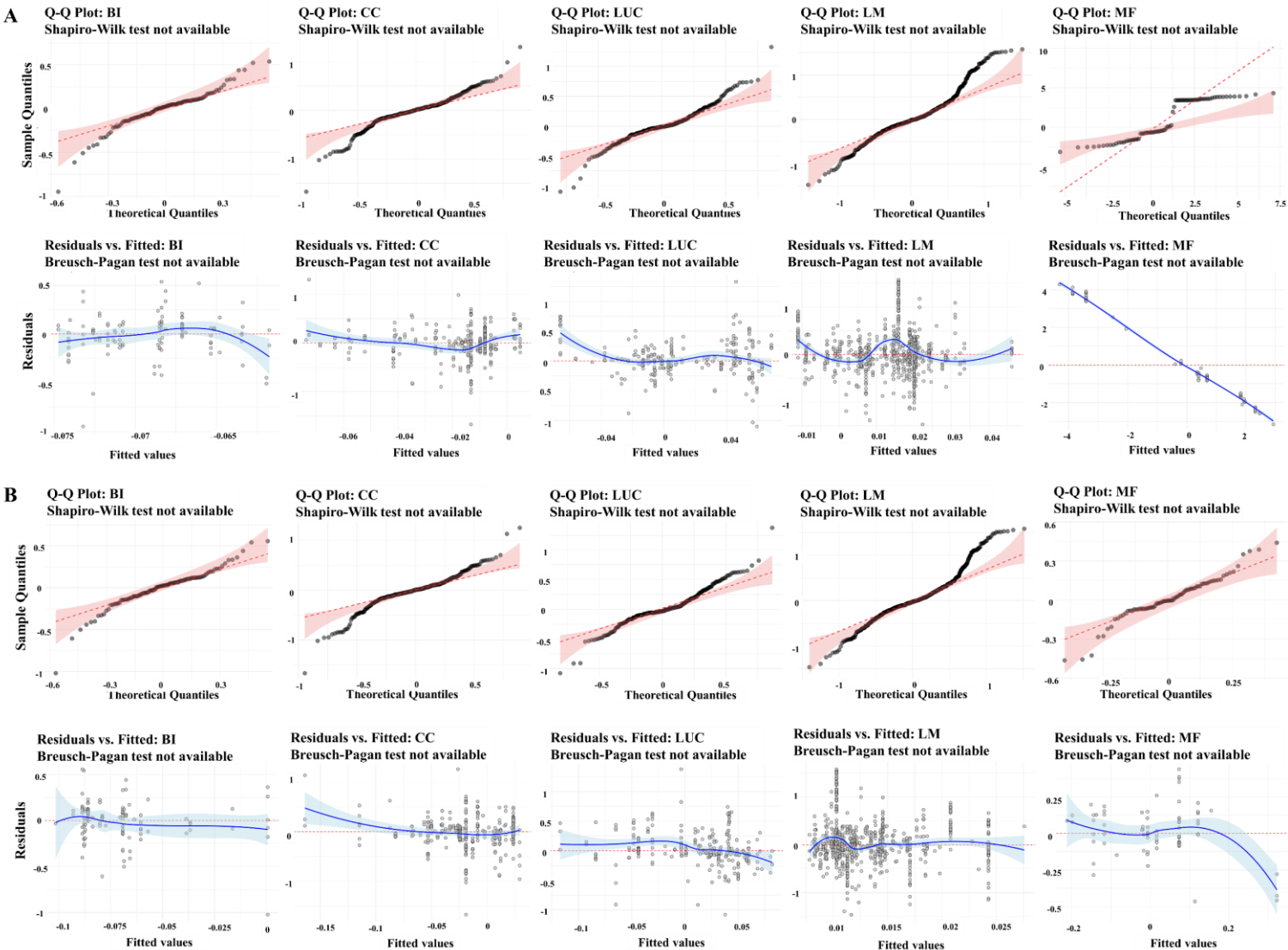


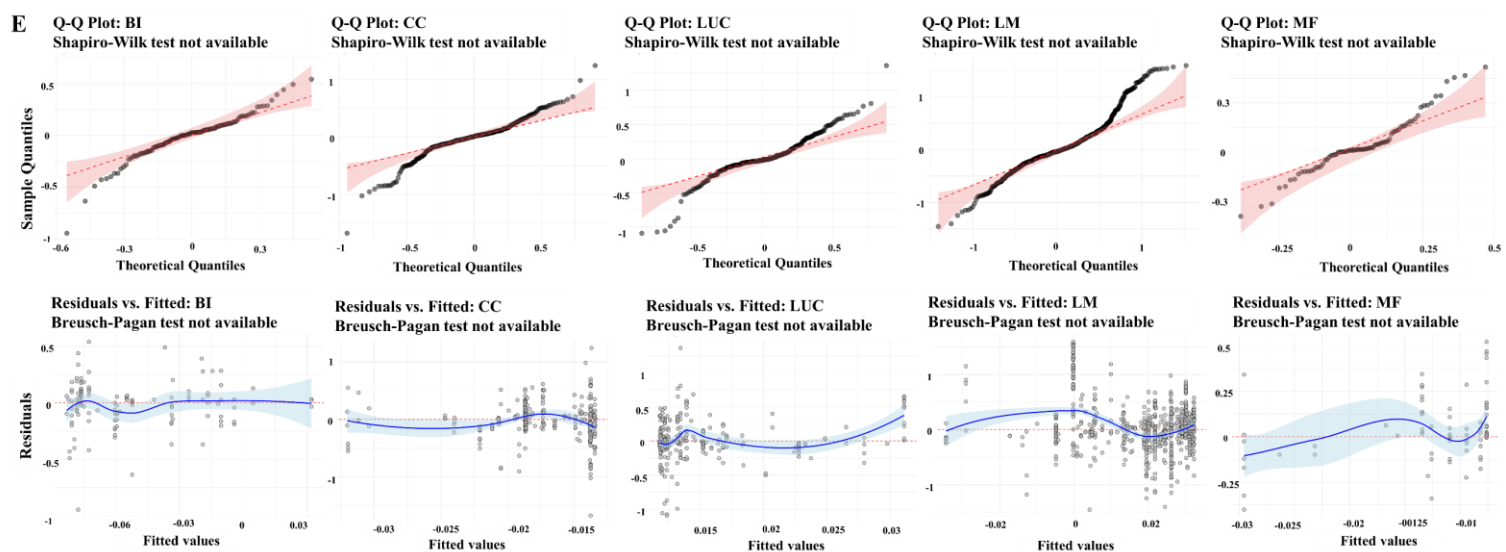
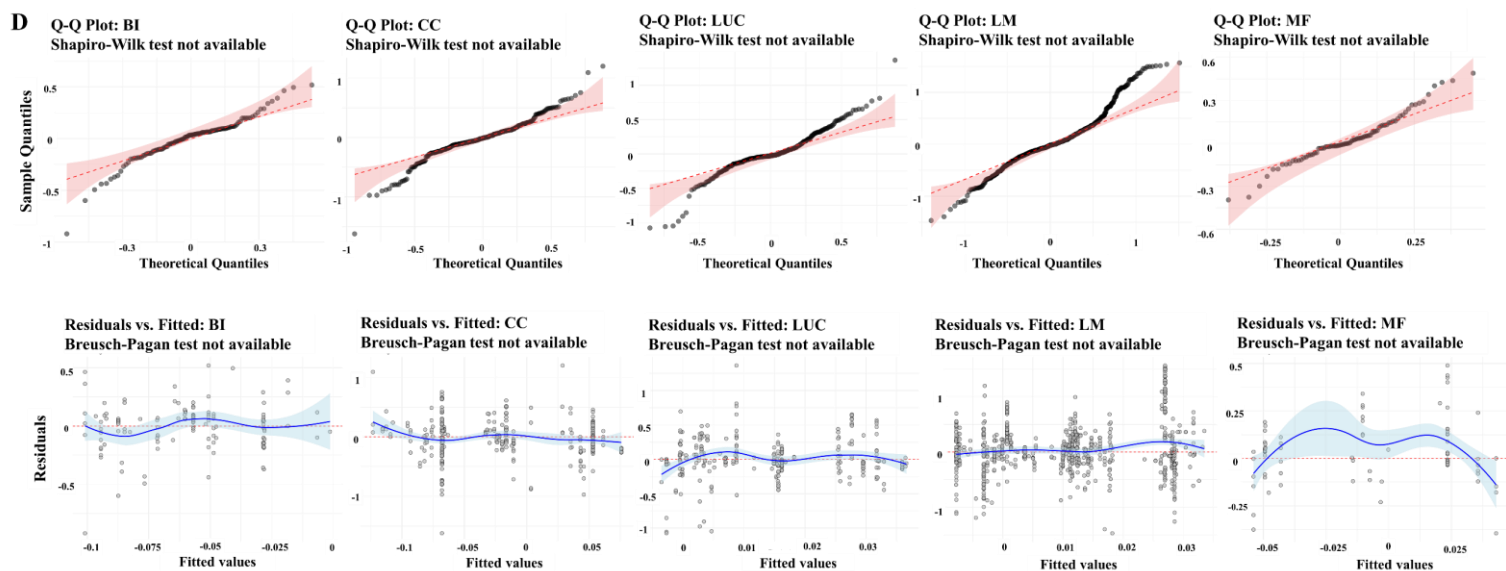
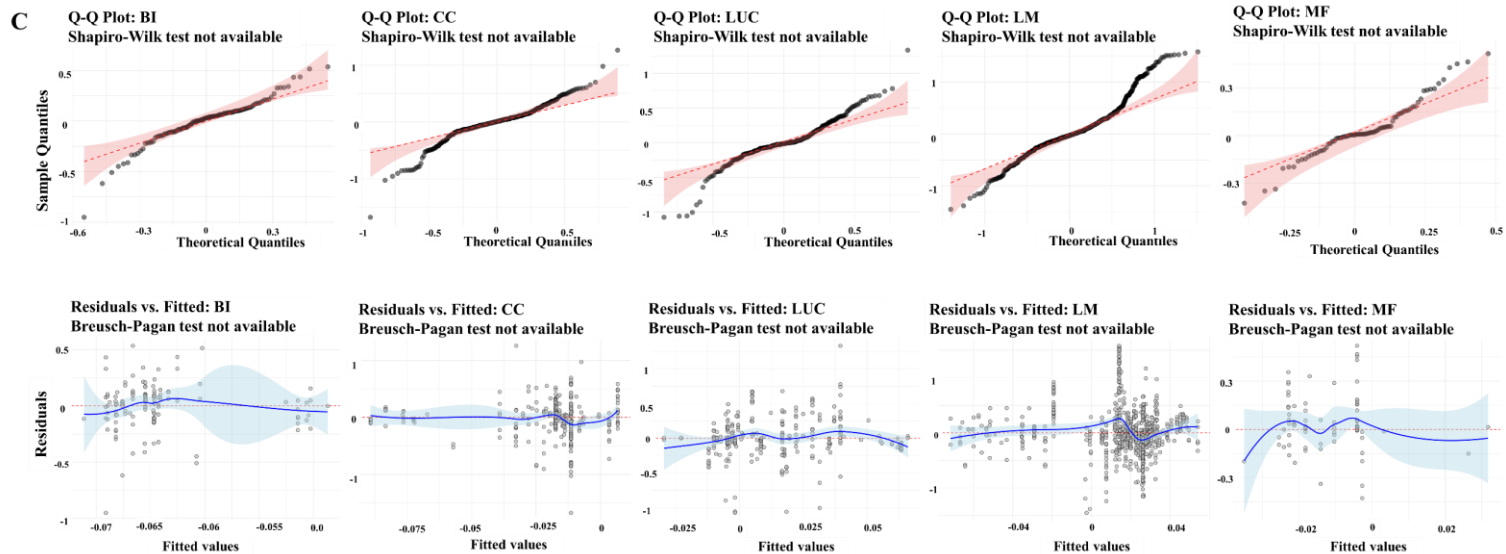


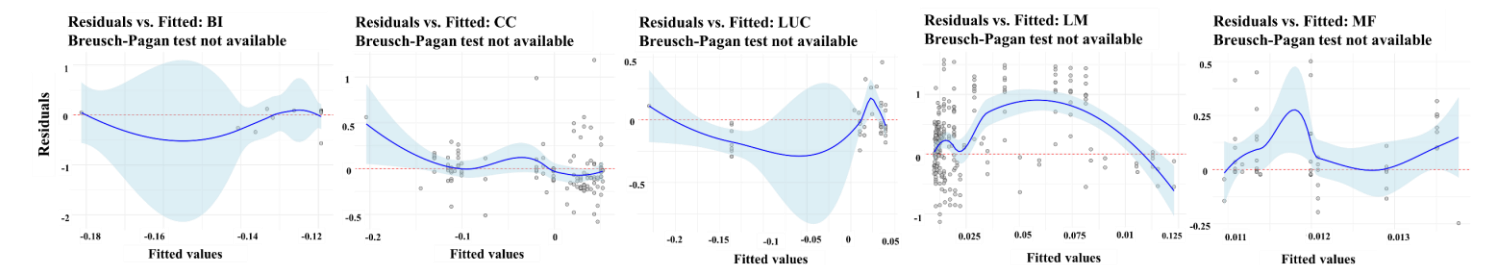
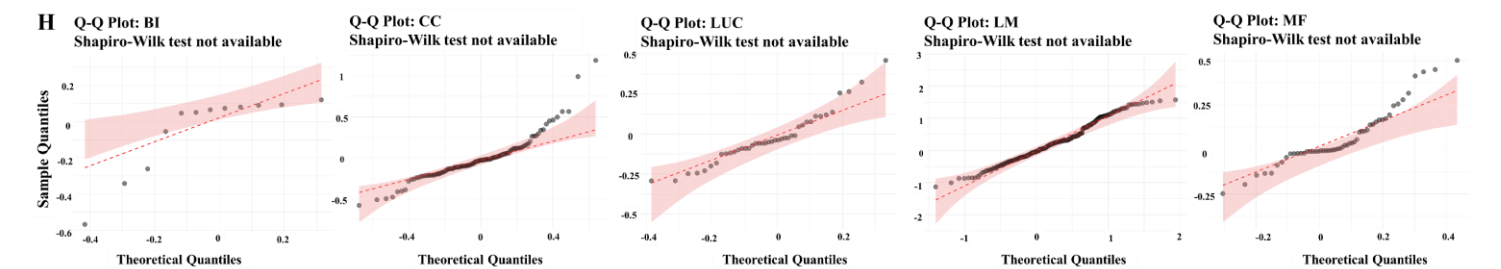
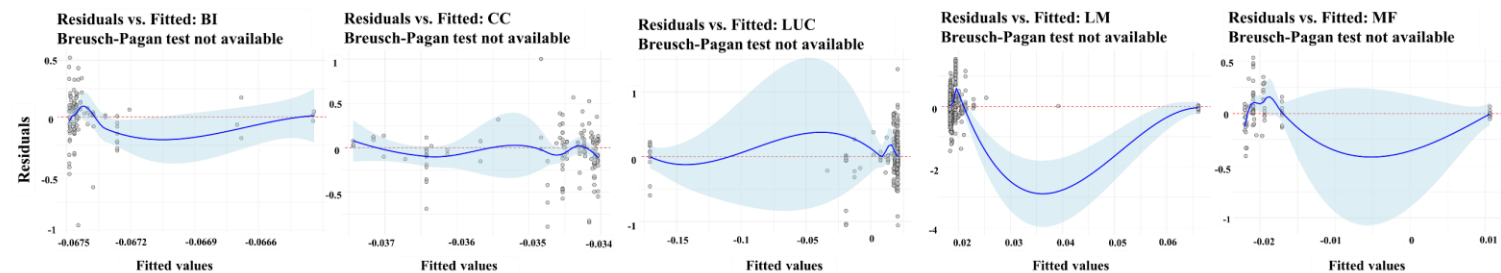
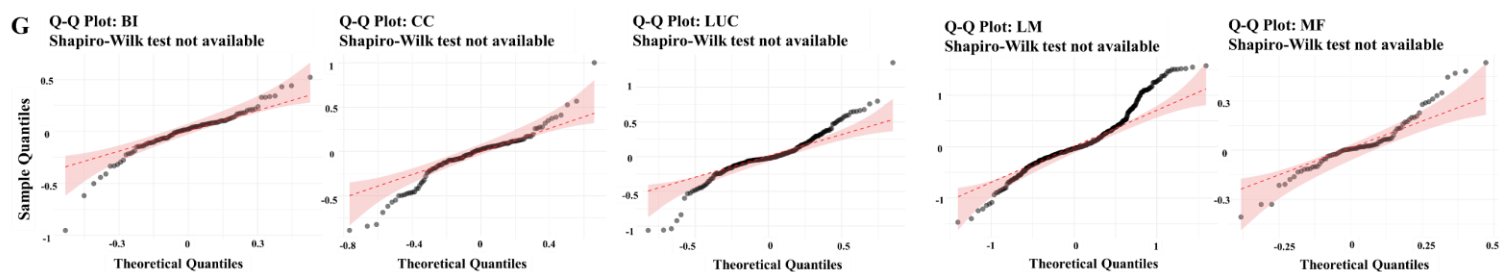
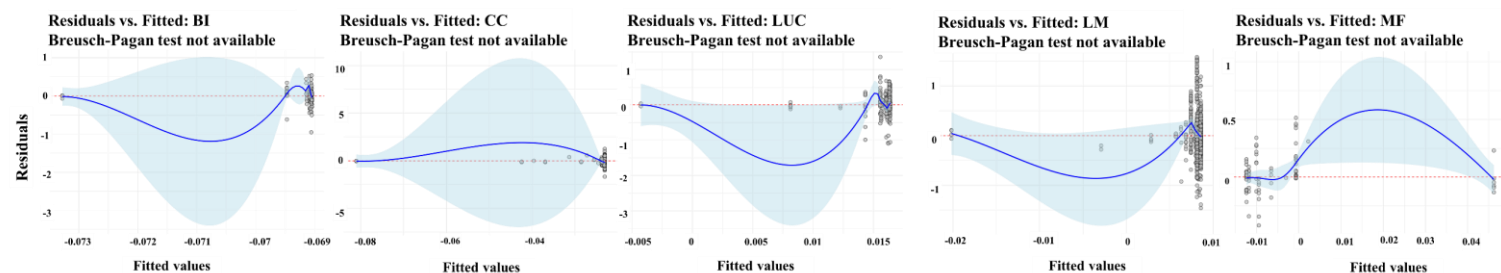
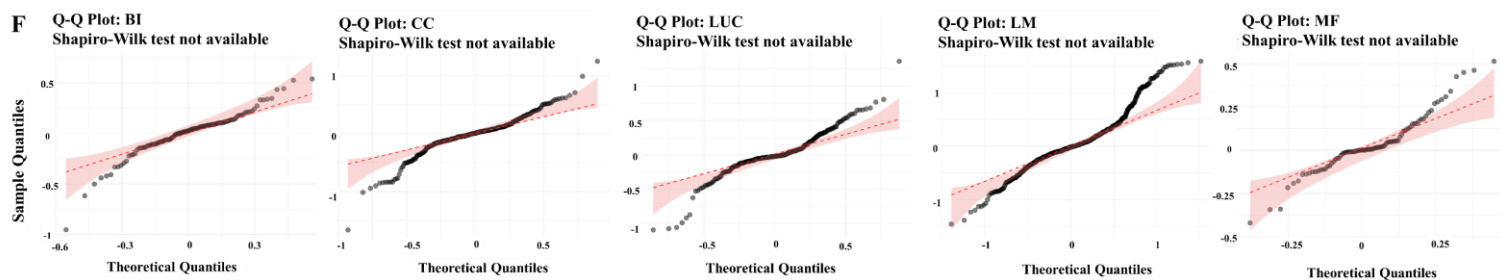
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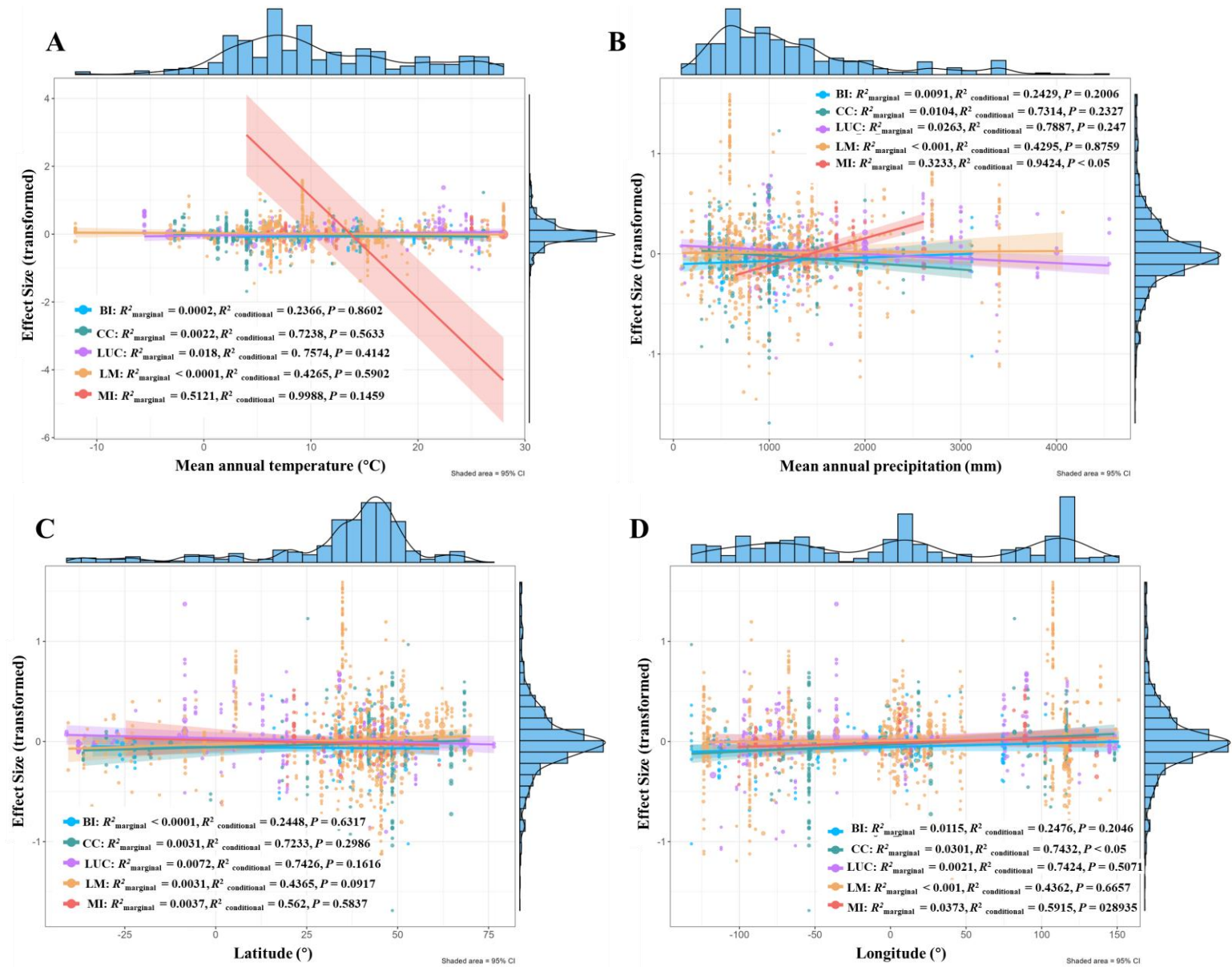
Supplementary Figure 6 Relative contribution of environmental factors and study design to the ln RR of plant β -diversity under the impacts of GCFs in the random forest models. Statistical significance is indicated as * for $p < 0.05$, ** for $p < 0.01$, and non-significant values are without symbols. Key: BI, biological invasion; CC, climate change; LUC, land use change; LM, land management; and MF, multiple factors. The bar graphs display the relative importance (in %) of the 21 individual predictors based on random forest analysis. The donut charts summarize the contributions of the seven predictor groups, calculated as the percentage of total importance, obtained by summing the relative importance values of all individual variables within each group. Source data are provided as a Source Data file.

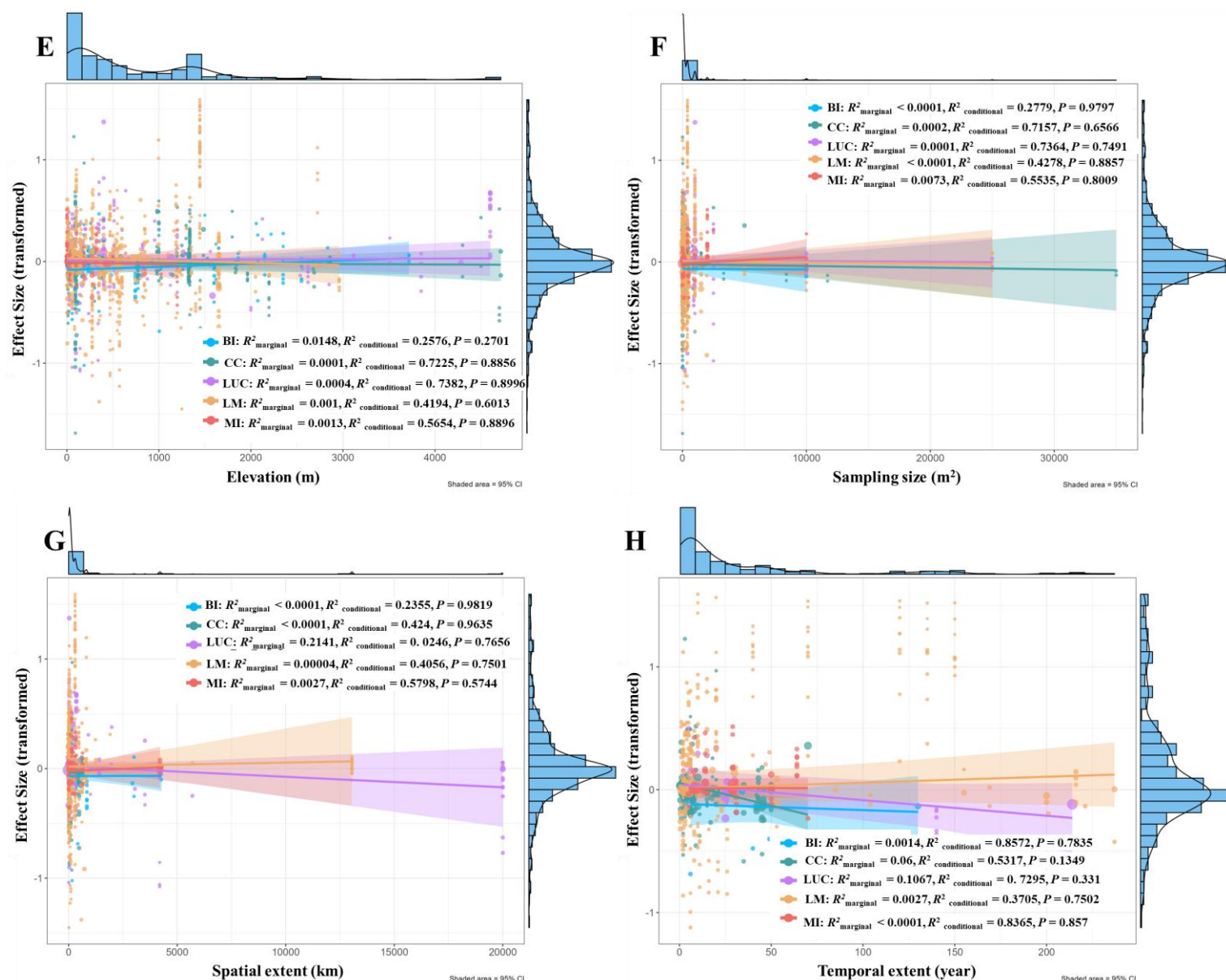






Supplementary Figure 7 Diagnostic plots for meta-regression models assessing the effects of continuous moderators on ln RR. Shown are Q–Q plots of residuals and residuals versus fitted values for (A) mean annual temperature (MAT), (B) mean annual precipitation (MAP), (C) latitude, (D) longitude, (E) elevation, (F) sampling size, (G) spatial extent, and (H) temporal extent. Source data are provided as a Source Data file.





59 **Supplementary Figure 8** Relationship between GCFs effect sizes on response ratios
 60 for plant β diversity and mean annual temperature (MAT), mean annual precipitation
 61 (MAP), latitude, longitude, elevation, sampling size, spatial extent and temporal
 62 extent. Key: BI, biological invasion; CC, climate change; LUC, land use change; LM,
 63 land management; and MF, multiple factors. Source data are provided as a Source
 64 Data file.

Quality checklist question	Score Yes=1, No=0
INTERNAL VALIDITY	
<i>Research aim</i>	
1.Does the study address a clearly focused question?	
2.Does the question match the answer?	
<i>Data collection</i>	
3.Was the population/area of interest defined in space, time and size?	
4.Selection bias: Was the sample area representative for the population defined?	
5.Was the sample size appropriate?	
6.Was probability/random sampling used for constructing the sample?	
7.If secondary data were used, did an evaluation of the original data take place?	
8.Were the data collection methods described in sufficient detail to permit replication?	
<i>Analysis</i>	
9.Were the statistical/analytical methods described in sufficient detail to permit replication?	
10.Is the choice of statistical/analytical methods appropriate and/or justified?	
11.Was uncertainty assessed and reported?	
<i>Results and conclusions</i>	
12.Do the data support the outcome?	
13.Magnitude of effect: Is the effect large, significant and/or without large uncertainty?	
14.Are all variables and statistical measures reported?	
DESIGN-SPECIFIC ASPECTS	
<i>Study with a reference/control</i>	
15.Allocation bias: Was the assignment of case-control groups randomized?	
16.Were groups designed equally, aside from the investigated point of interest?	
17.Were there sufficient replicates of treatment and reference groups?	
18.Detection bias: Were outcomes equally measured and determined between groups?	
<i>Observational studies</i>	
19.Were confounding factors identified and strategies to deal with them stated?	
FOCUS-SPECIFIC ASPECTS	
<i>Quantification</i>	
20.Is the unit of the quantification measurement appropriate?	
21.Was temporal change (e.g. annual or long-term) of quantities measured (e.g. species abundance or an ecosystem service) discussed?	
66	Note: For each criterion answered with “yes,” the study receives one point; otherwise,
67	it receives zero. If a criterion is not applicable to a particular study (e.g., due to its
68	design or focus), it may be excluded from the total. Based on the resulting percentage
69	score, studies are categorized as follows: (a) Weak evidence: score < 24%; (b)
70	Moderate evidence: score 25%–49%; (c) Strong evidence: score 50%–74%; (d) Very
71	strong evidence: score > 75%.

Supplementary Table 2 Summary of publication bias analyses regarding plant β -diversity response in global-level.

Types of global change factors	Mean effect size (95% confidence interval)	Egger's regression test		Corrected mean effect size (95% confidence interval)
		z-value	P-value	
Biological invasion		-0.587	0.5572	—
Climate change		-1.495	0.1349	—
Land use change	0.0063 (-0.0665 — 0.0792)	-3.823*	<0.0001	0.1689 (0.1174 — 0.2205)
Land management	-0.1358 (-0.3698 — 0.0982)	7.6385*	<0.0001	0.0731 (0.0323—0.1140)
Multiple factors		1.2381	0.2157	—
Allover	-0.0031 (-0.0406 — 0.0344)	5.17	<0.0001	0.0211 (-0.0012—0.0434)

Note: a* indicates $P < 0.05$, signifying statistical significance of publication bias based on the two-sided z-test. In these cases, we computed the corrected mean effect size.

76 **Supplementary Table 3** Summary of publication bias analyses regarding plant β -
77 diversity responses to specific GCFs.

Dimension of β - diversity	Types of intervention	Mean effect size (95% confidence interval)	Egger's regression test		Corrected mean effect size (95% confidence interval)
			<i>z</i> -value	<i>P</i> -value	
Taxonomic	Biological invasion		-0.1974	0.8435	—
	Climate change		0.6078	0.5433	—
	Land use change		-2.6691	0.0076	0.1669 (0.1152 — 0.2158)
	Land management	0.035 (-0.0097 — 0.0796)	5.1332*	<0.0001	0.0556 (0.0183 — 0.0929)
	Multiple factors		0.6887	0.491	—
	Allover	0.0029 (-0.0344 — 0.0401)	3.3203*	0.0009	0.0241 (0.0026 — 0.0455)
Functional	Biological invasion		0.2463	0.8054	—
	Climate change	-0.2283 (-0.3844 — -0.0722)	-3.3204*	0.0009	-0.3155 (-0.4945 — -0.1365)
	Land use change	0.0788 (-0.2489 — 0.4065)	-3.4586*	0.0005	-0.0255 (-0.4233 — 0.3724)
	Land management		-0.6423	0.5207	—
	Multiple factors		-0.9681	0.333	—
	Allover	-0.038 (-0.1817 — 0.1057)	-2.7355*	<0.05	-0.0638 (-0.1766 — 0.4590)
Phylogenetic	Biological invasion		0.7441	0.4568	—
	Climate change		0.4275	0.669	—
	Land use change	-0.0385 (-0.6375 — 0.5605)	-2.1427*	0.0321	-0.0207 (-0.0450 — 0.0035)
	Land management	-0.0106 (-0.4282 — 0.407)	7.0542*	<0.0001	0.1387 (-0.1432 — 0.4207)
	Multiple factors		0.1315	0.8954	—
	Allover	0.0001 (-0.2273 — 0.2274)	6.9159*	<0.0001	0.1238 (-0.0065 — 0.2542)

78 Note: a* indicates $P < 0.05$, signifying statistical significance of publication bias based
79 on the two-sided *z*-test. In these cases, we computed the corrected mean effect size.