Cool topoclimates promote cold-adapted plant diversity in temperate mountain forests.

Supplementary materials

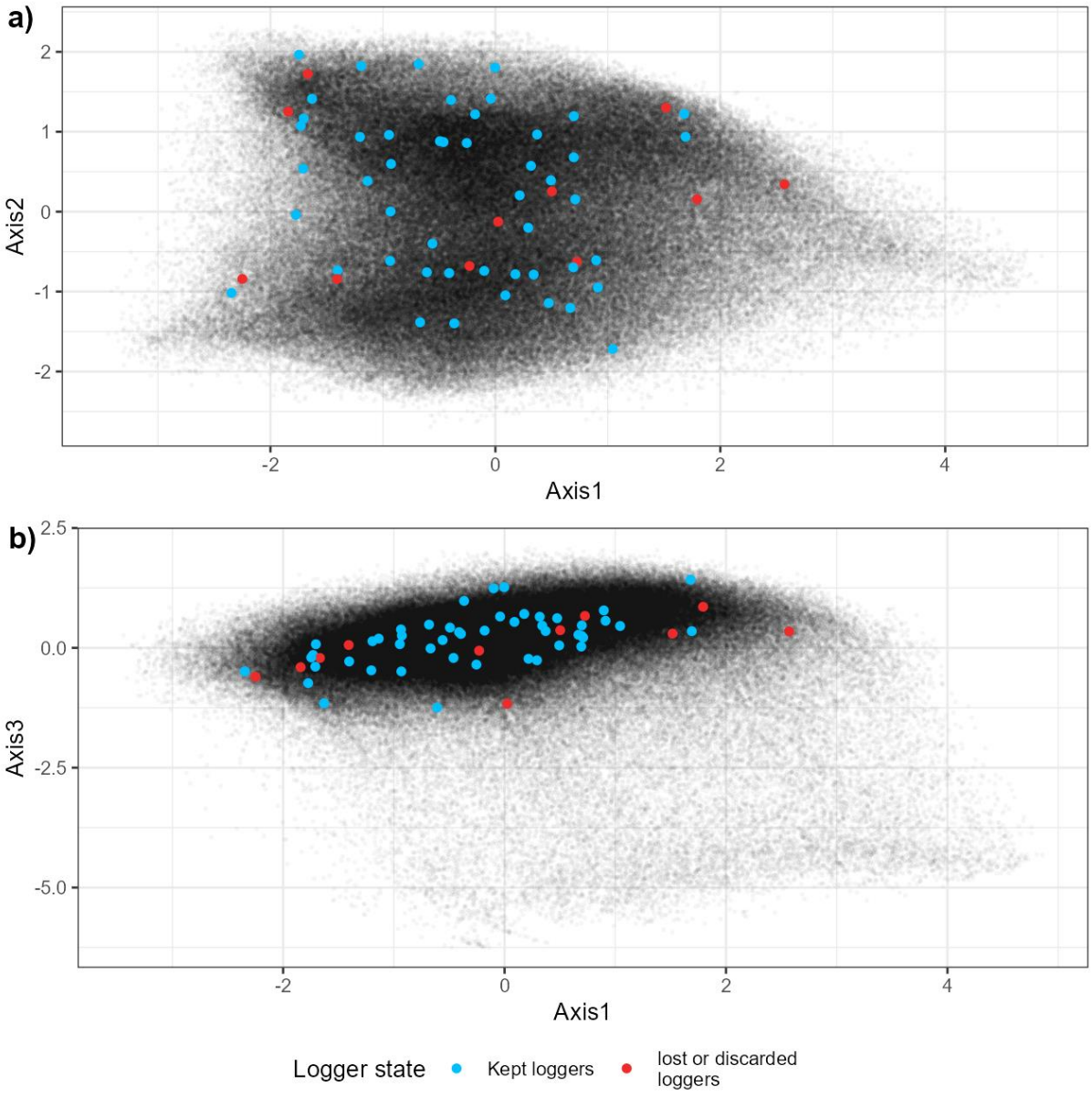

Figure S1; Principal component analysis of the spatial factor ought to influence microclimate. Axis 1 is explained by elevation and topographic position, Axis 2 represents mostly head load index, Axis 3 represents mostly canopy cover. The position in the PCA projection of the initial sampling and the final selection of loggers is shown (Lembrechts et al.*, 2021).*

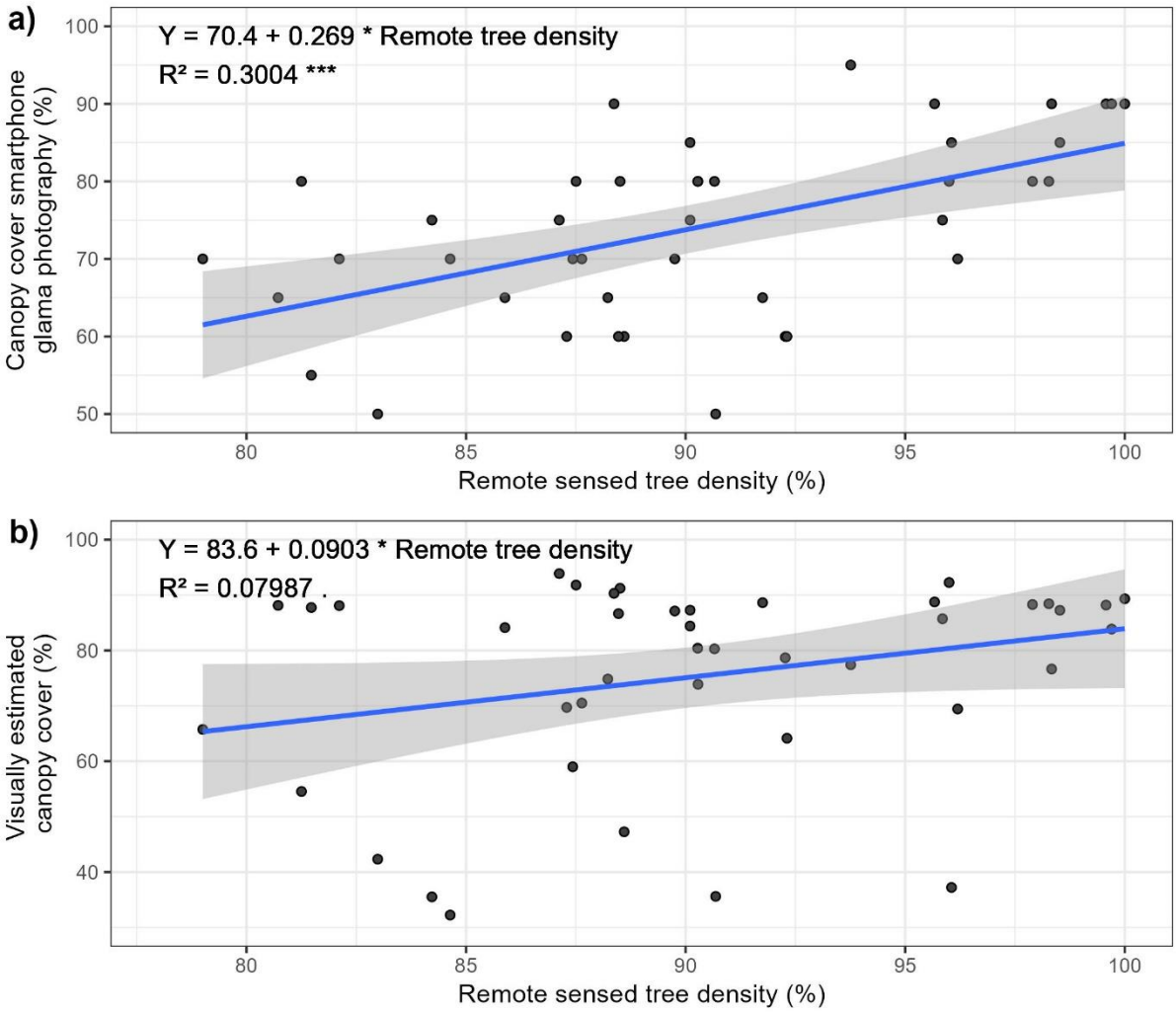

Figure S2: Relationship between Copernicus remote sensed tree density and canopy closure estimated in a 25-meter radius circle (a) and canopy cover estimated by a smartphone photography and segmented by the 'Glama' application (b). The blue line corresponds to a fitted linear model which equation, Person R^2, and its statistical significance are displayed (***): P<0.001, (.) P<0.1. The ribbons are the confidence interval of the model.

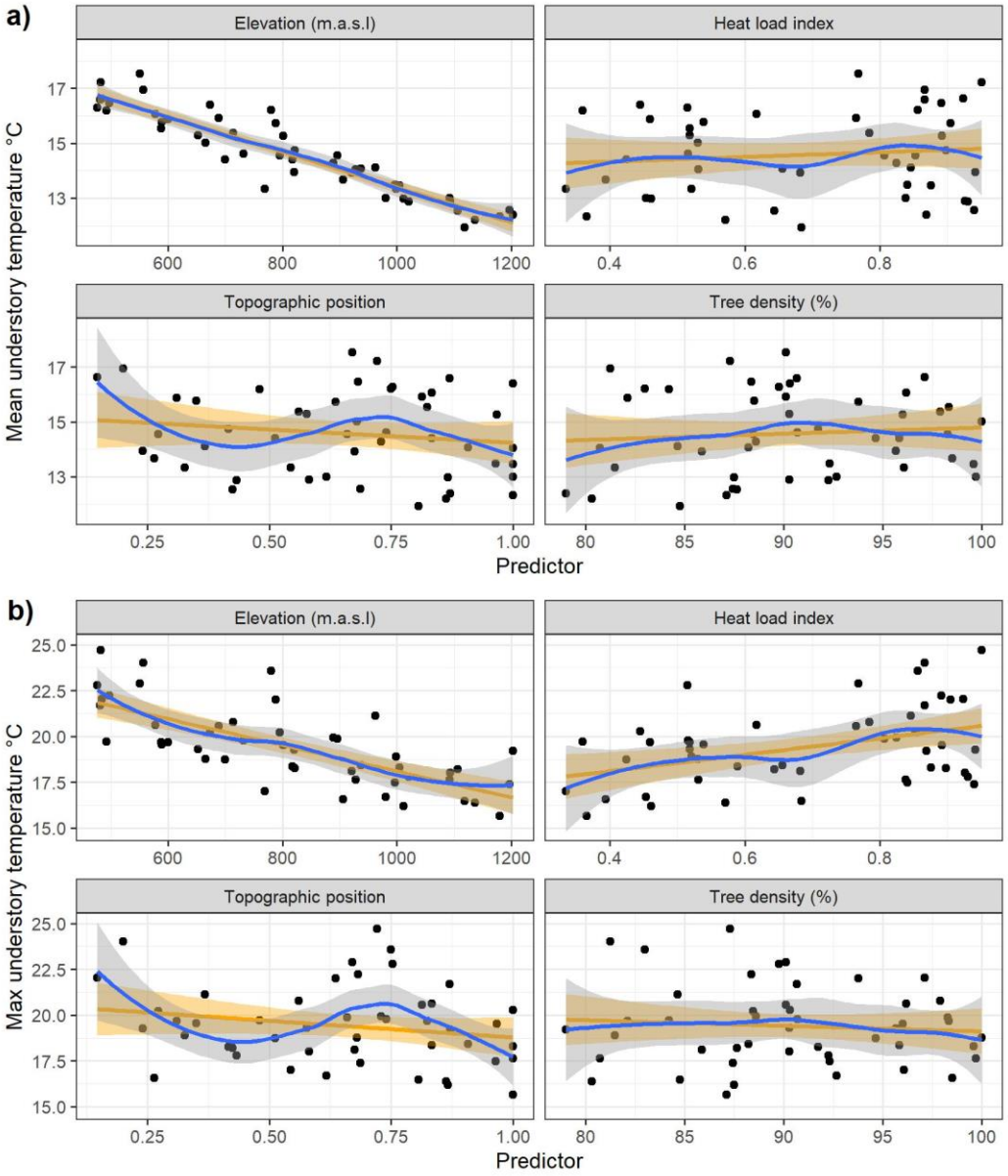

Figure S3: Relationship between mean and maximum understory temperature of the growing season with the 4 predictors of the linear temperature model. A loess smoother (blue) and an univariate linear model (orange) and their confidence interval are also displayed.

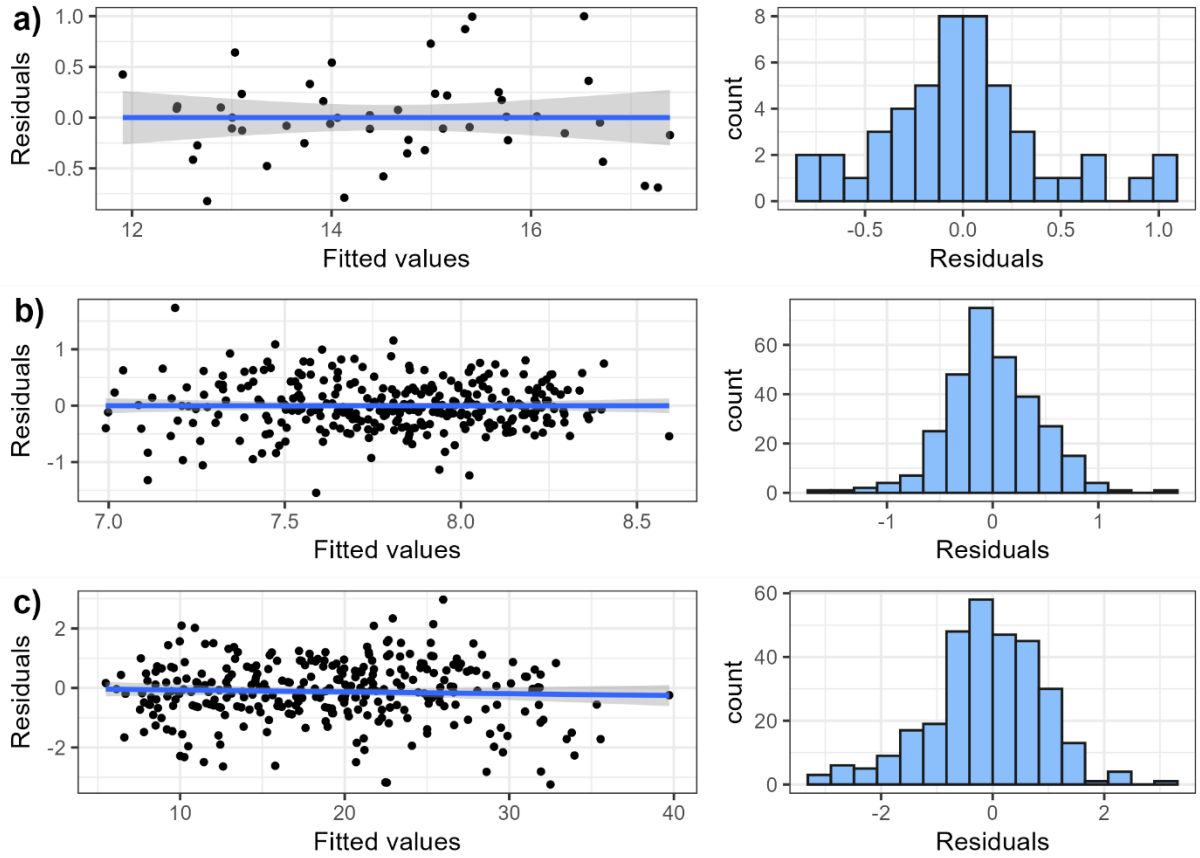

Figure S4: Relationship between residuals and fitted values, and histogram of residuals of the linear mean temperature model (a), the CTI linear model (b) and the species richness negative model (c).

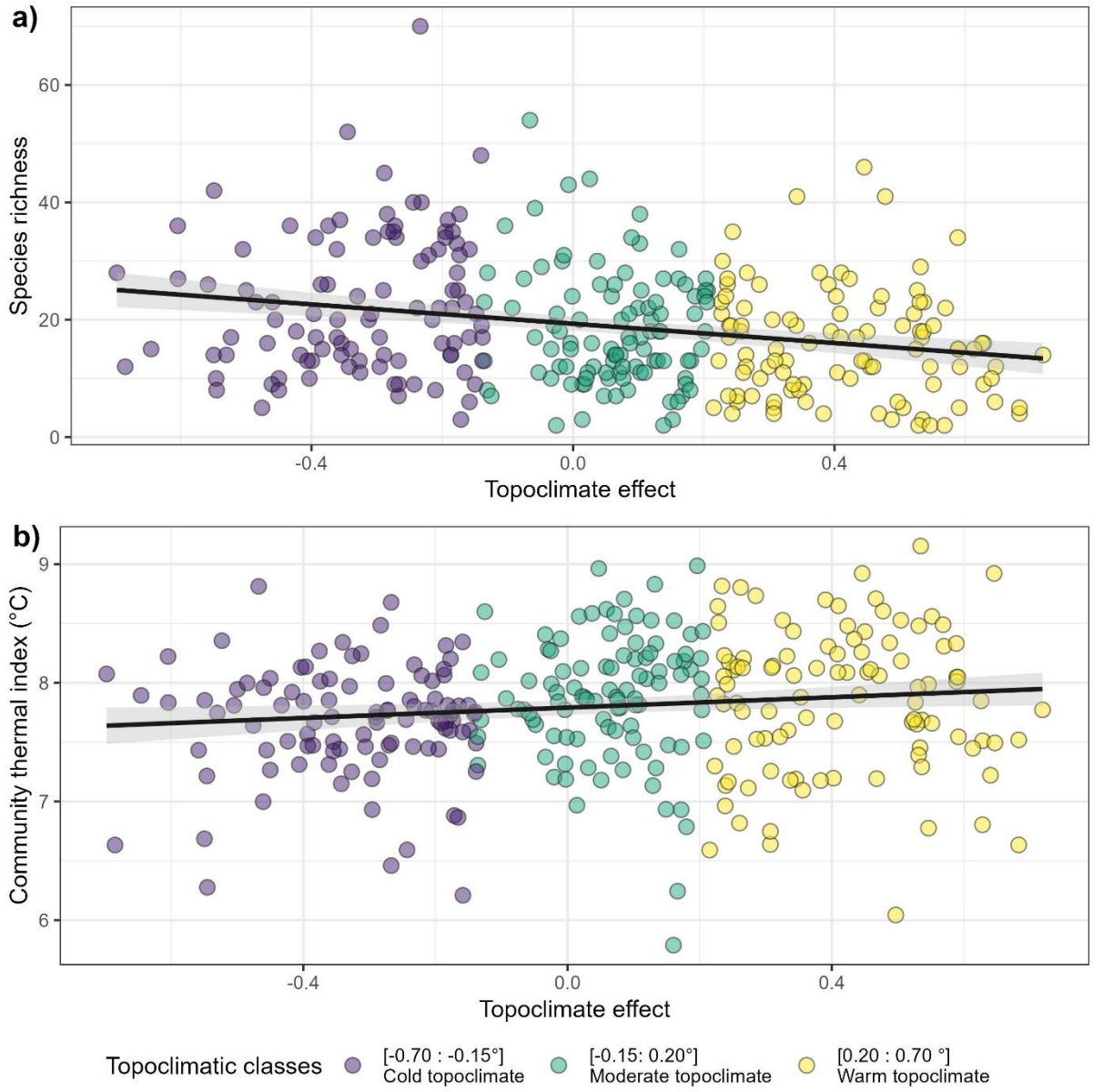

Figure S5 Species richness (a) and community thermal index (b) of 306 floristic surveys evenly spread into three topoclimatic buffering classes, as function of predicted topoclimatic effect on temperature (°C, compared to a moderate topographic situation).

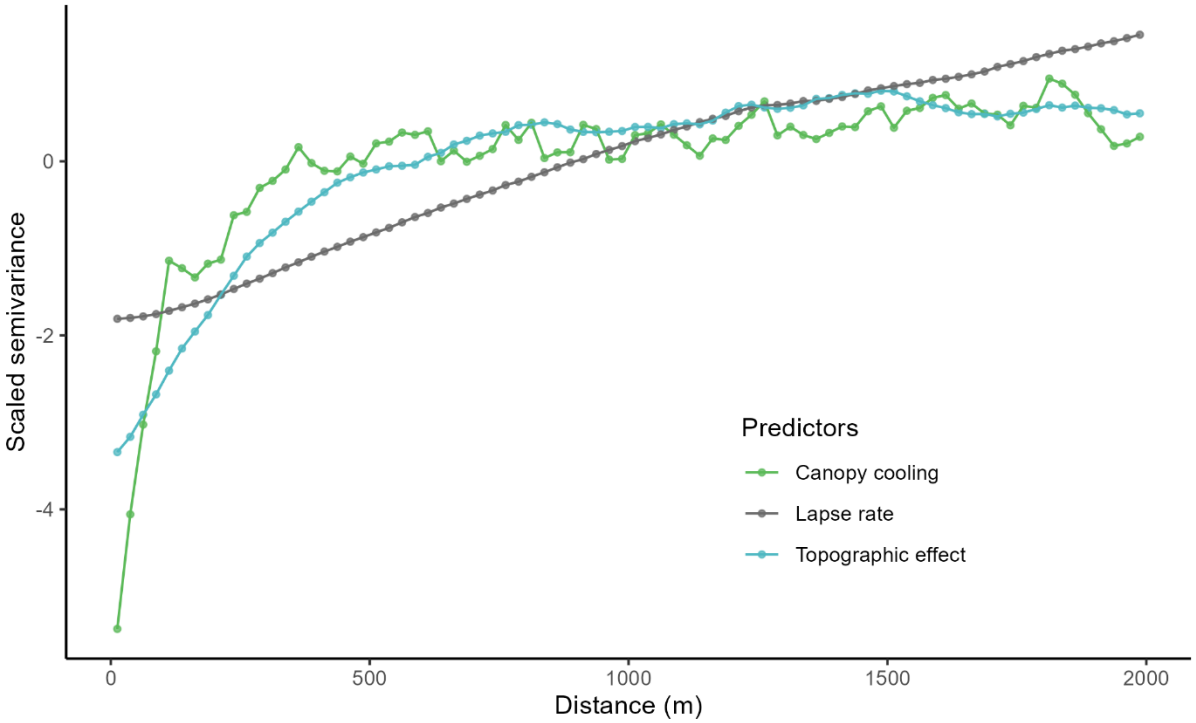

Figure S6: Variogram of the 3 maps of flora predictors (Figure 2), with a lag of 25m. Canopy cooling scale semivariance saturates first, followed by topographic effect and the lapse rate. The saturation of the lapse rate is not shown but is estimated at 6000 m.

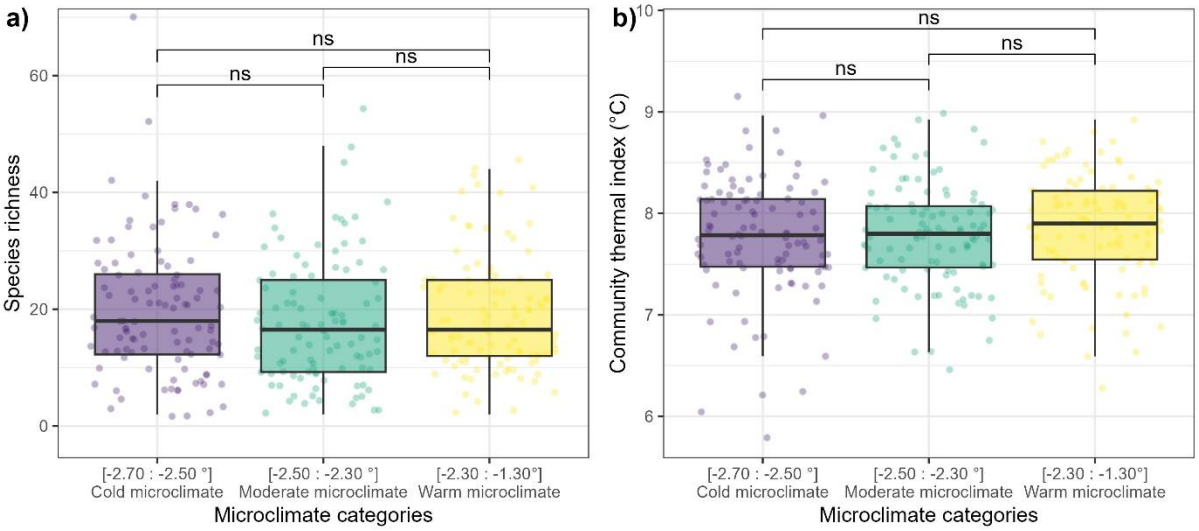

Figure S7: Species richness (a) and community thermal index (b) of 306 floristic surveys evenly spread into three microclimatic cooling classes. The p-value significance of a Wilcoxon test between two classes is displayed as follows: (ns): p>0.05.

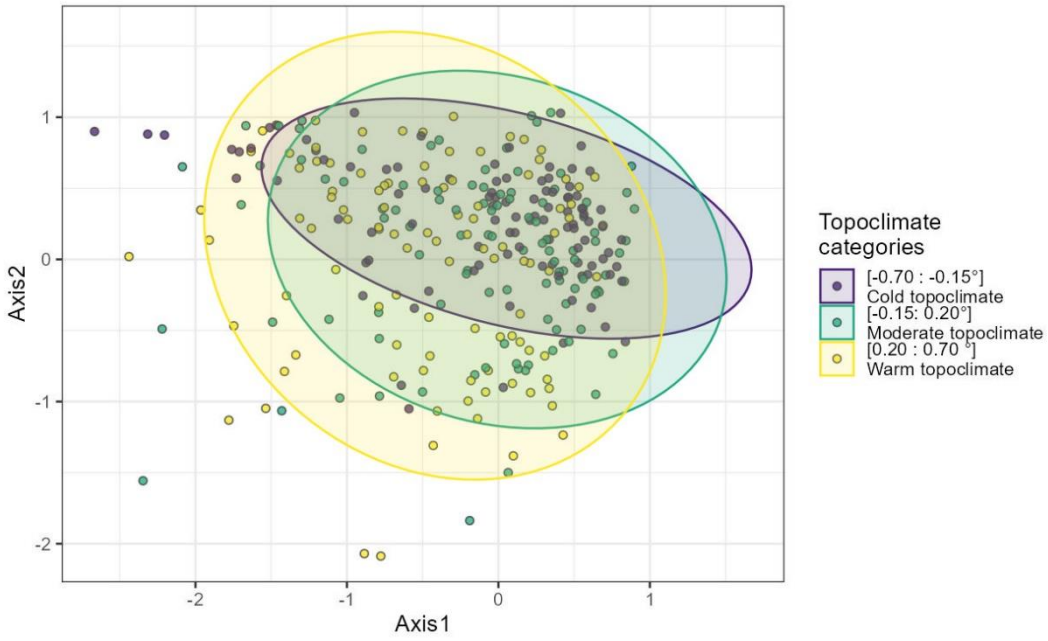

Figure S8: The first two axes of a correspondence analysis of the 306 floristic surveys spread among the three topoclimatic cooling class.

1.1. Tables

Table S1: Summary of the sampling scheme. The left number represents the theorical number of plots for the combination of targeted topographic feature and canopy closure (there were in total 8 strata), the right number represents the number of plots that had usable temperature data (logger found functioning). All other topographic feature aside from the targeted one were set to an intermediate value (nor high or low), read M&M ***Error! Reference source not found****. for more information on the sampling scheme.*

		Canopy closure	
		Low (< 80%)	High (> 80%)
Heat Load Index	Low (< 0.6)	8 - 5	8 - 8
	High (> 0.7)	8 - 5	8 - 8
Topographic Position Index	Low (< 0.2)		8 - 7
	High (> 0.8)		8 - 6
Slope	Low (< 10°)		8 - 4
	High (> 25°)		8 - 5

*Table S2: Estimated parameters, their standard error and p-values of the predictors included in models of the field canopy closure daily mean growing season temperature. The range of the predictors in the calibration dataset and their standardized effect size on the temperature (standard deviation * estimate) are displayed. The percentage of explained variation per type of predictor is included. P-values were obtained with a Wald test on parameters.*

Predictor	Type of predictor	Estimate	Standard error	Range	Effect size (°C)	P-value
Intercept (°C)		19.2	0.605			<10-4
Elevation (m a.s.l.)	Elevation	-0.00656	0.000333	475 : 1203	-1.49	<10-4
Heat load index (n.u)	Topography	1.52	0.359	0.335 : 0.951	0.29	<10-4
Topographic index (n.u)	Topography	0.42	0.295	0.201 : 1	0.15	0.163
Canopy closure 25 radius (%)	Canopy	-0.00767	0.00599	50 : 95	-0.092	0.208

*Table S3: Estimated parameters, their standard error and p-values of the predictors included in models of the immediate canopy closure (i.e. 'Glama' application) daily mean growing season temperature. The range of the predictors in the calibration dataset and their standardized effect size on the temperature (standard deviation * estimate) are displayed. The percentage of explained variation per type of predictor is included. P-values were obtained with a Wald test on parameters. The canopy cover was estimated visually in a 25-meter radius circle around the loggers. Immediate canopy cover was measured used a hemispherical photography above the logger and a sky segmentation application.*

Predictor	Type of predictor	Estimate	Standard error	Range	Effect size (°C)	P-value
Intercept (°C)		16.2	0.812			<10-4
Elevation (m a.s.l.)	Elevation	-0.00672	0.000299	475 : 1203	-1.52	<10-4
Heat load index (n.u)	Topography	5.47	1.22	0.335 : 0.951		<10-4
Topographic index (n.u)	Topography	0.481	0.256	0.147 : 1	0.15	0.0682
Immediate canopy closure (%)	Canopy	0.0346	0.0109	32.23 : 93.88		0.00311
Topography index X Immediate canopy closure	Interaction	-0.0547	0.0162			0.00171

*Table S4: Estimated parameters, their standard error and p-values of the predictors included in models of the daily maximum growing season temperature. The range of the predictors in the calibration dataset and their standardized effect size on the temperature (standard deviation * estimate) are displayed. The percentage of explained variation per type of predictor is included. P-values were obtained with a Wald test on parameters. Heat load and topographic indices have no units, refer to the methods for their calculation.*

Predictor	Type of predictor	Estimate	Standard error	Range	Effect size (°C)	Explained variation (%)	P-value
Intercept (°C)		30.6	2.45				<10-4
Elevation (m a.s.l.)	Elevation	-0.00803	0.000685	475.69 : 1203.17	-1.77	56.5	<10-4
Heat load index (n.u)	Topography	5.35	0.732	0.335 : 0.951	1.05	21.5	<10-4
Topographic index (n.u)		0.333	0.607	0.147 : 1	0.081		0.587
Canopy closure (%)	Canopy	-0.0947	0.0253	79.004 : 100	-0.54	3.17	<10-4

*Table S5: Estimated parameters, their standard error and p-values of the max temperature predictors of the community thermal index (CTI) linear model, and the species richness negative binomial generalized linear model. The range of the predictors and their standardized effect size on the community predicted variable (standard deviation * estimate) are displayed. The P-value is obtained by a Wald test on the parameter. (R^2 of the CTI model: 34.0%)*

Model	Predictor	Estimate	Standard error	Range	Effect size	P-value
Species richness	Intercept (°C)	0.307	0.478	NA	NA	0.522
	Lapse rate (°C)	0.0351	0.0156	20.6 : 27.5	1.15	0.024
	Topography effect (°C)	-0.112	0.0271	1.79 : 5.36	-1.76	<10-4
	Canopy cooling (°C)	0.00365	0.035	-9.47 : -4.58	0.0464	0.917
	Bioindicated pH	0.413	0.032	3 : 7.15	7.97	<10-4
Community Thermal Index (°C)	Intercept (°C)	4.57	0.484	NA	NA	<10-4
	Lapse rate (°C)	0.0589	0.0156	20.6 : 27.5	0.106	<10-4
	Topography effect (°C)	0.0965	0.0273	1.79 : 5.36	0.0912	<10-4
	Canopy cooling (°C)	-0.00128	0.0356	-9.47 : -4.58	-0.00093	0.971
	Bioindicated pH	0.268	0.0313	3 : 7.15	0.243	<10-4