Supporting information for

Relict populations of *Araucaria angustifolia* will be isolated, poorly protected, and unconnected under climate and land-use change in Brazil

Mario M. Tagliari[*a1], Ghislain Vieilledent[b2], Jonatas Alves[S3], Thiago C. L. Silveira[S4], Nivaldo Peroni[a5]

[a] Programa de Pós-graduação em Ecologia, Departamento de Ecologia e Zoologia, Laboratório de Ecologia Humana e Etnobotânica, 88010-970, Universidade Federal de Santa Catarina, Florianópolis, Brasil

[b] CIRAD, UMR AMAP, F-34398 Montpellier, France. AMAP, Univ Montpellier, CIRAD, CNRS, INRAE, IRD, Montpellier, France.

[1] https://orcid.org/0000-0002-8746-3598 | [2] https://orcid.org/0000-0002-1685-4997 | [3] https://orcid.org/0000-0003-2123-7560 | [4] https://orcid.org/0000-0002-3163-479X | [5] https://orcid.org/0000-0002-6770-5377

Corresponding author*

Email – Mario M. Tagliari (mario.tagliari@posgrad.ufsc.br; masemuta@gmail.com)

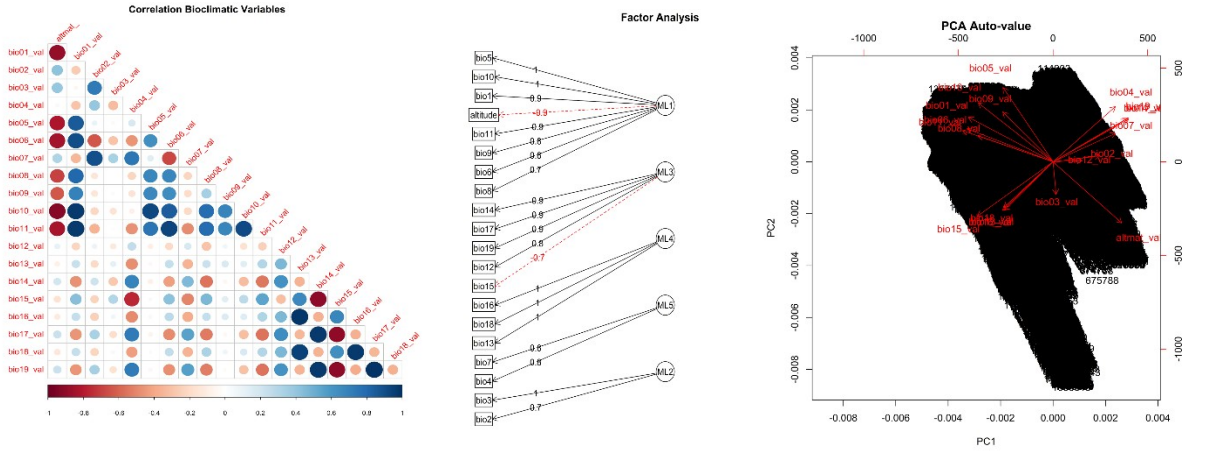

Figure S1. Three strategies to select bioclimatic variables for the Species Distribution Modelling. (left) The main strategy to select our climatic variables was the correlation graph, where we selected "Annual Mean Temperature (°C)" – bio01_val; "Mean Diurnal Range (Mean of monthly (max temp - min temp °C))" – bio02_val. We excluded "altitude" because it will not change in the future. (middle) Factor analysis: we selected "Annual Mean Temperature (°C)" – bio1; "Temperature seasonality (°C)" – bio4. (right) Principal Component Analysis (PCA): we selected "Temperature seasonality (°C)" – bio4; "Annual Mean Precipitation ($mm.y^{-1}$)" – bio12.

Table S1. Predictive performance of the ensemble model prior and based on committee averaging for Araucaria. Predictive performance before the binary conversion was evaluated by the Area Under de Curve (AUC) specifying a fixed threshold of 0.6 or 60%, where algorithms predicting Araucaria occurrence with values < 0.6 or 60% did not account for the committee averaging. The AUC was evaluated over the continuous prediction of Araucaria distribution after 10 model runs with 70% training and 30% testing data and 1 full dataset run (11 model runs X 5 selected algorithms). The mean AUC value was 0.788 (among 55 model runs), indicating very high predictive capacity. The True Skills Statistic (TSS), Sensitivity, and Specificity (all threshold-dependent) were selected to evaluate the statistical performance of the SDM algorithms: ANN, GAM, GLM, Maxent, and RF. All indexes' values were satisfactory to forecast Araucaria distribution, i.e. > 0.5 for TSS; > 0.65 for Sensitivity and Specificity.

Species	**Algorithms (ANN, GAM, GLM, Maxent, RF)**	**Area Under the receive operation Curve (AUC)[a]**	**True Skill Statistics (TSS)**	**Sensitivity (Sen)**	**Specificity (Spe)**
Araucaria angustifolia	Ensemble	0.788	0.556	0.883	0.673

[a] Before committee averaging

Table S2. Relative variable importance table showing which abiotic variables selected in the SDM were most relevant explaining potential Araucaria distribution in the present and future. Each algorithm used in the SDM presented an importance ranking value. The ranking is defined by the biggest importance value weighted amongst all five algorithms. Temperature-related variables (i.e. Annual Mean Temperature, Temperature Seasonality, and Mean Diurnal Range — °C) were the main variables explaining Araucaria projected distribution. Annual Precipitation (mm) was the fourth most important variable.

Species	**Environmental variables**	**ANN**	**Maxent**	**Random Forest**	**GLM**	**GAM**	**Ranking**
Araucaria angustifolia	*Annual Mean Temperature*	0.669	0.901	0.803	0.752	0.557	**1**
	Mean Diurnal Range	0.132	0.092	0.419	0.103	0.243	3
	Temperature Seasonality	0.414	0.095	0.387	0.138	0.220	**2**
	Annual Precipitation	0.263	0	0.385	0.002	0.074	4

Table S3. Bioclimatic niche calculated according to the Araucaria current distribution within the Mixed and Dense Forests. We computed the mean and the confidence interval (2.5 to 97.5%) values among all variables. The model confirmed the already known adaptation of Araucaria to lower temperatures (16.2°C), as well as the low mean diurnal range: 12°C. The altitude distribution varied from 5m to 1653m. Despite Araucaria's adaptation to more elevated areas, the species occurs in transitional ecosystems, like the Dense Ombrophilous Forest and the Mixed Ombrophilous Forest. As part of the Atlantic Forest biome, the Mixed and Dense Forests have an elevated annual precipitation regime, indicating why the species' average precipitation is > 1700 $mm.y^{-1}$**.**

Species	**Confidence interval**	**Annual Mean Temperature (°C)**	**Mean diurnal range (°C)**	**Temperature seasonality (°C *standard deviation* x 100)**	**Mean Annual Precipitation ($mm.y^{-1}$)**	**Altitude (m)**
Araucaria angustifolia	Mean	16.2	10.9	29.67	1701	645
	2.5%	14.1	14.1	25.69	1419	5
	97.5%	17.8	17.8	32.58	2072	1653

Table S4. The vulnerability of Araucaria to climate change under different scenarios: RCP 4.5 and 8.5; Full and Zero-Dispersal hypotheses; year 2085; with or without current land-use. We calculated the Percentage of Area Change (%) compared to the actual Species Distribution Area (SDA_c). The last column compares mean altitudinal (m) change in the future with current mean altitudinal optimal for Araucaria. As a subtropical species, Araucaria showed a common pattern to shift its centroid towards higher elevations, to tracking milder temperatures. This upward range contraction is explained because Annual Mean Temperature (°C) and Temperature seasonality were the main climatic variables explaining Araucaria projected distribution.

Species	**Present Area (km²) — SDA_c Suitable/ Land-use**	**RCP**	**Year**	**Dispersal Hypothesis**	**Area Future (km²) — SDA_f Suitable/ Land-use**	**Percentage of Area Change (%) — Suitable/ Land-use**	**Current elevation (mean/m)**	**Future elevation shift (mean/m)**
Araucaria angustifolia	135,468/ 108,174	4.5	2085	*Full*	47,683/ 36,365	-65/-66	645	1056
		4.5		*Zero*	47,558/ 36,240	-65/-66.5		1056
		8.5		*Full*	15,767/ 11,993	-88/-89		1142.5
		8.5		*Zero*	15,766/ 11,993	-88/-89		1142.5