

Ecography

ECOG-00670

Thuiller, W., Guéguen, M., Georges, D., Bonet, R., Chalmandrier, L., Garraud, L., Renaud, J., Roquet, C., Van Es, J., Zimmermann, N. E. and Lavergne, S. 2014. Are different facets of plant diversity well protected against climate and land cover changes? A test study in the French Alps. – *Ecography* doi: 10.1111/ecog.00670

Supplementary material

Appendix 1

Accounting for sampling effort to compare observed and projected species richness at increasing spatial resolution.

The 164,549 sampling units we used to calibrate the models were sampled with two different sampling methods. We had 31,569 complete phytosociological relevés within a 10x10m site and 132,980 single occurrences (19.2% and 80.8%, respectively). These two datasets do not bring the same level information. For instance, if a 2.5x2.5km pixel has been sampled twice using single occurrence method, they will have a maximum of 2 species. Instead, if the same sites were sampled using a phytosociological method, the actual number of species could range from 1 species to more than one hundred.

We thus built two maps to represent the sampling effort, one for each sampling method. For each sampling method, the weight value of each pixel corresponds to the number of sampling units. Each map is then re-scaled by the maximum of sampling units in the study area for a given sampling method. To give more weight to the phytosociological method that is more complete in terms of sampling, we multiplied the final map by 0.7 and the final map for single occurrence method by 0.3. The two maps were then summed to give a single weighing map of each pixel in function of the type and number of sampling units.

We used this protocol to build a single weighing map for each of the incremental grid: 250m, 1km, 2.5km and 5 km. For each resolution, we then compared the observed and projected species richness weighted by the sampling effort map (Fig. S1). We also tested the sensitivity of our differential weighing protocol for the two sampling methods.

The 2.5km resolution was finally retained given it was the best trade-off between high resolution and robustness. The differential weighing protocol did not influence the results (Fig. S1).

Appendix 2

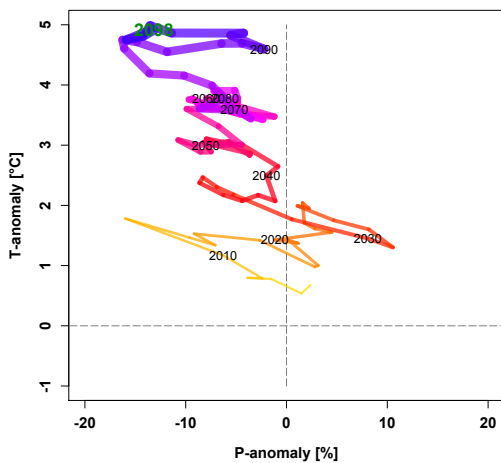
Description of the three selected regional climate models.

We selected three different Regional Climate Models (RCMs) fed by three different Global Circulation Models (GCMs) in turn, to reflect variation in the degree of projected warming by 2100. RCMs downscale the output from GCMs for a given region by taking the GCM output as boundary input, while the processes within the study area are downscaled based on physical, meteorological processes. Such downscaling is usually performed to a spatial resolution of ca. 20x20km (10'x10') or similar. We selected the following pairs of RCMxGCM for our analyses: HadRM3xHadCM3, CLMxECHAM5, and RCA3xCCSM3. These three model combinations are provided to the user community by the EU project ENSEMBLES (<http://www.ensembles-eu.org>), in which a larger number of RCMs runs were produced to reflect the best current knowledge on the future of the European climate.

We selected these three model combinations, because they represent well the variability of the climate future presented in ENSEMBLES for the A1B scenario. The runs by HadRM3xHadCM3 represent a high degree of warming (~4.9°C and ~5.0°C warming of annual or summer temperature) as is illustrated in the figure A2 below. The runs by CLMxECHAM5 represent an average degree of warming compared to all ENSEMBLE model runs (ca. +3.8°C for both annual and summer temperature). Finally, the RCA3xCCSM3 runs project a low degree of warming relative to all ENSEMBLE runs (ca. +2.5°C and +2.3°C for annual and summer temperature). All three RCM x GCM model combinations project a relative decrease in summer precipitation (-8 – -12%) while there is no clear trend in annual precipitation change.

Summer

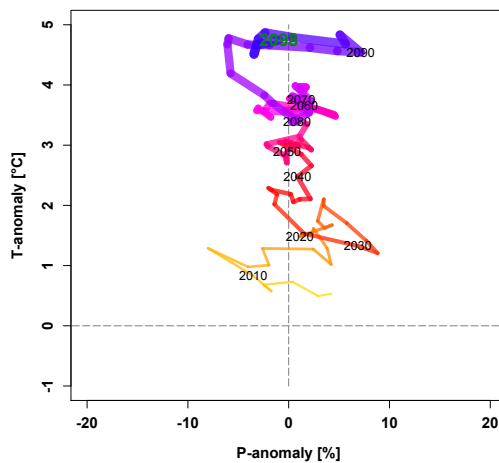
HadRM3/HadCM3 - Anomalies of 5-year means



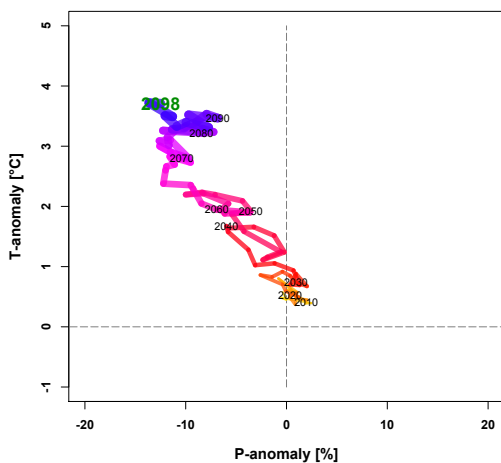
HadRM3_x
HadCM3

Annual

HadRM3/HadCM3 - Anomalies of 5-year means

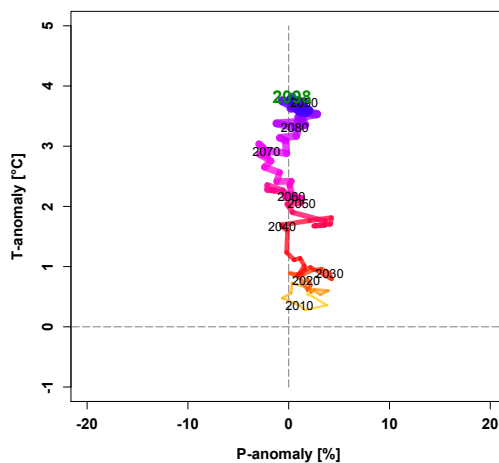


CLM/Echam5 - Anomalies of 5-year means

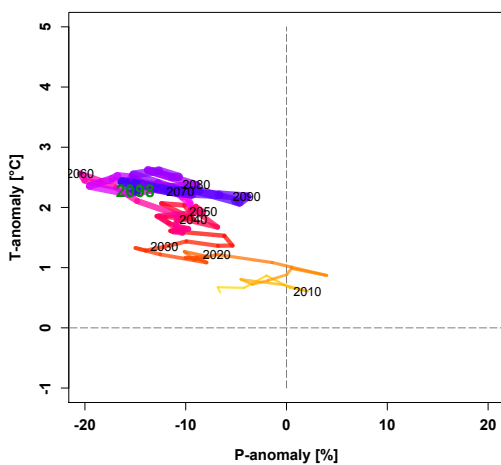


CLM_x
ECHAM5

CLM/Echam5 - Anomalies of 5-year means



RCA30/CCSM2 - Anomalies of 5-year means



RCA3_x
CCSM3

RCA30/CCSM2 - Anomalies of 5-year means

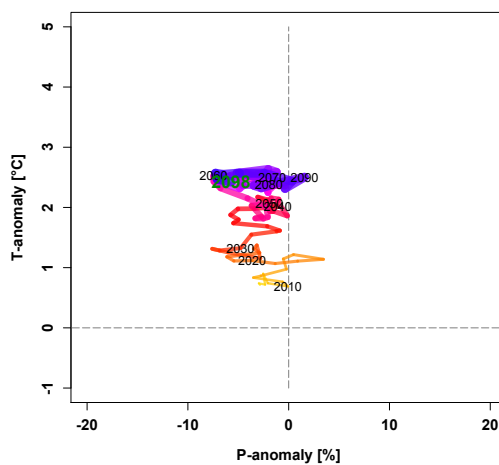


Figure A2 – Five-year averages of annual and summer half (April-September) climate anomalies (relative to 1961-1990 Normals) projected by three regional climate models over Europe for the A1B scenario. Colours from yellow through red to magenta indicate the progress of time from 2001 to 2098 represented in the anomaly graph.

Table A1 - Description of the rarity criteria used to classify each of the modeled species.

Rarity class	R
Exceptional	$R \geq 99.5$
Very rare	$99.5 > R \geq 98.5$
Rare	$98.5 > R \geq 96.5$
Moderately rare	$96.5 > R \geq 92.5$
Few common	$92.5 > R \geq 84.5$
Moderately common	$84.5 > R \geq 68.5$
Common	$68.5 > R \geq 36.5$
Very common	$R < 36.5$

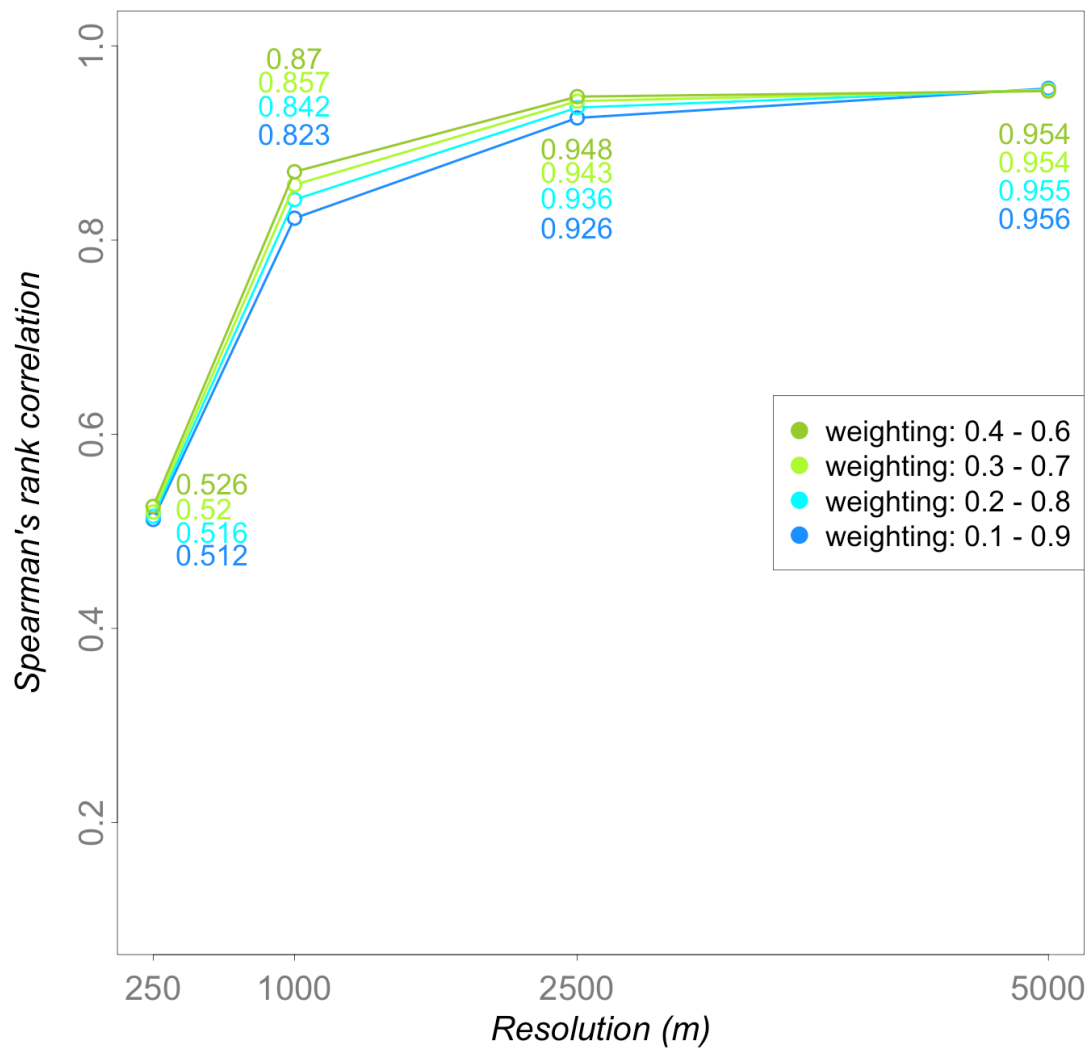


Figure A1 - Spearman rank correlation between observed and projected species richness at varying spatial resolution and in function of the weighting scheme ($q=0$ in Equ. 1).

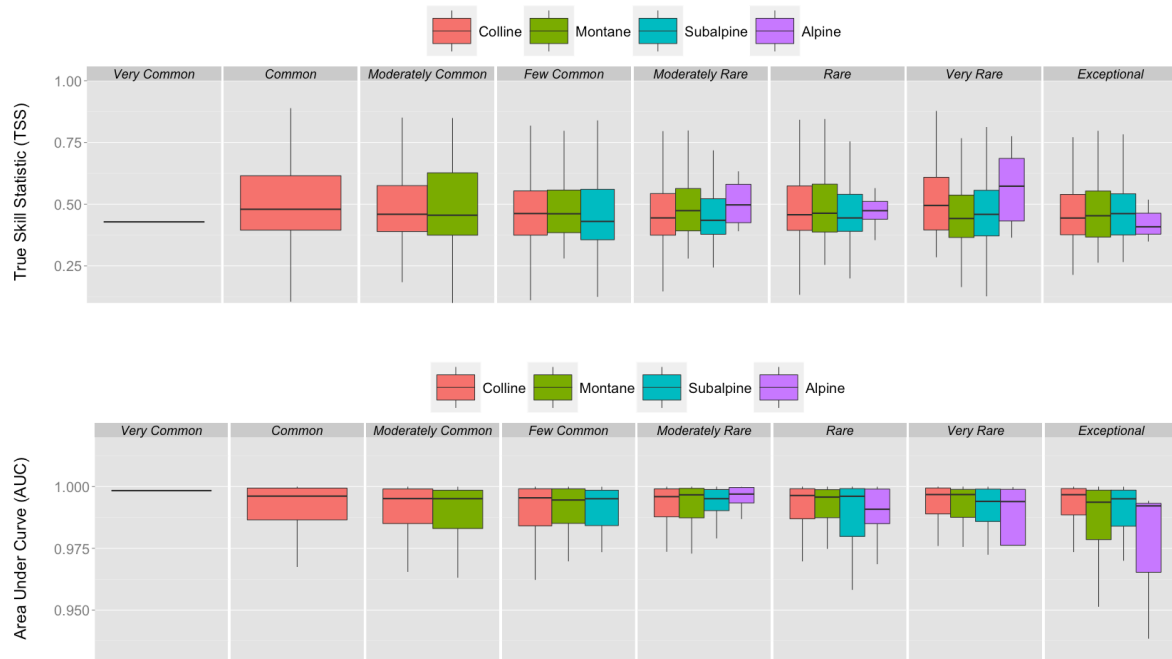


Figure A2 - Performance of SDMs to predict the observed distribution of species using both TSS and AUC metrics (top and low panels respectively). Performance is shown as a function of both the altitudinal vegetation belts to which species belong to and their rarity class.

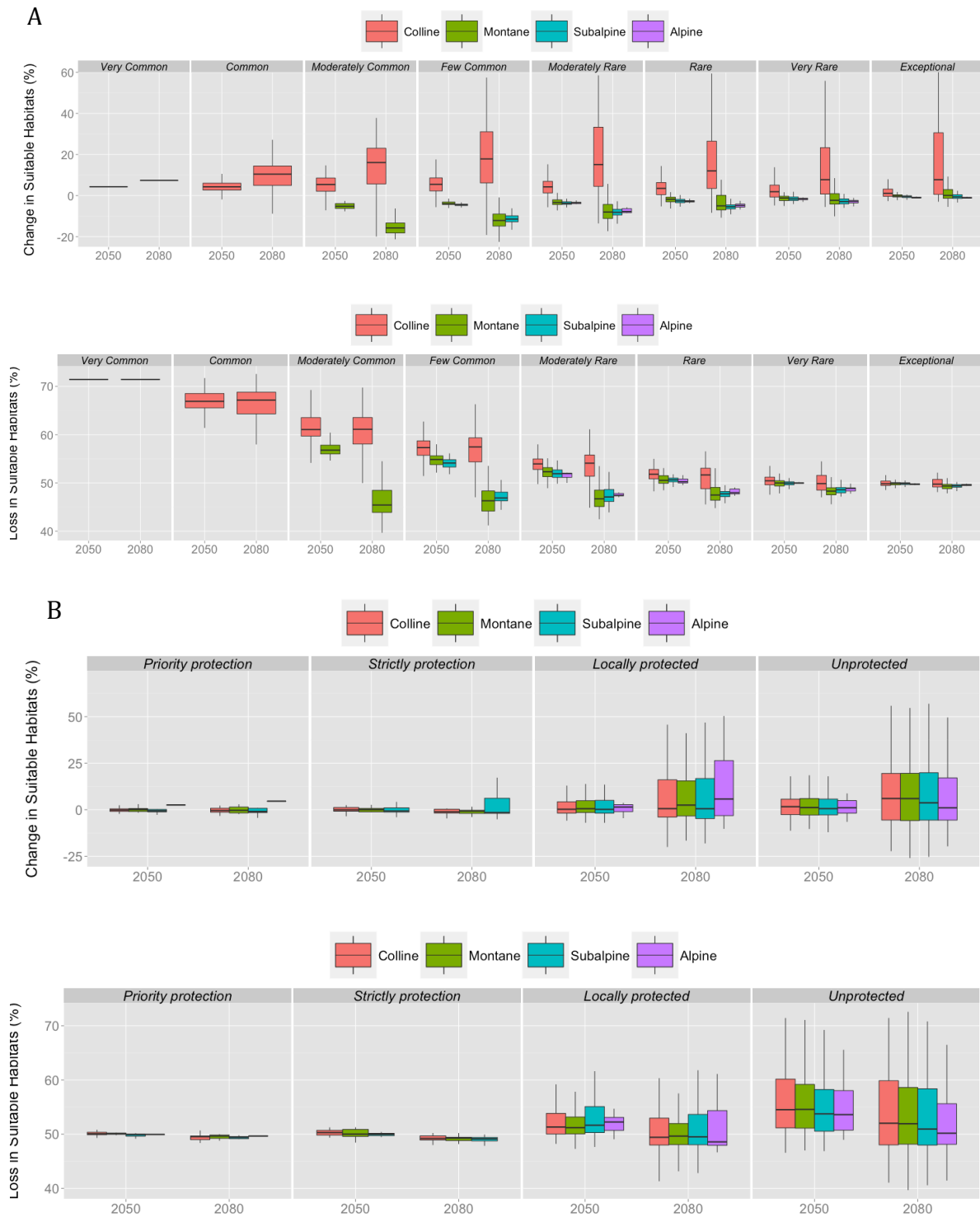


Figure A3 - Species sensitivity to climate and land cover change in respect to their rarity-commonness value (A) and their conservation status in the study area (B). Results are ordered by the altitudinal bands to which the species belong. Top and lower panels differ in the measure of sensibility. Top panel represent change in suitable habitats, while lower panel represents loss in suitable habitats. Only outputs for the CLMxECHAM5 climatic model with the A1b emission scenario and the GRASS land use storyline are represented

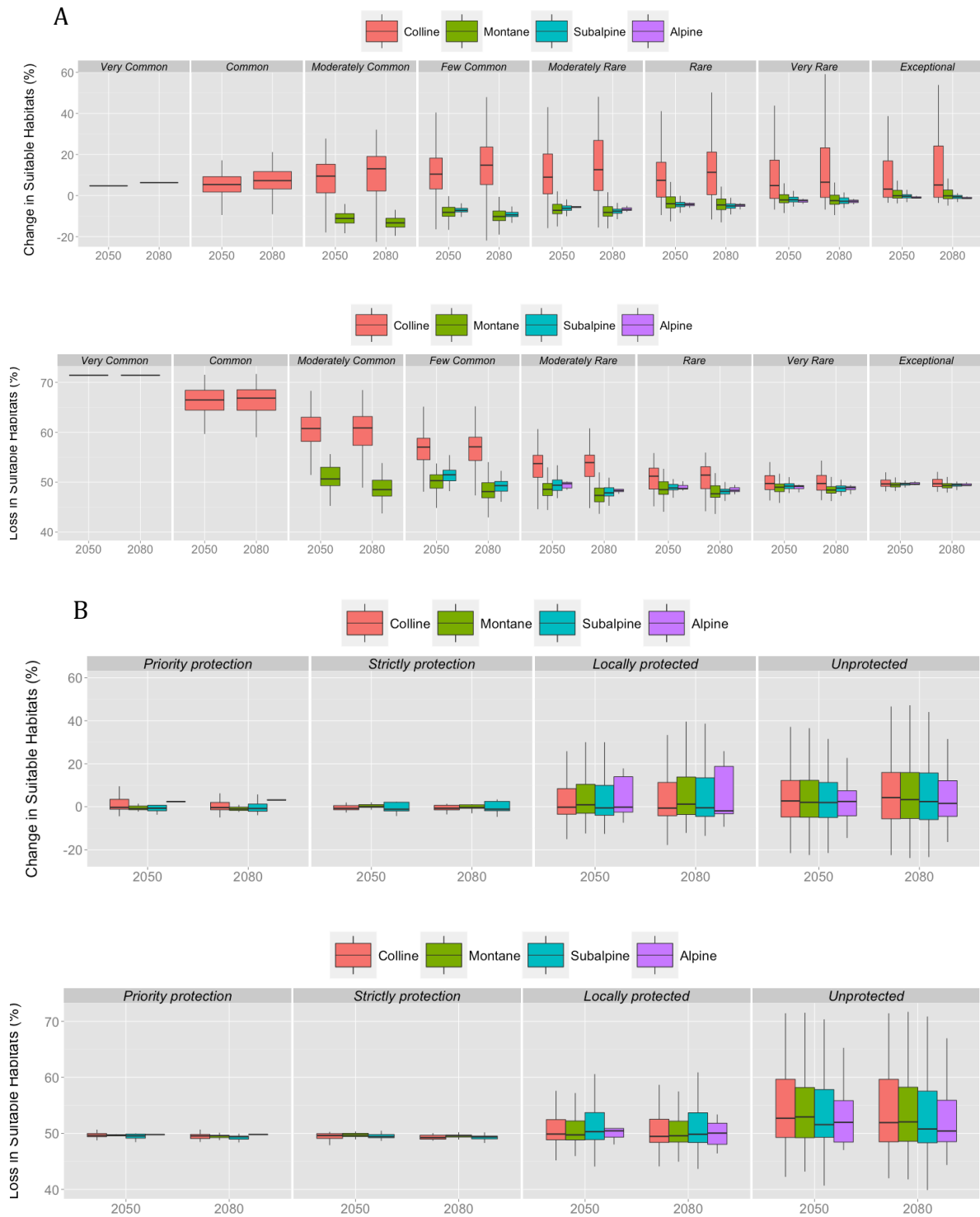


Figure A4 - Species sensitivity to climate and land cover change by 2080 in respect to their rarity-commonness value (A) and their conservation status in the study area (B). Results are ordered by the altitudinal bands to which the species belong. Top and lower panels differ in the measure of sensibility. Top panels represent change in suitable habitats, while lower panel represents loss in suitable habitats (RCA3xCCSM3 driven by the A1b scenario and GRASS storyline).

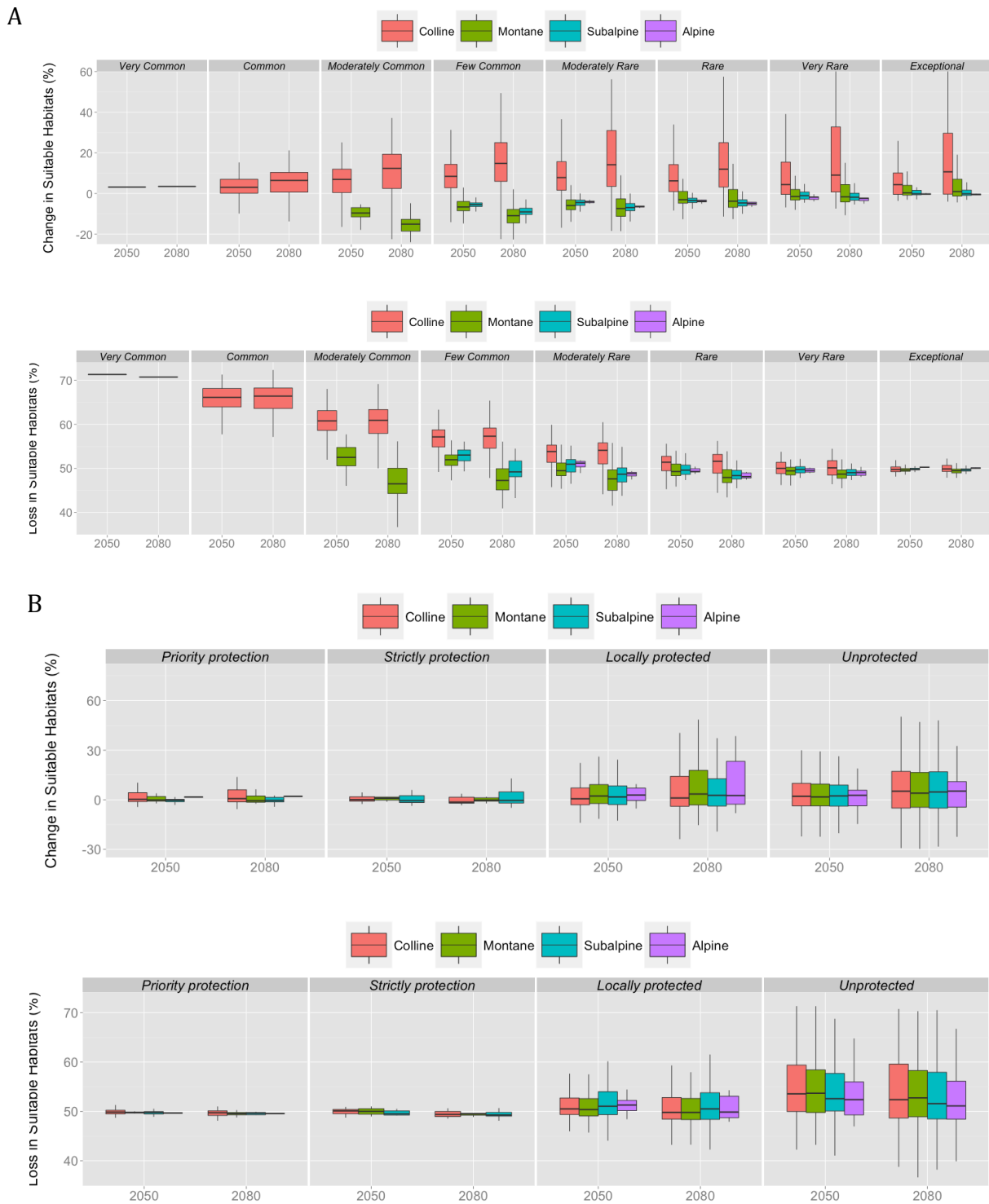


Figure A5 - Species sensitivity to climate and land cover change by 2080 in respect to their rarity-commonness value (A) and their conservation status in the study area (B). Results are ordered by the altitudinal bands to which the species belong. Top and lower panels differ in the measure of sensibility. Top panels represent change in suitable habitats, while lower panel represents loss in suitable habitats (RCA3xCCSM3 driven by the A2 scenario and BAMBU storyline)

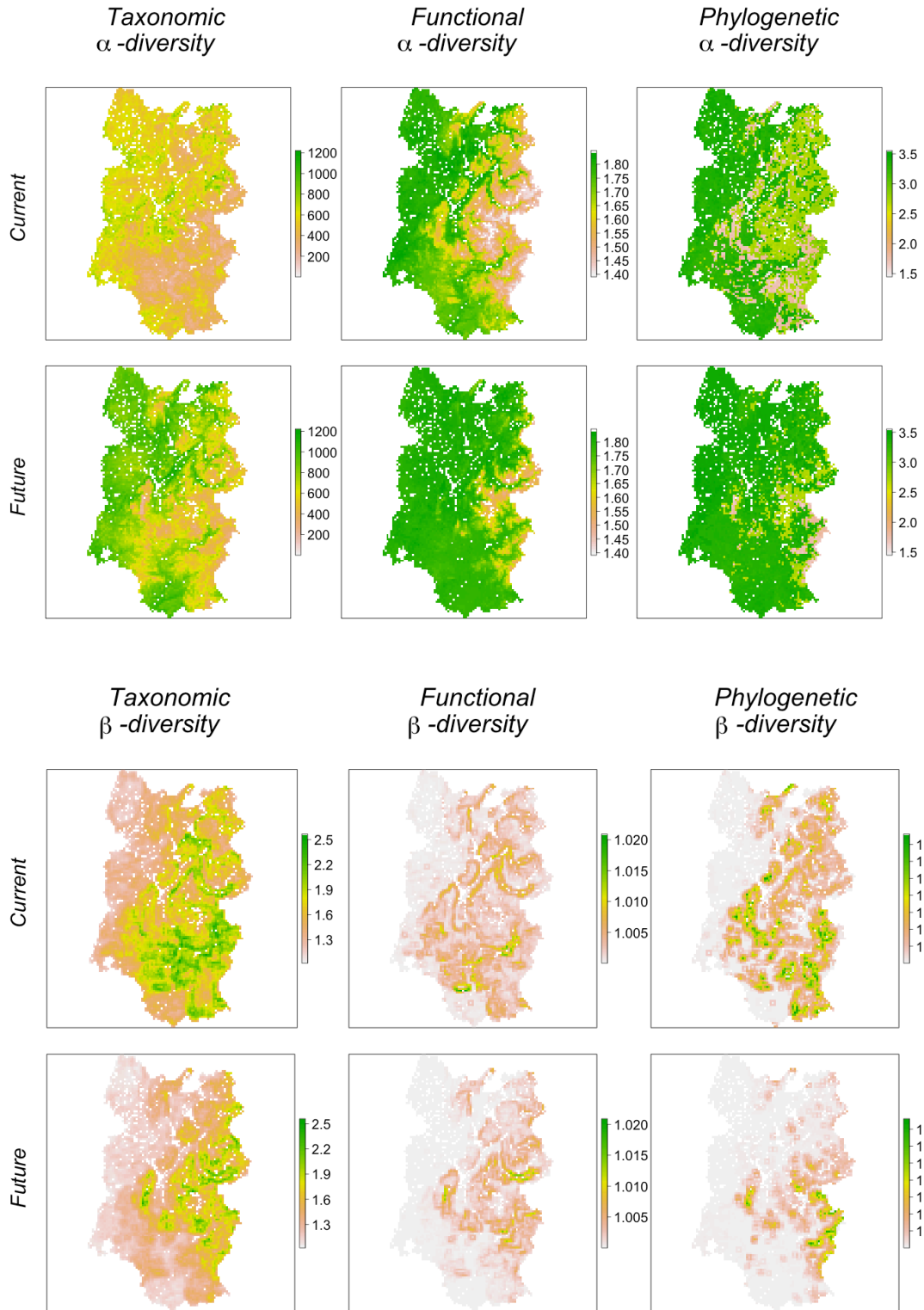


Figure A6 - Spatial variation in α -diversity (top panel) and β -diversity (bottom panel) for the three facets of plant diversity and under current and future conditions by 2080 (CLMx ECHAM5) driven by the A1b scenario and GRASS storyline).

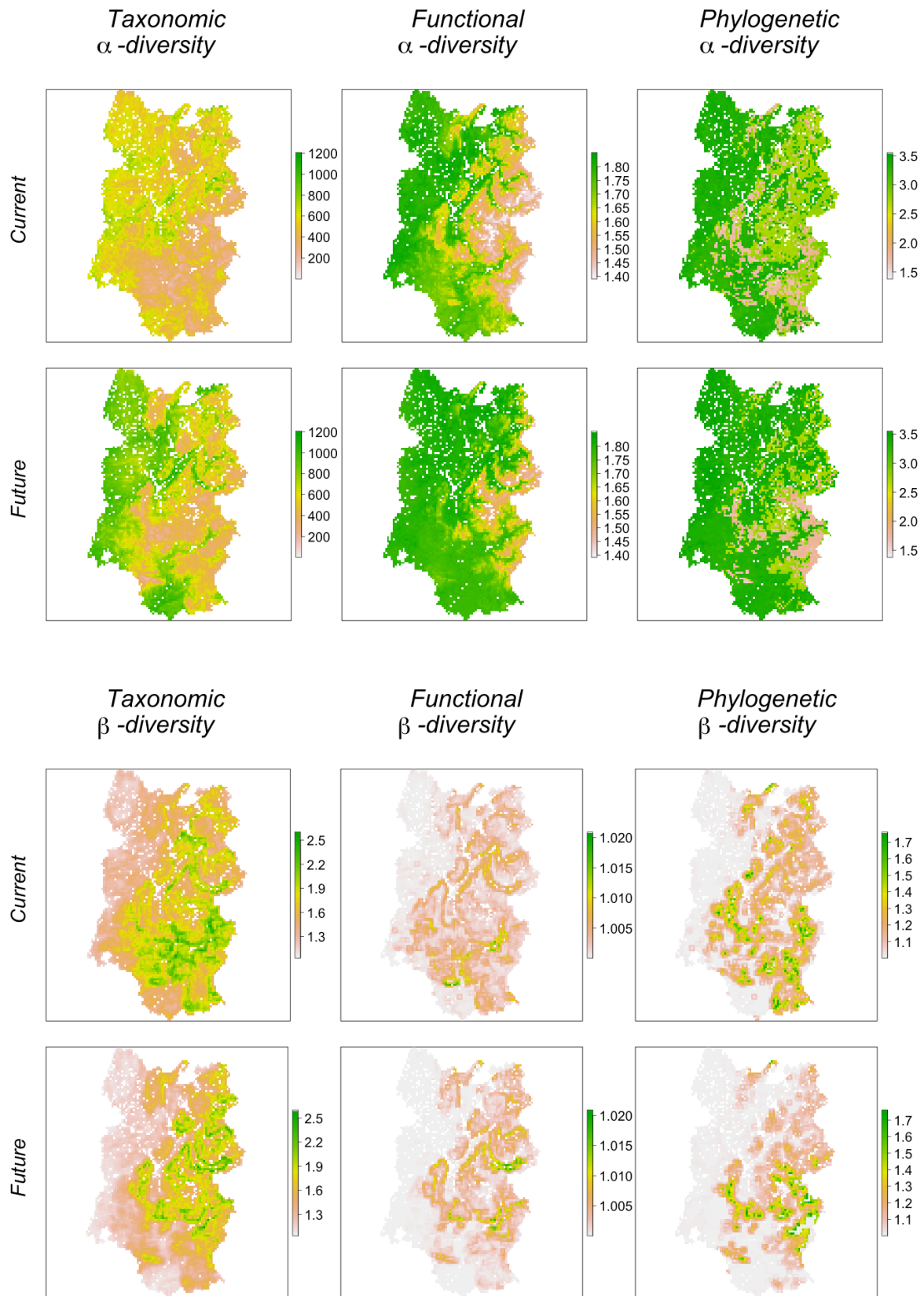


Figure A7 - Spatial variation in α -diversity (top panel) and β -diversity (bottom panel) for the three facets of plant diversity and under current and future conditions by 2080 (RCA3xCCSM3) driven by the A1b scenario and GRASS storyline).

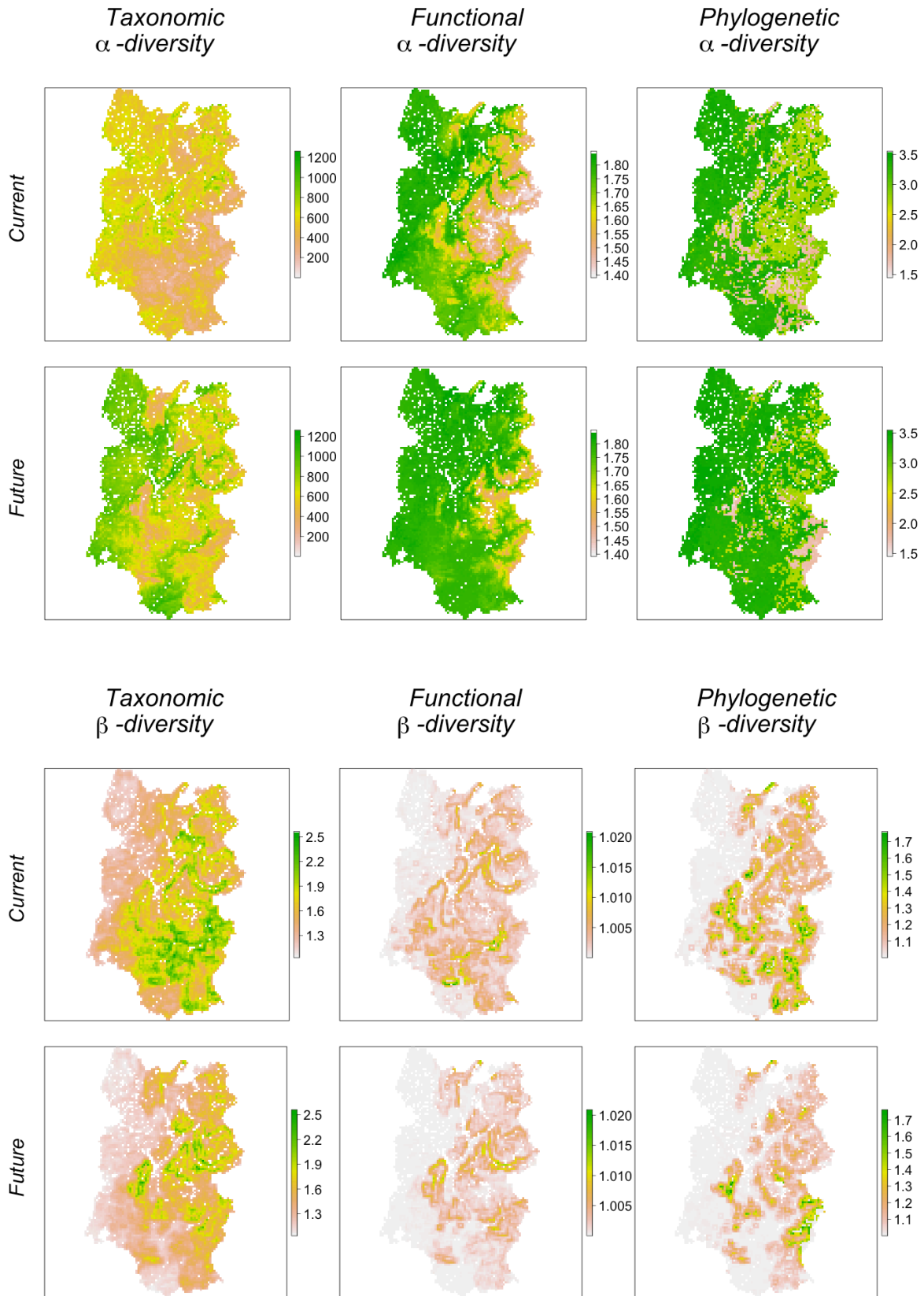


Figure A8 - Spatial variation in α -diversity (top panel) and β -diversity (bottom panel) for the three facets of plant diversity and under current and future conditions by 2080 (RCA3xCCSM3) driven by the A2 scenario and the BAMBU storyline).

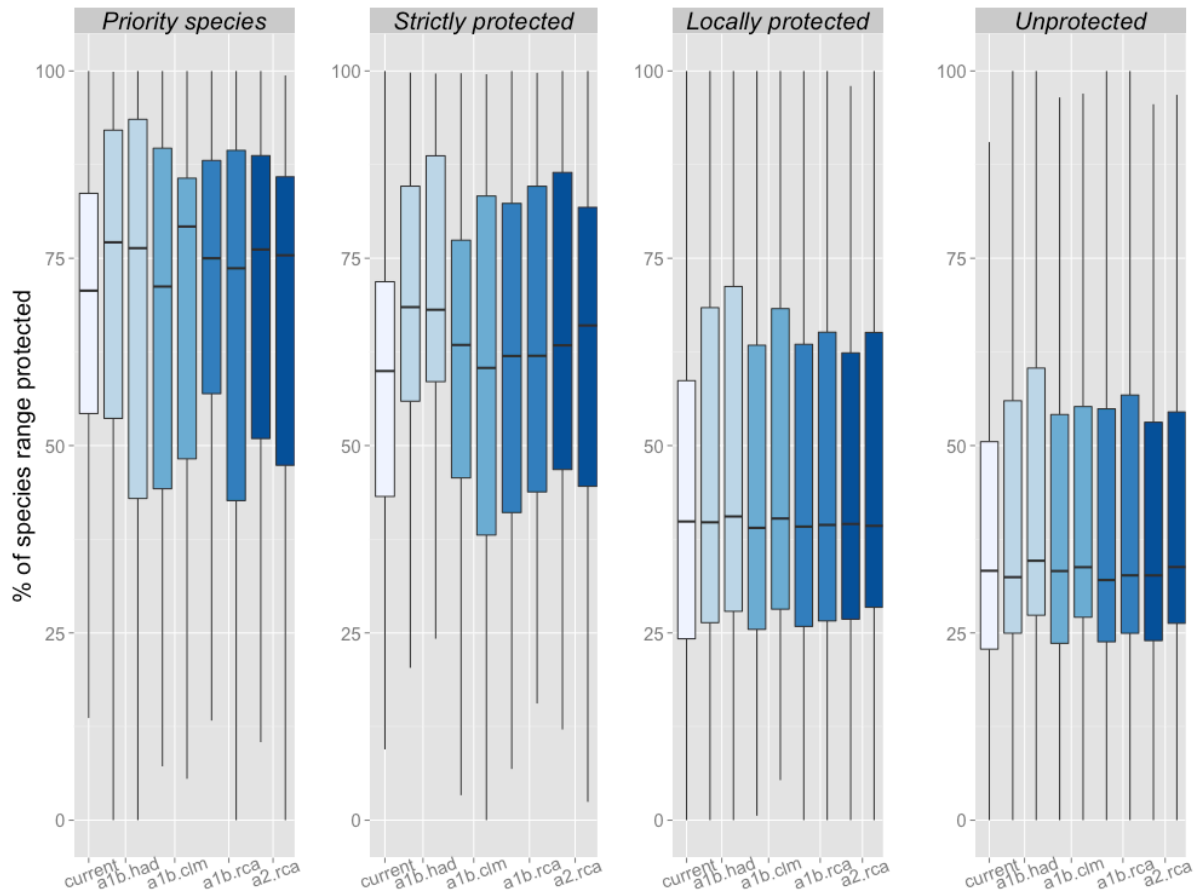


Figure A9 - Level of species protection over the French Alps under current and future conditions by 2050 and 2080 in respect to species conservation status. Y-axis represents the percentage of species range that are protected, over all species from a given conservation status (i.e. priority species, strictly protected, locally protected, unprotected). The X-axis represents the current and future conditions. For each future condition (i.e. a given color for a given name), there are two bars, one for 2050 and one for 2080 (from left to right). Abbr.: A1b.had: HadCM3xHadRM3 climate model driven by the A1b scenario and the GRASS storyline. A1b.clm: ECHAM5xCLM driven by the A1b scenario and GRASS storyline. A1b.rca and A2.rca: CCSM3xRCA3 climate model driven by the A1b and A2 scenarios and the GRASS and BAMBU storylines, respectively. The protected area network corresponds here to protected areas with sustainable use of natural resources (Ia, II, III, IV, V and Natura2000).