Appendix S3. Validation of drought module

The parameterisation of drought effects was validated following the procedure described in Boulangeat, Georges and Thuiller (2014), in respect to the simulated PFG distribution and strata abundances, as well as in respect to tree cover (strata > 1.5 m).

A validation simulation was run starting from the 800th year of the initialisation phase (instead of year 850 used for scenario simulations; see initialisation details in main text), after which we applied past drought intensity (*Din*) values for 30 years. Maps of past *Din* values corresponded to the yearly minimum moisture index (*MI)* values registered from 1961-1990 (see Appendix S2 for details on *MI* calculation). Given that the parameterisation of PFG responses to drought followed the same climatic period, we expected that including past drought events would not majorly affect model accuracy in comparison to what has been demonstrated by Boulangeat, Georges and Thuiller (2014). Hence, we re-assessed model accuracy by comparing simulated PFG distributions against PFG occurrences from the 'DELPHINE' database of vegetation composition and structure in the Ecrins National Park (ENP) (see full procedure in Boulangeat, Georges & Thuiller 2014). For each PFG we calculated model specificity (proportion of correctly predicted PFG presences – true positives), model sensitivity (proportion of correctly predicted PFG absences – true negatives) and error rate (overall proportion of false positives and false negatives). As in Boulangeat, Georges and Thuiller (2014), resulting statistics were compared against the specificity, sensitivity and error rate of habitat suitability models calculated for each PFG (see details on PFG habitat suitability maps in Appendix S1 and Boulangeat, Georges & Thuiller 2014). In addition, we assessed whether including drought effects improved vegetation structure predictions. Simulated tree

cover (> 1.5 m) in different habitats and overall strata abundances at three levels (< 1.5 m, 1.5 – 4 m and > 4 m) were compared against observation data and previous results obtained with the base model (see Boulangeat, Georges & Thuiller 2014 for details on observation data and base model results).

Including drought effects lowered PFG abundance in general (data not shown), which improved general estimates of tree cover (strata > 1.5 m) in rocky and alpine habitats, but led to underestimates in pasture fields, lowlands and mountainous forests. In subalpine and mountainous open habitats tree cover went from being overestimated to underestimated, but closer to the observed cover in absolute terms (Fig. S2). In general, simulated strata abundances remained consistent with observed presences and absences, with larger strata abundances being predicted where the strata were indeed observed present (Fig. S3). The predicted accuracy (error rate) of PFG distributions was very similar to that of the base model (Boulangeat, Georges & Thuiller 2014), with slight increases for seven PFGs and decreases for six PFGs (Table S4).

All in all, we are confident that the simulated drought effects and their parameterisation did not negatively affect model performance, since the simulation of past drought events allowed the representation of the current vegetation of the park.

Table S4. Model accuracy after implementing drought effects. Validation of the drought module was done by comparing simulated PFG distributions with PFG occurrences obtained from vegetation *relevés*. PFG occurrence data was obtained via a correspondence between vegetation types and the PFGs (presences corresponding to the presence of a vegetation type that the PFG is characteristic of; see Boulangeat, Georges & Thuiller 2014). Resulting values of model specificity (proportion of true positives), model sensitivity (proportion of true negatives) and error rate (proportion of false positives and false negatives) were compared with those obtained from habitat suitability models (HSM). Error rates in bold indicate higher predictive accuracy when compared to the previously validated version.

	Sensitivity		**Specificity**		**Error rate**	
PFG	**FATE-HD w/ drought**	**HSM**	**FATE-HD w/ drought**	**HSM**	**FATE-HD w/ drought**	**HSM**
C1	0.76	0.87	0.45	0.51	**0.51**	0.44
C2	0.84	0.00	0.57	1.00	0.38	0.19
C3	0.94	0.96	0.49	0.47	**0.31**	0.31
C4	0.42	0.75	0.88	0.64	0.21	0.34
C5	0.26	0.52	0.75	0.57	0.31	0.44
C6	0.60	0.64	0.57	0.60	0.43	0.40
H1	0.84	0.00	0.41	1.00	**0.44**	0.36
H2	0.91	0.93	0.12	0.20	0.67	0.60
H3	0.10	0.78	0.91	0.44	0.21	0.51
H4	0.17	0.57	0.87	0.62	0.21	0.38
H5	0.88	0.88	0.25	0.32	0.59	0.54
H6	0.64	0.61	0.55	0.59	0.43	0.40
H7	0.63	0.72	0.34	0.33	**0.60**	0.59
H8	0.52	0.52	0.67	0.71	**0.34**	0.30
H9	0.24	0.63	0.70	0.58	0.33	0.42
H10	0.47	0.52	0.59	0.61	0.42	0.40
P1	0.35	0.75	0.88	0.56	0.15	0.43
P2	0.31	0.56	0.84	0.64	0.17	0.36
P3	0.10	0.64	0.97	0.66	0.06	0.34
P4	0.35	0.62	0.77	0.66	0.28	0.34
P5	0.57	0.60	0.84	0.78	0.17	0.22
P6	0.42	0.63	0.74	0.47	**0.27**	0.53
P7	0.08	0.22	0.93	0.81	0.09	0.21
P8	0.15	0.06	0.90	0.98	0.12	0.04

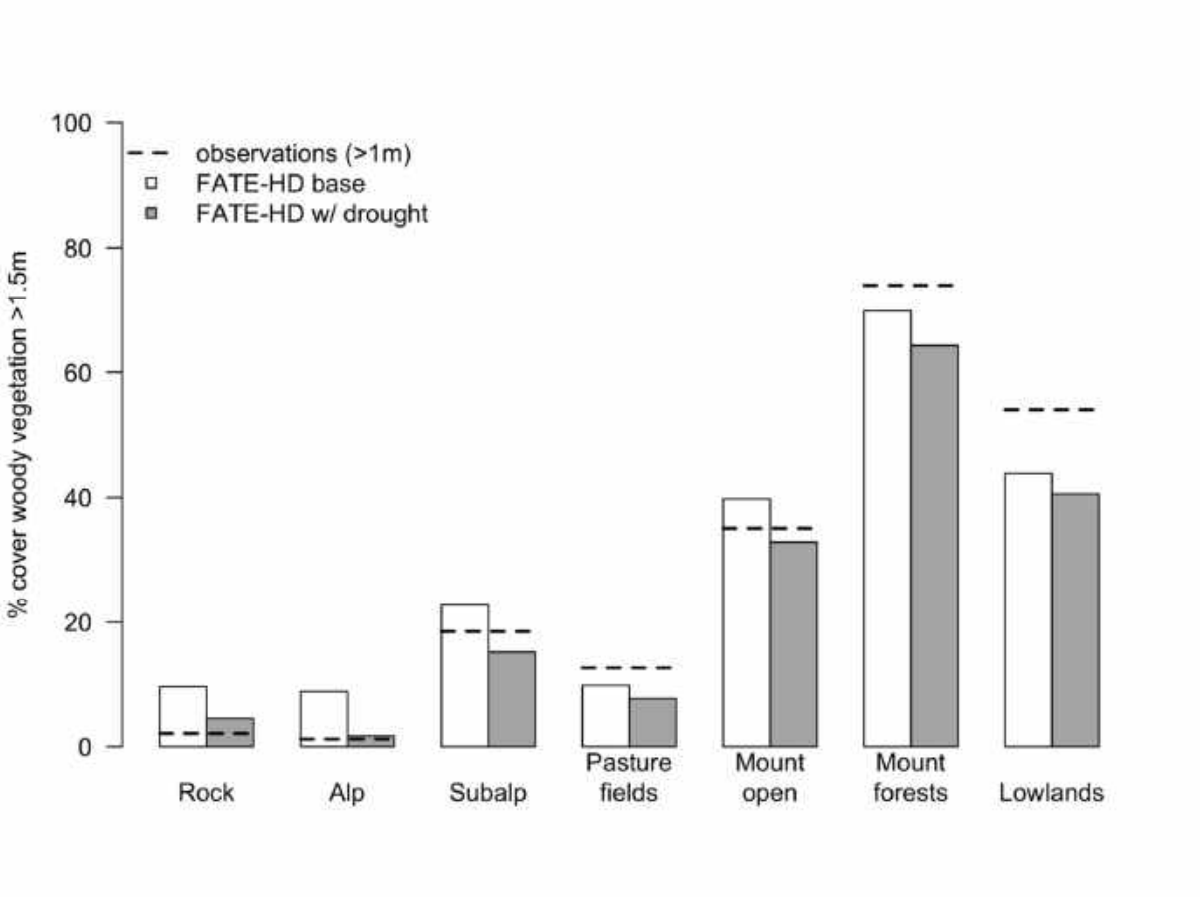

Figure S2. Observed vs. simulated tree cover in different habitats with and without drought effects. Percentages of observed and simulated tree cover were compared for seven broad habitat categories: rocky habitats (Rock, 29 791 pixels), alpine non-managed habitats (Alp, 2 154), subalpine non-managed habitats (Subalp, 5 544), managed habitats for grazing and mowing at all elevations (Pasture fields, 3 053), mountainous open habitats (Mount open, 779), young and mature mountainous forests (Mount forests, 8 881) and habitats of Mediterranean and *colline* (hill) vegetation (Lowlands, 390). Dashed lines indicate observed tree cover percentages, white bars are the predicted percentages of woody vegetation using the FATE-HD base model and grey bars the predicted percentages using the model with implemented drought effects.

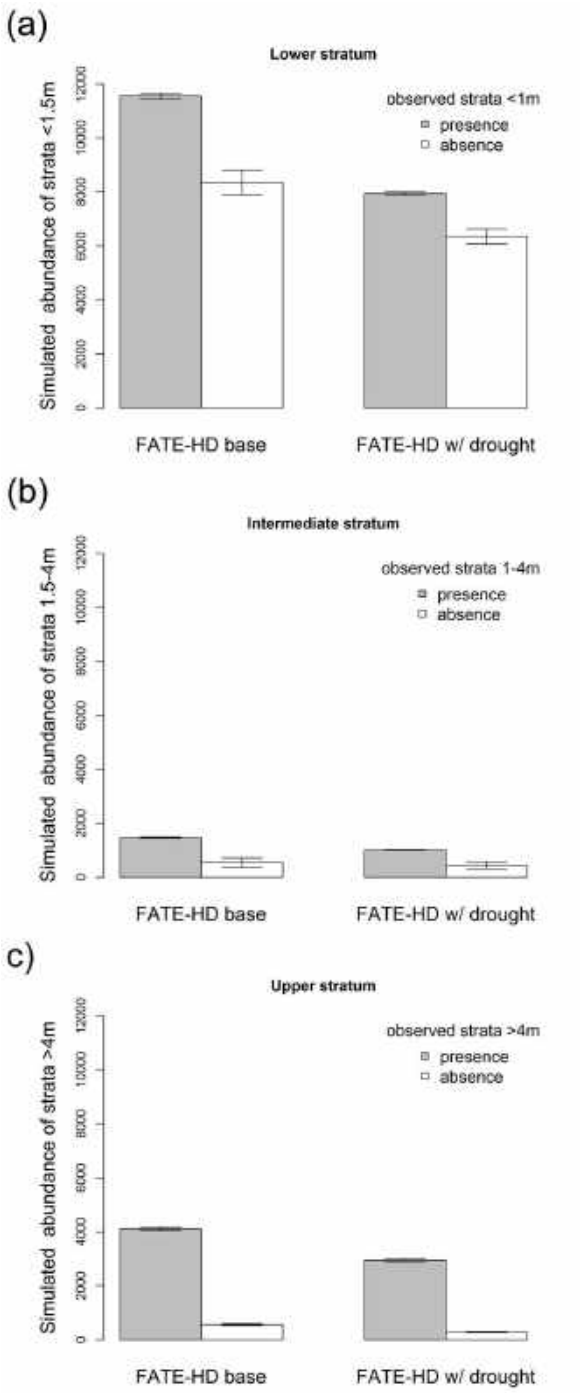

Figure S3. Observed vs. simulated strata abundances with and without drought effects. Observed presences and absences of three levels of vegetation strata (grey and white bars, respectively) are shown in relation to the predicted abundances (in y-axis) of the base model and the model with implemented drought effects. Note that lower strata observations correspond to vegetation up to 1 m tall, whereas the simulated first stratum represents vegetation up to 1.5 m.

References

Boulangeat, I., Georges, D. & Thuiller, W. (2014) FATE□HD: a spatially and temporally explicit integrated model for predicting vegetation structure and diversity at regional scale. *Global Change Biology,* **20,** 2368-2378.