Supplement of Earth Syst. Dynam., 16, 1391–1407, 2025
https://doi.org/10.5194/esd-16-1391-2025-supplement

Earth System Dynamics
Open Access
EGU

Supplement of

A climate suitability index for species distribution modelling applied to terrestrial arthropods in the Mediterranean region

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S1 Considerations of Climate Indices

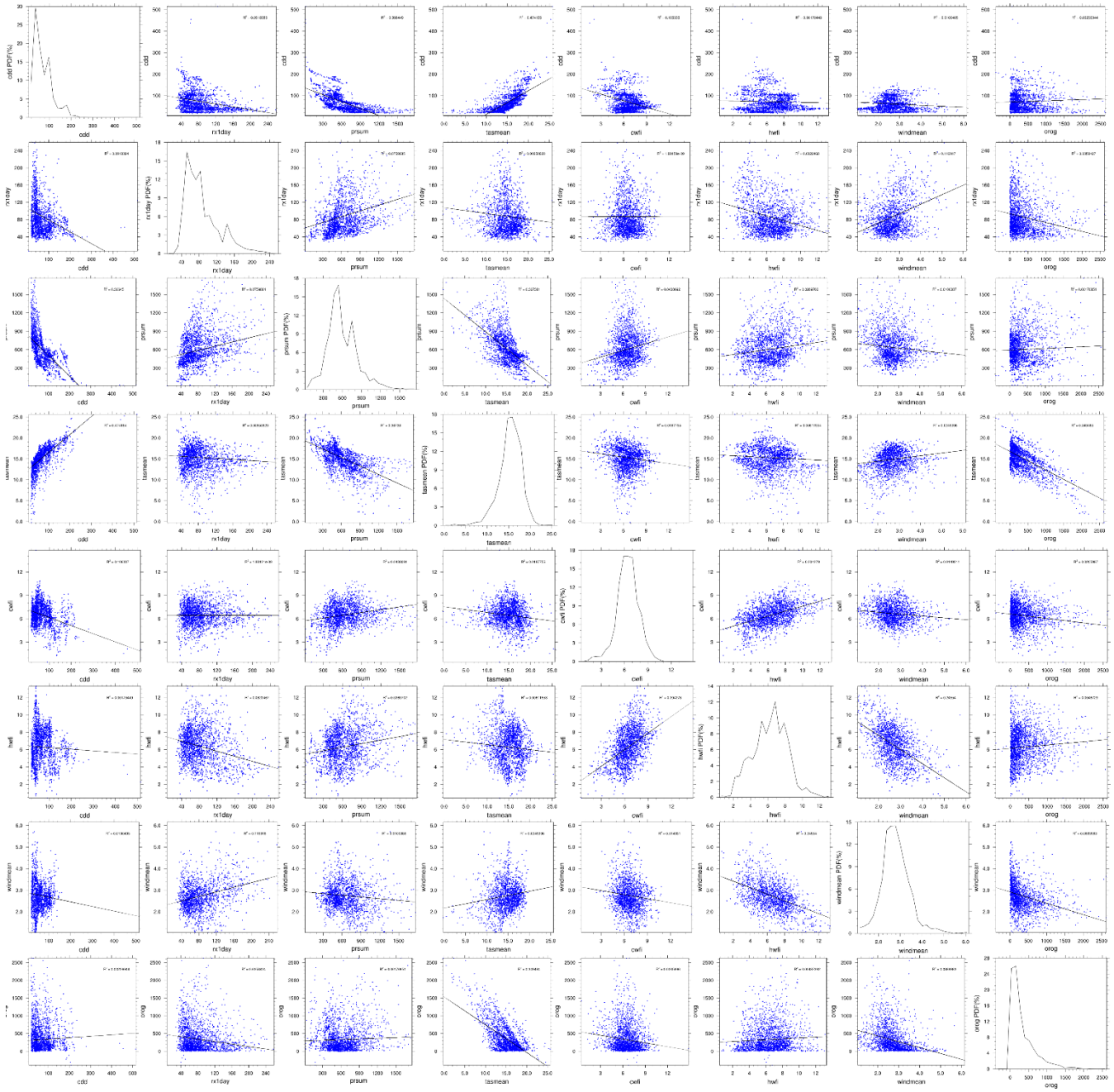
Additional variables to the ones presented in Table 2 were considered. These are listed in Table S1 below. Most of these were not considered due to the strong relationship with other variables such as prsum and tasmean. The wind extreme variable, fg6bft was omitted as too many observation points were returning a 0-value. The relationship between the final selected climate indices is shown in Figure S1 (full image on github), and the correlation coefficients, are summarised in Table S2.

Table S1: The eight climate indices used in this study to describe the climatological component of an ecological niche

Short Name	Long Name	Units
r10mm	Annual mean of heavy precipitation days	days
r20mm	Annual mean of very heavy precipitation days	days
rx5day	Maximum 5-day precipitation in time period	mm/5-days
nrx5day	Annual mean of number of 5-day precipitation periods	days
tx10p	Percentage of very cold days wrt 10th percentile	%
tx90p	Percentage of very warm days wrt 90th percentile	%
tasp10	10th percentile of Near-Surface Air Temperature	°C
tasp90	90th percentile of Near-Surface Air Temperature	°C
fg6bft	Annual mean of days with wind speed >/= 6Bft (10.8 m/s)	days

Table S2: Correlation coefficients from the matrix of scatter-plots shown in Figure S1.

	rx1day	**prsum**	**tasmean**	**cwfi**	**hwfi**	**windmean**	**orog**
cdd	0.091839	0.366449	0.474165	0.106336	0.001705	0.010041	0.002390
rx1day	-	0.075989	0.008508	1.88×10^{-9}	0.082247	0.116917	0.035843
prsum		-	0.367381	0.043809	0.026970	0.010039	0.001709
tasmean			-	0.018775	0.006116	0.024940	0.349485
cwfi				-	0.20428	0.014931	0.020600
hwfi					-	0.24554	0.004873
windmean						-	0.086998
orog							-



15 **Figure S1: A matrix of scatter-plots for the eight climate indices (derived from the 1980-2010 E-OBS dataset) extracted from the grid-cells that correspond to the coordinates where *Spilostethus pandurus* was observed (from the iNaturalist dataset). The plots include the regression line and R2 of each pair, as well as the PDF for each index.**

S2 EI_s assessment

The paper makes use of 8 different species to explore the effectiveness of the EI_s metric under different conditions. The complete output associated with this metric for all PSIs (except *Spilostethus pandurus*), and analogous to Figure 4 is given in Figures S2-S24. The EI_s products obtained from the E-OBS, Ens6, and WMD03 data-sets are shown in Figures S2-S8, S9-S16, S17-S24 respectively. Note in Figure S4, that *Brachytrupes megacephalus* does not produce a spatial EI_s map as none of the observation points could be used with the E-OBS data-set.

2.1 E-OBS based EI_s

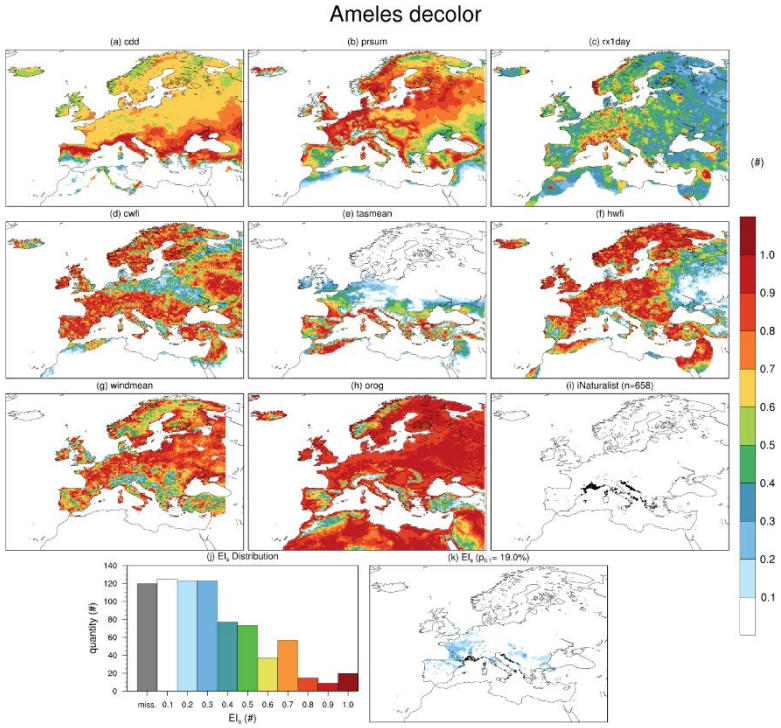
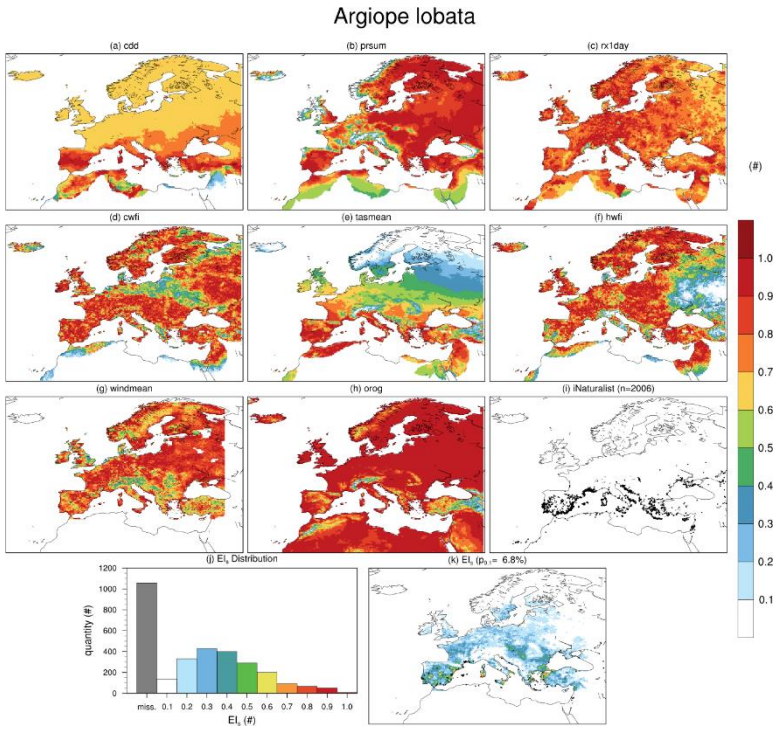


Figure S2. The EI_s products using E-OBS, analogous to Figure 4 for *Ameles decolor*.



30 **Figure S3. The *EIs* products using E-OBS, analogous to Figure 4 for *Argiope lobata*.**

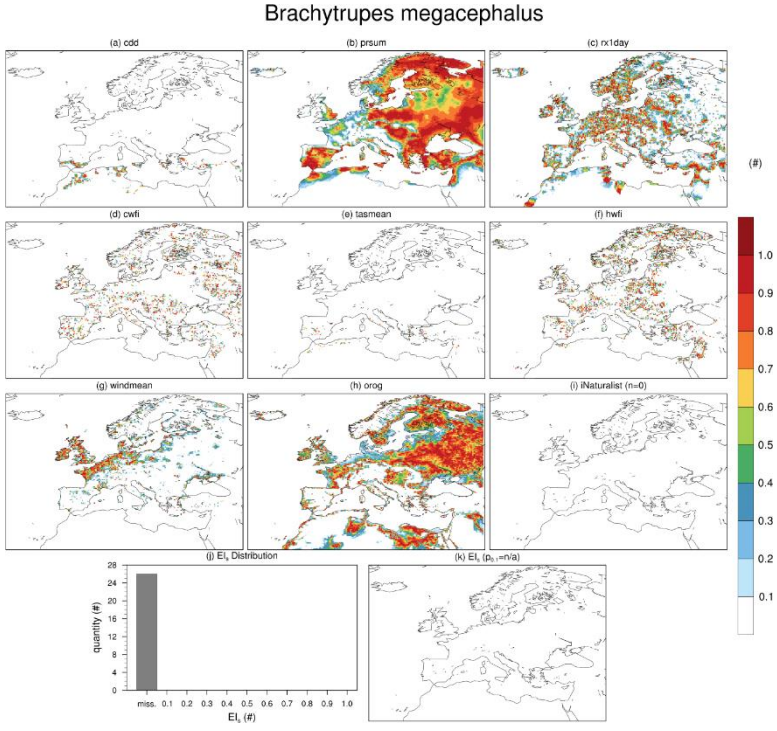


Figure S4. The *EIs* products using E-OBS, analogous to Figure 4 for *Brachytrupes megacephalus*.

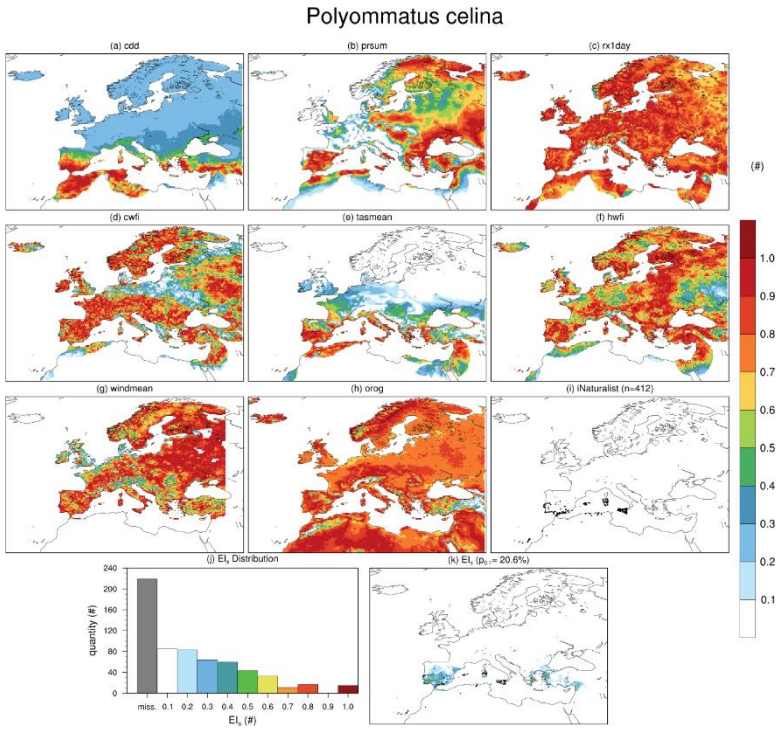


Figure S5. The *EIs* products using E-OBS, analogous to Figure 4 for *Polyommatus celina*.

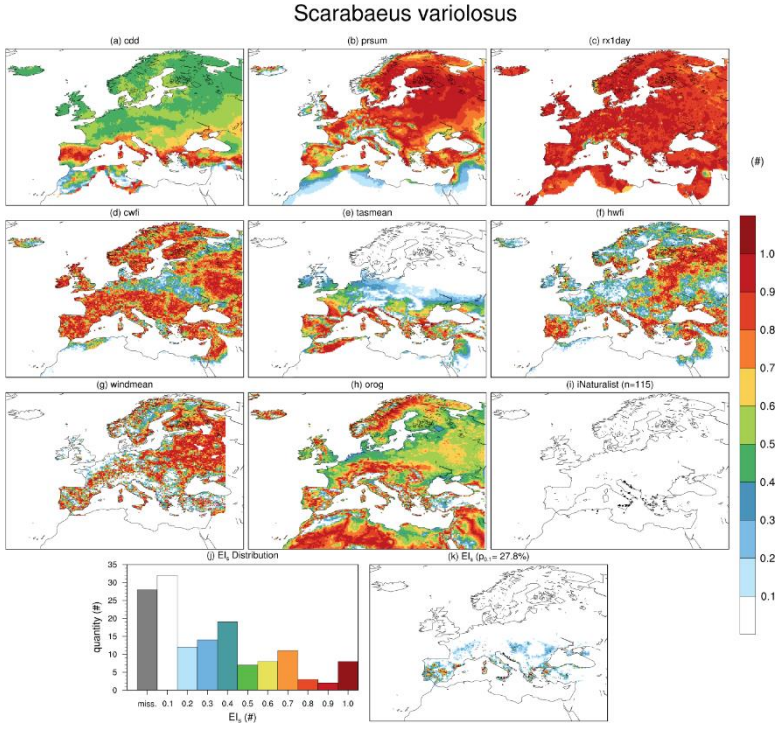


Figure S6. The *EIs* products using E-OBS, analogous to Figure 4 for *Scarabaeus variolosus.*

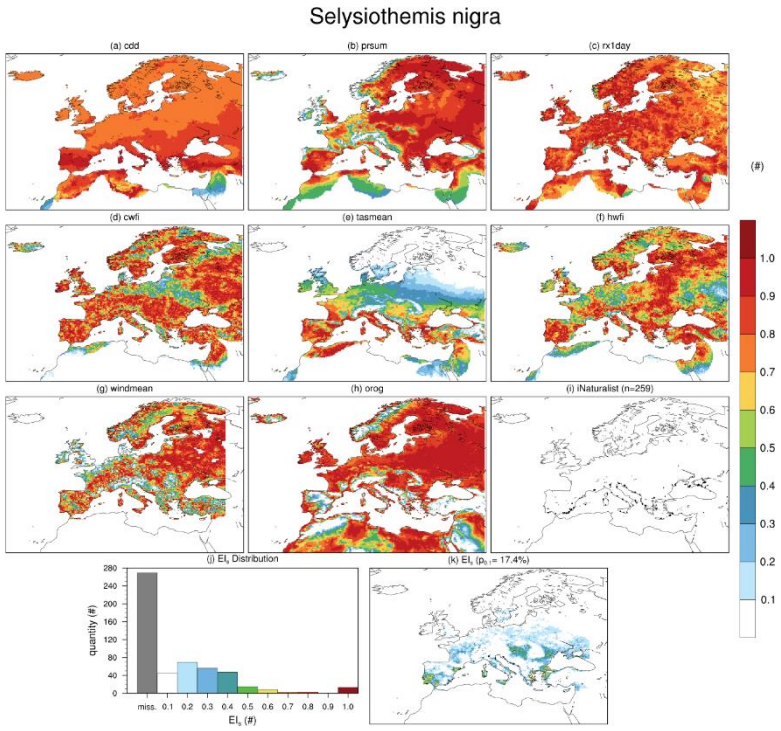


Figure S7. The *EIs* products using E-OBS, analogous to Figure 4 for *Selysiothemis nigra*.

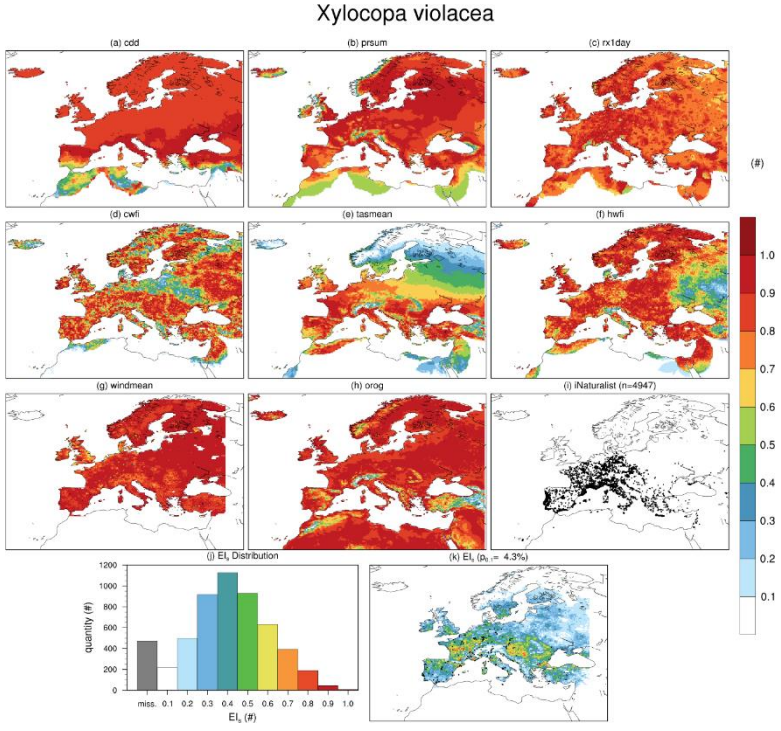


Figure S8. The *EIs* products using E-OBS, analogous to Figure 4 for *Xylocopa violacea*.

2.2 Ens6 based EI_s

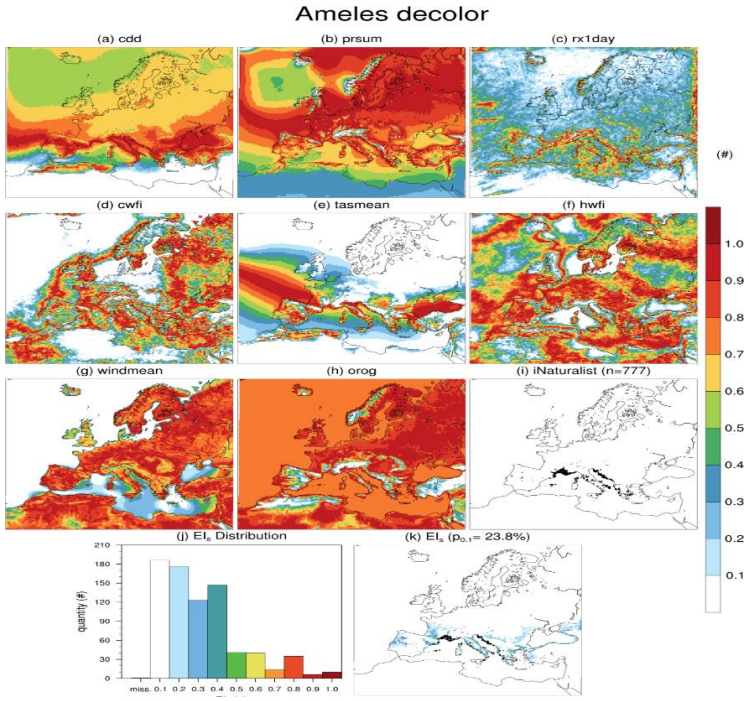


Figure S9. The EI_s products using Ens6, analogous to Figure 4 for *Ameles decolor*.

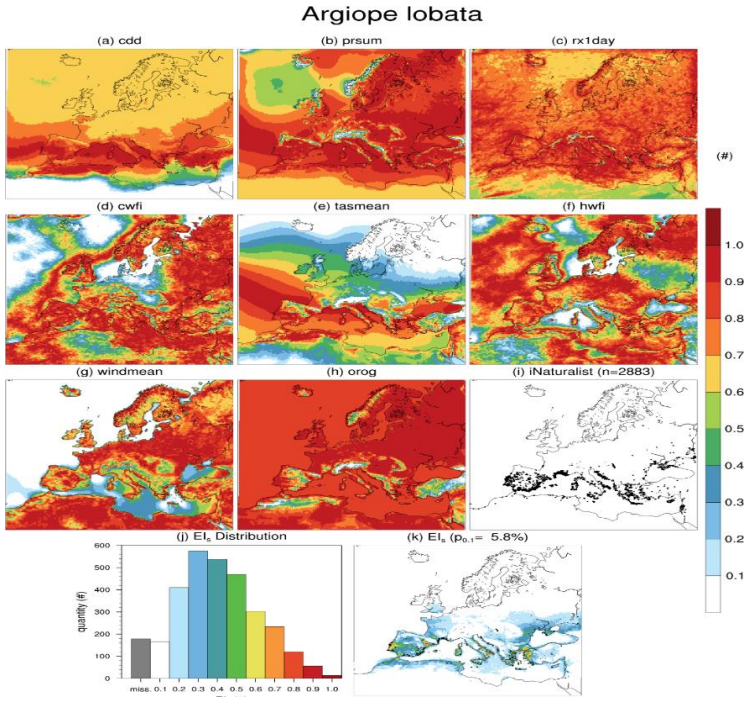


Figure S10. The EI_s products using Ens6, analogous to Figure 4 for *Argiope lobata*.

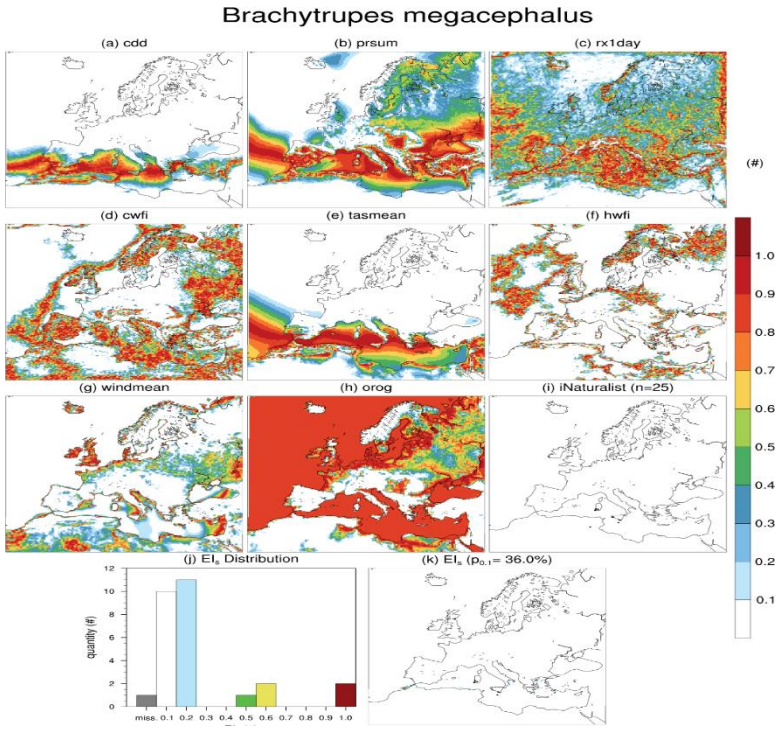


Figure S11. The *EI*$_s$ products using Ens6, analogous to Figure 4 for *Brachytrupes megacephalus*.

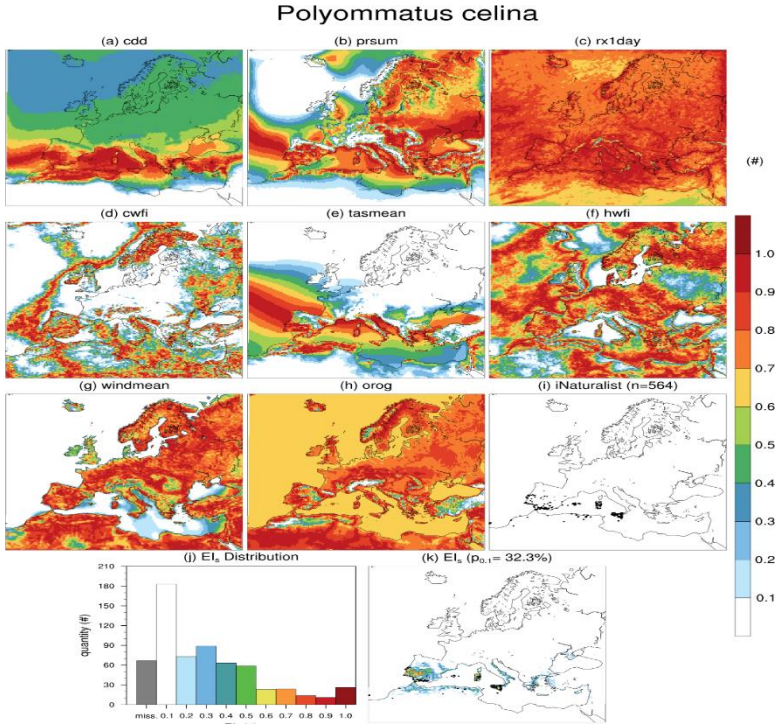


Figure S12. The *EI*$_s$ products using Ens6, analogous to Figure 4 for *Polyommatus celina*.

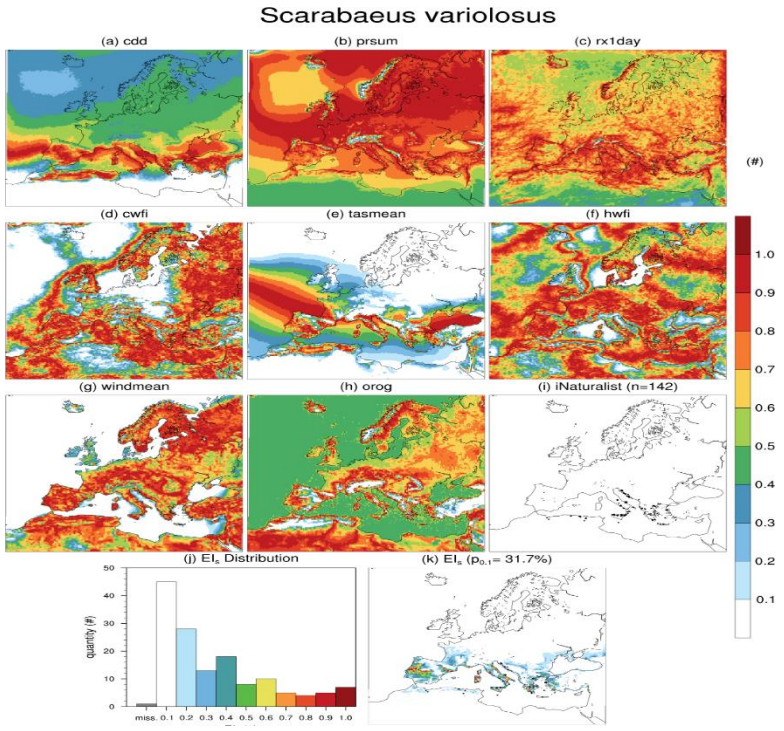


Figure S13. The *EI*$_s$ products using Ens6, analogous to Figure 4 for *Scarabaeus variolosus*.

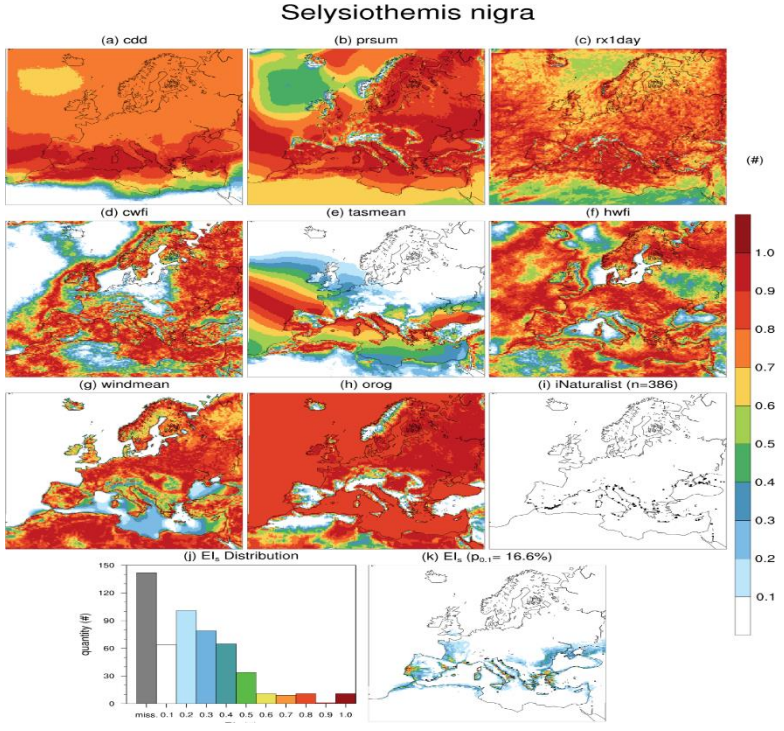
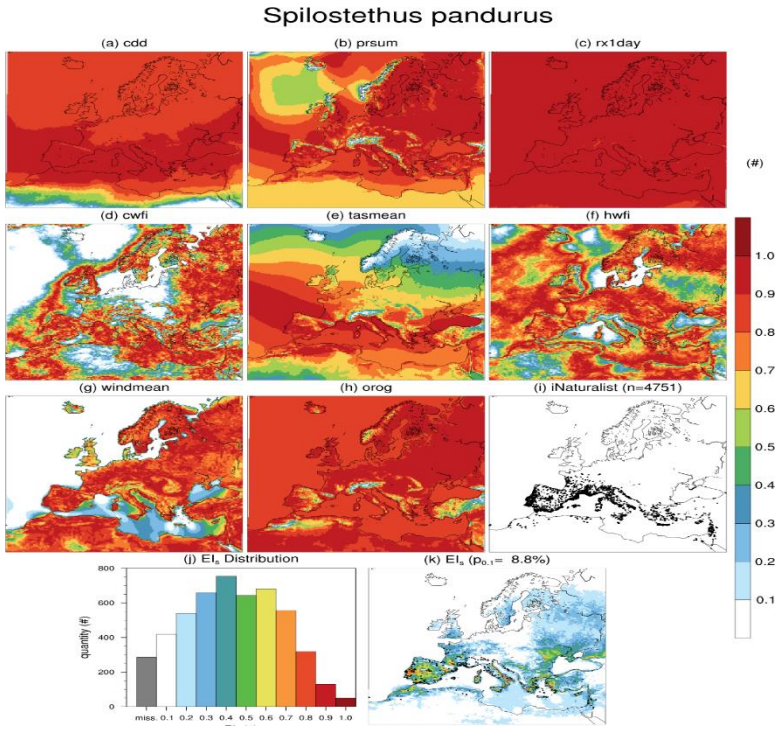


Figure S14. The *EI*$_s$ products using Ens6, analogous to Figure 4 for *Selysiothemis nigra*.



55 **Figure S15. The *EI*$_s$ products using Ens6, analogous to Figure 4 for *Spilostethus pandurus*.**

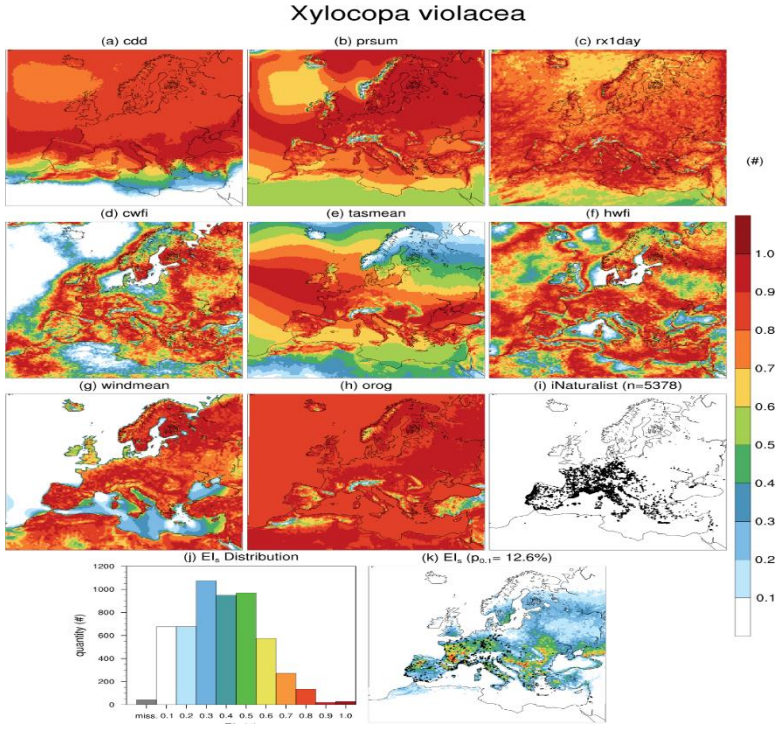


Figure S16. The *EI*$_s$ products using Ens6, analogous to Figure 4 for *Xylocopa violacea*.

2.3 WMD03 based EI_s

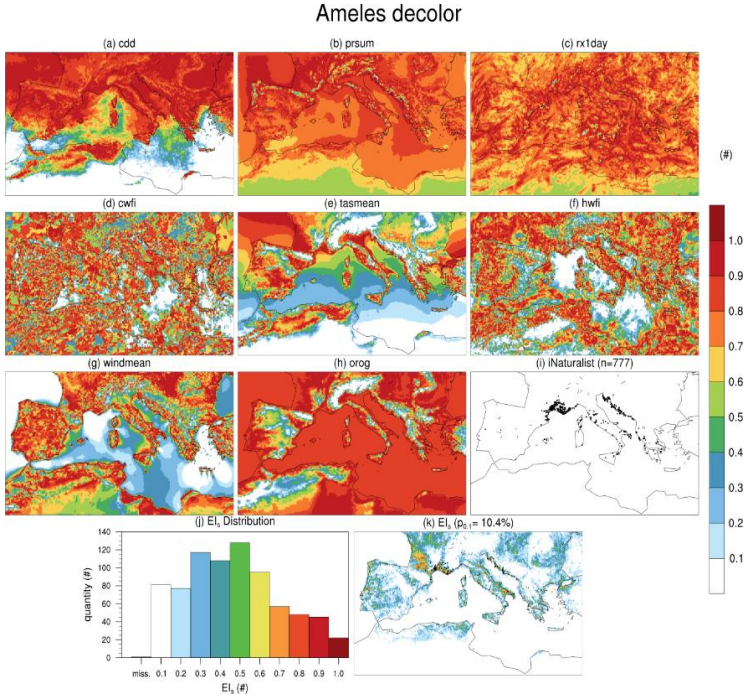


Figure S17. The EI_s products using WMD03, analogous to Figure 4 for *Ameles decolor*.

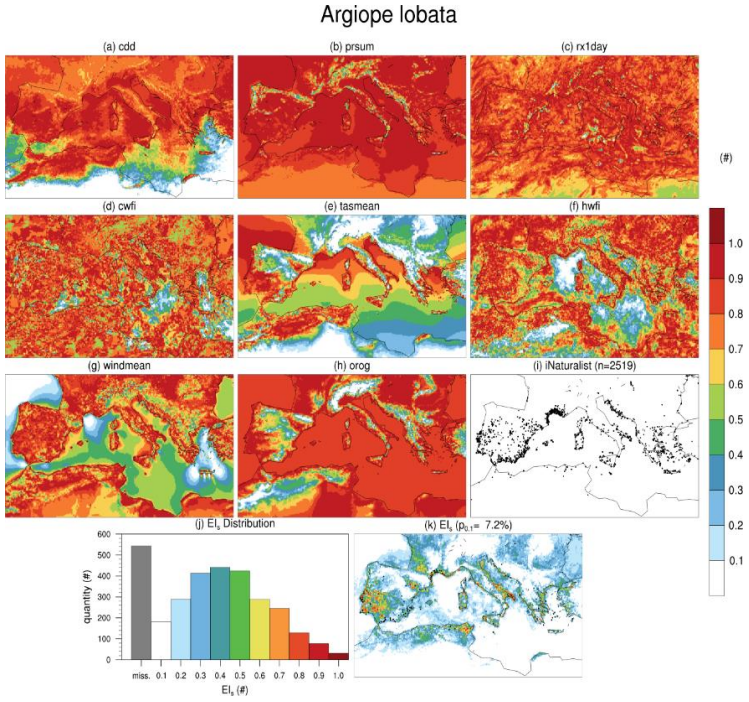


Figure S18. The EI_s products using WMD03, analogous to Figure 4 for *Argiope lobata*.

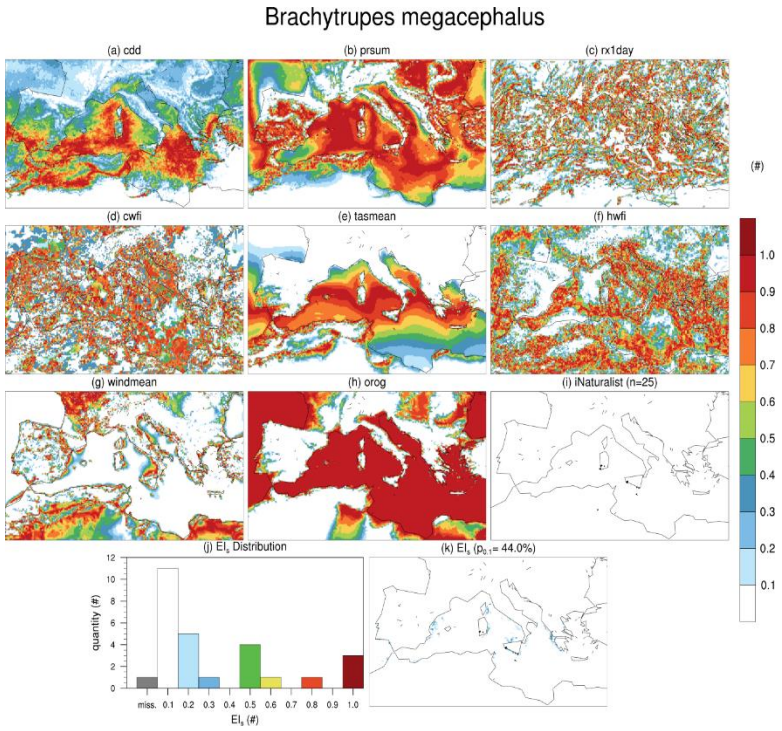


Figure S19. The *EI$_s$* products using WMD03, analogous to Figure 4 for *Brachytrupes megacephalus*.

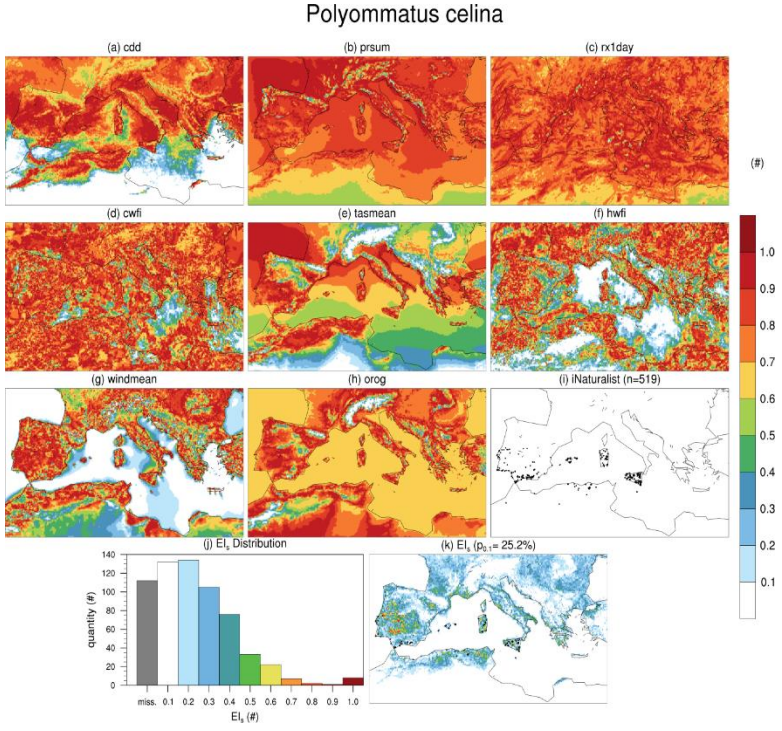


Figure S20. The *EI$_s$* products using WMD03, analogous to Figure 4 for *Polyommatus celina*.

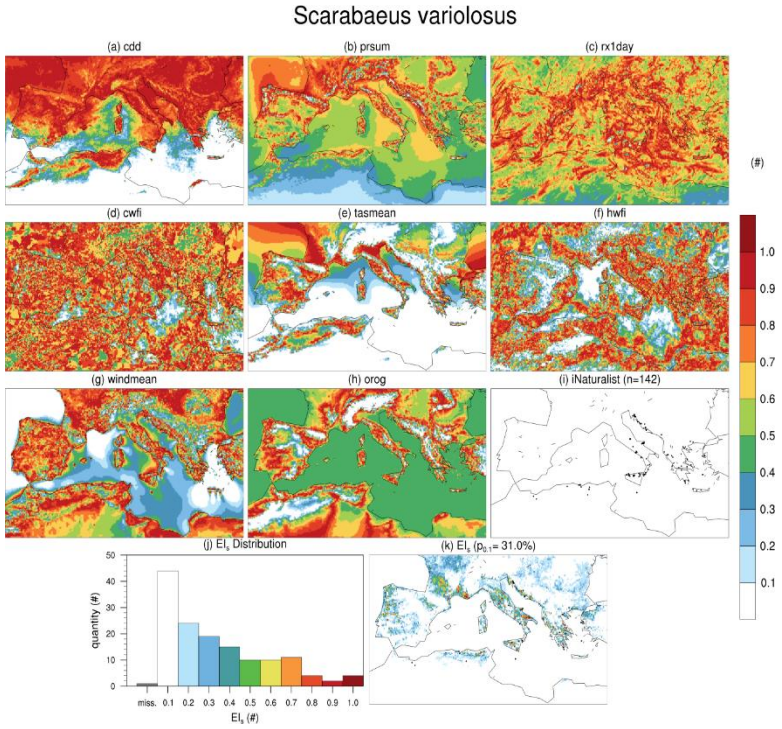
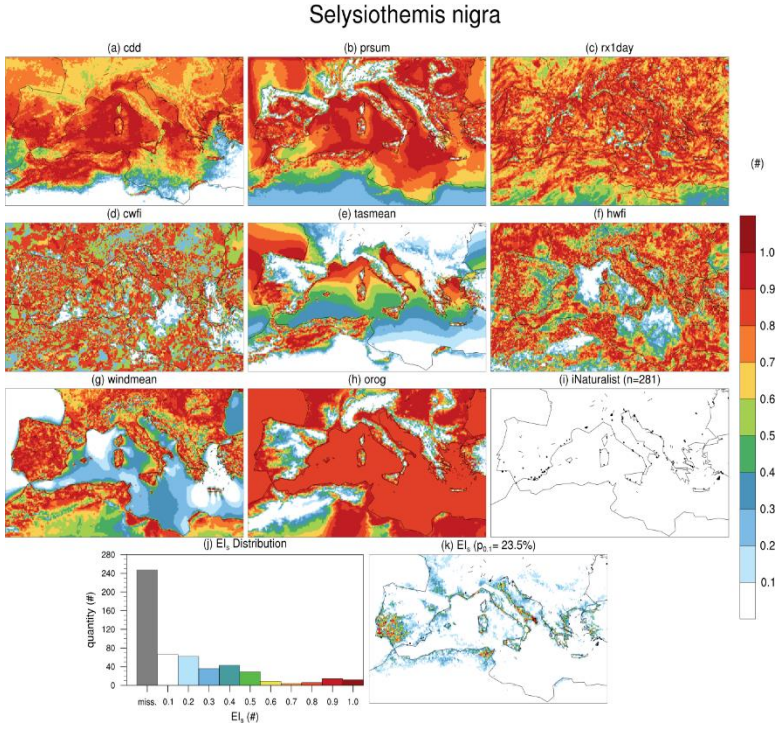


Figure S21. The *EI*$_s$ products using WMD03, analogous to Figure 4 for *Scarabaeus variolosus*.



70 **Figure S22. The *EI*$_s$ products using WMD03, analogous to Figure 4 for *Selysiothemis nigra*.**

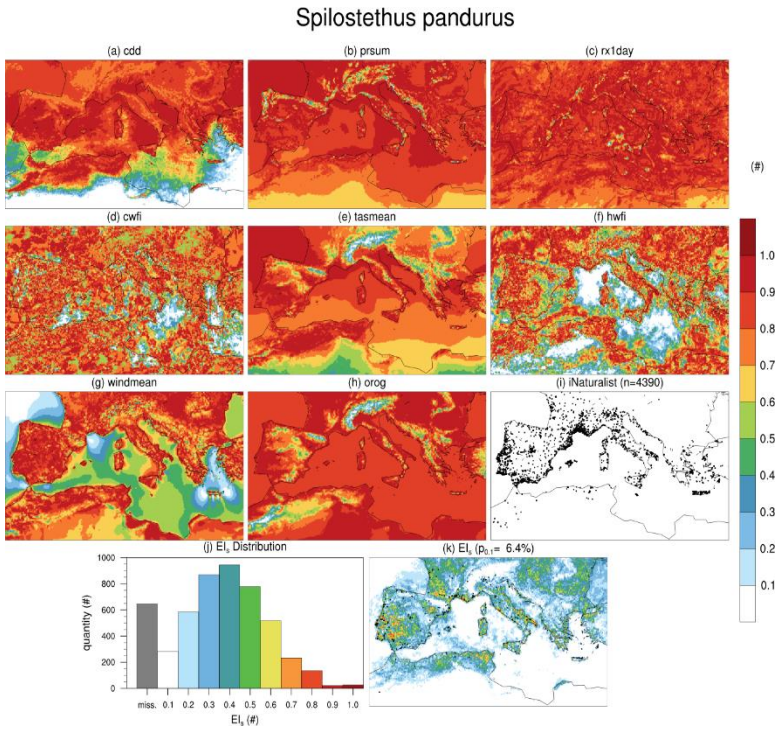


Figure S23. The *EI*$_s$ products using WMD03, analogous to Figure 4 for *Spilostethus pandurus*.

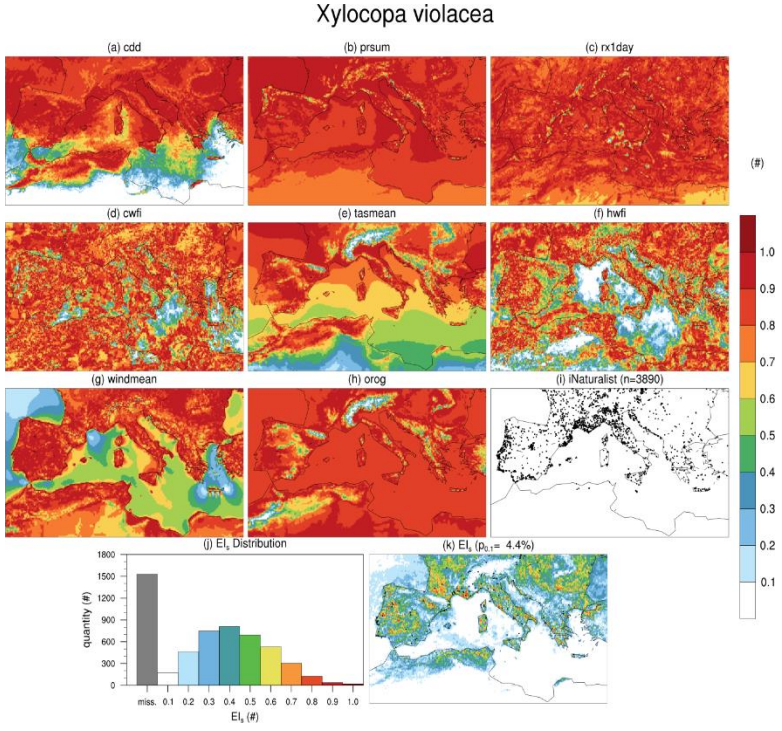


Figure S24. The *EI*$_s$ products using WMD03, analogous to Figure 4 for *Xylocopa violacea*.

2.4 E-OBS and Ens6 10-year analysis

This section displays the 10-year EI_s plots for the E-OBS and Ens6 data.

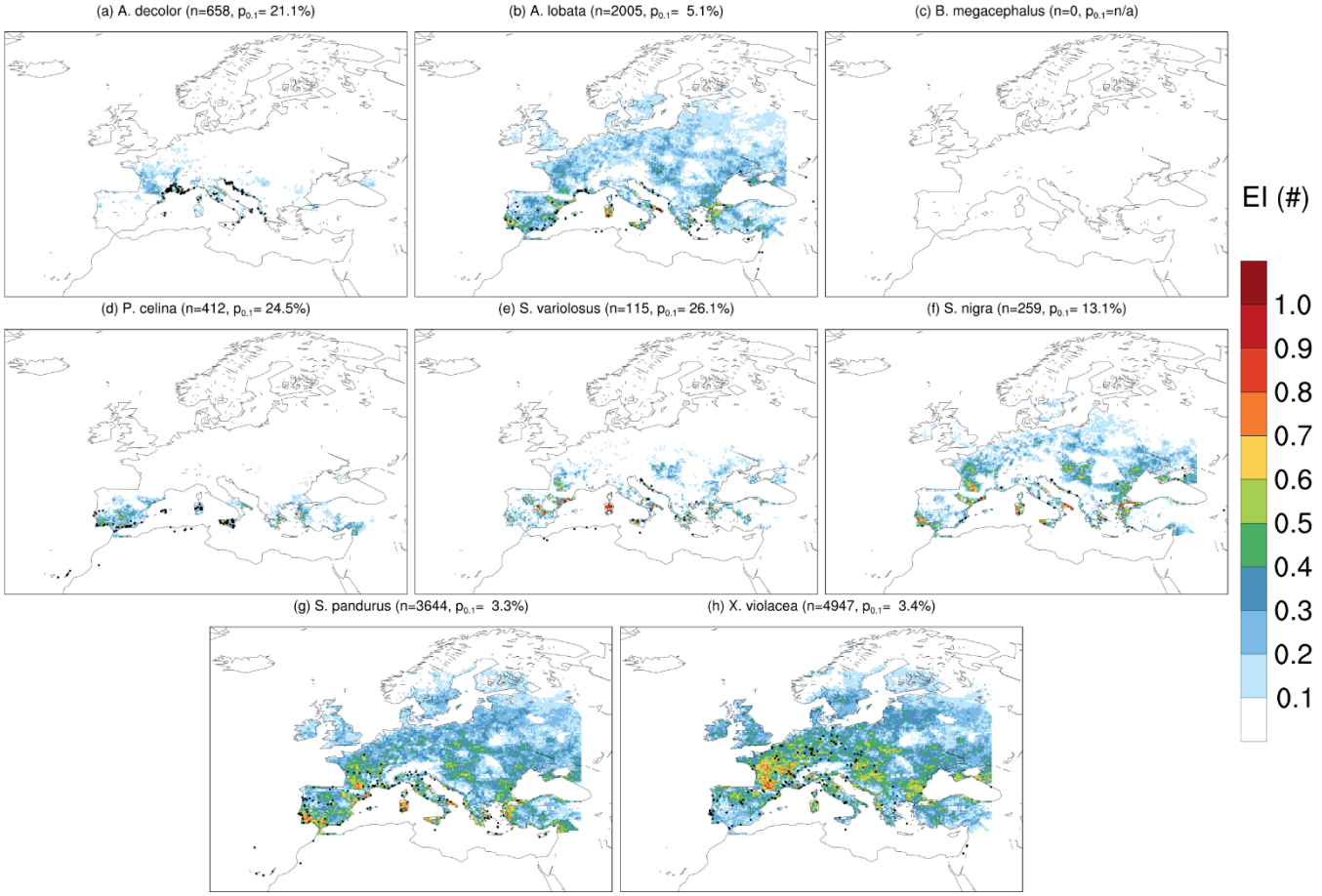


Figure S25. The spatial distribution of EI_s for all eight PSIs applied to the 1995-2004 E-OBS dataset.

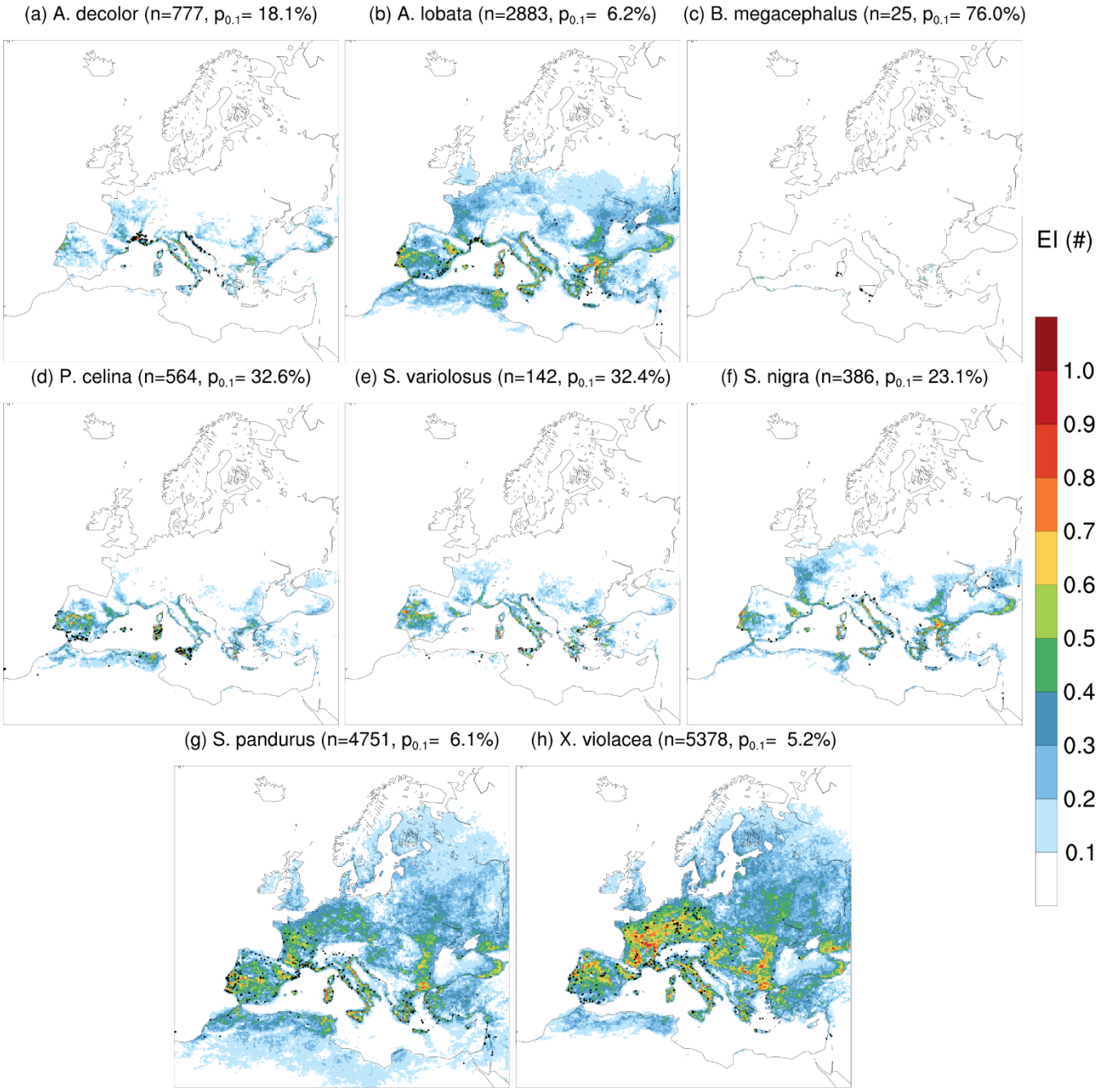


Figure S26. The spatial distribution of *EI*$_s$ for all eight PSIs applied to the 1995-2004 Ens6 dataset.

2.5 Ecological Parameters making EI_s

The statistical descriptors, mean (μ_{si}), standard deviation (σ_{si}), and limit (L_{si}) are described in Table S3 to S7 with the genus abbreviated. The units for mean and standard deviation are the same as the indices described in Table 2, while the limit is described in number of standard deviations. The precision of all values was reduced to 2 decimal places for better readability.

Table S3: Statistical descriptors for the 8 climate variables (described in Table 2), associated with each species, *s* (described in Table 1) when calculating EI_s using E-OBS (1980-2010).

s	SD	cdd	rx1day	prsum	tasmean	cwfi	hwfi	windmean	orog
A. decolor	μ_{si}	40.15	128.98	777.58	14.00	6.36	5.42	3.10	277.37
	σ_{si}	10.51	46.16	202.63	1.43	1.31	2.08	0.64	227.08
	L_{si}	5.18	3.01	3.47	4.23	3.30	2.42	3.69	6.57
A. lobata	μ_{si}	68.26	83.68	520.72	15.28	6.65	5.97	3.03	258.60
	σ_{si}	34.13	39.84	176.13	2.32	1.30	2.06	0.70	278.31
	L_{si}	4.19	3.87	5.58	6.45	3.93	2.68	4.15	9.81
B. megacephalus	μ_{si}	88.92	68.97	509.36	15.61	6.94	6.02	3.76	183.63
	σ_{si}	8.44	23.92	350.90	0.40	0.50	0.75	0.93	178.04
	L_{si}	1.13	1.09	1.15	0.71	0.71	0.71	1.00	1.11
P. celina	μ_{si}	98.05	65.67	443.84	15.90	6.16	7.12	2.74	523.22
	σ_{si}	35.43	25.11	192.67	2.85	1.52	1.64	0.42	435.83
	L_{si}	2.97	4.24	2.26	3.01	2.67	3.59	4.95	3.81
S. variolosus	μ_{si}	60.37	64.14	645.23	13.98	6.63	7.88	2.64	497.11
	σ_{si}	25.45	27.65	310.34	2.24	1.77	1.78	0.37	333.12
	L_{si}	3.05	6.02	2.17	3.03	2.29	2.24	2.43	2.43
S. nigra	μ_{si}	66.12	72.74	524.78	14.51	6.87	7.40	2.74	188.04
	σ_{si}	44.74	30.87	229.59	3.01	1.37	2.35	0.56	187.84
	L_{si}	4.77	4.22	3.62	3.24	3.21	2.48	2.57	4.40
S. pandurus	μ_{si}	72.69	86.79	597.11	15.36	6.39	6.26	2.79	337.01
	σ_{si}	42.74	38.75	240.53	2.63	1.45	1.97	0.67	357.76
	L_{si}	8.55	4.45	4.73	5.92	5.80	3.57	5.00	6.40
X. violacea	μ_{si}	41.03	83.01	724.97	12.34	6.88	6.15	2.79	345.50
	σ_{si}	25.99	34.98	238.41	3.10	1.25	1.94	0.72	363.50
	L_{si}	5.52	5.04	6.15	4.05	3.43	3.81	8.14	6.27

Table S4: Statistical descriptors for the 8 climate variables (described in Table 2), associated with each species, *s* (described in Table 1) when calculating EI_s using E-OBS (1995-2004).

s	SD	cdd	rx1day	prsum	tasmean	cwfi	hwfi	windmean	orog
A. decolor	μ_{si}	37.77	107.33	844.48	14.31	1.02	3.42	2.97	277.37
	σ_{si}	9.21	42.25	249.73	1.40	0.71	1.30	0.62	227.08
	L_{si}	6.30	2.62	2.86	4.37	2.93	3.45	4.06	6.57
A. lobata	μ_{si}	68.06	68.16	549.39	15.56	1.42	3.24	3.01	258.60
	σ_{si}	35.16	35.54	201.49	2.35	0.92	1.55	0.73	278.31
	L_{si}	3.62	4.75	4.98	6.32	4.01	3.27	4.23	9.81
B. megacephalus	μ_{si}	81.03	59.37	514.61	15.89	1.65	4.00	3.80	183.63
	σ_{si}	7.57	26.93	346.02	0.40	0.35	0.42	0.94	178.04
	L_{si}	1.12	1.15	1.15	0.71	0.71	0.71	1.01	1.11
P. celina	μ_{si}	95.11	51.02	449.70	16.16	1.63	3.75	2.71	523.22
	σ_{si}	38.57	17.90	198.92	2.83	0.82	1.55	0.44	435.83
	L_{si}	2.52	3.72	2.15	3.06	3.24	2.80	4.96	3.81
S. variolosus	μ_{si}	57.95	47.86	634.94	14.26	1.65	3.94	2.66	497.11
	σ_{si}	26.78	17.92	333.56	2.23	0.97	1.38	0.37	333.12
	L_{si}	3.14	5.47	2.17	3.07	2.64	2.08	2.20	2.43
S. nigra	μ_{si}	67.41	58.90	534.07	14.81	1.16	3.48	2.82	188.04
	σ_{si}	48.15	25.26	241.03	3.03	0.88	1.50	0.57	187.84
	L_{si}	5.26	4.75	3.55	3.21	3.58	2.68	2.89	4.40
S. pandurus	μ_{si}	72.74	70.64	619.99	15.67	1.42	3.41	2.78	337.01
	σ_{si}	44.93	32.47	258.49	2.63	0.93	1.66	0.68	357.76
	L_{si}	13.26	5.12	4.79	5.82	4.18	3.80	5.22	6.40
X. violacea	μ_{si}	40.58	69.37	745.65	12.62	1.32	3.19	2.79	345.50
	σ_{si}	27.49	30.95	254.36	3.14	0.82	1.64	0.72	363.50
	L_{si}	5.33	5.26	5.66	3.91	4.22	4.69	7.50	6.27

Table S5: Statistical descriptors for the 8 climate variables (described in Table 2), associated with each species, *s* (described in Table 1) when calculating EI_s using Ens6 (1980-2010).

s	SD	cdd	rx1day	prsum	tasmean	cwfi	hwfi	windmean	orog
A. decolor	μ_{si}	42.79	139.16	839.63	14.09	7.45	7.81	3.67	231.97
	σ_{si}	10.52	36.37	230.52	1.50	0.55	1.57	0.73	210.75
	L_{si}	6.38	2.54	5.10	3.88	3.51	2.01	4.57	5.10
A. lobata	μ_{si}	62.71	110.12	579.52	15.39	6.84	6.91	4.11	204.98
	σ_{si}	24.39	32.44	208.88	2.16	0.68	1.31	0.97	263.83
	L_{si}	5.37	5.46	8.12	5.21	5.11	3.61	3.37	6.99
B. megacephalus	μ_{si}	82.49	107.96	496.87	17.93	6.44	6.63	5.03	47.41
	σ_{si}	12.92	14.17	109.86	1.09	0.48	0.59	0.67	75.81
	L_{si}	3.43	4.10	3.77	3.51	2.48	1.36	1.92	3.46
P. celina	μ_{si}	69.26	113.07	584.82	15.62	6.13	7.35	3.75	442.07
	σ_{si}	22.11	42.31	237.14	2.31	0.56	1.37	0.88	417.49
	L_{si}	3.97	5.03	2.55	2.87	2.80	2.46	3.14	3.28
S. variolosus	μ_{si}	53.07	121.68	859.61	14.32	6.80	7.84	3.51	401.82
	σ_{si}	18.63	36.28	362.37	2.30	0.97	1.55	0.66	343.21
	L_{si}	3.18	4.18	4.20	2.73	2.41	2.37	3.66	2.33
S. nigra	μ_{si}	64.03	102.74	584.94	15.28	6.92	7.22	4.00	145.03
	σ_{si}	32.73	25.20	266.91	2.53	0.91	1.65	0.95	159.38
	L_{si}	5.30	5.12	5.36	2.89	2.89	2.78	3.13	4.93
S. pandurus	μ_{si}	62.67	113.08	663.47	15.17	6.86	7.29	3.66	282.25
	σ_{si}	31.97	35.90	272.94	2.58	0.77	1.47	0.88	338.20
	L_{si}	12.42	25.00	6.22	7.12	3.04	3.05	4.11	6.88
X. violacea	μ_{si}	39.26	104.60	806.67	12.36	7.64	7.81	3.46	329.67
	σ_{si}	22.09	36.36	285.61	3.17	1.13	1.28	0.77	359.17
	L_{si}	5.87	4.43	5.91	4.88	2.77	3.29	4.99	6.32

Table S6: Statistical descriptors for the 8 climate variables (described in Table 2), associated with each species, *s* (described in Table 1) when calculating EI_s using Ens6 (1995-2004).

s	SD	cdd	rx1day	prsum	tasmean	cwfi	hwfi	windmean	orog
A. decolor	μ_{si}	41.03	110.33	882.04	14.22	1.71	4.99	3.69	231.97
	σ_{si}	10.18	27.76	240.74	1.51	0.57	1.27	0.74	210.75
	L_{si}	6.69	3.18	4.89	3.82	2.65	2.83	4.43	5.10
A. lobata	μ_{si}	60.66	87.70	606.03	15.52	1.74	4.23	4.13	204.98
	σ_{si}	24.71	24.94	221.18	2.19	0.58	1.26	0.97	263.83
	L_{si}	5.48	5.09	7.17	5.16	4.47	4.04	3.29	6.99
B. megacephalus	μ_{si}	77.43	76.74	489.70	18.05	1.66	3.68	5.06	47.41
	σ_{si}	12.55	10.64	106.54	1.10	0.33	0.57	0.67	75.81
	L_{si}	3.43	3.54	3.84	3.54	1.38	2.05	1.92	3.46
P. celina	μ_{si}	67.59	92.10	597.16	15.75	1.47	4.58	3.78	442.07
	σ_{si}	22.74	38.50	243.30	2.33	0.45	1.31	0.88	417.49
	L_{si}	4.02	5.35	2.52	2.89	3.77	2.53	3.18	3.28
S. variolosus	μ_{si}	51.05	100.47	862.78	14.44	1.93	5.19	3.55	401.82
	σ_{si}	17.99	29.32	360.18	2.30	0.54	1.42	0.65	343.21
	L_{si}	3.25	3.82	4.12	2.72	2.28	2.81	3.69	2.33
S. nigra	μ_{si}	62.01	82.44	605.53	15.41	1.78	4.21	4.03	145.03
	σ_{si}	33.62	21.79	275.38	2.58	0.62	1.27	0.96	159.38
	L_{si}	5.57	4.82	5.28	2.87	2.75	2.77	3.12	4.93
S. pandurus	μ_{si}	61.34	89.91	697.70	15.31	1.71	4.45	3.69	282.25
	σ_{si}	33.39	27.36	295.74	2.58	0.49	1.33	0.88	338.20
	L_{si}	13.97	7.61	6.23	7.13	3.78	3.51	4.05	6.88
X. violacea	μ_{si}	38.09	83.62	838.93	12.53	1.85	4.75	3.48	329.67
	σ_{si}	22.00	30.11	303.24	3.15	0.49	1.08	0.77	359.17
	L_{si}	6.41	5.29	5.68	4.94	4.47	4.23	4.92	6.32

Table S7: Statistical descriptors for the 8 climate variables (described in Table 2), associated with each species, *s* (described in Table 1) when calculating EI_s using WMD03 (1995-2004).

s	SD	cdd	rx1day	prsum	tasmean	cwfi	hwfi	windmean	orog
A. decolor	μ_{si}	26.40	126.18	1241.45	13.18	1.57	4.31	4.34	227.75
	σ_{si}	5.75	44.10	453.81	1.56	0.81	1.34	0.77	224.21
	L_{si}	9.99	5.52	6.18	4.18	2.87	3.34	3.30	5.92
A. lobata	μ_{si}	37.99	104.02	854.95	14.77	1.59	3.88	4.40	194.31
	σ_{si}	16.18	39.44	336.54	1.89	0.89	1.67	0.94	262.25
	L_{si}	5.09	5.33	8.52	3.72	4.07	3.91	3.93	5.92
B. megacephalus	μ_{si}	57.74	90.97	663.84	17.28	2.38	6.13	4.94	25.01
	σ_{si}	12.39	15.37	177.83	1.03	0.67	1.28	0.57	76.43
	L_{si}	3.63	2.66	3.05	3.22	2.64	2.83	1.91	4.48
P. celina	μ_{si}	33.31	125.55	1131.66	14.12	1.39	3.78	4.06	508.23
	σ_{si}	16.13	71.40	630.91	2.89	0.89	1.73	0.70	483.86
	L_{si}	3.05	3.93	4.17	3.24	4.16	2.73	3.35	3.17
S. variolosus	μ_{si}	25.09	129.62	1358.21	12.79	1.58	5.16	4.48	452.71
	σ_{si}	11.21	54.71	517.29	2.21	0.91	1.60	0.91	341.59
	L_{si}	3.98	3.24	3.09	2.19	3.20	2.64	2.75	2.42
S. nigra	μ_{si}	44.40	97.16	740.75	15.08	1.65	4.38	4.11	121.25
	σ_{si}	21.61	30.85	249.37	2.18	0.92	2.02	0.98	167.29
	L_{si}	3.52	4.46	3.70	2.22	2.56	2.68	2.96	6.11
S. pandurus	μ_{si}	35.50	103.25	977.36	14.32	1.47	3.85	4.18	257.49
	σ_{si}	16.71	41.96	431.02	2.38	0.92	1.63	0.90	334.24
	L_{si}	5.08	6.85	6.79	6.87	3.39	3.28	4.67	7.20
X. violacea	μ_{si}	30.08	102.66	1108.39	12.69	1.41	3.86	4.06	361.90
	σ_{si}	13.72	42.38	510.23	3.04	0.86	1.68	0.89	398.52
	L_{si}	5.49	6.30	7.99	4.48	4.28	3.30	5.52	5.38

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S3 Bias of Ensemble Members

This section presents the percentage bias of all indices used in this study for every member of the Ens6 ensemble.

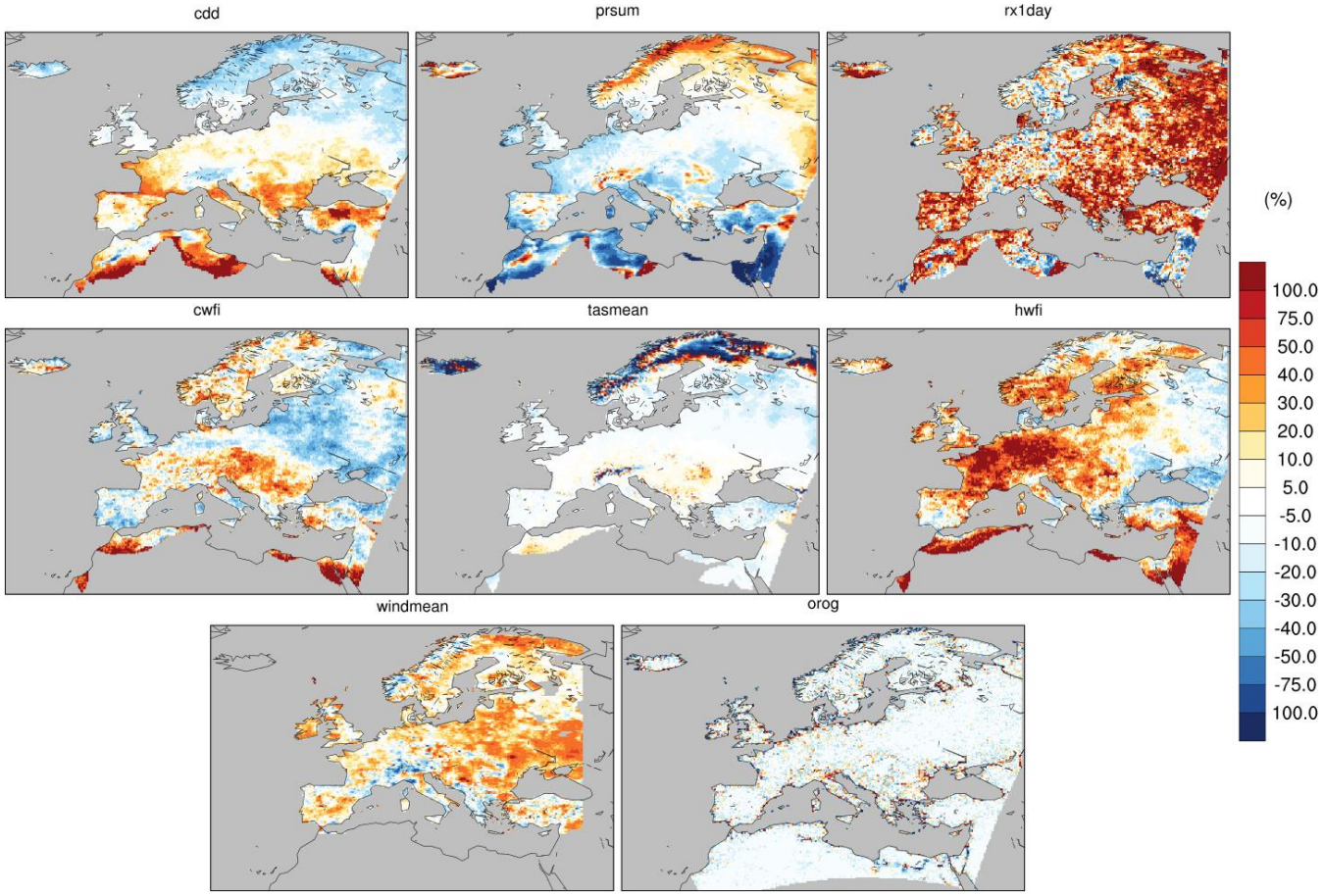

Figure S27. Percentage bias for climate indices from the 30-year CLMcom-ETH-COSMO-crCLIM compared to E-OBS dataset (1980-2010).

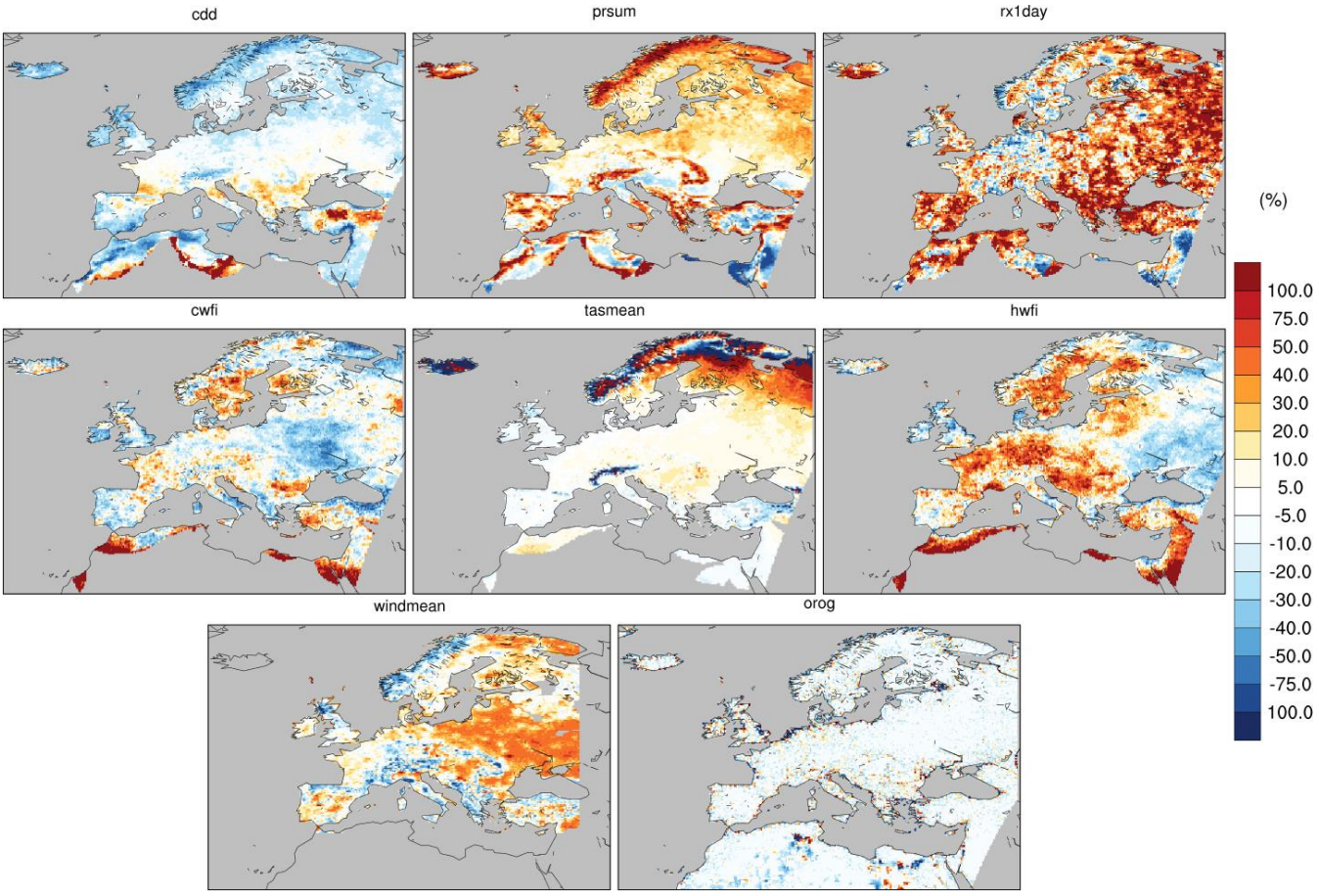

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Figure S28. Percentage bias for climate indices from the 30-year CNRM-ALADIN63 compared to E-OBS dataset (1980-2010).

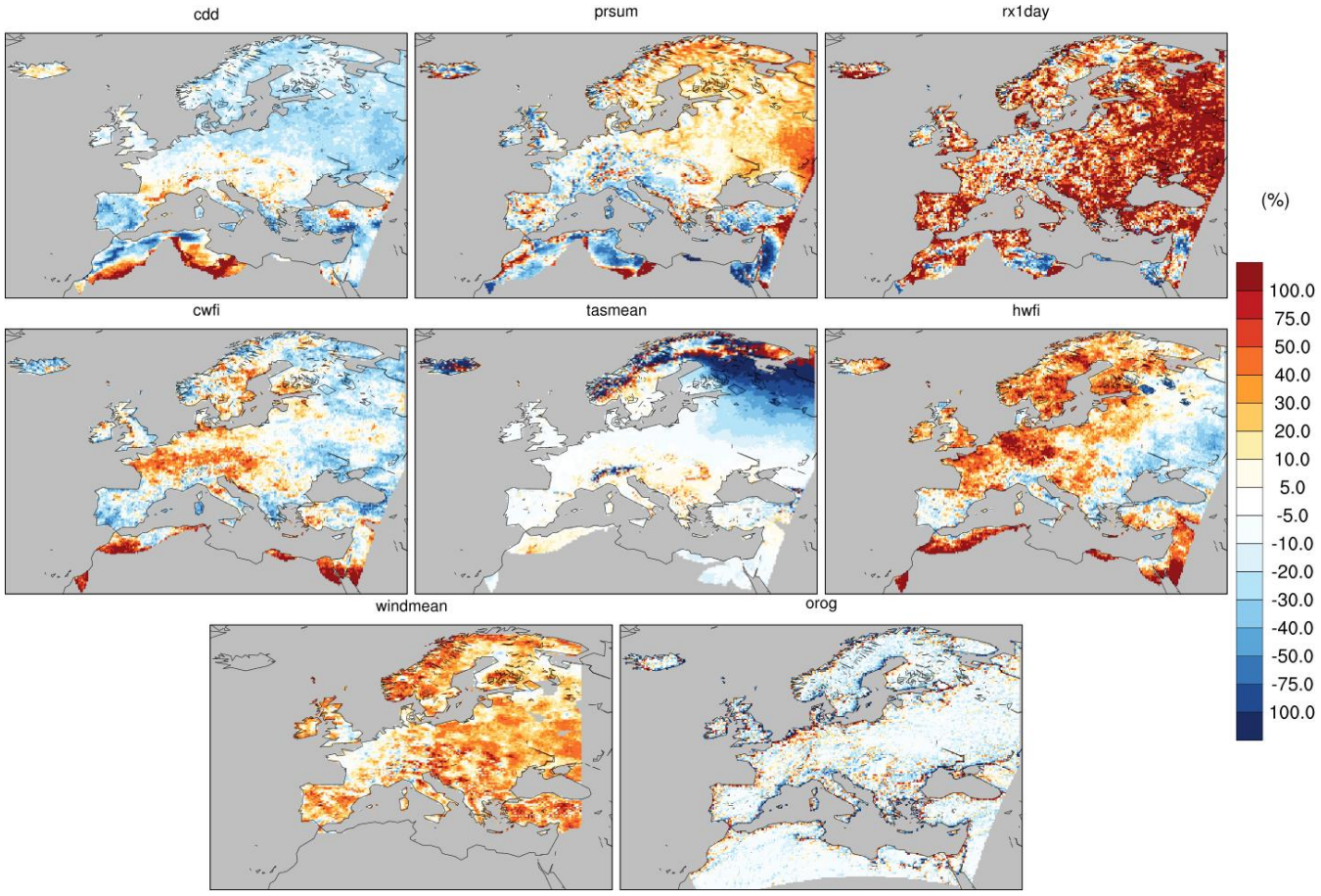

Figure S29. Percentage bias for climate indices from the 30-year GERICS-REMO2015 compared to E-OBS dataset (1980-2010).

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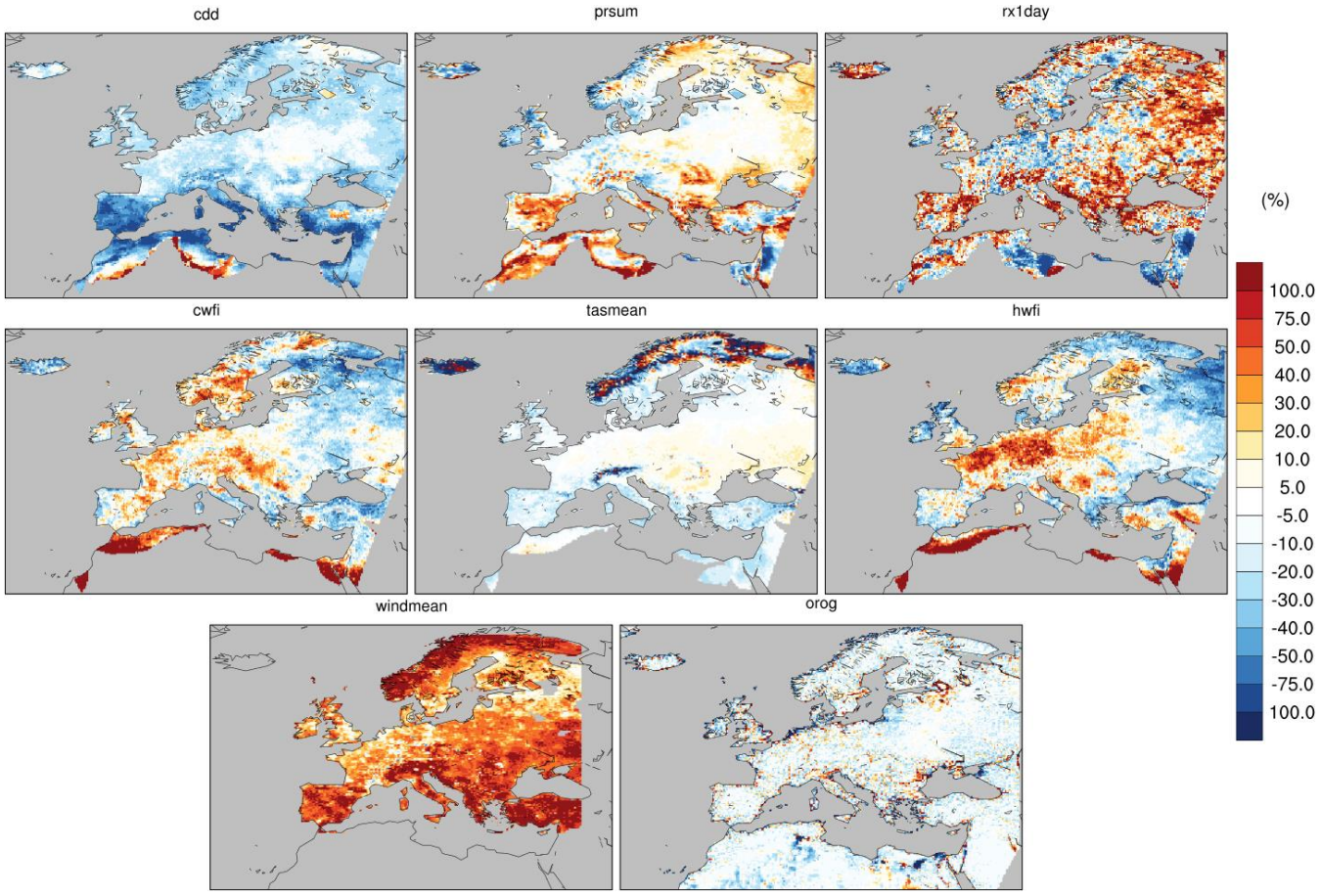
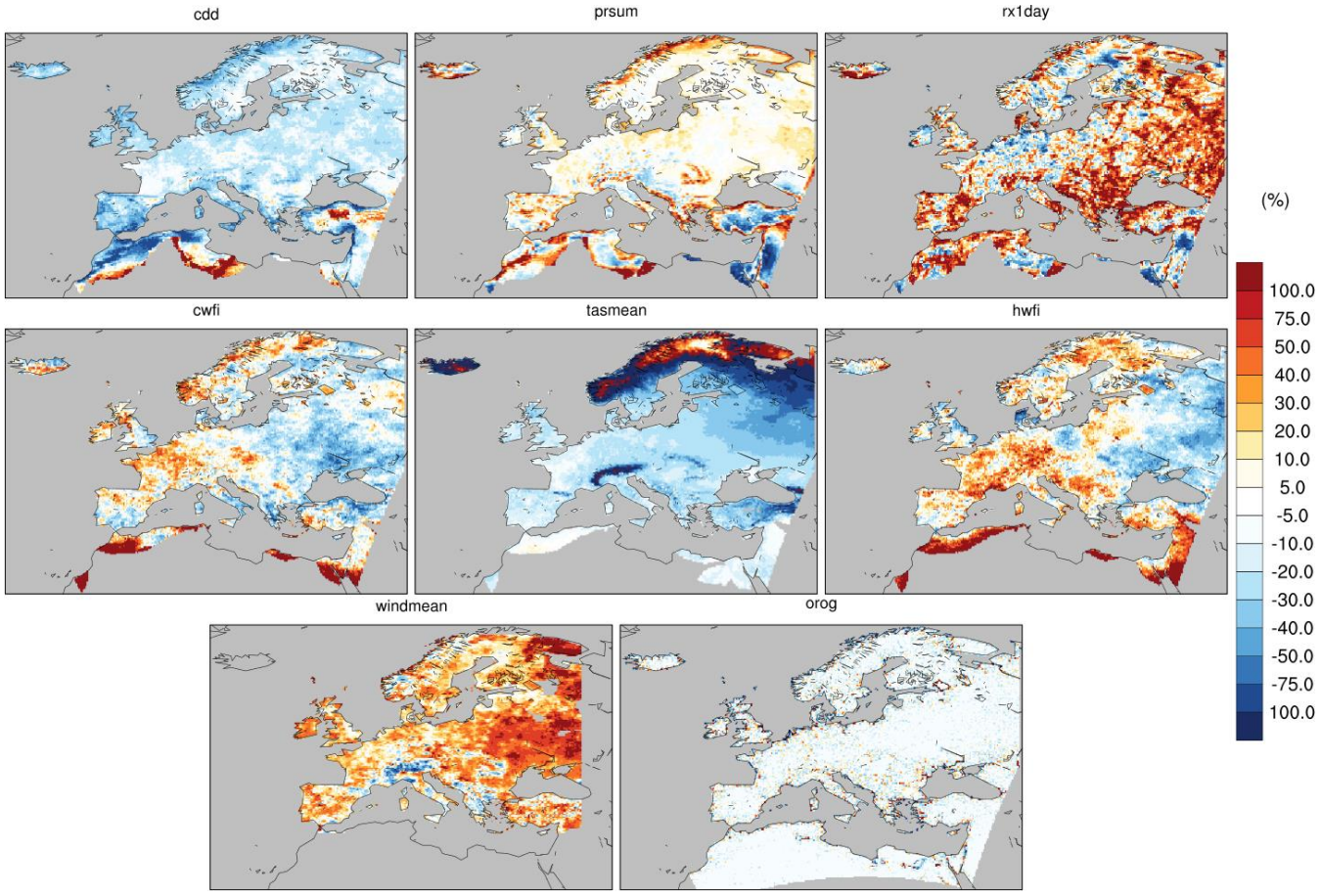


Figure S30. Percentage bias for climate indices from the 30-year ICTP-RegCM4-6 compared to E-OBS dataset (1980-2010).



135 **Figure S31. Percentage bias for climate indices from the 30-year KNMI-RACMO22E compared to E-OBS dataset (1980-2010).**

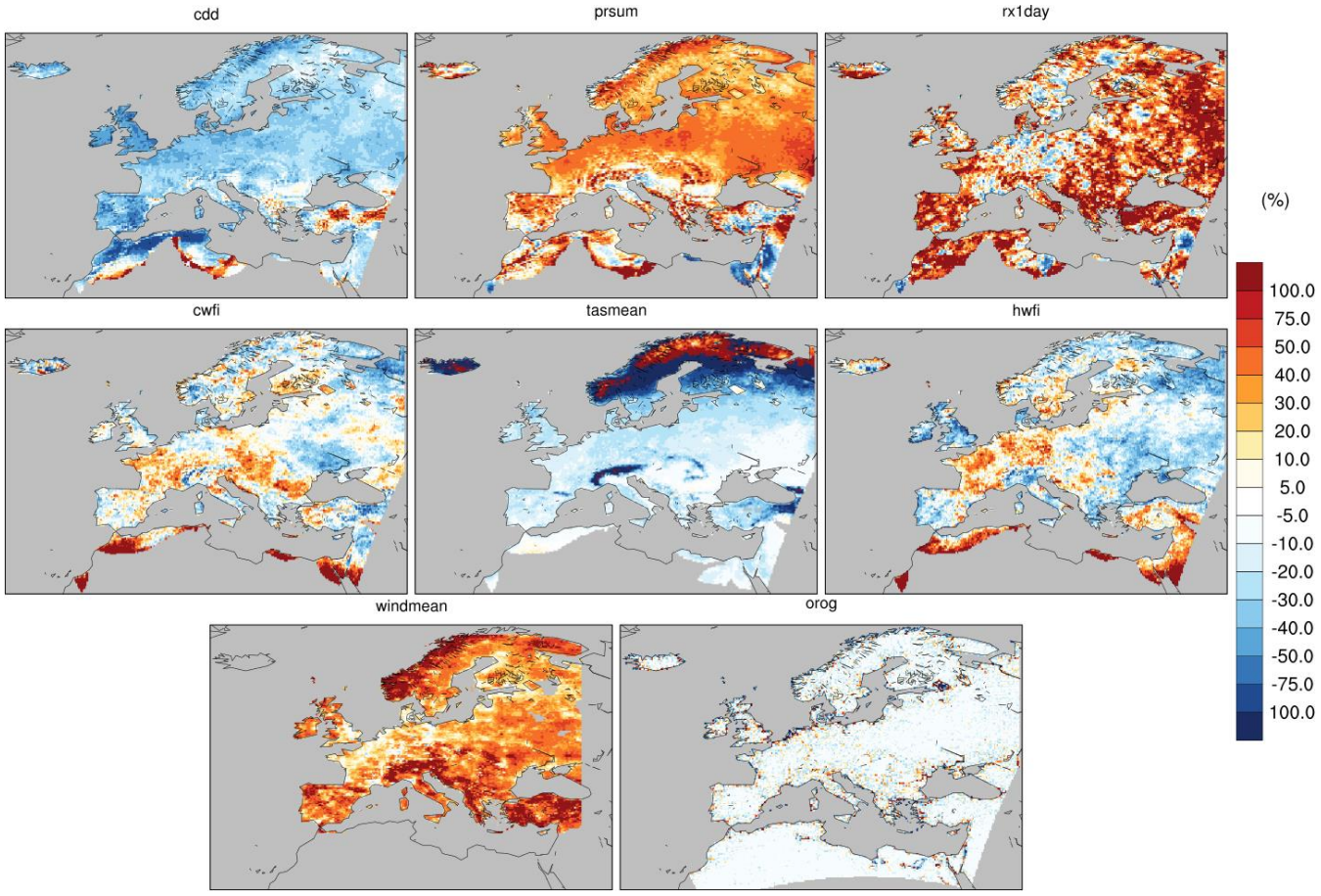


Figure S32. Percentage bias for climate indices from the 30-year SMHI-RCA4 compared to E-OBS dataset (1980-2010).