



Supplement of

Investigation of the extreme wet–cold compound events changes between 2025–2049 and 1980–2004 using regional simulations in Greece

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Supplementary material

	<i>HNMS</i>	<i>CNRM</i>	<i>KNMI</i>	<i>CLMcom</i>	<i>SMHI</i>	<i>DMI</i>	<i>WRF_EC</i>	<i>ENSEMBLE</i>	<i>ERA5</i>	<i>WRF_ERA_I</i>
1	0.1770	0.3310	0.2868	0.4222	0.0000	0.0663	0.2427	0.22484	0.2648	0.3089
2	0.0000	0.0000	0.0221	0.0667	0.0000	0.0000	0.0221	0.01847	0.0000	0.0221
3	0.2210	1.5446	0.5296	0.2222	0.0883	0.1326	0.3972	0.48573	0.3972	0.4634
4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000
5	0.0440	0.0221	0.1103	0.0000	0.0221	0.0000	0.0000	0.02574	0.0000	0.0000
6	0.7500	1.0812	0.3530	0.6000	0.1986	0.0000	0.3972	0.43833	0.4192	0.3751
7	0.0440	0.0000	0.0441	0.0000	0.0000	0.0000	0.0000	0.00736	0.0000	0.0000
8	0.0220	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000
9	0.1320	0.1324	0.0441	0.0444	0.0441	0.0000	0.0662	0.05522	0.0000	0.0000
10	0.1100	0.0883	0.0221	0.0667	0.0221	0.0442	0.0221	0.04422	0.0000	0.0441
11	0.0440	0.0221	0.0221	0.0000	0.0000	0.0000	0.0000	0.00736	0.0000	0.0000
12	0.0220	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000
13	0.0220	0.0883	0.0000	0.0222	0.0000	0.0000	0.0000	0.01841	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0221	0.0000	0.0000	0.00368	0.0000	0.0000
16	0.0440	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0221
17	0.0220	0.0000	0.0221	0.0222	0.0221	0.0000	0.0000	0.01106	0.0000	0.0000
18	0.0440	0.0000	0.0000	0.0222	0.0000	0.0000	0.0000	0.00370	0.0000	0.0221
19	0.1770	0.0662	0.1765	0.1111	0.0221	0.0000	0.0221	0.06633	0.0221	0.1545
20	0.5520	1.2798	0.4192	0.2889	0.0883	0.0884	0.7944	0.49315	0.1986	0.6620
21	0.0440	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000
22	0.9147	1.7283	0.5112	0.6863	0.2434	0.2925	0.7546	0.7027	0.3895	2.0448
23	0.0446	0.0662	0.0662	0.0222	0.0000	0.0000	0.0000	0.0258	0.0000	0.0000
24	0.2364	0.1051	0.2364	0.2116	0.0000	0.0000	0.0525	0.1009	0.0525	0.0263
25	0.1363	0.1103	0.2427	0.2222	0.0000	0.0000	0.0000	0.0959	0.1324	0.0662
26	0.0000	0.0441	0.0221	0.0222	0.0000	0.0000	0.0000	0.0147	0.0000	0.0000
27	0.0000	0.0828	0.1103	0.0556	0.0276	0.0000	0.0000	0.0460	0.0000	0.0000
28	0.2101	0.2101	0.1839	0.1587	0.0000	0.0000	0.4203	0.1622	0.0000	0.2889
29	0.1051	0.0263	0.0263	0.0265	0.0000	0.0000	0.0000	0.0132	0.0000	0.0000
30	0.0264	0.0525	0.0525	0.0529	0.0000	0.0000	0.2364	0.0657	0.0000	0.1051

Table S1: RR20-FD probabilities using the empirical method for all stations and models. ENSEMBLE is the mean of the 6 projection models (CNRM, KNMI, CLMcom, SMHI, DMI, WRF_EC).

	<i>HNMS</i>	<i>CNRM</i>	<i>KNMI</i>	<i>CLMcom</i>	<i>SMHI</i>	<i>DMI</i>	<i>WRF_EC</i>	<i>ENSEMBLE</i>	<i>ERA5</i>	<i>WRF_ERA_I</i>
1	0.0000	0.0000	0.0000	0.0889	0.0000	0.0000	0.0441	0.0222	0.0000	0.0441
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0444	0.0000	0.0000	0.0000	0.0074	0.0221	0.0441
4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.1320	0.0221	0.1324	0.2000	0.0221	0.0000	0.0441	0.0701	0.0662	0.0662
7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

10	0.0000	0.0000	0.0000	0.0222	0.0000	0.0000	0.0000	0.0037	0.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	0.0220	0.0221	0.0221	0.0000	0.0000	0.0000	0.0000	0.0074	0.0000	0.0662
20	0.0660	0.0221	0.0441	0.0889	0.0000	0.0000	0.1765	0.0553	0.0000	0.0883
21	0.0220	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
22	0.1978	0.0000	0.2191	0.2206	0.0000	0.0488	0.2678	0.1260	0.0974	0.8033
23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	0.1051	0.0000	0.0263	0.0265	0.0000	0.0000	0.0263	0.0132	0.0000	0.0000
25	0.0227	0.0000	0.0662	0.0222	0.0000	0.0000	0.0000	0.0147	0.0221	0.0000
26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28	0.0000	0.0263	0.0000	0.0265	0.0000	0.0000	0.1051	0.0263	0.0000	0.0525
29	0.0788	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	0.0000	0.0263	0.0000	0.0000	0.0000	0.0000	0.0788	0.0175	0.0000	0.0263

Table S2: RR20-ID probabilities using the empirical method for all stations and models. ENSEMBLE is the mean of the 6 projection models (CNRM, KNMI, CLMcom, SMHI, DMI, WRF_EC).

	<i>HNMS</i>	<i>CNRM</i>	<i>KNMI</i>	<i>CLMcom</i>	<i>SMHI</i>	<i>DMI</i>	<i>WRF_EC</i>	<i>ENSEMBLE</i>	<i>ERA5</i>	<i>WRF_ERA_I</i>
1	0.3964	0.3559	0.2959	1.3846	0.0326	0.1579	0.2043	0.4052	0.2358	0.2477
2	0.0268	0.0428	0.0507	0.1342	0.0110	0.0022	0.0179	0.0431	0.0055	0.0122
3	0.8588	1.4363	0.4953	0.5755	0.2382	0.5554	0.5561	0.6428	0.5601	0.3295
4	0.0000	0.0055	0.0020	0.0046	0.0000	0.0000	0.0000	0.0020	0.0000	0.0000
5	0.0547	0.0413	0.1966	0.1335	0.0110	0.0013	0.0017	0.0642	0.0000	0.0076
6	0.7737	1.1540	0.2341	0.6626	0.2335	0.0801	0.2707	0.4392	0.3390	0.3978
7	0.1008	0.0082	0.0329	0.0316	0.0158	0.0182	0.0003	0.0178	0.0013	0.0000
8	0.0127	0.0005	0.0005	0.0063	0.0022	0.0017	0.0067	0.0030	0.0000	0.0026
9	0.2444	0.3143	0.0377	0.1509	0.0399	0.0286	0.0917	0.1105	0.0955	0.0516
10	0.1765	0.0143	0.0386	0.1091	0.0042	0.0194	0.0882	0.0456	0.0045	0.0805
11	0.0709	0.0465	0.0314	0.046	0.0006	0.0000	0.0000	0.0208	0.0021	0.0000
12	0.0285	0.0000	0.0000	0.0021	0.0007	0.0000	0.0000	0.0005	0.0000	0.0000
13	0.0334	0.1040	0.0081	0.2911	0.0146	0.0000	0.0020	0.0700	0.0028	0.0032
14	0.0000	0.0100	0.0002	0.007	0.0020	0.0000	0.0024	0.0036	0.0000	0.0008
15	0.0000	0.0057	0.0026	0.0138	0.0015	0.0000	0.0000	0.0039	0.0000	0.0000
16	0.0376	0.0042	0.0173	0.1077	0.0056	0.0207	0.0184	0.0290	0.0000	0.0213
17	0.0189	0.0076	0.0007	0.0315	0.0158	0.0045	0.0000	0.0100	0.0000	0.0000
18	0.0128	0.0000	0.0165	0.0126	0.0004	0.0000	0.0124	0.0070	0.0000	0.0017
19	0.1887	0.0559	0.1133	0.2141	0.0214	0.0408	0.0341	0.0799	0.0182	0.0930
20	0.9920	1.8309	0.5863	0.4755	0.0642	0.1079	1.0651	0.6883	0.2937	0.8393
21	0.2396	0.0045	0.0025	0.0073	0.0016	0.0000	0.0002	0.0027	0.0000	0.0006

22	0.8697	2.2732	0.5537	0.8103	0.5031	0.4115	0.8130	0.8941	0.2750	1.3189
23	0.0272	0.1081	0.0943	0.0668	0.0106	0.0267	0.0001	0.0511	0.0010	0.0245
24	0.2742	0.2129	0.3725	0.2910	0.0227	0.0154	0.1191	0.1723	0.0573	0.1767
25	0.1444	0.2965	0.2271	0.2813	0.0300	0.0048	0.0805	0.1534	0.1729	0.1057
26	0.0582	0.0610	0.0330	0.0267	0.0128	0.0069	0.0028	0.0239	0.0056	0.0053
27	0.0397	0.0806	0.1036	0.1415	0.0034	0.0324	0.0083	0.0616	0.0077	0.0007
28	0.1915	0.2855	0.1735	0.1585	0.0283	0.0276	0.4183	0.1820	0.0160	0.5450
29	0.1267	0.0286	0.0428	0.1174	0.0070	0.0160	0.0152	0.0378	0.0000	0.0048
30	0.0490	0.1345	0.1087	0.0929	0.0092	0.0043	0.1838	0.0889	0.0022	0.0931

Table S3: RR20-FD probabilities using the copula method for all stations and models. ENSEMBLE is the mean of the 6 projection models (CNRM, KNMI, CLMcom, SMHI, DMI, WRF_EC).

	<i>HNMS</i>	<i>CNRM</i>	<i>KNMI</i>	<i>CLMcom</i>	<i>SMHI</i>	<i>DMI</i>	<i>WRF_EC</i>	<i>ENSEMBLE</i>	<i>ERA5</i>	<i>WRF_ERA_I</i>
1	0.0138	0.0821	0.0222	0.2564	0.0008	0.0204	0.0601	7.367E-02	0.0746	0.0639
2	0.0015	0.0013	0.0007	0.0049	0.0007	0.0000	0.0107	3.050E-03	0.0000	0.0000
3	0.0462	0.1305	0.0535	0.0919	0.0479	0.0054	0.0865	6.928E-02	0.0361	0.0822
4	0.0000	0.0000	0	0.0009	0.0000	0.0000	0.0000	1.500E-04	0.0000	0.0000
5	0.0000	0.0000	0	0.0036	0.0000	0.0000	0.0000	6.000E-04	0.0000	0.0000
6	0.2832	0.1710	0.0632	0.1771	0.0627	0.0040	0.0785	9.275E-02	0.1592	0.1520
7	0.0000	0.0000	0	0.0000	0.0000	0.0000	0.0000	0.000E+00	0.0000	0.0000
8	0.0045	0.0000	0	0.0004	0.0000	0.0000	0.0000	6.667E-05	0.0000	0.0000
9	0.0278	0.0080	0.0496	0.0185	0.0022	0.0001	0.0028	1.353E-02	0.0027	0.0096
10	0.0145	0.0071	0.0036	0.0172	0.0003	0.0006	0.0248	8.933E-03	0.0000	0.0422
11	0.0066	0.0000	0	0.0009	0.0000	0.0000	0.0000	1.500E-04	0.0000	0.0000
12	0.0000	0.0000	0	0.0000	0.0000	0.0000	0.0000	0.000E+00	0.0000	0.0000
13	0.0000	0.0092	0	0.0164	0.0031	0.0000	0.0010	4.950E-03	0.0000	0.0011
14	0.0000	0.0000	0	0.0003	0.0000	0.0000	0.0000	5.000E-05	0.0000	0.0000
15	0.0000	0.0000	0	0.0005	0.0000	0.0000	0.0000	8.333E-05	0.0000	0.0000
16	0.0000	0.0000	0	0.0061	0.0044	0.0000	0.0023	2.133E-03	0.0000	0.0000
17	0.0045	0.0000	0	0.0006	0.0014	0.0000	0.0000	3.333E-04	0.0000	0.0000
18	0.0000	0.0000	0	0.0018	0.0000	0.0000	0.0000	3.000E-04	0.0000	0.0000
19	0.0345	0.0619	0.0554	0.0310	0.0024	0.0006	0.0706	0.0370	0.0020	0.0423
20	0.1403	0.3231	0.1069	0.0934	0.0133	0.0052	0.1866	0.1214	0.0151	0.1819
21	0.0139	0.0000	0	0.0000	0.0000	0.0000	0.0000	0.000	0.0000	0.0000
22	0.2115	0.3767	0.1942	0.2613	0.1628	0.0502	0.4437	0.2482	0.1441	0.7707
23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018
24	0.0410	0.0592	0.0895	0.0429	0.0014	0.0000	0.0122	0.0342	0.0000	0.0043
25	0.0136	0.0210	0.0523	0.0391	0.0022	0.0000	0.0339	0.0248	0.0674	0.0122
26	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
27	0.0000	0.0065	0.0000	0.0023	0.0000	0.0000	0.0000	0.0015	0.0000	0.0000
28	0.0364	0.0180	0.0272	0.1072	0.0013	0.0000	0.0949	0.0414	0.0000	0.1022
29	0.1001	0.0033	0.0000	0.0036	0.0035	0.0000	0.0023	0.0021	0.0000	0.0000
30	0.0005	0.0121	0.0029	0.0108	0.0006	0.0000	0.0539	0.0134	0.0000	0.0123

Table S4: RR20-ID probabilities using the copula method for all stations and models. ENSEMBLE is the mean of the 6 projection models (CNRM, KNMI, CLMcom, SMHI, DMI, WRF_EC).

	HNMS	CNRM	KNMI	CLMcom	SHMI	DMI	WRF_EC	ERA5	WRF_ERA_I
1	Rot. BB8 270 deg	Rot. BB8 90 deg	Rot. BB8 90 deg	Rot. Tawn type 1 180 deg	t	Rot. BB8 90 deg	Gaussian	Frank	Rot. BB7 270 deg.
2	Frank	Rot. BB8 90 deg	Rot. BB8 90 deg	Rot. Tawn type 1 180 deg	Rot. Tawn type 2 90 deg	Rot. Tawn type 1 180 deg	Clayton	Rot Gumbel 270 deg	Clayton
3	Rot. BB8 270 deg	Rot. BB8 90 deg	Rot. BB8 90 deg	Rot. Tawn type 1 270 deg	Rot. BB8 270 deg	Rot. Tawn type 2 90 deg	Rot. Tawn type 1 270 deg	Rot. BB8 270 deg	Rot. Tawn type 1 270 deg
4	Gaussian	Rot. BB8 270 deg	Rot. BB8 270 deg	Frank	Rot. Tawn type 1 270 deg	Clayton	Gaussian	BB8	Survival BB8
5	Gaussian	Rot. Tawn type 1 270 deg	Frank	Survival BB8	Rot. Tawn type 2 90 deg	Clayton	Rot. Tawn type 1 270 deg	Rot. BB8 270 deg	Rot. Tawn type 2 180 deg
6	Rot. BB8 270 deg	Rot. BB8 90 deg.	Rot. BB8 90 deg	Survival Joe	t	Rot. Tawn type 1 180 deg	Rot. Tawn type 1 270 deg	Rot. BB8 270 deg	Rot. Tawn type 1 270 deg
7	Rot. BB8 270 deg	Rot. Joe 270 deg.	Frank	Rot. Tawn type 2 90 deg	Rot. BB8 270 deg	Rot. BB8 90 deg	Rot. Tawn type 1 270 deg	Rot. BB8 270 deg	Rot. Clayton 90 deg
8	Survival BB8	Rot. Clayton 90 deg.	Gaussian	Survival BB8	Gaussian	Rot. Tawn type 1 180 deg	Gaussian	Frank	Rot, Tawn type 2 180 deg
9	Rot. BB8 270 deg	Rot. Tawn type 2 90 deg	Rot. BB8 90 deg	Survival BB8	t	Rot. Tawn type 1 180 deg	Rot. BB8 270 deg	Rot. BB8 270 deg	Rot. Tawn type 1 270 deg
10	Rot. BB8 270 deg	Rot. Tawn type 2 270 deg	Frank	Survival BB8	Gaussian	Rot. Tawn type 1 180 deg	Tawn type 1	BB8	Rot. Clayton 90 deg
11	Rot. Tawn type 2 180 deg	Rot. BB8 270 deg	Rot. BB8 270 deg	Clayton	Gaussian	Rot. Tawn type 1 180 deg	Rot. Tawn type 1 270 deg	Rot Clayton 90 deg	Clayton
12	Gaussian	BB8	Gaussian	Survival BB8	Rot. Tawn type 1 270 deg	Frank	BB8	BB8	Gaussian
13	Rot. BB8 270 deg	Rot. BB8 90 deg	Frank	Rot. Tawn type 1 180 deg	Rot. BB8 90 deg	Rot. Tawn type 1 180 deg	Rot. Tawn type 1 270 deg	Frank	Rot. BB8 270 deg
14	Survival BB8	Rot. BB8 270 deg	Rot. Tawn type 2 270 deg	Survival BB8	Rot. Tawn type 2 90 deg	Rot. Tawn type 1 180 deg	Gaussian	BB8	Rot, Tawn type 2 180 deg
15	Rot. Tawn type 2 180 deg	Rot. Tawn type 1 270 deg	Rot. BB7 270 deg.	Survival BB8	Gaussian	Rot. Tawn type 1 180 deg	Rot. Tawn type 1 270 deg	Rot, Tawn type 2 180 deg	Gaussian
16	Rot. BB8 270 deg	Rot. Clayton 90 deg	Rot. BB8 90 deg	Rot. Tawn type 1 180 deg	Rot. BB8 90 deg	Rot. Tawn type 1 180 deg	Rot. BB8 270 deg	Rot. BB7 270 deg.	Rot. Clayton 90 deg
17	Rot. Tawn type 2 180 deg	BB8	Rot. Tawn type 2 270 deg	Survival BB8	Rot. Tawn type 2 90 deg	Rot. Tawn type 1 180 deg	BB8	BB8	Gaussian
18	Gaussian	Clayton	Tawn type 1	Survival BB8	Rot. Tawn type 1 270 deg	BB7	Gaussian	BB8	Survival BB8
19	Rot. BB8 270 deg	Rot. BB7 270 deg.	Frank	Survival BB8	Rot. BB8 90 deg	Rot. Tawn type 1 180 deg	Rot. Clayton 90 deg	Rot. Joe 270 deg	Rot. Tawn type 1 270 deg
20	Rot. BB8 270 deg	Rot. Tawn type 1 270 deg	Rot. BB8 90 deg	Survival BB8	Rot. Tawn type 1 270 deg	Clayton	Rot. Tawn type 2 180 deg	Rot. BB7 270 deg.	Clayton
21	Rot. Tawn type 2 90 deg	Rot. BB8 270 deg.	Rot. BB7 270 deg.	Survival BB8	t	Rot. Tawn type 1 180 deg	Rot. Tawn type 1 270 deg	Frank	Rot. Tawn type 1 270 deg
22	Tawn type 1	Frank	Rot BB8 270 deg	Clayton	Rot BB8 270 deg	Rot Tawn type 2 90 deg	Rot Tawn type 1 270 deg	Rot BB8 270 deg	Rot BB8 270 deg
23	Rot BB8 270 deg	Rot BB8 270 deg	Rot BB8 270 deg	Rot Tawn type 2 90 deg	Rot BB8 270 deg	Rot Tawn type 2 90 deg	Rot Tawn type 1 270 deg	Rot BB8 270 deg	Rot Tawn type 1 270 deg
24	Tawn type 2	t	Rot BB8 90 deg	Survival BB8	Clayton	Clayton	Rot Tawn type 2 180 deg	Rot BB8 270 deg	Survival BB8
25	Rot BB8 270 deg	t	Rot BB8 90 deg	Survival BB8	Rot Tawn type 2 90 deg	Clayton	Gaussian	Rot Tawn type 2 180 deg	Gaussian
26	Gaussian	Rot Tawn type 1 270 deg	Rot BB8 270 deg	Survival BB8	Rot Tawn type 1 270 deg	Rot Tawn type 2 90 deg	Rot Tawn type 2 180 deg	Rot BB8 270 deg	Rot Tawn type 2 180 deg
27	Tawn type 1	Rot Tawn type 2 90 deg	Rot BB8 90 deg	Survival BB8	Rot Tawn type 2 90 deg	Clayton	Clayton	Rot BB8 270 deg	Rot Tawn type 2 180 deg
28	Frank	Rot BB8 270 deg	Frank	Survival BB8	Rot Tawn type 2 90 deg	Clayton	Rot Tawn type 2 180 deg	Rot BB8 270 deg	Clayton
29	Rot Tawn type 2 180 deg	Rot BB8 270 deg	Rot Tawn type 2 270 deg	Survival BB8	Rot Tawn type 2 90 deg	Clayton	Gaussian	Rot Joe 270 deg	Gaussian
30	Frank	Rot BB1 270 deg	Rot BB8 90 deg	Rot Tawn type 1 180 deg	Rot BB8 90 deg	Rot Tawn type 1 180 deg	Rot BB8 270 deg	Frank	Rot BB8 270 deg

Table S5: Copula families chosen in every station for the bivariate case of precipitation (RR) and negative minimum temperature (-TN).

	HNMS	CNRM	KNMI	CLMcom	SHMI	DMI	WRF_EC	ERA5	WRF_ERA_I
1	Rot. Tawn type 1 270 deg	Survival Joe	Rot. BB8 270 deg	Survival BB8	Rot. Tawn type 1 270 deg	Survival BB8	Rot. Tawn type 2 180 deg	Gaussian	Rot. Tawn type 2 180 deg
2	Survival BB8	Clayton	Rot. Tawn type 2 180 deg	Survival BB8	Survival BB8	Survival BB8	Gaussian	Gaussian	Gaussian
3	Rot. Tawn type 2 180 deg	Rot. Tawn type 2 180 deg	Rot. Tawn type 2 180 deg	Survival BB8	Rot. Tawn type 2 180 deg	Clayton	Rot. Tawn type 2 180 deg	Rot. Tawn type 2 180 deg	Rot. Tawn type 2 180 deg
4	BB8	Gaussian	Survival BB1	Frank	T	BB1	Gaussian	BB8	Frank
5	Survival BB8	Rot. Tawn type 2 180 deg	Rot. Tawn type 2 180 deg	Survival BB8	Survival BB8	Survival BB8	Rot. Tawn type 2 180 deg	Rot. Tawn type 2 180 deg	Rot. Tawn type 2 180 deg

6	Survival BB8	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg	Survival BB 8	Rot.Tawn type 2 180 deg	Survival BB 8	Rot.Tawn type 2 180 deg	Gaussian	Rot.Tawn type 2 180 deg
7	Survival BB8	t	Rot.Tawn type 2 180 deg	Survival BB 8	Rot.Tawn type 2 180 deg	Clayton	Rot. Tawn type 1 270 deg	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg
8	Survival BB8	Rot.Tawn type 2 180 deg	Clayton	Survival BB 8	Survival BB8	Survival BB 8	Gaussian	Frank	Rot.Tawn type 2 180 deg
9	Survival BB8	Survival BB 8	Tawn type 1	Survival BB 8	Rot.Tawn type 2 180 deg	Survival BB 8	Rot.Tawn type 2 180 deg	BB8	Rot.Tawn type 2 180 deg
10	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg	Survival BB 8	Rot. Tawn type 1 270 deg	Survival BB 8	Gaussian	Tawn type 2	Tawn type 1
11	Frank	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg	Survival BB 8	Survival BB8	Survival BB 8	Rot. Tawn type 1 270 deg	Survival BB 8	Survival BB 8
12	Survival BB8	Rot.Tawn type 2 180 deg	Rot. Clayton 270 deg	Survival BB 8	Survival BB8	Rot.Tawn type 1 180 deg	Gaussian	BB8	Frank
13	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg	Rot. BB8 270 deg	Survival BB 8	Rot.Tawn type 2 180 deg	Rot.Tawn type 1 180 deg	Rot.Tawn type 2 180 deg	Rot. BB8 270 deg	Rot.Tawn type 2 180 deg
14	Survival BB8	Rot.Tawn type 2 180 deg	Rot. Tawn type 1 180 deg	Survival BB 8	Survival BB8	Survival BB 8	Gaussian	Tawn type 2	Rot.Tawn type 2 180 deg
15	Survival BB8	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg	Survival BB 8	Rot.Tawn type 2 180 deg	Survival BB 8	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg
16	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg	Rot. BB8 270 deg	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg	Clayton	Rot.Tawn type 2 180 deg	Rot. BB8 270 deg	Rot.Tawn type 2 180 deg
17	Gaussian	Rot.Tawn type 2 180 deg	Tawn type 2	Survival BB 8	Survival BB8	Survival BB 8	Gaussian	BB8	Survival BB 8
18	Frank	Gaussian	Gaussian	Frank	t	Gaussian	Gaussian	Frank	BB8
19	Gaussian	t	Tawn type 1	Survival BB 8	Rot.Tawn type 2 180 deg	Survival BB 8	Tawn type 1	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg
20	Survival BB8	Rot.Tawn type 2 180 deg	Survival BB8	Survival BB 8	Survival BB8	Survival BB 8	Survival BB8	Survival BB 8	Survival BB 8
21	Frank	Rot.Tawn type 2 180 deg	Rot.Tawn type 2 180 deg	Survival BB 8	Survival BB8	Survival BB 8	RotTawn type 2 180 deg	Frank	Rot.Tawn type 2 180 deg
22	Tawn type 1	Clayton	Rot Tawn type 2 180 deg	Survival BB 8	Rot Tawn type 2 180 deg	Survival BB 8	Rot Clayton 90 deg	Ro Tawn type 2 270 deg	Rot Tawn type 2 180 deg
23	Survival BB8	Rot Tawn type 2 180 deg	Rot Tawn type 2 180 deg	Survival BB 8	Rot Tawn type 2 180 deg	Survival BB 8	Rot Tawn type 2 180 deg	Rot Tawn type 2 180 deg	Rot Tawn type 2 180 deg
24	Gaussian	BB1	Frank	Survival BB 8	Survival BB8	Survival BB 8	Gaussian	Gaussian	Frank
25	Frank	BB1	Rot Tawn type 2 180 deg	Survival BB 8	Survival BB8	Survival BB 8	Gaussian	Gaussian	Gaussian
26	Survival BB8	Rot Tawn type 2 180 dg	Rot Tawn type 2 180 deg	Survival BB 8	Rot Tawn type 2 180 deg	Survival BB 8	Rot Tawn type 2 180 deg	RotTawn type 2 180 deg	Rot Tawn type 2 180 deg
27	Survival Clayton	Rot Tawn type 2 180 dg	Rot Tawn type 2 180 dg	Survival BB 8	Rot Tawn type 2 180 deg	Survival BB 8	Gaussian	Gaussian	Gaussian
28	Frank	Tawn type 1	Frank	Survival BB 8	Survival BB8	BB1	Gaussian	Gaussian	Survival BB 8
29	Frank	Rot Tawn type 2 180 deg	BB8	Gaussian	Survival BB8	Gaussian	Gaussian	Gaussian	Gaussian
30	Frank	Rot Tawn type 2 180 deg	Rot BB8 270 deg	Survival BB 8	Rot Tawn type 2 180 deg	Survival BB 8	Rot Tawn type 2 180 deg	Rot Tawn type 2 180 deg	Rot Tawn type 2 180 deg

Table S6: Copula families chosen in every station for the bivariate case of precipitation (RR) and negative maximum temperature (-TX).

	A	B	C	D
CNRM	17	7	4	2
KNMI	18	6	3	3
CLMcom	17	7	3	3
SMHI	9	15	4	2
DMI	5	19	6	0
WRF_EC	11	13	5	1
ENSEMBLE	20	4	2	4
ERA5	8	16	6	0
WRF_ERA_I	13	11	5	1

Table S7: Empirical probabilities RR20FD contingency table where “A” is the number of non-zero probability from models that correspond to non-zero probability observations, or the number of hits. Entry "B" is the number of non-zero probability from models and zero probability observations, or the number of false alarms. Entry "C" is the number of zero probability from projections corresponding to non-zero probability observations, or the number of misses. Entry "D" is the number of zero probabilities both for models and observations, or the number of correct rejections.

	A	B	C	D
<i>CNRM</i>	3	5	20	2
<i>KNMI</i>	6	2	22	0
<i>CLMcom</i>	5	3	18	4
<i>SMHI</i>	1	7	22	0
<i>DMI</i>	1	7	22	0
<i>WRF_EC</i>	4	4	19	3
<i>ENSEMBLE</i>	6	2	17	5
<i>ERA5</i>	3	5	21	1
<i>WRF_ERA_I</i>	4	4	18	4

Table S8: Empirical probabilities RR20ID contingency table where “A” is the number of non-zero probability from models that correspond to non-zero probability observations, or the number of hits. Entry “B” is the number of non-zero probability from models and zero probability observations, or the number of false alarms. Entry “C” is the number of zero probability from projections corresponding to non-zero probability observations, or the number of misses. Entry “D” is the number of zero probabilities both for models and observations, or the number of correct rejections.

	A	B	C	D
<i>CNRM</i>	25	2	0	3
<i>KNMI</i>	26	1	0	3
<i>CLMcom</i>	27	0	0	3
<i>SMHI</i>	27	0	1	2
<i>DMI</i>	22	5	3	0
<i>WRF_EC</i>	24	3	2	1
<i>ENSEMBLE</i>	27	0	0	3
<i>ERA5</i>	19	8	3	0
<i>WRF_ERA_I</i>	23	4	2	1

Table S9: Copula probabilities RR20FD contingency table where “A” is the number of non-zero probability from models that correspond to non-zero probability observations, or the number of hits. Entry “B” is the number of non-zero probability from models and zero probability observations, or the number of false alarms. Entry “C” is the number of zero probability from projections corresponding to non-zero probability observations, or the number of misses. Entry “D” is the number of zero probabilities both for models and observations, or the number of correct rejections.

	A	B	C	D
<i>CNRM</i>	14	4	10	2
<i>KNMI</i>	13	5	12	0
<i>CLMcom</i>	17	1	3	9
<i>SMHI</i>	15	3	10	2
<i>DMI</i>	8	10	12	0
<i>WRF_EC</i>	14	4	10	2
<i>ENSEMBLE</i>	17	1	3	9
<i>ERA5</i>	8	10	12	0
<i>WRF_ERA_I</i>	12	6	10	2

Table S10: Copula probabilities RR20ID contingency table where “A” is the number of non-zero probability from models that correspond to non-zero probability observations, or the number of

hits. Entry "B" is the number of non-zero probability from models and zero probability observations, or the number of false alarms. Entry "C" is the number of zero probability from projections corresponding to non-zero probability observations, or the number of misses. Entry "D" is the number of zero probabilities both for models and observations, or the number of correct rejections.

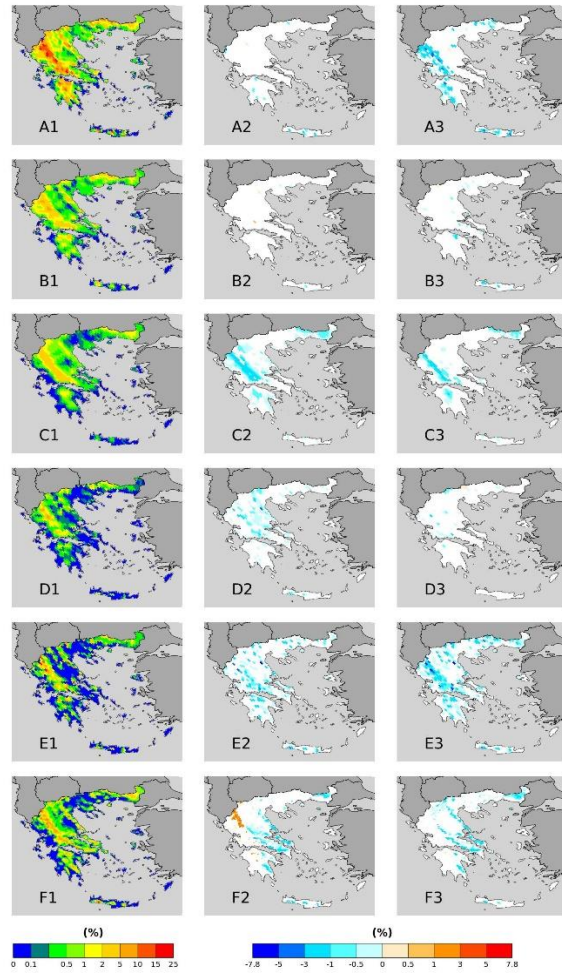


Figure S1: Empirical RR20FD probabilities for all projection models and difference between past and future. Column 1 is historical period and Columns 2 and 3 are the differences of RCP4.5 and RCP8.5 with the past period. Models exhibited are A) CNRM, B) KNMI, C) CLMcom, D) SMHI, E) DMI and F) WRF_EC.

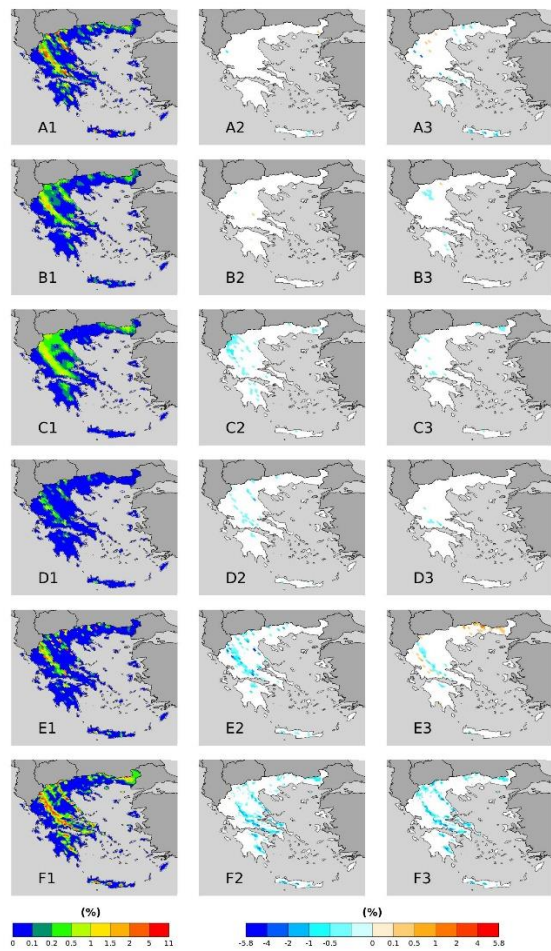


Figure S2: Empirical RR20ID probabilities for all projection models and difference between past and future. Column 1 is historical period and Columns 2 and 3 are the differences of RCP4.5 and RCP8.5 with the past period. Models exhibited are A) CNRM, B) KNMI, C) CLMcom, D) SMHI, E) DMI and F) WRF_EC.

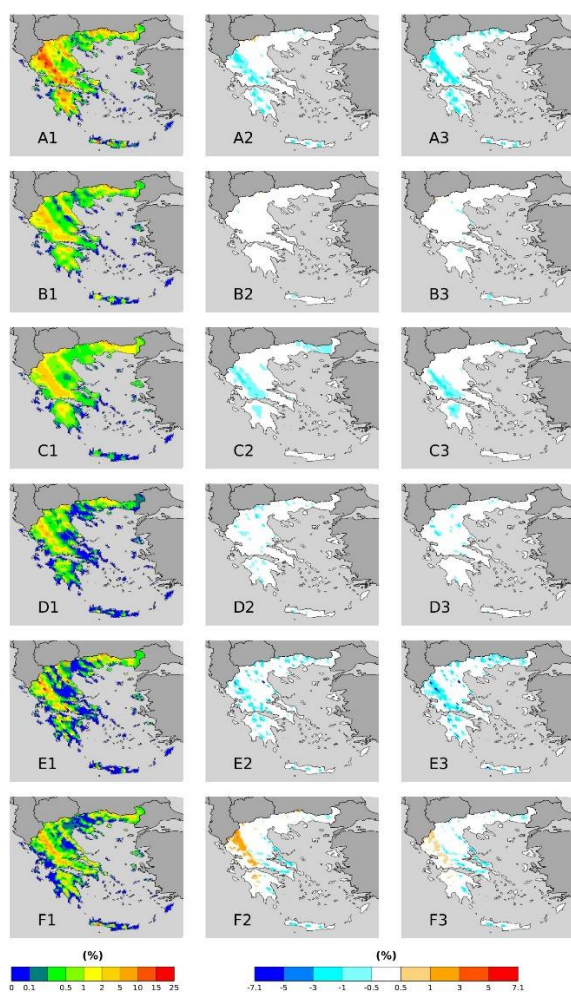


Figure S3: Copula RR20FD probabilities for all projection models and difference between past and future. Column 1 is historical period and Columns 2 and 3 are the differences of RCP4.5 and RCP8.5 with the past period. Models exhibited are A) CNRM, B) KNMI, C) CLMcom, D) SMHI, E) DMI and F) WRF_EC.

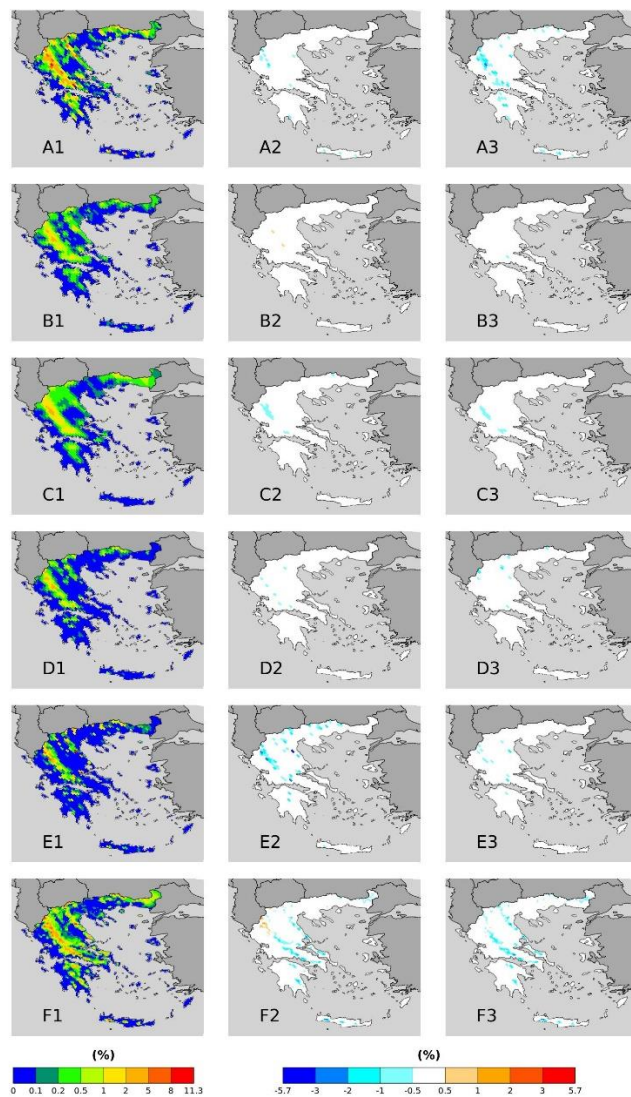


Figure S4: Copula RR20ID probabilities for all projection models and difference between past and future. Column 1 is historical period and Columns 2 and 3 are the differences of RCP4.5 and RCP8.5 with the past period. Models exhibited are A) CNRM, B) KNMI, C) CLMcom, D) SMHI, E) DMI and F) WRF_EC.

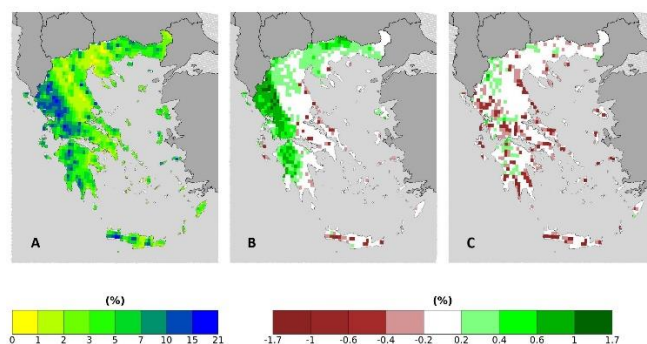


Figure S5: Ensemble RR20 events probability for (A) 1980-2004 and the differences of (2025-2049)-(1980-2004) periods for (B) RCP4.5 and (C) RCP8.5 scenarios.

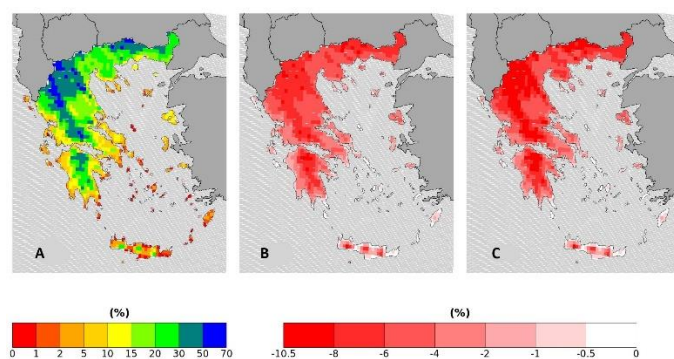


Figure S6: Ensemble FD events probability for (a) 1980-2004 and the differences of (2025-2049)-(1980-2004) periods for (b) RCP4.5 and (c) RCP8.5 scenarios.

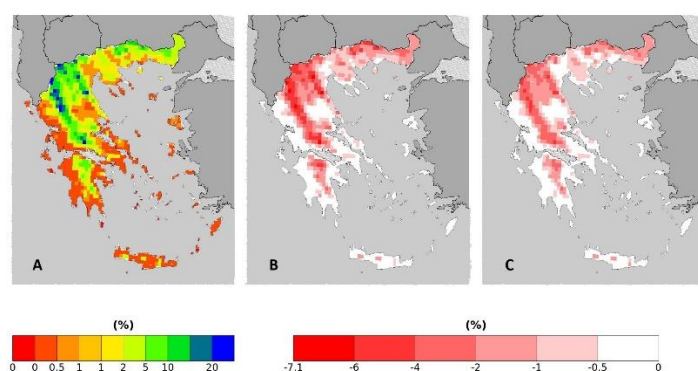


Figure S7: Ensemble ID events probability for (a) 1980-2004 and the differences of (2025-2049)-(1980-2004) periods for (b) RCP4.5 and (c) RCP8.5 scenarios.