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Supplement of

Higher statistical moments and an outlier detection technique as two alternative methods that capture long-term changes in continuous environmental data

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SUPPLEMENT

Table S1 Skewness in probability distributions of daily minimum stream temperature by season and decade at unregulated and regulated streams.

Site	Season/time period											
	fall			winter			spring			summer		
	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99	00-09
site 1	0.335	-0.225	-0.066	-0.543	-0.662	-0.631	0.865	0.747	0.789	-0.221	-0.142	-0.486
site 2	-0.170	-0.225	-0.115	-0.345	-0.538	-0.574	0.823	0.664	0.772	-0.522	-0.220	-0.764
site 3	0.064	-0.025	-0.142	0.152	0.103	-0.805	0.450	0.549	1.010	0.048	-0.204	-0.630
site 4	-0.355	-0.210	-0.185	0.210	0.138	-0.244	1.059	0.831	1.371	-0.859	-0.604	-0.999
site 5	0.109	-0.060	0.003	-0.074	-0.462	-0.206	0.716	1.044	0.963	-0.922	-0.743	-0.821
site 6	-0.300	0.067	-0.283	0.456	-0.005	-0.034	0.647	0.216	0.195	-0.422	0.153	0.744
site 7	0.031	-0.263	-0.177	-0.353	-0.581	-0.340	0.902	0.763	0.771	-0.421	-0.160	-0.606
site 8	-0.836	-0.529	-0.416	0.002	-0.363	-0.143	0.621	0.340	0.633	-0.361	-0.395	-1.335
site 9	0.853	0.877	0.711	0.781	0.562	0.397	0.444	0.277	0.017	0.414	0.329	0.519
site 10	-0.163	-0.137	-0.103	0.187	0.755	-0.118	0.134	0.138	0.200	-1.161	-0.835	-0.229

Table S2 Skewness in probability distributions of daily mean stream temperature by season and decade at unregulated and regulated streams.

Site	Season/time period											
	fall			winter			spring			summer		
	magnitude/direction	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99
site 1	0.364	-0.192	-0.022	-0.466	-0.579	-0.493	1.026	0.827	0.821	-0.292	-0.191	-0.533
site 2	-0.122	-0.182	-0.108	-0.322	-0.572	-0.557	0.902	0.711	0.713	-0.501	-0.192	-0.732
site 3	-0.001	-0.034	-0.156	0.214	0.072	-0.561	0.449	0.506	1.002	-0.079	-0.259	-0.674
site 4	-0.303	-0.218	-0.155	0.217	0.166	-0.060	1.000	0.778	1.335	-0.874	-0.562	-1.015
site 5	0.124	-0.005	0.084	-0.227	-0.607	-0.351	0.641	1.016	0.882	-1.056	-0.640	-0.934
site 6	-0.199	0.099	-0.252	0.484	0.187	-0.058	0.594	0.229	0.306	-0.468	0.218	0.777
site 7	0.027	-0.265	-0.180	-0.322	-0.622	-0.316	0.980	0.777	0.755	-0.518	-0.286	-0.674
site 8	-0.730	-0.465	-0.389	0.107	-0.286	-0.031	0.702	0.420	0.617	-0.402	-0.432	-1.251
site 9	0.806	0.906	0.626	0.795	0.675	0.416	0.418	0.302	0.024	0.394	0.299	0.437
site 10	-0.182	-0.145	-0.061	-0.012	0.609	-0.128	0.120	0.246	0.202	-1.280	-1.023	-0.872

Table S3 Skewness in probability distributions of daily maximum stream temperature by season and decade at unregulated and regulated streams.

Site	Season/time period											
	fall			winter			spring			summer		
	magnitude/direction	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99
site 1	0.382	-0.161	0.018	-0.396	-0.503	-0.369	1.132	0.889	0.857	-0.374	-0.264	-0.576
site 2	-0.066	-0.154	-0.101	-0.335	-0.608	-0.551	0.945	0.741	0.652	-0.477	-0.185	-0.705
site 3	-0.064	0.010	-0.159	0.265	0.082	-0.339	0.509	0.487	0.899	-0.178	-0.332	-0.766
site 4	-0.292	-0.226	-0.162	0.231	0.195	0.145	0.946	0.725	1.208	-0.840	-0.464	-0.874
site 5	0.147	0.069	0.194	-0.355	-0.697	-0.521	0.569	0.893	0.762	-0.960	-0.398	-0.828
site 6	-0.111	0.134	-0.191	0.461	0.300	-0.049	0.545	0.245	0.397	-0.448	0.291	0.794
site 7	0.032	-0.263	-0.185	-0.300	-0.681	-0.317	1.029	0.787	0.756	-0.550	-0.435	-0.775
site 8	-0.581	-0.380	-0.324	0.213	-0.205	0.077	0.772	0.507	0.618	-0.398	-0.459	-1.025
site 9	0.796	0.972	0.552	0.671	0.747	0.363	0.402	0.333	0.042	0.319	0.231	0.264
site 10	-0.147	-0.070	0.005	-0.111	0.477	-0.063	0.109	0.349	0.219	-0.821	-0.723	-0.551

Table S4 Type of excess kurtosis of probability distributions of daily minimum stream temperature by season and decade at unregulated and regulated streams.

Site	Season/time period											
	fall			winter			spring			summer		
	magnitude/direction	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99
site 1	-0.187	-0.268	-0.571	0.768	0.715	0.906	1.193	0.053	0.168	-0.396	-0.428	-0.021
site 2	0.220	-0.240	-0.592	0.119	-0.135	0.671	1.104	0.016	0.208	-0.347	-0.587	0.706
site 3	-0.770	-0.877	-0.806	-0.289	-0.093	1.223	-0.104	-0.269	0.893	-0.598	-0.479	-0.290
site 4	-0.366	-0.480	-0.667	-0.332	0.039	0.065	1.171	0.414	2.004	0.409	-0.046	0.953
site 5	-0.785	-0.983	-0.981	-0.513	-0.038	-0.398	0.172	0.737	0.702	1.288	0.200	0.910
site 6	-0.683	-0.792	-0.790	0.076	0.178	-0.168	0.453	-0.491	-0.052	-0.302	-0.687	0.664
site 7	-0.528	-0.466	-0.639	-0.219	-0.155	0.137	1.275	0.434	0.322	0.056	-0.192	-0.026
site 8	0.960	-0.178	-0.612	0.670	0.314	0.800	-0.140	-0.691	-0.375	0.342	0.660	4.217
site 9	0.037	-0.178	-0.852	0.613	0.314	0.215	-0.955	-0.993	-0.867	-0.896	-0.863	-0.125
site 10	-1.079	-1.066	-1.166	-0.513	2.350	-0.074	-1.052	-0.996	-0.940	2.440	0.958	0.570

Table S5 Type of excess kurtosis of probability distributions of daily mean stream temperature by season and decade at unregulated and regulated streams.

Site	Season/time period											
	fall			winter			spring			summer		
	magnitude/direction	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99
site 1	-0.177	-0.340	-0.551	0.886	0.704	0.770	1.672	0.228	0.188	-0.284	-0.374	0.062
site 2	0.159	-0.301	-0.580	0.194	0.003	0.752	1.291	0.109	0.114	-0.250	-0.509	0.694
site 3	-0.759	-0.872	-0.744	-0.286	-0.006	1.026	-0.091	-0.419	0.582	-0.557	-0.529	-0.114
site 4	-0.370	-0.469	-0.720	-0.427	0.113	0.016	1.054	0.160	1.504	0.586	-0.059	1.251
site 5	-0.893	-1.133	-1.072	-0.319	0.315	-0.116	-0.151	0.750	0.445	1.536	-0.040	0.976
site 6	-0.774	-0.816	-0.828	0.084	-0.047	-0.203	0.214	-0.485	-0.107	-0.336	-0.717	0.704
site 7	-0.544	-0.457	-0.612	-0.095	0.042	0.243	1.463	0.374	0.320	0.239	-0.068	0.195
site 8	0.692	-0.320	-0.639	0.788	0.369	0.860	0.047	-0.591	-0.357	0.227	0.500	3.718
site 9	-0.069	-0.210	-1.000	0.598	0.297	0.403	-1.035	-0.962	-0.887	-0.861	-0.837	-0.345
site 10	-0.958	-1.244	-1.183	-0.501	2.208	-0.658	-1.029	-0.729	-0.921	1.999	1.166	1.753

Table S6 Type of excess kurtosis of probability distributions of daily maximum stream temperature by season and decade at unregulated and regulated streams.

Site	Season/time period											
	fall			winter			spring			summer		
	magnitude/direction	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99	00-09	80-89	90-99
site 1	-0.173	-0.398	-0.508	1.133	0.723	0.767	1.962	0.374	0.285	-0.209	-0.331	0.114
site 2	0.098	-0.319	-0.559	0.311	0.133	0.883	1.278	0.164	0.038	-0.148	-0.401	0.678
site 3	-0.771	-0.852	-0.708	-0.275	0.017	0.891	0.031	-0.412	0.281	-0.483	-0.617	0.148
site 4	-0.352	-0.453	-0.681	-0.462	0.159	0.126	0.802	-0.050	0.917	0.667	-0.035	1.544
site 5	-0.954	-1.191	-1.032	-0.052	0.745	0.290	-0.373	0.588	0.190	1.223	-0.249	0.700
site 6	-0.727	-0.822	-0.810	0.058	-0.108	-0.194	0.040	-0.466	-0.131	-0.435	-0.684	0.752
site 7	-0.504	-0.428	-0.572	0.165	0.355	0.473	1.374	0.292	0.289	0.142	-0.019	0.497
site 8	0.441	-0.416	-0.635	1.005	0.500	0.924	0.218	-0.430	-0.302	-0.090	0.150	2.325
site 9	-0.169	0.025	-1.105	0.282	0.371	0.359	-1.015	-0.871	-0.848	-0.797	-0.841	-0.524
site 10	-0.908	-1.235	-1.166	-0.425	1.627	-0.577	-1.011	-0.536	-0.871	0.757	0.493	1.068

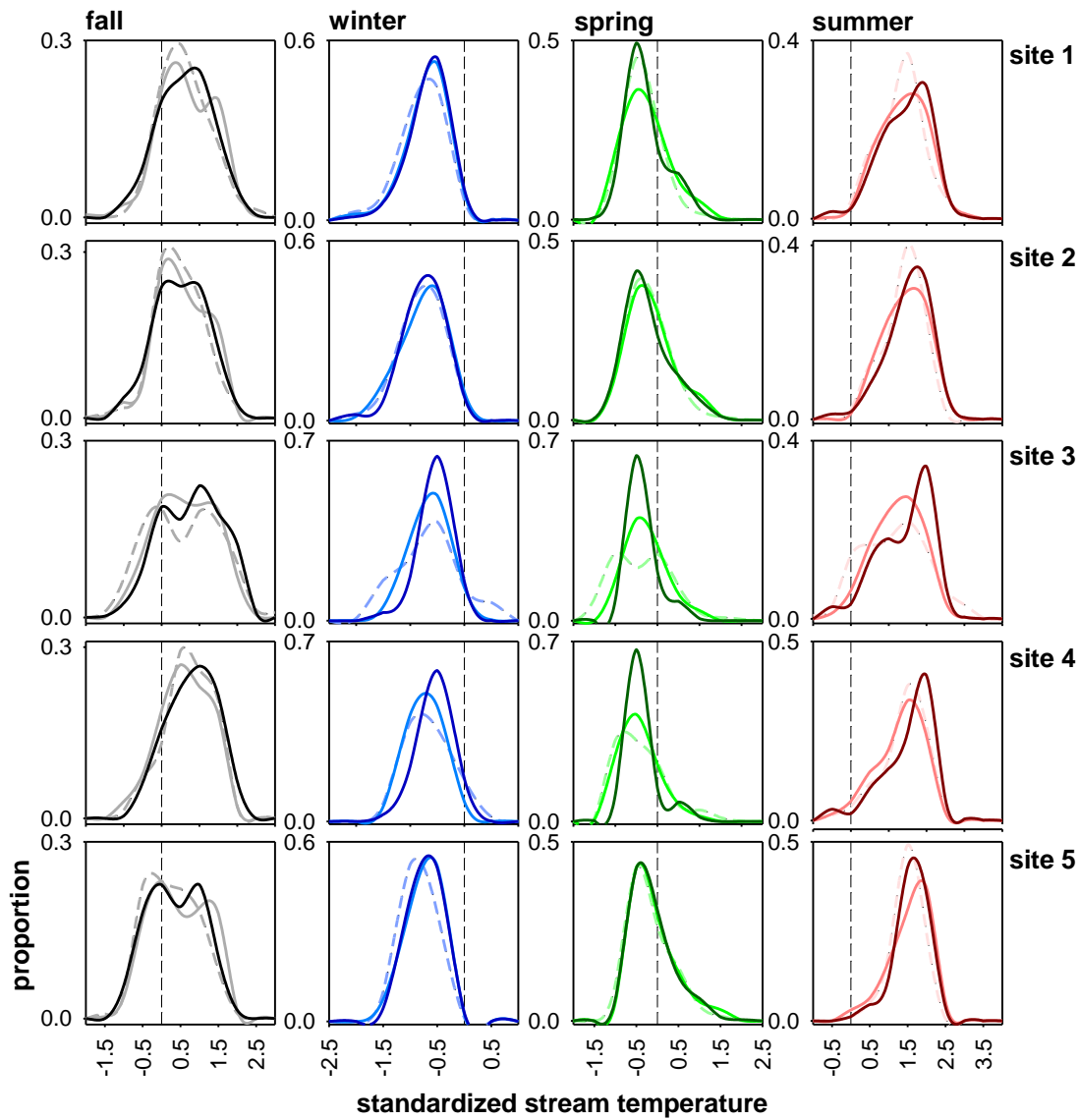


Fig. S1 Density plots of standardized temperatures by decade (period 80-89 dashed line; period 90-99 solid lighter color; period 00-09 dark color) and season (winter – blue line; spring – green line; summer – red line; fall – black line) using time series of daily minimum in unregulated streams.

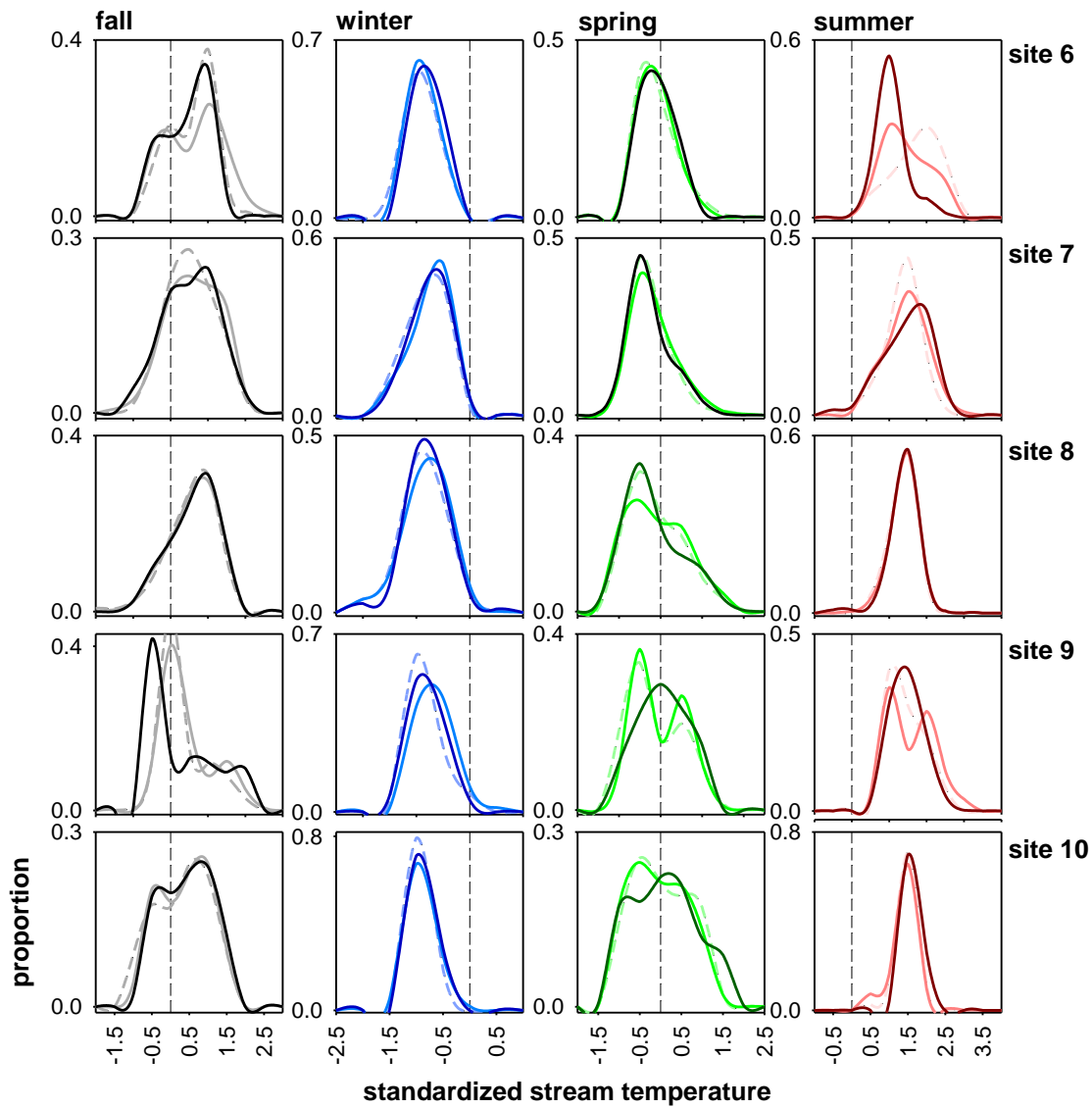


Fig. S2 Density plots of standardized temperatures by decade (period 80-89 dashed line; period 90-99 solid lighter color; period 00-09 dark color) and season (winter – blue line; spring – green line; summer – red line; fall – black line) using time series of daily minimum in water-regulated streams.

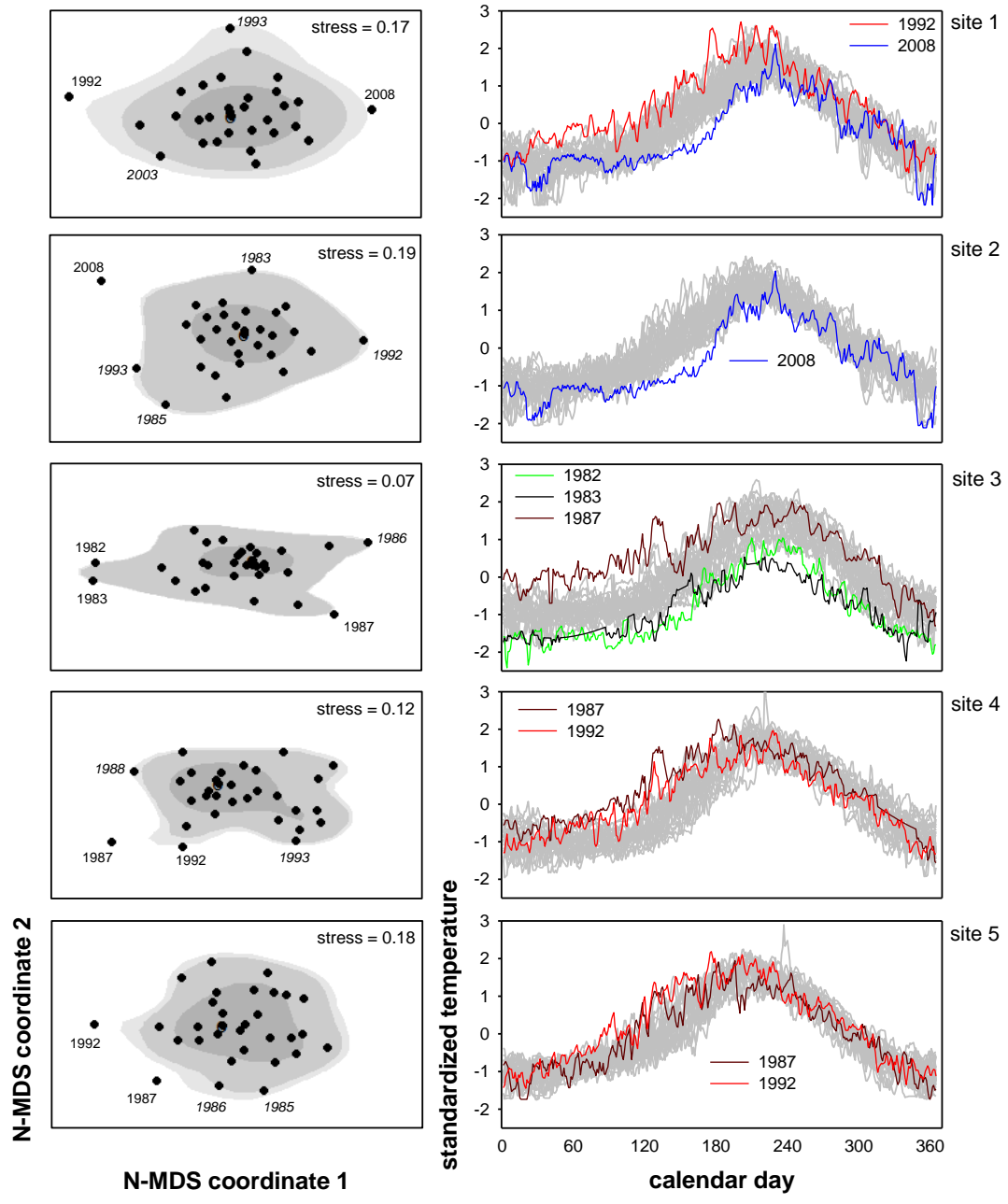


Fig. S3 Bivariate HDR boxplots and standardized daily temperature distribution in unregulated sites using annual time series of daily minimum. The dark and light grey regions show the 50%, 90%, 95% coverage probability. The symbols outside the grey regions and the colored lines represent outlier's years. Italicized years were between 90% and 95% of the coverage probability.

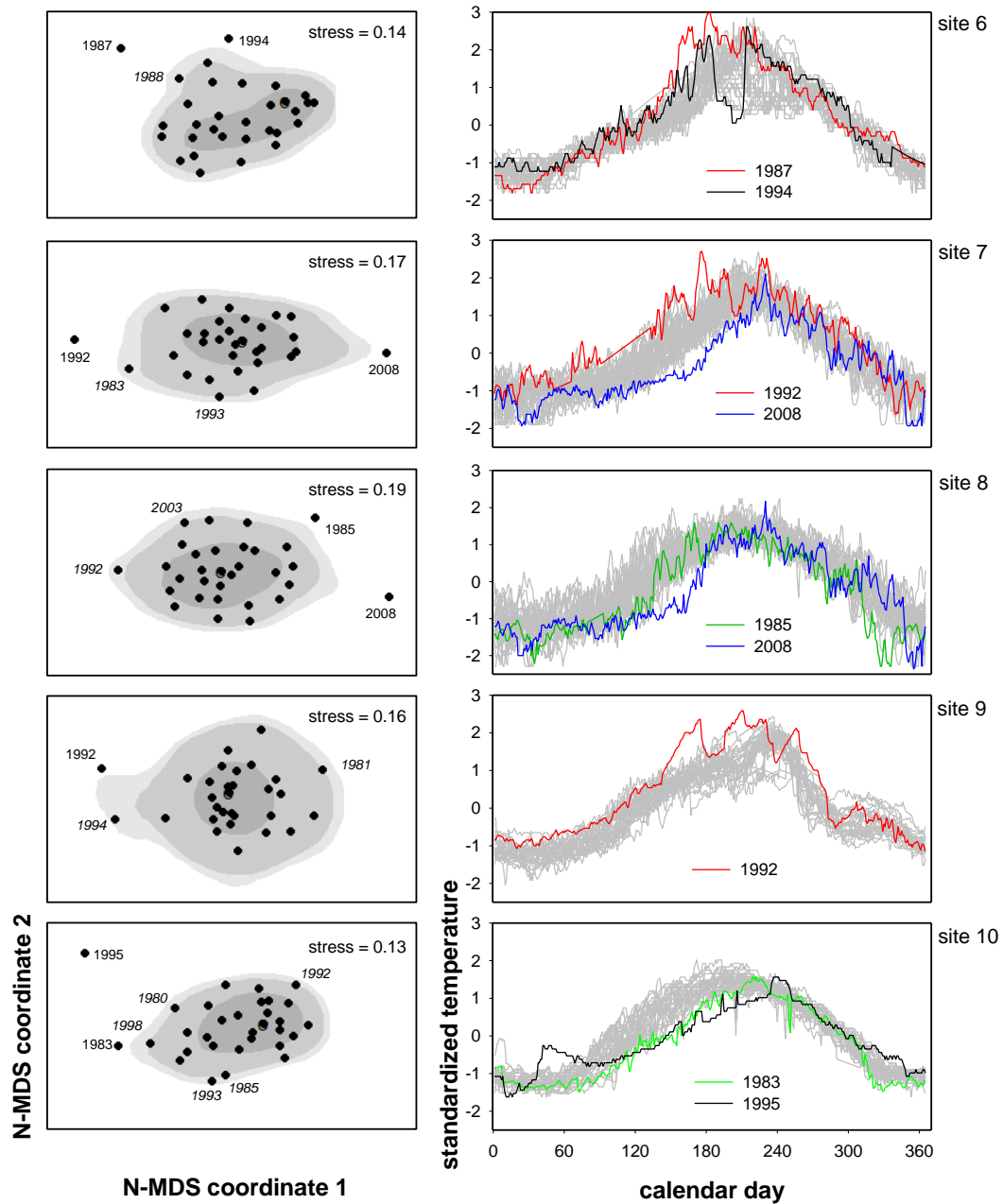


Fig. S4 Bivariate HDR boxplots and standardized daily temperature distribution in regulated sites using annual time series of daily minimum. The dark and light grey regions show the 50%, 90%, 95% coverage probability. The symbols outside the grey regions and the colored lines represent outlier's years. Italicized years were between 90% and 95% of the coverage probability.