water

MDPI

Supplemental Information for

Integrating Climatic and Physical Information in a Bayesian Hierarchical Model of Extreme Daily Precipitation

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1. Introduction

This supporting information provides additional information on model predictive performance, region-based results at all overlapping stations, individual station annual maxima (AM) temporal distributions, and Pearson correlation coefficients of performance and station information for both regions.

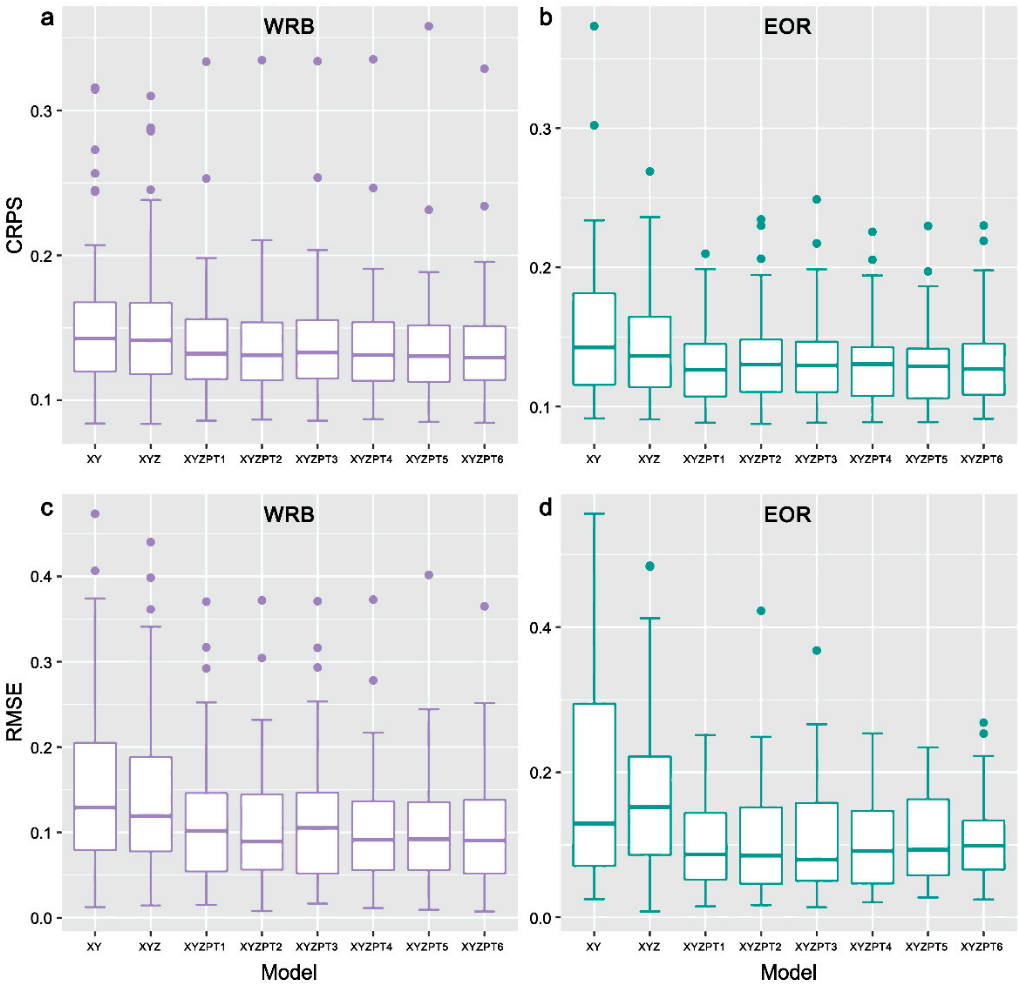

Figure S1. Distribution of station performance by model, where models are listed in order (left to right) by increasing complexity.

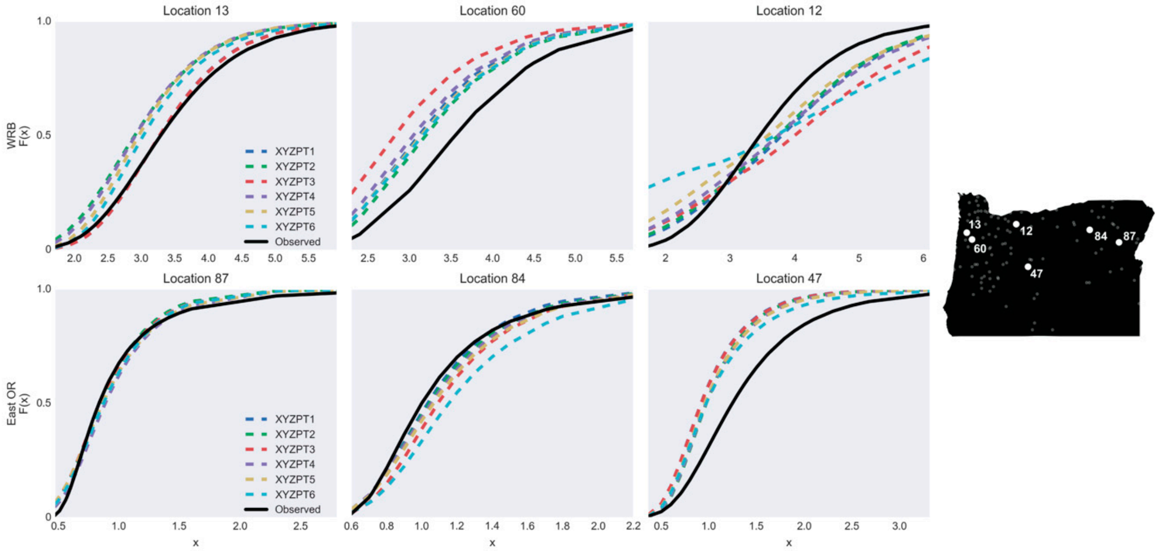

Figure S2. Examples of observed versus simulated distributions for the WRB and EOR models which include PRISM-based covariates. These CDFs are included to give examples of stations were predictive performance was good (locations 13, 87), moderate (locations 60, 84), and poor (locations 12, 47).

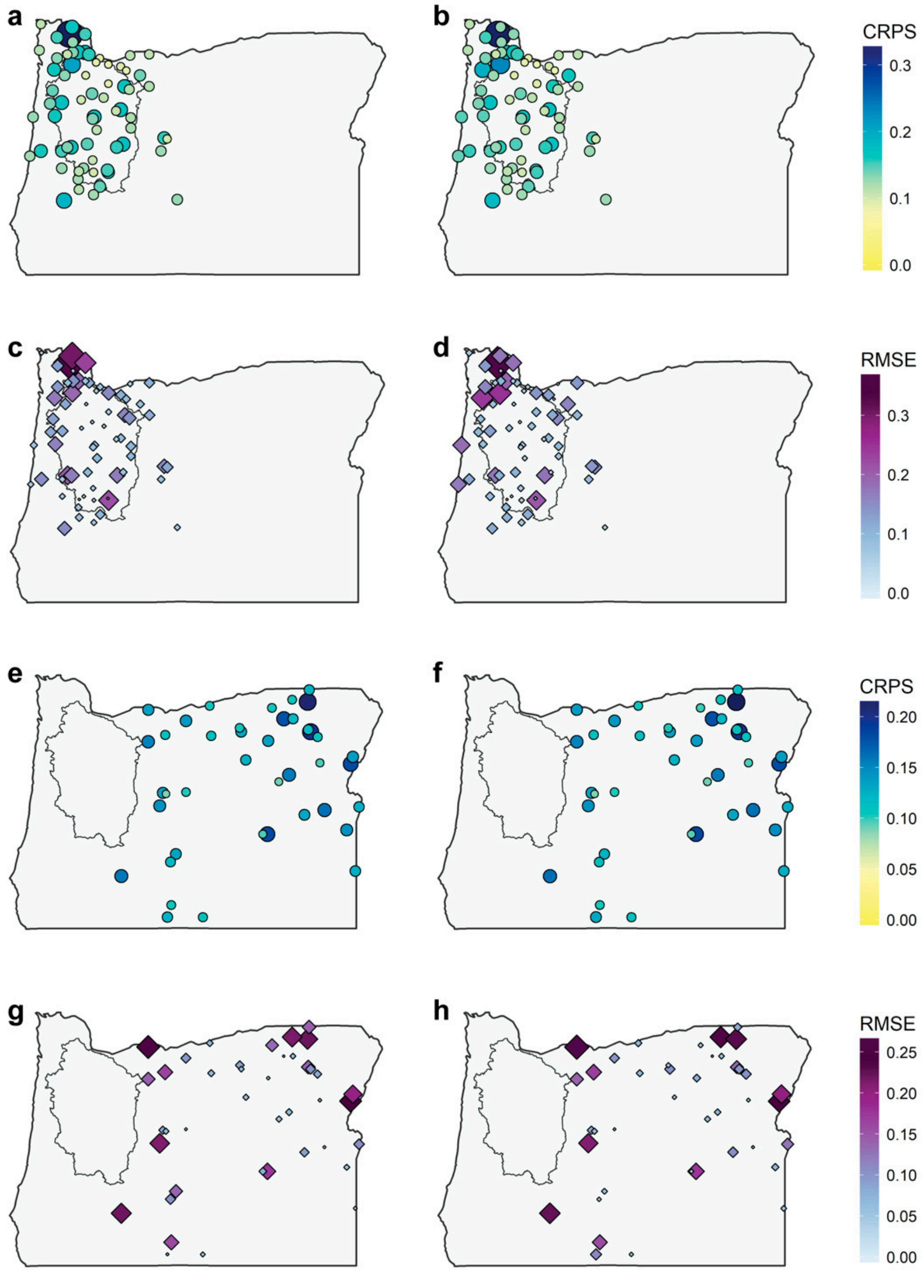

Figure S3. Maps of CRPS (circle markers) and RMSE (diamond markers) for the top models for each region (model complexity increases from left to right). The outline in the northwestern part of Oregon delineates the Willamette River watershed. Models displayed for the WRB are the simplest of the top performing XYZPT2 (a, c), and the most complex of the top performing XYZPT6 (b, d). Both top performing models are displayed for EOR; XYZPT1 (e, g) and XYZPT3 (f, h).

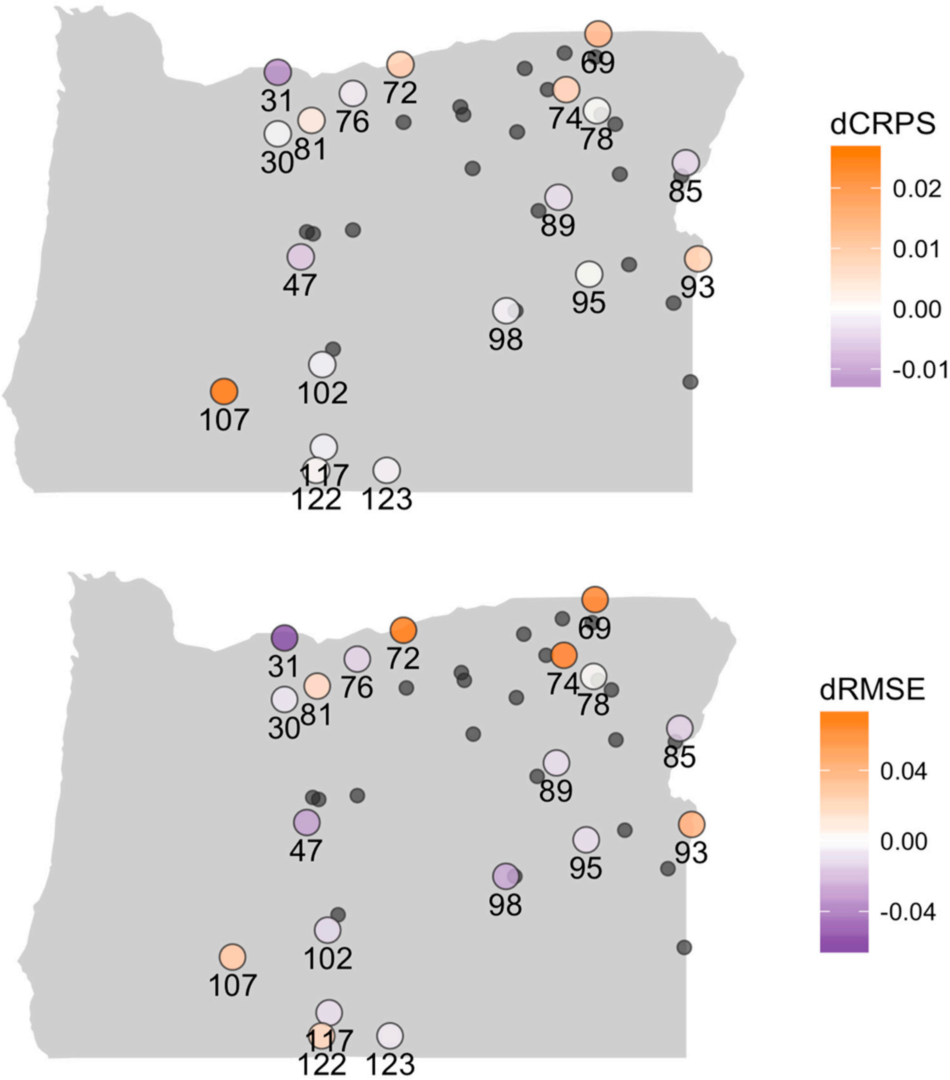

Figure S4. The difference in predictive performance between EOR models XYZPT2 and XYZPT1 at the EOR stations which have WRB-like AM. Using the best performing model for the WRB does not guarantee an improvement in performance for all EOR stations that have a WRB-like AM temporal distribution. A few show a slight improvement (purple), while the performance at others worsens (orange). More factors are involved than simply which set of covariates are used.

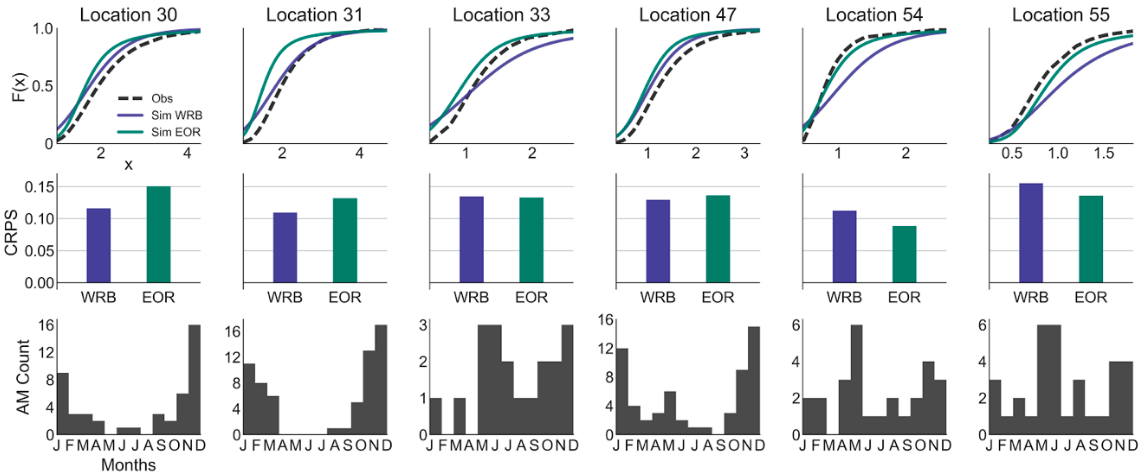

Figure S5. Performance at all overlapping stations. Example of how a small (hundredths) change in CRPS has a noticeable difference in CDF. Station 54's EOR result has a CRPS of 0.08 and the simulated CDF is similar to the observed. Whereas, the WRB result has a CRPS of 0.11 and performs poorly relative to the EOR model.

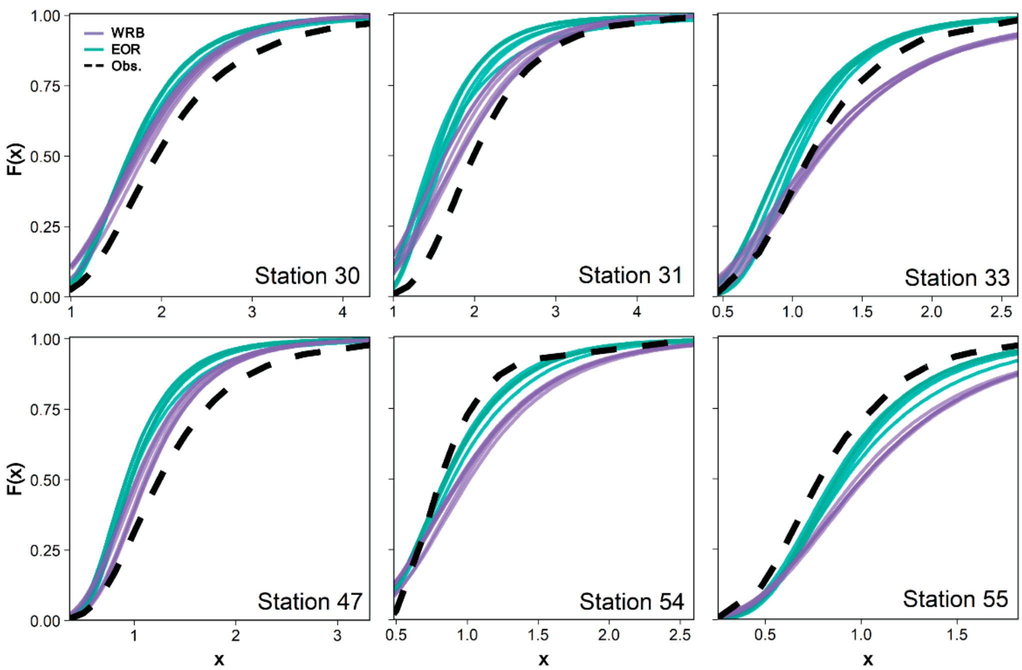

Figure S6. CDFs at the overlapping stations for models XYZPT1-XYZPT6 for both the WRB and EOR regions compared with CDF of observed. These models include both geographic and climatic information. The models for each region tend to group together, such that all the models (which include climatic information) from the region that performed best are generally better than those of the other region.

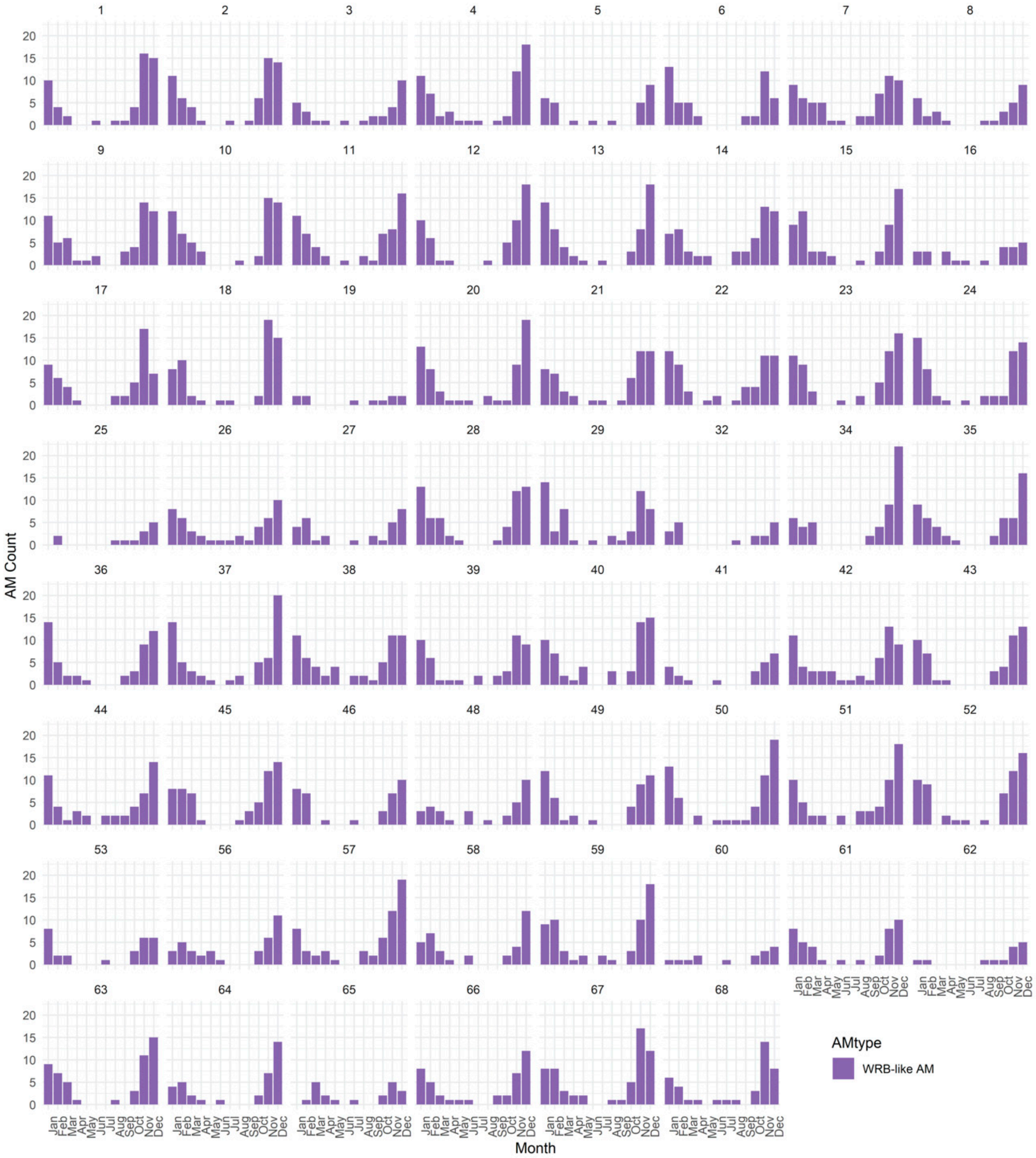

Figure S7. AM temporal distribution by station for the WRB study region, excluding the six overlapping stations. Fill color indicates AM type, Fill color indicates AM type, where purple indicate WRB-like AM. None of the non-overlap stations in the WRB have an EOR-like AM.

Figure S8. AM temporal distribution by station for the EOR study region, excluding the six overlapping stations. Fill color indicates AM type, where green represents EOR-like AM and purple indicates WRB-like AM.

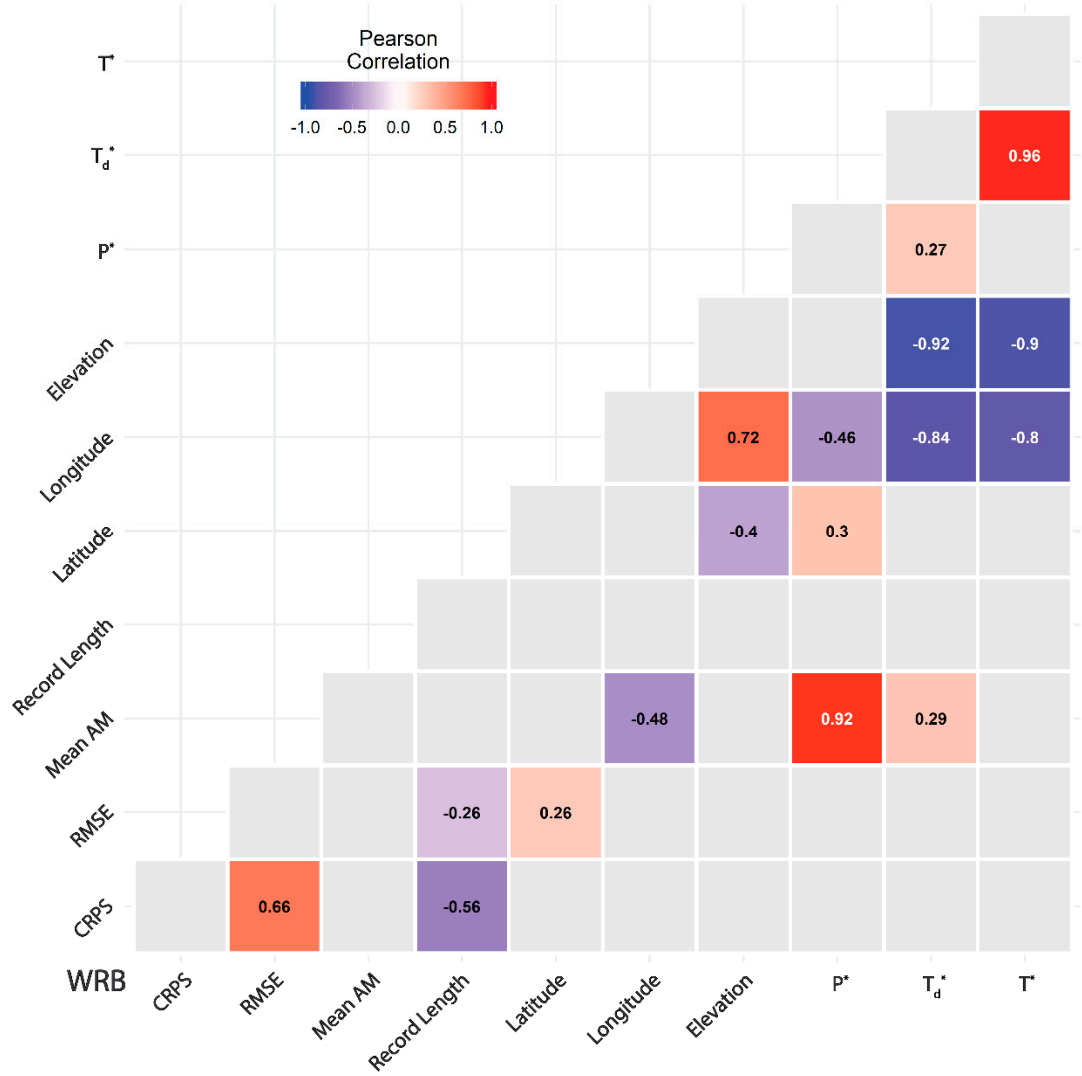

Figure S9. Statistically significant (α = 0.05) Pearson correlation coefficients for the top WRB model's predictive performance and covariates, as well as mean AM and record length. The moderate negative correlation between CRPS and record length is due to normalizing CRPS by record length. The weak correlation between latitude and RMSE is most likely due to the stations at the northern end of the Coastal Mountains which display poorer model predictive performance across all models. The worst of the aforementioned stations has a relatively short record length and could be the reason for the equally weak negative correlation between RMSE and record length.

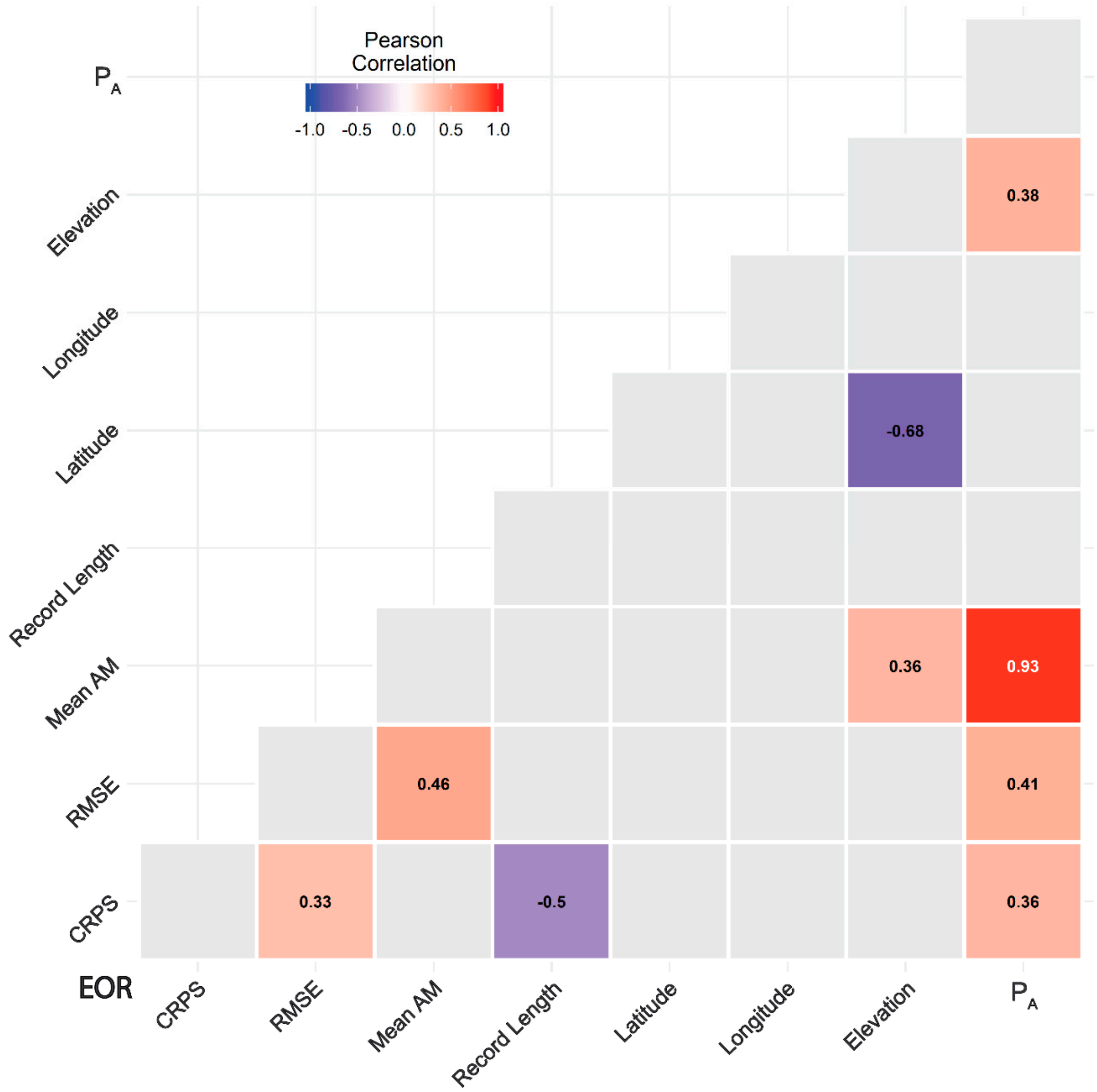

Figure S10. Statistically significant (α = 0.05) Pearson correlation coefficients for the top EOR model's predictive performance and covariates, as well as mean AM and record length. The moderate negative correlation between CRPS and record length is due to normalizing CRPS by record length. The EOR region covers a large area that includes stations with WRB-like AM, this could be the reason for the weak correlations between performance, mean annual maximum, and annual precipitation.

Table S1. WRB Model Performance.

Acronym	Model Covariates	CRPS Mean	CRPS St. Dev.	CRPS Median	RMSE Mean	RMSE St. Dev.	RMSE Median
XY	Latitude, Longitude	0.151	0.048	0.143	0.153	0.101	0.129
XYZ	Lat., Lon., Elevation	0.148	0.046	0.141	0.146	0.097	0.119
XYZPT1	Lat., Lon., Elevation, P_A	0.138	0.038	0.132	0.112	0.072	0.102
XYZPT2	Lat., Lon., Elevation, P^*, T_d^*, T^*	0.137	0.037	0.131	0.104	0.066	0.089
XYZPT3	Lat., Lon., Elevation, P_A, T_{dA}, T_A	0.139	0.039	0.133	0.113	0.073	0.105
XYZPT4	Lat., Lon., Elevation, P^*, Td^*, T^*, P^c, T_d^c, T^c	0.136	0.037	0.131	0.104	0.064	0.091
XYZPT5	Lat., Lon., Elevation, P_1, …, P_{12}, T_{dA}, T_A	0.137	0.039	0.130	0.102	0.065	0.092
XYZPT6	Lat., Lon., Elevation, P_1, …, P_{12}, T_{d1}, …, T_{d12}, T_1, …, T_{12}	0.136	0.037	0.129	0.101	0.065	0.090

Note: Models considered for the WRB listed with each model's mean, standard deviation, and median CRPS and RMSE across stations. (($)_A$ = mean annual; ($)_1$ = mean January; ($)_2$ = mean February; …; ($)_{12}$ = mean December; ( )* = mean [November, March], ($)^c$ = mean [April, October]).

Table S2. EOR Model Performance.

Acronym	Model Covariates	CRPS Mean	CRPS St. Dev.	CRPS Median	RMSE Mean	RMSE St. Dev.	RMSE Median
XY	Latitude, Longitude	0.158	0.057	0.143	0.186	0.137	0.129
XYZ	Lat., Lon., Elevation	0.148	0.044	0.136	0.171	0.116	0.152
XYZPT1	Lat., Lon., Elevation, P_A	0.131	0.029	0.126	0.104	0.068	0.087
XYZPT2	Lat., Lon., Elevation, P^*, T_d^*, T^*	0.133	0.032	0.128	0.108	0.069	0.085
XYZPT3	Lat., Lon., Elevation, P_A, T_{dA}, T_A	0.131	0.030	0.128	0.102	0.070	0.079
XYZPT4	Lat., Lon., Elevation, P^*, Td^*, T^*, P^c, T_d^c, T^c	0.132	0.031	0.131	0.110	0.066	0.092
XYZPT5	Lat., Lon., Elevation, P_1, …, P_{12}, T_{dA}, T_A	0.131	0.030	0.129	0.107	0.062	0.093
XYZPT6	Lat., Lon., Elevation, P_1, …, P_{12}, T_{d1}, …, T_{d12}, T_1, …, T_{12}	0.133	0.033	0.127	0.109	0.063	0.099

Note: Models considered for EOR listed with each model's mean, standard deviation, and median CRPS and RMSE across stations. (($)_A$ = mean annual; ($)_1$ = mean January; ($)_2$ = mean February; …; ($)_{12}$ = mean December; ( )* = mean [November, March], ($)^c$ = mean [April, October]).

Table S3. Spatial GEV Model Fit.

Model	TIC, WRB	TIC, EOR
XY	8756	2422
XYZ	8639	2190
XYZPT1	7355	1587
XYZPT2	7265	1600
XYZPT3	7345	1584
XYZPT4	7251	1561
XYZPT5	7240	1508
XYZPT6	7195	1477