Supporting Information

XIS-Temperature: A daily spatiotemporal machine-learning model for air temperature in the contiguous United States

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Cross-validation results showing model performance by region and year and for isolated sites and for a subset of warmer or colder days by year, as well as comparisons of performance with other gridded products for daily max temperature by year

Figure S1 shows how accuracy and SD vary across regions and over time.
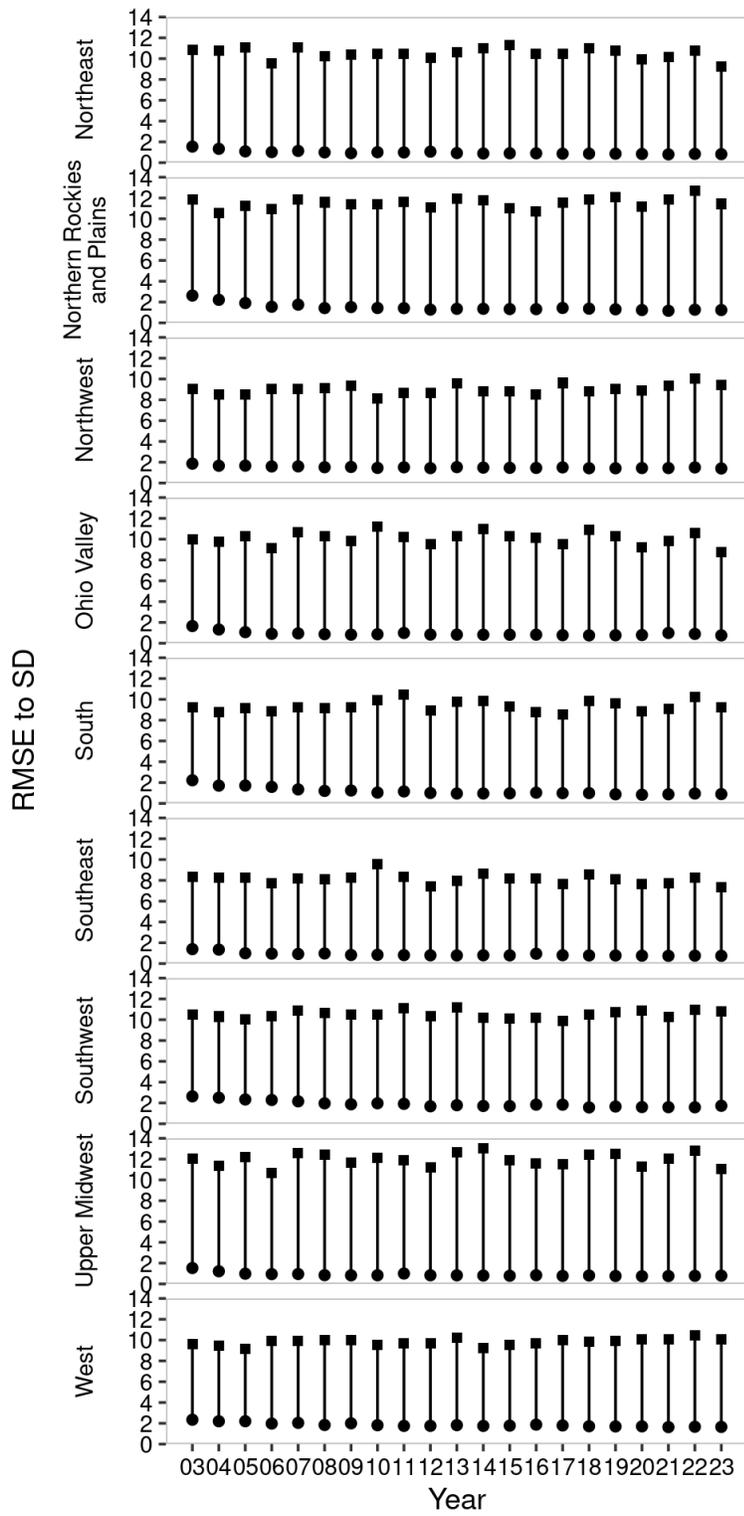

Figure S1: Weighted SD (upper) and RMSE (lower) from mean-temperature CV for each region and year.

Table S1 shows unweighted CV results among isolated stations, which are defined as stations that are at least 12 km away from all other stations in the same year. We chose 12 km for being the median distance of all cells in a 1-km grid from the nearest station in 2019.

Table S1: Unweighted SDs and RMSEs (K) for isolated stations in yearly CV.

Year	Observations	Sites	Min temp.		Mean temp.		Max temp.	
			SD	RMSE	SD	RMSE	SD	RMSE
2003	431,228	2,316	10.22	2.24	10.70	1.72	11.85	2.28
2004	598,311	2,690	9.94	1.99	10.29	1.56	11.25	2.05
2005	666,606	2,905	10.12	2.02	10.51	1.48	11.53	1.95
2006	854,198	3,334	9.87	2.05	10.28	1.43	11.27	1.88
2007	906,651	3,398	10.65	2.05	11.06	1.45	12.11	1.97
2008	925,907	3,557	10.70	1.83	10.99	1.31	11.93	1.71
2009	960,770	3,682	10.48	1.83	10.75	1.29	11.64	1.69
2010	991,293	3,734	10.42	1.81	10.88	1.26	11.95	1.66
2011	1,003,154	3,741	10.65	1.82	11.09	1.26	12.10	1.66
2012	1,050,319	3,913	9.94	1.80	10.40	1.22	11.45	1.60
2013	1,099,383	4,036	10.85	1.82	11.14	1.29	12.01	1.69
2014	1,107,703	4,028	10.92	1.81	11.11	1.26	11.98	1.64
2015	1,041,691	3,731	10.53	1.76	10.64	1.22	11.47	1.59
2016	1,118,630	3,945	10.03	1.79	10.32	1.25	11.29	1.62
2017	1,126,534	3,951	10.22	1.75	10.58	1.21	11.59	1.56
2018	1,113,128	4,042	11.07	1.71	11.26	1.15	12.12	1.50
2019	1,036,778	3,842	10.94	1.74	11.23	1.18	12.13	1.54
2020	1,085,209	3,935	10.24	1.80	10.54	1.16	11.47	1.49
2021	1,110,307	3,946	10.47	1.76	10.72	1.14	11.62	1.47
2022	1,108,343	3,849	11.44	1.79	11.63	1.17	12.43	1.48
2023	1,074,674	3,902	10.24	1.75	10.60	1.16	11.55	1.46

Tables S2 and S3 examine accuracy during hot and cold days. Here, the SDs are calculated relative to the overall mean for the year and DV in question, rather than the mean of the hot or cold subset. This tactic ensures that the trivial model represented by the SD, like our actual model, does not benefit from foreknowledge of which days are hot or cold.

Table S2: Unweighted SDs and RMSEs (K) from station-days with a max temperature of 92 °F (33.33 °C) or greater.

Year	Observations	Sites	Min temp.		Mean temp.		Max temp.	
			SD	RMSE	SD	RMSE	SD	RMSE
2003	70,471	3,096	14.14	2.33	16.22	1.82	18.62	2.48
2004	68,898	3,318	14.12	2.12	16.12	1.64	18.47	2.26
2005	131,567	5,447	14.55	1.90	16.11	1.40	18.09	2.02
2006	191,466	7,080	14.34	1.95	15.88	1.33	17.78	1.98
2007	202,071	7,697	14.27	2.04	15.80	1.51	17.99	2.53
2008	176,397	7,700	15.06	1.87	16.77	1.31	18.89	1.83
2009	193,539	8,205	14.90	1.86	16.67	1.30	18.87	1.81
2010	266,204	9,772	15.20	1.62	16.42	1.18	18.19	1.68
2011	342,168	10,552	15.22	1.61	16.64	1.13	18.40	1.61
2012	497,655	16,396	13.19	1.59	14.66	1.10	16.46	1.56
2013	389,358	15,912	14.94	1.60	16.41	1.14	18.24	1.68
2014	392,155	14,515	14.61	1.61	15.97	1.13	17.84	1.69
2015	451,511	16,034	14.05	1.57	15.33	1.09	17.11	1.62
2016	487,674	16,777	13.98	1.53	15.07	1.06	16.70	1.54
2017	459,577	16,859	13.73	1.69	15.25	1.14	17.26	1.61
2018	521,191	16,907	14.28	1.55	15.69	1.05	17.47	1.50
2019	524,905	17,960	14.36	1.47	15.58	0.98	17.31	1.44
2020	645,142	21,585	13.19	1.68	14.58	1.04	16.47	1.44
2021	629,849	21,652	12.93	1.67	14.35	1.08	16.26	1.50
2022	749,220	22,478	14.02	1.55	15.20	0.99	16.84	1.39
2023	644,471	21,671	14.02	1.55	15.45	0.98	17.24	1.40

Table S3: Unweighted SDs and RMSEs (K) from station-days with a min temperature of 0 °C or less.

Year	Observations	Sites	Min temp.		Mean temp.		Max temp.	
			SD	RMSE	SD	RMSE	SD	RMSE
2003	265,128	4,548	13.33	2.16	13.87	1.63	15.03	2.12
2004	357,054	5,380	13.17	2.02	13.58	1.55	14.57	2.01
2005	497,570	7,626	13.23	2.06	13.67	1.46	14.77	1.85
2006	638,843	9,000	12.79	2.11	13.13	1.45	14.08	1.87
2007	781,222	10,171	13.75	2.01	14.30	1.41	15.52	1.90
2008	913,634	11,080	13.19	1.76	13.56	1.25	14.63	1.65
2009	915,572	11,593	13.52	1.81	13.82	1.31	14.77	1.69
2010	974,277	12,620	13.10	1.78	13.68	1.29	14.88	1.65
2011	1,067,179	13,977	13.60	1.79	13.94	1.28	14.90	1.64
2012	1,214,723	18,938	13.65	1.73	14.11	1.21	15.17	1.54
2013	1,736,308	20,640	13.64	1.70	13.95	1.20	14.91	1.53
2014	1,652,748	20,717	14.91	1.69	15.05	1.17	15.97	1.51
2015	1,483,323	21,627	15.18	1.71	15.24	1.18	16.10	1.49
2016	1,444,745	20,400	14.21	1.71	14.61	1.22	15.70	1.53
2017	1,533,135	20,982	14.23	1.71	14.74	1.24	15.91	1.54
2018	1,638,509	20,551	14.28	1.66	14.47	1.15	15.37	1.43
2019	1,617,295	22,894	14.56	1.67	14.79	1.17	15.75	1.47
2020	1,612,929	23,162	13.89	1.67	14.13	1.14	15.08	1.41
2021	1,683,636	23,642	14.32	1.65	14.67	1.10	15.78	1.37
2022	1,939,562	24,762	15.21	1.71	15.32	1.15	16.10	1.41
2023	1,733,156	25,347	13.93	1.70	14.16	1.16	15.02	1.43

Table S4 compares the weighted RMSEs of our model on private weather stations from Weather Underground to those of PRISM, gridMET, and Daymet for max temperature.

Table S4: Between-model comparisons of weighted RMSEs (K) for max temperature.

Year	Observations	SD	PRISM	gridMET	Daymet	XIS
2015	3,613,296	11.54	1.98	2.04	1.89	1.89
2016	3,612,812	11.46	1.95	1.93	1.85	1.88
2017	3,602,753	11.76	2.10	2.18	2.01	2.00
2018	3,593,725	12.29	2.37	2.31	2.22	2.18
2019	3,600,723	12.35	2.19	2.15	2.04	1.98
2020	3,609,000	11.57	2.02	2.00	1.91	1.82
2021	3,508,692	11.79	1.94	1.94	1.87	1.80