

Supplementary Data for:

Plants of the Eastern United States display variation in phenological sensitivity to temperature within and between species across their geographic range

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Table S2. Number of specimens per geographic bin and temporal range of specimens per phenophase.

Species	Number Flowering					Number Fruiting				
	Appalachians	Mid-Atlantic	Northeast	Ozarks Complex	Southeast	Appalachians	Mid-Atlantic	Northeast	Ozarks Complex	Southeast
<i>Anemone canadensis</i>	0	0	41	0	0	0	0	59	0	0
<i>Anemone hepatica</i>	1	0	39	0	0	0	0	60	0	0
<i>Aquilegia canadensis</i>	7	17	221	5	1	21	19	186	10	2
<i>Bidens vulgata</i>	3	6	74	0	0	9	5	122	0	0
<i>Celastrus orbiculatus</i>	5	23	123	0	0	15	42	163	0	0
<i>Centaurea stoebe</i>	10	4	79	0	0	12	6	142	0	1
<i>Cirsium arvense</i>	1	7	178	0	0	3	8	160	0	0
<i>Cirsium discolor</i>	3	4	36	3	0	6	9	74	3	1
<i>Geranium maculatum</i>	19	183	264	17	6	19	186	291	13	4
<i>Geranium robertianum</i>	0	3	45	0	0	0	29	278	0	0
<i>Hemerocallis fulva</i>	2	40	93	7	2	3	17	23	2	0
<i>Hibiscus moscheutos</i>	1	17	58	7	22	0	10	60	3	27
<i>Impatiens capensis</i>	10	40	89	6	8	25	76	377	8	15
<i>Iris pseudacorus</i>	6	4	77	2	1	6	4	55	0	1
<i>Iris versicolor</i>	0	2	340	0	2	0	2	180	0	3
<i>Lilium canadense</i>	0	3	133	3	0	0	0	27	0	0
<i>Lonicera bella</i>	0	1	36	0	0	1	0	61	0	0
<i>Lonicera canadensis</i>	0	2	191	1	0	0	0	200	1	0
<i>Lonicera japonica</i>	7	140	65	27	90	7	31	43	5	29
<i>Malus pumila</i>	1	6	66	1	0	1	1	38	0	0
<i>Malva neglecta</i>	0	2	23	0	0	3	7	128	0	2
<i>Oenothera perennis</i>	2	5	186	0	1	0	2	212	0	0
<i>Orobancha uniflora</i>	4	20	173	5	11	2	11	86	2	4
<i>Rosa gallica</i>	0	1	44	0	0	0	0	17	0	0
<i>Rubus odoratus</i>	9	3	163	1	0	16	4	296	2	0
<i>Sarracenia purpurea</i>	0	2	231	0	1	0	0	75	0	0
<i>Sisyrinchium mucronatum</i>	1	26	52	6	1	4	38	96	6	13
<i>Solanum rostratum</i>	0	1	19	0	1	0	8	75	0	2
<i>Trillium grandiflorum</i>	22	2	99	6	0	8	0	30	2	0
<i>Trillium undulatum</i>	56	0	345	1	0	28	1	127	0	0

Species	Number Flowering		Number Fruiting	
	Cold	Mixed/Warm	Cold	Mixed/Warm
<i>Anemone canadensis</i>	41	0	59	0
<i>Anemone hepatica</i>	39	1	60	0
<i>Aquilegia canadensis</i>	221	30	186	52
<i>Bidens vulgata</i>	76	7	125	11
<i>Celastrus orbiculatus</i>	116	35	158	62
<i>Centaurea stoebe</i>	79	14	144	17
<i>Cirsium arvense</i>	174	12	153	18
<i>Cirsium discolor</i>	38	8	79	14
<i>Geranium maculatum</i>	294	195	330	183
<i>Geranium robertianum</i>	47	1	287	20
<i>Hemerocallis fulva</i>	94	50	23	22
<i>Hibiscus moscheutos</i>	54	51	57	43
<i>Impatiens capensis</i>	88	65	381	120
<i>Iris pseudacorus</i>	78	12	58	8
<i>Iris versicolor</i>	336	8	180	5
<i>Lilium canadense</i>	132	7	26	1
<i>Lonicera bella</i>	36	1	62	0
<i>Lonicera canadensis</i>	191	3	200	1
<i>Lonicera japonica</i>	61	268	41	74
<i>Malus pumila</i>	67	7	38	2
<i>Malva neglecta</i>	23	2	130	10
<i>Oenothera perennis</i>	186	8	213	1
<i>Orobancha uniflora</i>	173	40	85	20
<i>Rosa gallica</i>	44	1	17	0
<i>Rubus odoratus</i>	165	11	297	21
<i>Sarracenia purpurea</i>	230	4	74	1
<i>Sisyrinchium mucronatum</i>	53	33	97	60
<i>Solanum rostratum</i>	18	3	65	20
<i>Trillium grandiflorum</i>	99	30	30	10
<i>Trillium undulatum</i>	371	31	134	22

Species	Flowering Collection Year		Fruiting Collection Year	
	Minimum	Maximum	Minimum	Maximum
<i>Anemone canadensis</i>	1896	2011	1895	2003
<i>Anemone hepatica</i>	1895	1990	1898	1990
<i>Aquilegia canadensis</i>	1895	2004	1895	2014
<i>Bidens vulgata</i>	1897	2014	1895	2014
<i>Celastrus orbiculatus</i>	1928	2015	1912	2015
<i>Centaurea stoebe</i>	1903	2013	1903	2014
<i>Cirsium arvense</i>	1895	2011	1895	2013
<i>Cirsium discolor</i>	1897	2013	1896	2012
<i>Geranium maculatum</i>	1895	2014	1895	2013
<i>Geranium robertianum</i>	1896	2014	1895	2014
<i>Hemerocallis fulva</i>	1895	2010	1899	2001
<i>Hibiscus moscheutos</i>	1895	2014	1895	2014
<i>Impatiens capensis</i>	1895	2013	1895	2014
<i>Iris pseudacorus</i>	1901	2015	1898	2012
<i>Iris versicolor</i>	1895	2014	1895	2014
<i>Lilium canadense</i>	1895	2012	1895	2005
<i>Lonicera bella</i>	1910	2009	1903	2010
<i>Lonicera canadensis</i>	1895	2015	1895	2015
<i>Lonicera japonica</i>	1899	2014	1898	2013
<i>Malus pumila</i>	1895	2013	1896	2011
<i>Malva neglecta</i>	1897	2012	1896	2007
<i>Oenothera perennis</i>	1895	2013	1895	2015
<i>Orobancha uniflora</i>	1895	2013	1897	2010
<i>Rosa gallica</i>	1896	2004	1896	1958
<i>Rubus odoratus</i>	1896	2015	1895	2015
<i>Sarracenia purpurea</i>	1895	2014	1895	2013
<i>Sisyrinchium mucronatum</i>	1897	2012	1897	2014
<i>Solanum rostratum</i>	1896	2008	1895	2010
<i>Trillium grandiflorum</i>	1895	2014	1895	2000
<i>Trillium undulatum</i>	1895	2015	1895	2012

Table S3. Posterior median parameter estimates and 90% credible intervals from the regional model (Model 1) for flowering. Sensitivity estimates different from zero with > 95% posterior probability are indicated with “*” and estimates different from zero with > 95% probability are indicated with “***”. Mean Phase Date, the model intercept, represents mean flowering time at 7.4C spring temperature and 216m ASL, mean conditions across all specimens.

Species	Mean Flowering Date (α_1 , Day of Year)	SpringT Sensitivity (β_1 , Days / C)	Elevation Sensitivity (β_4 , Days / 100m ASL)
<i>Anemone canadensis</i>	163.6 (147.5, 180.9)	-3.009 (-5.133, -0.816)**	0.656 (-1.505, 2.525)
<i>Anemone hepatica</i>	129.7 (113.0, 145.8)	-3.098 (-5.440, -0.779)**	-1.757 (-4.396, 0.193)*
<i>Aquilegia canadensis</i>	143.3 (131.6, 155.1)	-2.944 (-4.580, -1.294)**	-0.859 (-2.144, 0.286)
<i>Bidens vulgata</i>	252.9 (239.9, 265.8)	0.043 (-2.209, 2.292)	-0.199 (-1.949, 1.280)
<i>Celastrus orbiculatus</i>	169.9 (155.4, 183.1)	-2.151 (-4.147, 0.001)*	0.064 (-2.357, 2.153)
<i>Centaurea stoebe</i>	202.1 (188.3, 214.5)	-3.235 (-5.461, -1.315)**	0.056 (-1.718, 1.562)
<i>Cirsium arvense</i>	199.6 (186.0, 212.3)	-2.691 (-4.876, -0.604)**	0.448 (-1.029, 1.684)
<i>Cirsium discolor</i>	239.4 (227.0, 252.3)	-0.829 (-2.829, 1.196)	0.510 (-1.394, 2.092)
<i>Geranium maculatum</i>	143.0 (132.7, 152.9)	-3.511 (-4.997, -2.057)**	0.376 (-0.459, 1.105)
<i>Geranium robertianum</i>	186.8 (168.9, 205.8)	-1.889 (-4.302, 0.817)	-1.515 (-4.529, 0.781)
<i>Hemerocallis fulva</i>	196.8 (185.6, 208.9)	-4.258 (-5.890, -2.669)**	-2.409 (-3.645, -1.392)**
<i>Hibiscus moscheutos</i>	229.7 (216.4, 241.7)	-2.545 (-4.296, -0.897)**	-1.384 (-3.329, 0.307)*
<i>Impatiens capensis</i>	215.7 (203.8, 228.7)	-0.580 (-2.351, 1.205)	-0.802 (-2.574, 0.605)
<i>Iris pseudacorus</i>	167.4 (154.7, 179.8)	-4.381 (-6.205, -2.650)**	-0.075 (-1.169, 0.889)
<i>Iris versicolor</i>	167.5 (152.3, 181.4)	-3.555 (-5.568, -1.689)**	-1.485 (-2.948, -0.335)**
<i>Lilium canadense</i>	198.2 (185.6, 211.0)	-2.981 (-4.685, -1.334)**	-2.989 (-4.004, -2.109)**
<i>Lonicera bella</i>	144.7 (129.1, 159.8)	-2.831 (-5.091, -0.712)**	-1.606 (-4.577, 0.409)*
<i>Lonicera canadensis</i>	143.9 (129.6, 160.5)	-2.408 (-4.261, -0.423)**	-0.573 (-1.998, 0.719)
<i>Lonicera japonica</i>	179.0 (164.2, 192.4)	-1.829 (-3.714, 0.125)*	-2.540 (-5.323, -0.593)**
<i>Malus pumila</i>	139.9 (126.3, 153.7)	-3.392 (-5.445, -1.530)**	-0.505 (-2.545, 1.256)
<i>Malva neglecta</i>	202.0 (181.3, 223.2)	-2.451 (-5.037, 0.187)*	-1.257 (-4.438, 1.049)
<i>Oenothera perennis</i>	187.1 (174.3, 201.5)	-0.601 (-2.579, 1.409)	-1.239 (-2.850, 0.073)*
<i>Orobanche uniflora</i>	155.1 (142.7, 166.2)	-4.345 (-5.999, -2.729)**	-0.578 (-1.751, 0.381)
<i>Rosa gallica</i>	176.5 (159.9, 191.8)	-3.270 (-5.170, -1.402)**	0.731 (-0.754, 2.019)
<i>Rubus odoratus</i>	199.1 (186.3, 213.3)	-0.949 (-2.947, 1.073)	-1.804 (-3.498, -0.420)**
<i>Sarracenia purpurea</i>	194.5 (178.4, 210.3)	-2.052 (-3.978, -0.021)**	-0.738 (-2.605, 0.848)
<i>Sisyrinchium mucronatum</i>	159.6 (145.4, 172.6)	-3.642 (-5.521, -1.857)**	-1.112 (-3.562, 0.760)
<i>Solanum rostratum</i>	215.2 (197.4, 232.5)	-2.536 (-4.873, -0.327)**	-1.911 (-5.191, 0.486)*
<i>Trillium grandiflorum</i>	137.3 (125.8, 149.6)	-2.498 (-4.222, -0.732)**	0.124 (-0.963, 1.054)
<i>Trillium undulatum</i>	150.6 (137.9, 163.9)	-2.061 (-3.889, -0.125)**	-1.937 (-2.987, -1.036)**
Assemblage Means (μ_{α_1}, μ_{β_1}, μ_{β_4})	179.7 (167.5, 190.2)	-2.556 (-3.433, -1.715)**	-0.881 (-1.587, -0.230)**

Table S4. Posterior median parameter estimates and 90% credible intervals from the regional model (Model 1) for fruiting. Sensitivity estimates different from zero with > 95% posterior probability are indicated with “*” and estimates different from zero with > 95% probability are indicated with “***”. Mean Phase Date, the model intercept, represents mean flowering time at 7.4C spring temperature and 216m ASL, mean conditions across all specimens.

Species	Mean Fruiting Date (α_1 , Day of Year)	SpringT Sensitivity (β_1 , Days / C)	Elevation Sensitivity (β_4 , Days / 100m ASL)
<i>Anemone canadensis</i>	181.9 (163.7, 196.8)	-3.624 (-6.588, -0.900)**	-1.791 (-4.230, 0.154)*
<i>Anemone hepatica</i>	141.6 (122.7, 155.6)	-2.148 (-4.935, 0.553)*	-1.806 (-3.992, -0.140)**
<i>Aquilegia canadensis</i>	160.9 (143.9, 173.2)	-3.366 (-5.648, -1.222)**	-0.709 (-2.415, 0.697)
<i>Bidens vulgata</i>	257.3 (239.1, 268.5)	-0.462 (-3.255, 2.429)	-0.155 (-1.827, 1.322)
<i>Celastrus orbiculatus</i>	253.1 (235.2, 265.5)	-2.640 (-5.243, -0.068)**	-0.844 (-3.121, 1.195)
<i>Centaurea stoebe</i>	227.5 (209.7, 240.4)	-1.271 (-3.828, 1.289)	-1.160 (-3.111, 0.392)
<i>Cirsium arvense</i>	206.2 (187.6, 217.7)	-3.370 (-6.050, -0.727)**	-2.293 (-3.689, -1.098)**
<i>Cirsium discolor</i>	250.2 (232.8, 262.4)	-0.941 (-3.309, 1.528)	0.372 (-1.247, 1.829)
<i>Geranium maculatum</i>	161.9 (144.1, 171.9)	-4.254 (-6.325, -2.052)**	-1.339 (-2.300, -0.491)**
<i>Geranium robertianum</i>	200.5 (182.1, 212.1)	-2.454 (-5.017, 0.205)*	-4.739 (-6.917, -2.889)**
<i>Hemerocallis fulva</i>	183.2 (164.9, 194.8)	-3.439 (-5.841, -0.956)**	-0.486 (-2.343, 1.401)
<i>Hibiscus moscheutos</i>	236.1 (217.3, 249.5)	-2.709 (-5.153, -0.094)**	-1.224 (-4.145, 1.200)
<i>Impatiens capensis</i>	225.3 (207.6, 236.1)	-0.169 (-2.490, 2.231)	-0.480 (-1.455, 0.386)
<i>Iris pseudacorus</i>	190.3 (172.8, 203.6)	-4.169 (-7.000, -1.393)**	-0.698 (-3.074, 1.516)
<i>Iris versicolor</i>	198.1 (180.7, 212.7)	-2.393 (-4.818, 0.233)*	-1.392 (-3.609, 0.362)*
<i>Lilium canadense</i>	202.5 (182.9, 218.9)	-2.414 (-5.802, 0.971)	-0.098 (-2.969, 2.999)
<i>Lonicera bella</i>	169.5 (150.6, 183.0)	-2.794 (-5.797, 0.185)*	-1.648 (-4.212, 0.531)
<i>Lonicera canadensis</i>	163.5 (145.2, 176.9)	-3.310 (-6.157, -0.601)**	-2.397 (-4.333, -0.929)**
<i>Lonicera japonica</i>	252.7 (232.5, 269.7)	-2.229 (-4.903, 0.501)*	-0.577 (-3.459, 2.045)
<i>Malus pumila</i>	178.6 (159.5, 193.2)	-4.801 (-8.071, -1.721)**	-0.805 (-3.524, 1.423)
<i>Malva neglecta</i>	219.9 (202.6, 232.7)	-2.645 (-5.039, -0.052)**	-0.859 (-3.029, 0.967)
<i>Oenothera perennis</i>	194.8 (176.6, 207.3)	-2.438 (-5.120, 0.240)*	-1.290 (-3.378, 0.317)*
<i>Orobanche uniflora</i>	159.9 (141.5, 171.7)	-4.687 (-6.857, -2.370)**	-1.757 (-3.573, -0.264)**
<i>Rosa gallica</i>	214.5 (191.4, 235.2)	-2.432 (-5.526, 0.938)	-1.685 (-5.032, 0.954)
<i>Rubus odoratus</i>	202.6 (184.9, 215.8)	-1.691 (-4.075, 0.719)	-1.916 (-3.408, -0.608)**
<i>Sarracenia purpurea</i>	192.4 (174.1, 208.2)	-1.943 (-4.947, 1.094)	-1.494 (-4.584, 0.905)
<i>Sisyrinchium mucronatum</i>	167.1 (149.9, 180.2)	-3.878 (-6.052, -1.743)**	0.208 (-1.710, 1.744)
<i>Solanum rostratum</i>	236.4 (218.3, 249.1)	-2.122 (-4.567, 0.500)*	0.127 (-2.460, 2.806)
<i>Trillium grandiflorum</i>	155.2 (136.5, 168.7)	-3.497 (-6.214, -0.849)**	-0.045 (-2.513, 2.383)
<i>Trillium undulatum</i>	195.7 (178.3, 208.6)	-2.837 (-5.529, -0.331)**	-0.239 (-2.084, 1.368)
Assemblage Means (μ_{α_1}, μ_{β_1}, μ_{β_4})	179.7 (167.5, 190.2)	-2.556 (-3.433, -1.715)**	-0.881 (-1.587, -0.230)**

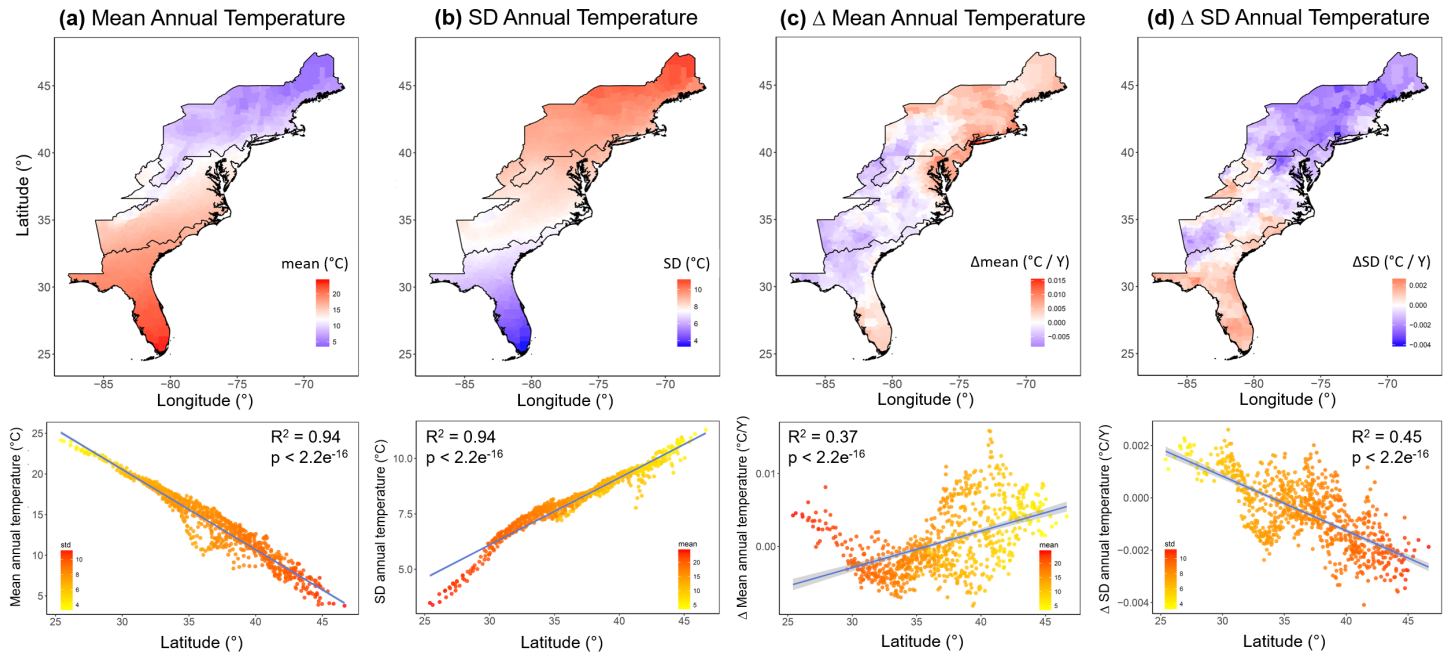


Figure S1. Geographic patterns of mean annual temperature, the standard deviation of intra-annual temperature, and their changes from 1895 to 2016 in the eastern United States. Top panels in (a) and (b) represent choropleth maps in which colors indicate the current climate. Top panels in (c) and (d) are colored by the coefficient of climate change. Climate zone boundaries are depicted as black lines. Lower panels depict the relationships between latitude and: (a) mean annual temperature; (b) the standard deviation of intra-annual temperature; (c) mean annual temperature change; and (d) change in the variance of temperature. Points represent counties, and colors indicate the average standard deviation (SD) of intra-annual temperature in (a) and (c) and mean annual temperature in (b) and (d), respectively. The line segments represent the linear regression of latitude and each variable, with 95% confidence intervals depicted in grey. Adjusted R^2 values and p-values are reported in each panel.

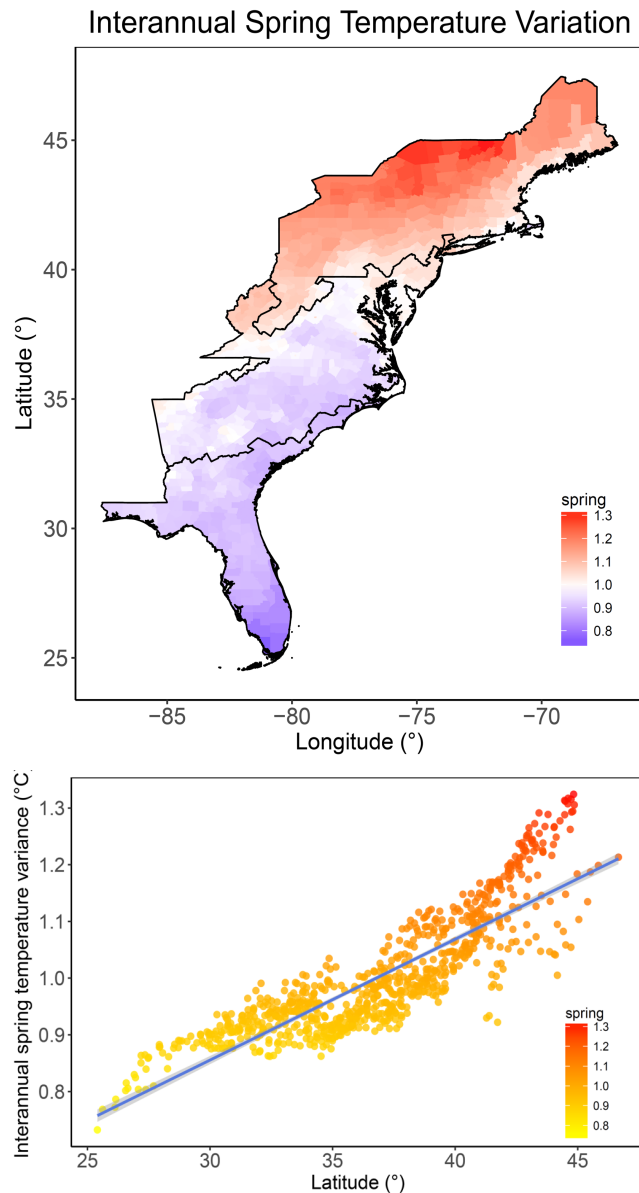


Figure S1. Geographic patterns inter-annual variation in spring temperature in terms of standard deviation across the eastern United States. The top panel is a choropleth map in which colors indicate the standard deviation of spring temperature from 1895 to 2016. The lower panel depicts the relationship between latitude and inter-annual variation in spring temperature. Points represent counties, and colors indicate inter-annual variation in spring temperature. The line segment represents the linear regression of latitude and inter-annual variation in spring temperature, with 95% confidence intervals depicted in grey. Adjusted R^2 values and p-values are reported in each panel.

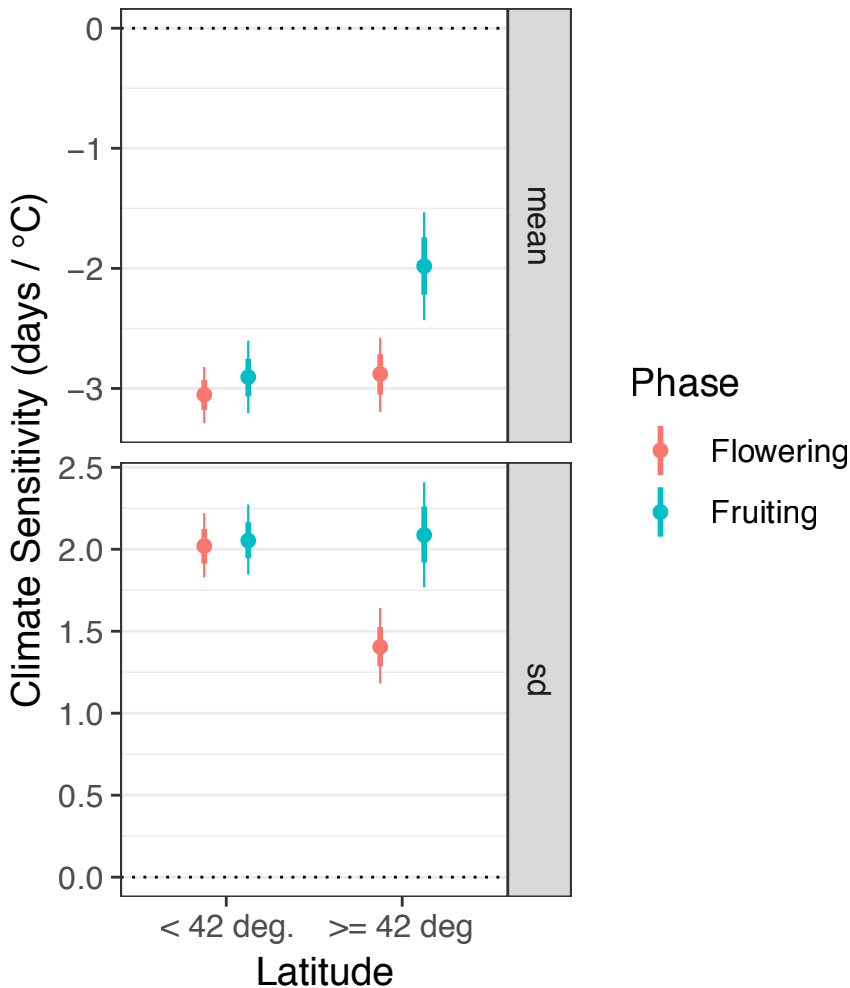


Figure S3. Community average (a) and standard deviation (b) spring temperature temperature climate sensitivities from Model 2 using an alternative spatial binning scheme based on latitude alone, using a cutoff of 42 degrees latitude. Red and blue represent flowering and fruiting stages, and thick and thin bars represent 50 and 80% posterior credible intervals, respectively. Differences are highly credible (>99% posterior probability) for differences in the mean for fruiting and standard deviation for flowering. Differences in the mean for flowering have a posterior probability of 67%, and differences in standard deviation for fruiting have a posterior probability of 55%.

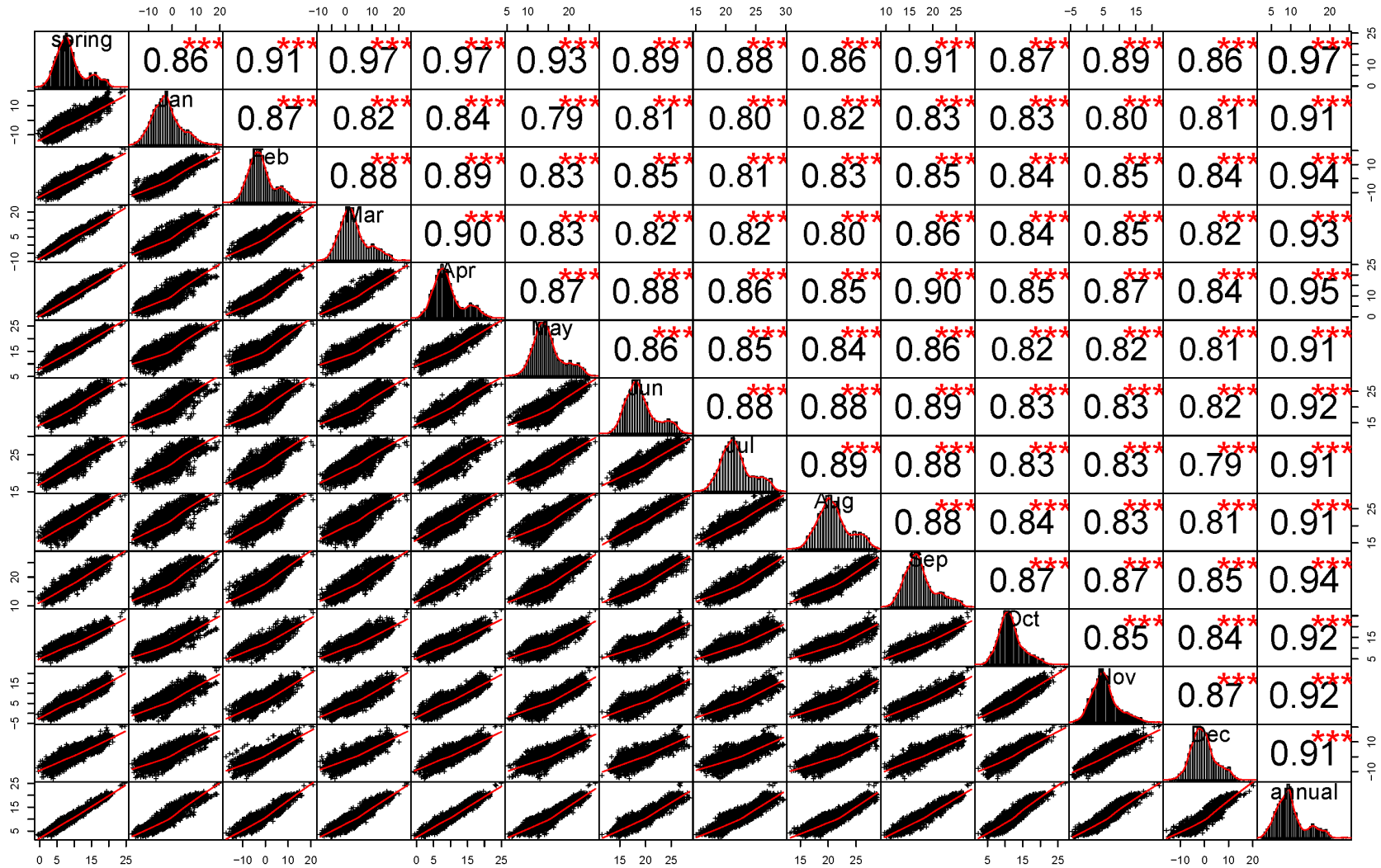


Figure S2. Correlation matrix of spring temperature, monthly temperatures, and mean annual temperature. The diagonal illustrates the distribution of each category of temperature. The lower left scatterplots illustrate the relationships between different temperature categories. The upper right panels depict Pearson's correlation coefficients. Asterisks denote p-values, where * = $p < 0.05$, ** = $p < 0.01$, and *** = $p < 0.001$.