Supporting Information: Differences in flower and leaf bud responses to the environment drive shifts in spring phenological sequences of temperate woody plants

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Tables

Species	Family	flower-leaf sequence classification
Acer pensylvanicum	Sapindaceae	flowers after leaves
Acer rubrum	Sapindaceae	flowers before leaves
Corylus cornuta	Betulaceae	flowers before leaves
Comptonia peregrina	Myrtaceae	flowers before leaves
Ilex mucronata	Aquifoliaceae	flowers with leaves
Ilex verticillata	Aquifoliaceae	flowers after leaves
Prunus pensylvanica	Rosaceae	flowers with leaves
Prunus virginiana	Rosaceae	flowers with/after leaves
Vaccinium corymbosum	Ericaceae	flowers after leaves
Viburnum acerifolium	Adoxaceae	flowers after leaves

Table S1: **Flower and leaf phenological sensitivity to environmental cues was investigated in 10 species.** Flower-leaf sequences classifications are based on Barnes & Wagner (1981,2004) and Barnes *et al.* (2016). We also sampled cutting from *Acer saccharum* and *Betula alleghaniensis*but did not include them in this this analyses because they failed to flower under any treatment conditions.

Chilling_model	Harvard Forest Mean (sd)	Chamber: 30 days	Chamber: 60 days
Utah Model	979.64 (248.34)	720.00	1440.00
Chill Hours	1170.71 (273.07)	720.00	1440.00
Dynamic Model	86.56 (16.64)	21.25	43.50

Table S2: **Comparisons between chilling treatments applied in our experiment to the average chilling at our sampling site (Harvard Forest in Petersham, MA) are sensitive to the way chilling is calculated.** We used daily temperature data from Harvard Forest () to calculate average field chilling from October 15-April 15 over a 20 year period using three different chilling models. The Utah and Chilling hours models suggest the average chilling at our sampling site is between our two experimental chilling treatments, while the dynamic models suggests that field chilling is generally higher than either of our experiment treatments. Should add a sentence about why.

	Estimate	Est.Error	Q25	Q75	phase
Intercept	77.54	10.01	70.91	84.01	flower
	70.30	8.93	64.56	76.01	budburst
Chill	-21.31	7.54	-26.14	-16.78	flower
	-30.35	5.20	-33.66	-27.06	budburst
Light	-5.99	5.83	-9.73	-2.12	flower
	5.95	5.12	2.68	9.29	budburst
Force	-18.87	6.36	-22.85	-14.85	flower
	-17.39	5.16	-20.70	-14.01	budburst
Chill:Light	-0.70	6.17	-4.60	3.44	flower
	-5.04	4.16	-7.73	-2.26	budburst
Chill:Force	6.75	6.62	2.73	10.96	flower
	12.31	4.77	9.28	15.42	budburst
Light:Force	-5.42	6.22	-9.39	-1.30	flower
	-12.90	4.12	-15.54	-10.17	budburst

Table S3: **Model estimates of the effect of variation in chilling, forcing and photoperiod on the flower and leaf phenology of 10 temperate woody plant species suggest that the strength of phenological responses to environmental change is phase specific.**

Simulations

To better understand the patterns of phenological sensitivity generated by the precocity hierarchy hypothesis (PHH) and the differential sensitivity hypothesis (DSH) respectively, we mathematically simulated the underlying physiology of each hypothesis, and these simulations to generate flower and leaf phenology under two levels of chilling, forcing and photoperiod in a fully factorial simulation.

For the PHH we assigned flowering and leafing a critical heat sum threshold (F*) above which the phenological event would take place. We did this using a growing degree model with a base temperature of 5°C (). For the PHH simulations, we assigned flowering an F* of 200 GDDs and leafing an F* of 400 GDDs. In this scenario we let increased both chilling and photoperiod reduce the F* value for each phenophase by 100 and 20 respectively.

For the DSH we assigned flowering and leafing identical F* values of 400. As in the previous scenario, we let increased chilling and photoperiod reduce the F* values, but these cues reduced the F* for leafing by 200 and 0 respectively and for flowering by 100 and 20.
We also included a third scenario that included both initial F* differences of the PHH (flowering: 200 and leafing: 400) and the differential response to chilling and photoperiod of the DSH (flowering: -100 chilling, -20 photoperiod, leafing -200 chilling, 0 photoperiod).

References

Barnes, B.V., Dick, C.W. & Gunn, M.E. (2016) *Michgan Shrubs Vines: A guide to species of the Great Lakes Region.* University of Michigan Press, Ann Arbor, MI, USA.

Barnes, B.V. & Wagner, W.H.J. (1981,2004) *Michigan Trees: A guide to the Trees of the Great Lakes Region.* University of Michigan Press, Ann Arbor, MI, USA.

O'Keefe, J. (2015) *Phenology of Woody Species at Harvard Forest since 1990.* Harvard Forest Data Archive: HF003., Petersham, MA, USA.

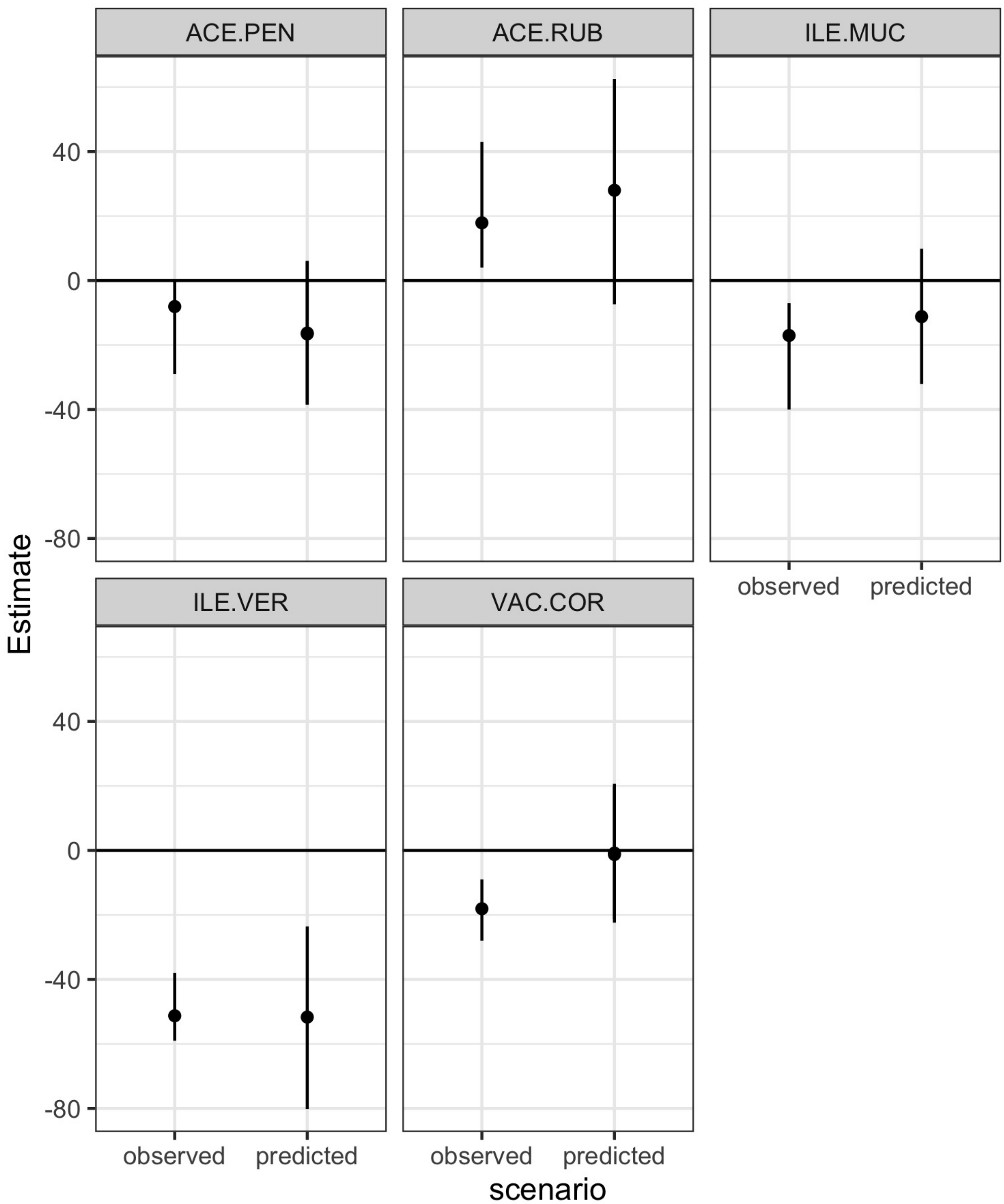

Figure S1: **Model predictions of flower-leaf sequence interphases (days between phenophase) under artificial conditions designed to approximate "average" field conditions reflect FLS interphases observed at Harvard Forest in Pertersham MA.**. This comparison suggest that the baseline environmental treatments applied in our experiment appropriately capture natural conditions. Dot represent means FLS interphase in both datasets, and lines represent the 89% credible intervals and the full range of observations for our model predictions and Harvard Forest data respectively. Harvard Forest phenological records are from O'Keefe (2015).