1 Supplementary Material

1.1 Methods

We used a phylogenetic generalized least-squares regression model (PGLS) to test the relationship between day of budburst and each trait. This analysis allowed us to test for phylogenetic non-independence in the phenology-trait relationship (Freckleton2002). We obtained a rooted phylogenetic tree by pruning the tree developed by (Smith2018a) and performed the PGLS analysis using the mean trait values and mean posterior estimates of the cue responses from our joint model. The PGLS was run using the "Caper" package in R (Orme2013).

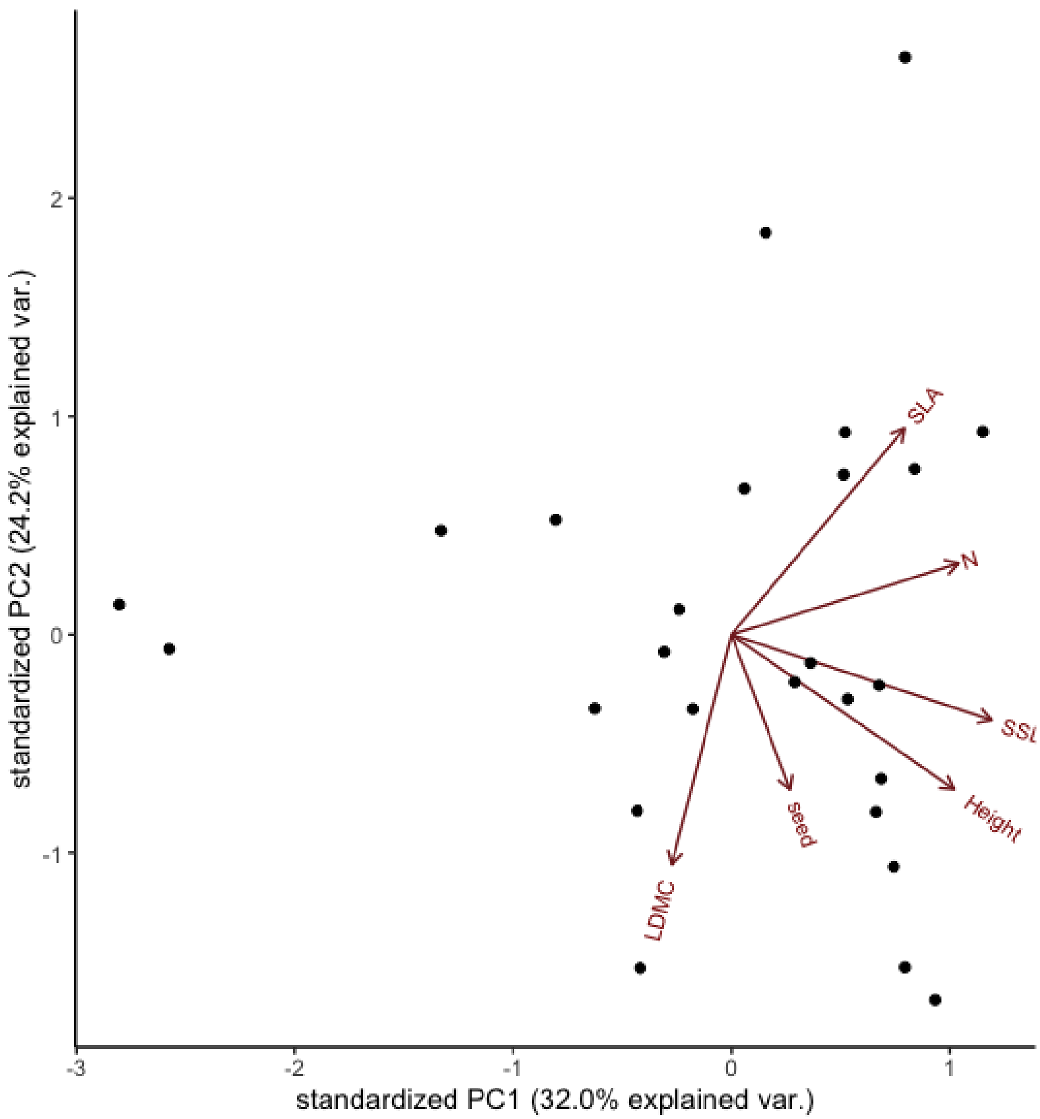

Figure 1: A projection of tree traits across the first and second principle component axis. Arrows represent the direction of vectors for six functional traits. Points represent the 26 speices for which complete trait data was available

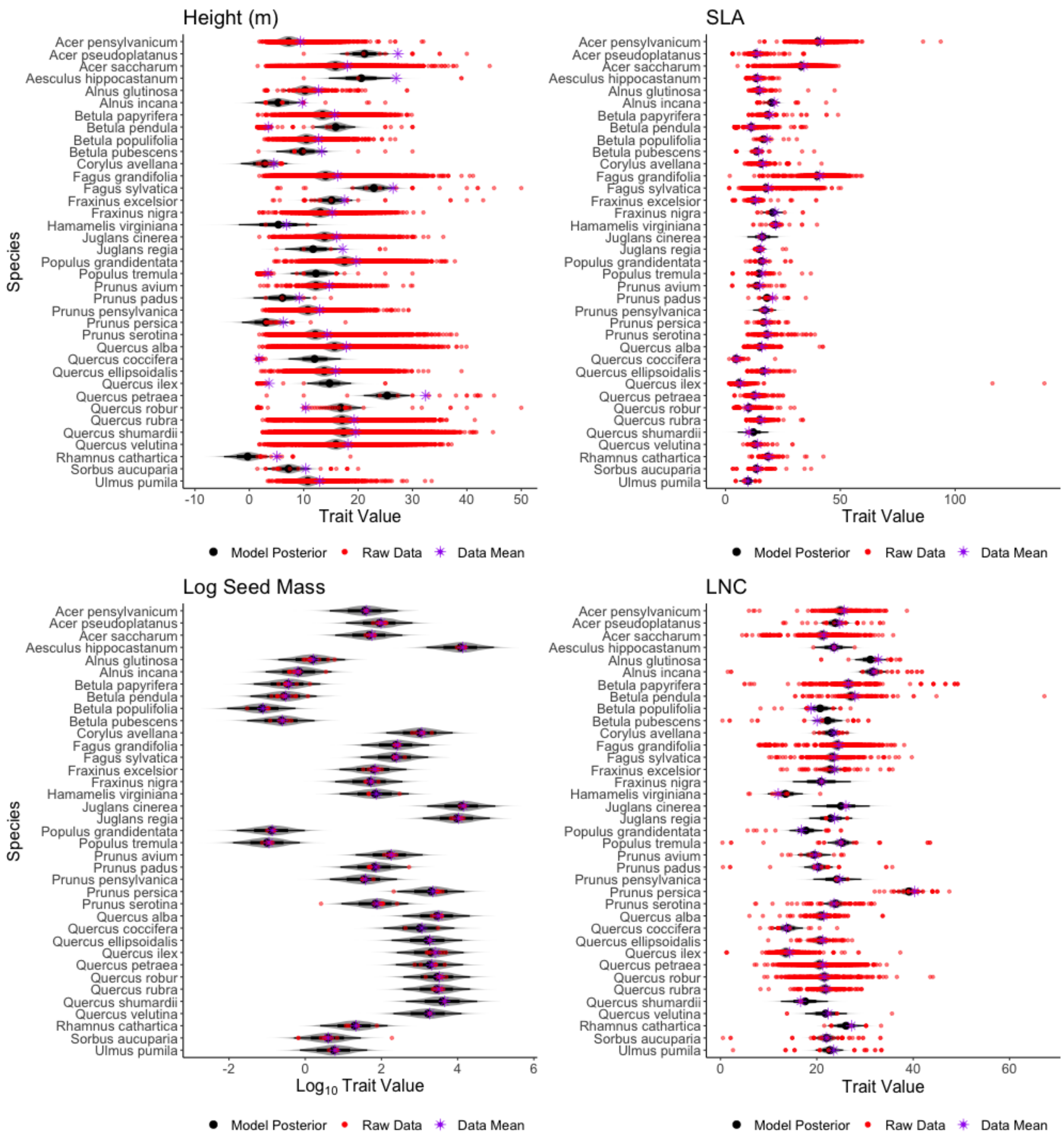

Figure 2: Comparisons of estimated model fits and raw data from joint models of trait effects on budburst phenological cues for 37 species of woody deciduous plants. Four functional traits – a. height, b. SLA, c. seed mass, and d. LNC – were modelled individually, with the calculated trait value being used to jointly model species responses to standardized chilling, forcing, and photoperiod cues. Model posteriors are shown in black, with the thicker line depicting the 66% interval and the thinner black line the 97% interval. Overall species level model posterior distributions were well aligned with the raw data, shown in red, and the species level means from the raw data, denoted as a purple stars.

Table 1: Data sources

traitname	unitname	no.obs	no.spp	database	datasetid	reference
Height	m	26.00	8	bien	10_bien	
Height	m	2.00	2	bien	12_bien	
Seed mass	mg	3.00	3	bien	12_bien	
LNC	mg/g	287.00	12	try	130_try	Craine et al. (2009)
Height	m	27.00	19	bien	14_bien	
LNC	mg/g	44.00	2	try	154_try	Wilson et al. (2000)
SLA	mm2 mg-1	44.00	2	try	154_try	Wilson et al. (2000)
Height	m	2.00	1	try	156_try	Bond-Lamberty et al. (2002)
Seed mass	mg	4.00	2	bien	17_bien	
Height	m	18.00	16	bien	18_bien	
LNC	mg/g	7.00	4	try	180_try	Wenxuan et al. (2012)
LNC	mg/g	7.00	3	try	181_try	Yahan et al. (2011)
Height	m	275.00	3	try	186_try	unpub.
SLA	mm2 mg-1	204.00	3	try	186_try	unpub.
Seed mass	mg	250.00	37	bien	19_bien	
Seed mass	mg	12.00	12	bien	2_bien	
Height	m	90.00	19	bien	20_bien	
Height	m	28.00	19	try	20_try	Wright et al. (2004)
LNC	mg/g	65.00	32	try	20_try	Wright et al. (2004)
SLA	mm2 mg-1	93.00	33	try	20_try	Wright et al. (2004)
Height	m	10.00	10	bien	21_bien	
Height	m	21.00	14	bien	22_bien	
Height	m	2.00	2	try	236_try	Prentice et al. (2011)
LNC	mg/g	3.00	2	try	236_try	Prentice et al. (2011)
SLA	mm2 mg-1	2.00	2	try	236_try	Prentice et al. (2011)
Height	m	47036.00	19	bien	24_bien	
LNC	mg/g	120.00	20	try	240_try	Vergutz et al. 2012
Height	m	5.00	5	bien	25_bien	
SLA	mm2 mg-1	102.00	18	try	25_try	Kleyer et al. (2008)
Height	m	21.00	21	try	251_try	Schweingruber & Landolt (2005)
Height	m	8.00	5	bien	26_bien	
Height	m	35.00	2	try	275_try	unpub.
SLA	mm2 mg-1	83.00	2	try	275_try	unpub.
Height	m	5.00	5	try	28_try	Moles et al. (2004)
LNC	mg/g	24.00	8	try	286_try	Atkin et al. (2015)
SLA	mm2 mg-1	40.00	11	try	286_try	Atkin et al. (2015)
Height	m	18.00	1	bien	3_bien	
LNC	mg/g	72.00	22	try	342_try	Maire et al. (2015)
SLA	mm2 mg-1	86.00	23	try	342_try	Maire et al. (2015)
LNC	mg/g	2.00	1	try	37_try	Cornelissen et al. (2003)
SLA	mm2 mg-1	615.00	14	try	37_try	Cornelissen et al. (2003)
LNC	mg/g	3216.00	37	try	412_try	unpub.
SLA	mm2 mg-1	6307.00	37	try	412_try	unpub.
LNC	mg/g	6.00	2	try	443_try	Wang et al. 2017
SLA	mm2 mg-1	6.00	2	try	443_try	Wang et al. 2017
Height	m	120.00	1	bien	5_bien	
SLA	mm2 mg-1	20.00	2	try	50_try	Shipley et al. (2002)
Height	m	1.00	1	try	54_try	Cavender-Bares et al. (2006)
SLA	mm2 mg-1	42.00	2	try	54_try	Cavender-Bares et al. (2006)
SLA	mm2 mg-1	1.00	1	try	65_try	unpub.
Height	m	20.00	1	bien	7_bien	
Height	m	11.00	10	try	86_try	Diaz et al. (2004)
SLA	mm2 mg-1	11.00	10	try	86_try	Diaz et al. (2004)
Seed mass	mg	12.00	7	bien	9_bien	

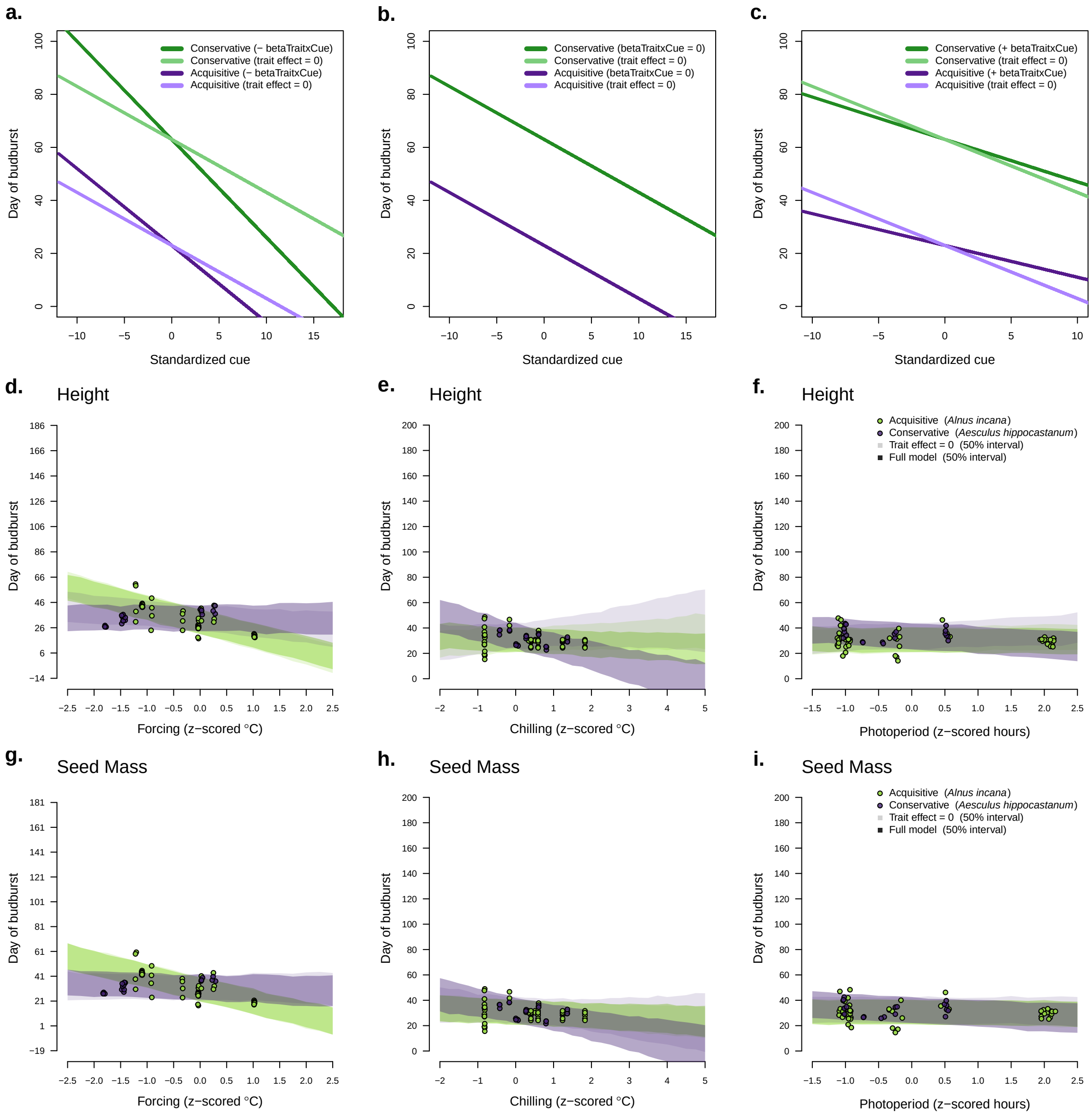

Figure 3: Functional traits may contribute to the species responses to forcing, chilling, or photoperiod cues in several ways. a) If traits are contribute negatively to the timing of phenological events, we expect the phenological response to be stronger and budburst earlier with increasing cue values. b) But if traits have no effects on the timing of budburst then cue responses will be zero and equivalent to the cue only trends. c) Lastly, traits that have a positive contribution to the timing of phenological events produce weaker responses with later budburst dates. The effect of height on phenological cue responses was weaker in response to forcing cues, but stronger in response to both chilling and photoperiod. In contrast, seed mass has a negligble effect on forcing and photoperiod cue responses, but a greater response with chilling. Band represent the 50% uncertainty intervals of the model estimates.

Table 2: Height model estimates

	mean	sd	2.5%	50%	97.5%	Rhat
mu_grand	12.71	1.96	8.73	12.75	16.46	1.00
muPhenoSp	32.07	2.63	26.97	32.05	37.30	1.00
muForceSp	-10.74	2.86	-16.63	-10.66	-5.38	1.01
muChillSp	-4.08	4.13	-12.46	-4.02	3.99	1.01
muPhotoSp	1.11	2.18	-3.37	1.14	5.27	1.01
betaTraitxForce	0.16	0.19	-0.21	0.16	0.55	1.01
betaTraitxChill	-0.54	0.28	-1.07	-0.54	0.02	1.01
betaTraitxPhoto	-0.25	0.15	-0.54	-0.25	0.08	1.00
sigma_sp	5.91	0.76	4.63	5.84	7.57	1.00
sigma_study	7.53	1.22	5.52	7.40	10.28	1.00
sigma_traity	5.39	0.02	5.36	5.39	5.43	1.00
sigmaPhenoSp	15.11	2.05	11.20	15.06	19.36	1.00
sigmaForceSp	4.96	1.16	3.01	4.85	7.55	1.00
sigmaChillSp	8.53	2.10	5.21	8.26	13.38	1.00
sigmaPhotoSp	3.25	0.86	1.79	3.17	5.15	1.00
sigmapheno_y	14.18	0.26	13.69	14.18	14.70	1.00

Table 3: SLA model estimates

	mean	sd	2.5%	50%	97.5%	Rhat
mu_grand	16.85	1.47	14.03	16.85	19.71	1.01
muPhenoSp	31.33	2.55	26.45	31.30	36.39	1.00
muForceSp	-11.40	2.71	-17.29	-11.33	-6.42	1.01
muChillSp	-16.66	4.70	-26.35	-16.61	-7.84	1.00
muPhotoSp	1.85	2.47	-3.13	1.98	6.47	1.00
betaTraitxForce	0.17	0.15	-0.11	0.17	0.47	1.01
betaTraitxChill	0.34	0.25	-0.13	0.34	0.83	1.00
betaTraitxPhoto	-0.23	0.14	-0.50	-0.24	0.05	1.00
sigma_sp	7.78	0.93	6.21	7.70	9.77	1.00
sigma_study	3.28	0.97	1.87	3.13	5.57	1.00
sigma_traity	6.17	0.05	6.07	6.16	6.27	1.00
sigmaPhenoSp	13.92	2.11	10.10	13.79	18.34	1.00
sigmaForceSp	4.97	1.12	3.07	4.87	7.49	1.00
sigmaChillSp	10.57	2.30	6.79	10.33	15.56	1.00
sigmaPhotoSp	3.48	0.81	2.14	3.40	5.36	1.00
sigmapheno_y	14.17	0.26	13.66	14.17	14.68	1.00

Table 4: Log10 Seed mass model estimates

	mean	sd	2.5%	50%	97.5%	Rhat
mu_grand	1.87	0.50	0.89	1.88	2.84	1.00
muPhenoSp	31.35	2.64	26.32	31.27	36.76	1.00
muForceSp	-8.17	1.60	-11.35	-8.16	-5.07	1.00
muChillSp	-9.41	2.82	-15.21	-9.43	-3.92	1.00
muPhotoSp	-1.26	1.25	-3.72	-1.27	1.19	1.00
betaTraitxForce	-0.30	0.69	-1.61	-0.31	1.06	1.00
betaTraitxChill	-1.09	1.09	-3.28	-1.08	1.01	1.00
betaTraitxPhoto	-0.56	0.58	-1.68	-0.56	0.62	1.00
sigma_sp	1.62	0.19	1.30	1.61	2.05	1.00
sigma_study	0.97	0.10	0.77	0.97	1.17	1.00
sigma_traity	0.25	0.01	0.23	0.25	0.27	1.00
sigmaPhenoSp	14.84	2.25	10.58	14.79	19.42	1.00
sigmaForceSp	4.92	0.98	3.22	4.85	7.03	1.00
sigmaChillSp	10.67	2.57	6.55	10.33	16.65	1.00
sigmaPhotoSp	3.58	0.86	2.13	3.49	5.52	1.00
sigmapheno_y	14.12	0.25	13.66	14.12	14.61	1.00

Table 5: LNC model estimates

	mean	sd	2.5%	50%	97.5%	Rhat
mu_grand	22.61	1.37	19.91	22.60	25.32	1.01
muPhenoSp	31.14	2.52	26.33	31.09	36.29	1.00
muForceSp	-19.33	5.37	-30.02	-19.45	-8.62	1.02
muChillSp	-27.10	7.04	-40.56	-27.27	-12.84	1.01
muPhotoSp	-9.40	4.67	-18.09	-9.41	-0.37	1.02
betaTraitxForce	0.47	0.23	0.01	0.47	0.93	1.02
betaTraitxChill	0.72	0.30	0.12	0.72	1.29	1.01
betaTraitxPhoto	0.31	0.19	-0.06	0.31	0.68	1.02
sigma_sp	5.12	0.61	4.09	5.06	6.48	1.00
sigma_study	3.55	0.98	2.03	3.44	5.83	1.00
sigma_traity	5.13	0.06	5.02	5.13	5.25	1.00
sigmaPhenoSp	14.05	1.97	10.30	13.97	18.23	1.00
sigmaForceSp	4.59	1.09	2.80	4.47	7.05	1.00
sigmaChillSp	8.92	1.97	5.74	8.71	13.44	1.00
sigmaPhotoSp	3.59	0.81	2.25	3.52	5.41	1.00
sigmapheno_y	14.17	0.26	13.67	14.17	14.67	1.00