## Supplementary Material - Species differences in cue responses in woody plants of North America

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Table S1: Approximate chill units from our two western sites, E.C. Manning Park and Smithers B.C., Canada, and our two eastern sites, Harvard Forest, USA and St. Hippolyte, Canada. Weather data was obtained from the Hope Slide weather station for our E.C. Manning Park estimates and the Smithers airport weather station for our Smithers communities. For our eastern communities, weather data was obtained from weather stations at Harvard Forest and in St. Hippolyte

Population	Chilling treatment	Chill hours	Utah model	Chill portions
Harvard forest	Field chilling	892	814.50	56.62
Harvard forest	Field chilling $+$ 30 d at 4 degree C	2140	2062.50	94.06
St. Hippoltye	Field chilling	682	599.50	44.63
St. Hippoltye	Field chilling $+$ 30 d at 4 degree C	1930	1847.50	82.06
Smithers	Field chilling $+$ 30 d at 4 degree C	1317	1368.00	54.95
Smithers	Field chilling $+$ 70 d at 4 degree C	1965	2016.00	74.67
Manning Park	Field chilling $+$ 30 d at 4 degree C	1213	1377.00	55.09
Manning Park	Field chilling + 70 d at 4 degree C	1861	2025.00	75.33

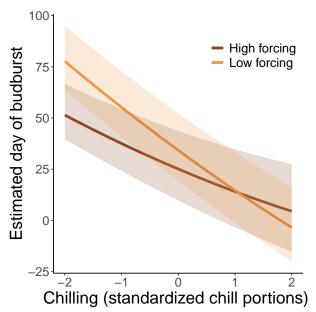


Figure S1: Estimated day of budburst of first bud in response to chill portions and forcing, estimated for our defined baseline conditions. We found a positive interaction between chilling and forcing cues, with high forcing compensating for low chilling to produce earlier budburst, while budburst occurred earlier under low forcing following high chilling. In our analysis, we standardized predictors, (here specifically chilling) via z-scores, using two standard deviations, see methods for further details.

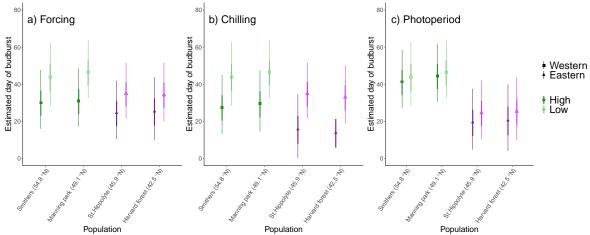


Figure S2: Estimated day of budburst of first bud in response to (a) forcing across populations under low chilling conditions and short photoperiods, (b) chilling across populations under low forcing and short photoperiods, and (c) across photoperiods under our baseline forcing and chilling conditions for species sampled from our four populations. The thin error bars represent the 90% uncertainty interval, while the thicker error bars represent the 50% uncertainty interval.

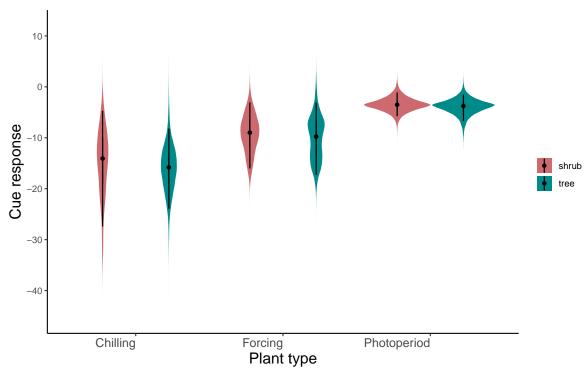


Figure S3: Comparisons of posterior distributions for cues estimates between shrub and tree species. Black circles represent the median cues, while the thinner black line the 90% quantile interval. The coloured distribution is the the posterior density of the posteriors of the cues for all species within a given architectural type. The y-axis spans the entire range of the data.

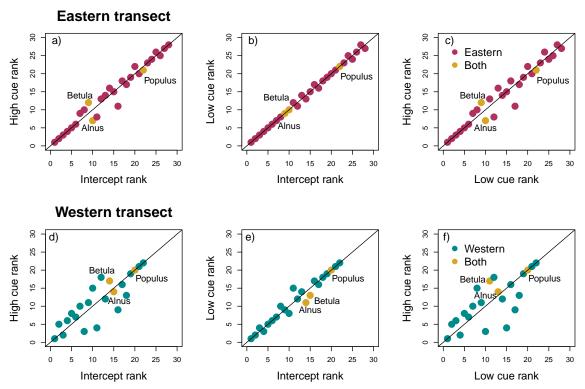


Figure S4: Estimated changes in species ranked budburst order, compared between species level effects (species intercept) and under high cue conditions (a and d), species level effects and under low cue condition (b and e), and ranked order under low and high cue conditions (c and f) for our eastern in red (a-c) and western species in blue (d-f). For the three species that occur in both transect, shown in yellow, *Alnus incana* exhibited the greatest rank change with a difference of three, while *Betula papyrifera* had a rank difference of two and *Populus tremuloides* a rank difference of one.

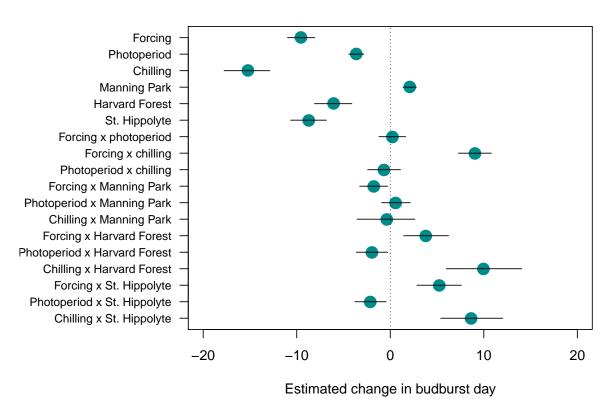


Figure S5: Estimated mean responses in budburst date of first bud to varying forcing, chilling, and photoperiod cues for 47 deciduous woody species across North America. Points represent mean posterior estimate, while bars depict the 95% uncertainty interval. Negative responses represent advances budburst, while positive values represent delaying effects.

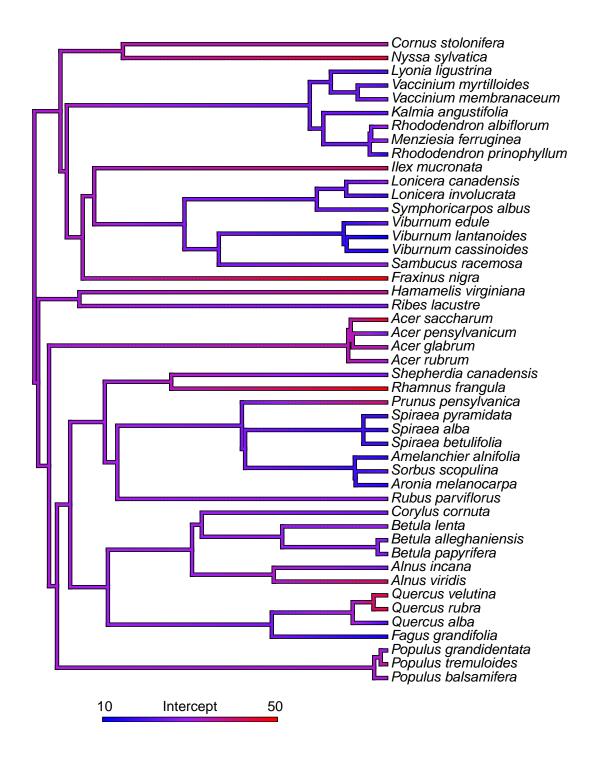


Figure S6: Species differences were accounted for by including phylogenetic effects on the species intercept in a model estimating days to budburst after the start of forcing treatments. We pruned to our species subset an existing phylogeny for flowering plants developed by Smith and Brown (2018)

Table S2: Mean budburst dates across all treatments from raw data for 47 species at our two western sites, E.C. Manning Park (MP) and Smithers B.C.(SM) Canada, and our two eastern

sites, Harvard Forest (HF) USA and St. Hippolyte (SH) Canada.

Acer pensylvanicum         16.00         18.00           Acer valvrum         22.00         25.00           Acer saccharum         45.00         36.00           Alnus incana         28.00         3           Alnus viridis         44.00         4           Amelanchier alnifolia         19.00         1           Aronia melanocarpa         14.00         1           Betula elida         30.00         21.00           Betula papyrifera         3         20.00         21.00           Betula papyrifera         17.00         18.00         2           Coryus cornuta         25.00         19.00         2           Coryus solnifera         15.00         1         1           Fagus grandifolia         42.00         43.00         43.00         1           Frazinus nigra         38.00         38.00         38.00         1           Hamamelis virginiana         44.00         16.00         15.00         1           Kalmia angustifolia         30.00         32.00         2         2         2         2         2         2         2         2         0         2         2         2         0         2         2	Species	Harvard Forest	St. Hippoltye	Manning Park	Smither
Acer rubrum         22.00         25.00           Acer saccharum         45.00         36.00           Almus incana         28.00         3           Almus viridis         44.00         4           Amelanchier dnifolia         19.00         1           Aronia melanocarpa         14.00         Betula alleghaniensis         20.00         21.00           Betula papyrifera         30.00         3         3           Betula papyrifera         17.00         18.00         3           Corylus cornuta         25.00         19.00         19.00           Cornus stolonifera         15.00         1           Fogus grandifolia         42.00         43.00         4           Fearinus nigra         38.00         38.00         38.00           Hamamelis virginiana         44.00         15.00         1           Ilex mucronata         16.00         15.00         1           Kalmia angustifolia         30.00         32.00         2           Lonicer canadensis         17.00         16.00         2           Lonicer involucrata         2.00         2         2           Lyonia ligustrina         31.00         3         3 <tr< td=""><td>Acer glabrum</td><td>40.00</td><td>40.00</td><td>36.00</td><td>39.00</td></tr<>	Acer glabrum	40.00	40.00	36.00	39.00
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Populus grandidentata       33.00       31.00         Populus tremuloides       46.00       3         Prunus pensylvanica       18.00       16.00         Quercus alba       45.00       34.00         Quercus velutina       52.00       34.00         Rhamnus frangula       32.00       32.00         Rhododendron albiflorum       19.00       2         Rhododendron prinophyllum       29.00       2         Ribes lacustre       29.00       2         Rubus parviflorus       28.00       3         Sambucus racemosa       33.00       3         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00				30.00	31.0
Populus tremuloides       46.00       3         Prunus pensylvanica       18.00       16.00         Quercus alba       45.00       34.00         Quercus rubra       36.00       34.00         Quercus velutina       52.00       8         Rhamnus frangula       32.00       19.00         Rhododendron albiftorum       19.00       2         Rhododendron prinophyllum       29.00       2         Ribes lacustre       29.00       2         Rubus parviflorus       28.00       3         Sambucus racemosa       33.00       3         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00		33.00	31.00		
Prunus pensylvanica       18.00       16.00         Quercus alba       45.00         Quercus rubra       36.00       34.00         Quercus velutina       52.00         Rhamnus frangula       32.00         Rhododendron albiflorum       19.00         Ribes lacustre       29.00       2         Rubus parviflorus       28.00       3         Sambucus racemosa       33.00       2         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00				46.00	35.0
Quercus alba       45.00         Quercus rubra       36.00       34.00         Quercus velutina       52.00         Rhamnus frangula       32.00         Rhododendron albiflorum       19.00         Ribes lacustre       29.00         Rubus parviflorus       28.00       3         Sambucus racemosa       33.00         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00	_	18.00	16.00		
Quercus rubra       36.00       34.00         Quercus velutina       52.00         Rhamnus frangula       32.00         Rhododendron albiflorum       19.00         Rhododendron prinophyllum       29.00         Ribes lacustre       29.00       2         Rubus parviflorus       28.00       3         Sambucus racemosa       33.00       2         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00					
Quercus velutina       52.00         Rhamnus frangula       32.00         Rhododendron albiflorum       19.00         Rhododendron prinophyllum       29.00         Ribes lacustre       29.00       2         Rubus parviflorus       28.00       3         Sambucus racemosa       33.00       2         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00	=		34.00		
Rhamnus frangula       32.00         Rhododendron albiflorum       19.00         Rhododendron prinophyllum       29.00         Ribes lacustre       29.00         Rubus parviflorus       28.00         Sambucus racemosa       33.00         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00	=		01.00		
Rhododendron albiflorum       19.00         Rhododendron prinophyllum       29.00         Ribes lacustre       29.00       2         Rubus parviflorus       28.00       3         Sambucus racemosa       33.00       3         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00	•				
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Ribes lacustre       29.00       2         Rubus parviflorus       28.00       3         Sambucus racemosa       33.00       3         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Vaccinium myrtilloides       13.00       17.00         Viburnum cassinoides       15.00       18.00         Viburnum lantanoides       31.00       28.00	· ·	29.00		10.00	
Rubus parviflorus       28.00       3         Sambucus racemosa       33.00       3         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Vaccinium myrtilloides       13.00       17.00         Viburnum cassinoides       15.00       18.00         Viburnum lantanoides       31.00       28.00		20.00		29.00	23.0
Sambucus racemosa       33.00         Shepherdia canadensis       25.00       2         Sorbus scopulina       21.00       1         Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Viburnum cassinoides       13.00       17.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00					30.0
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Spiraea alba       18.00       20.00         Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Vaccinium myrtilloides       13.00       17.00         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00	_				19.0
Spiraea betulifolia       24.00       1         Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Vaccinium myrtilloides       13.00       17.00         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00	_	19.00	20.00	21.00	19.0
Spiraea pyramidata       26.00       2         Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Vaccinium myrtilloides       13.00       17.00         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00	_	10.00	20.00	24.00	18.0
Symphoricarpos albus       27.00       3         Vaccinium membranaceum       22.00       2         Vaccinium myrtilloides       13.00       17.00         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00					$\frac{18.0}{22.0}$
Vaccinium membranaceum       22.00       2         Vaccinium myrtilloides       13.00       17.00         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00					$\frac{22.0}{32.0}$
Vaccinium myrtilloides       13.00       17.00         Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00	0 1				
Viburnum cassinoides       15.00       18.00         Viburnum edule       19.00         Viburnum lantanoides       31.00       28.00		19.00	17.00	22.00	23.0
Viburnum edule 19.00 Viburnum lantanoides 31.00 28.00	9				
Viburnum lantanoides 31.00 28.00		15.00	18.00	10.00	0.0
		01.00	00.00	19.00	8.0
7	v iournum iantanoides		28.00		

Table S3: Proportion of samples per species for which budburst was observed.

Species name	Proportion budburst	Plant type
Acer glabrum	0.83	tree
$Alnus\ incana$	1.00	shrub
$Alnus\ viridis$	0.92	shrub
$Amelanchier\ alnifolia$	0.99	shrub
$Betula\ papyrifera$	1.00	tree
$Cornus\ stolonifera$	0.99	shrub
$Lonicera\ involucrata$	0.87	shrub
$Menziesia\ ferruginea$	0.80	shrub
$Populus\ balsamifera$	0.98	tree
$Populus\ tremuloides$	0.90	tree
$Rhododendron\ albiflorum$	1.00	shrub
$Ribes\ lacustre$	0.82	shrub
$Rubus\ parviflorus$	0.94	shrub
$Sambucus\ racemosa$	0.95	shrub
$Shepherdia\ canadensis$	1.00	shrub
$Sorbus\ scopulina$	0.99	shrub
$Spiraea\ betulifolia$	0.94	shrub
$Spiraea\ pyramidata$	0.92	shrub
$Symphoricar pos\ albus$	0.84	shrub
$Vaccinium\ membranaceum$	0.90	shrub
$Viburnum\ edule$	1.00	shrub