

Supplemental materials for Chilling outweighs photoperiod and forcing cues for temperate trees in experiments, but not in natural systems

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Supplemental Methods

1. Equation of our model
2. Forecasting with the OSPREE model: We selected sites in Germany where temperature and budburst have been monitored since the 1950s. We extracted mean temperature data from 1950 through 1980 (pre warming time period) and used these values as baseline data in our model. We then investigated model predictions of budburst given different levels of warming (from 1-7 °C), including altered chilling and forcing as well as potential declines in photoperiod due to advancing phenology. We did this for two common European species: *Betula pendula* (silver birch) and *Fagus sylvatica* at all lat/longs included in the PEP database for Germany.
3. To understand how experimental temperature, photoperiod, and budburst sensitivity compares to past and current conditions in nature, we used data from the PEP database (cite). We summarized forcing, chilling, and budburst day for two common species: *Betula pendula* (silver birch) and *Fagus sylvatica* (European beech) during a pre-warming time-period (1950-1980) and post-warming period (1981-2014?).

Supplemental figures/tables:

1. Map of study locations, shading or symbol coding for number of cues (Lizzie)
2. Map of species forecasting to justify sites
3. Heat maps for the main data, including by actual study design and by calculated chilling (our calculations)
4. Photoperiod x latitude effects figure

Reference list

A few categories:

Papers about contrasting results over what cues matter from growth chamber studies: Basler and Körner (2012, 2014); Caffarra et al. (2011*a*); Caffarra and Donnelly (2011); Caffarra et al. (2011*b*); Heide and Prestrud (2005); Koerner and Basler (2010); Laube et al. (2014); Vitasse and Basler (2013); Zohner et al. (2016). Get Nanninga *et al.* 2017: 'Increased exposure to chilling advances the time to budburst in North American tree species' and maybe Malyshev *et al.* 2018 'Temporal photoperiod sensitivity and forcing requirements for budburst in temperate tree seedlings.'

Papers about declining sensitivities (Ailene will update this list): Rutishauser et al. (2008); Fu et al. (2015). Also look for a Wang *et al.* article 'Impacts of global warming on phenology of spring leaf unfolding remain stable in the long run.' Vitasse paper on declining variation across elevation gradient. See Yu et al. (2010), but this is not temperate trees.

Papers about chilling units paper (Lizzie gets a list): Fu 2012 from OSPREE. Harrington and Gould (2015)Luedeling et al. (2011); Luedeling and Brown (2011); Luedeling et al. (2013)

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