Table S1. The difference of budburst (BP50, the date at which 50% trees have burst buds) between the Orsay and Barbeau sites, for hornbeam and oak over 2004-2022 and 2003-2022, respectively. Positive (negative) value mean budburst in Barbeau (Orsay) is earlier.

Species	Averaged difference of budburst between Orsay and Barbeau/days	Minimum difference of budburst between Orsay and Barbeau/days	Maximum difference of budburst between Orsay and Barbeau/days
Carpinus	-2	-12	+2
Quercus	-1	-4	+1

Table S2. Sensitivity of budburst to mean spring temperature (from January to May) for 50% of budburst (BP50) in three tree populations during the periods 1976-1984 and 1992-2006. Validation values are taken from Vitasse et al. (2009, their Table 4) (*: P<0.05, **:P<0.01, ***: P<0.001).

| Species | Simulations from WPV model | | | | Values from Vitasse' paper | | |
| | Orsay | | Orsay | | Fontainebleau | | Pyrénées |
	Sensitivity of BP50 to decade (days per decade)	R^2	Sensitivity of BP50 to temperature (days per °C)	R^2	Sensitivity of BP50 to decade (days per decade)	Sensitivity of BP50 to temperature (days per °C)	Sensitivity of BP50 to temperature (days per °C)
Carpinus	2.6	0.03	9.8***	0.46	1.80	4.58*	
Quercus	4.4*	0.21	5.7**	0.23	4.20*	7.26**	7.48***
Castanea	5.6**	0.30	7.4***	0.38			

Fig. S1. The flow diagram of the within-population variability (WPV) model for budburst. In short, the model represents the release of endodormancy through the accumulation of chilling temperatures and simulates the ontogenetic growth of the buds through the accumulation of forcing temperatures. One particularity of the model is that ontogenetic growth is regulated by the state of dormancy release and prevailing temperatures (Lundell et al. 2020). In the WPV model, we assumed that F* follows a normal distribution at the level of the tree population. At a given date, the proportion of trees that fulfilled a level of the forcing requirement are regarded as the percentage of trees to have burst buds in the population.
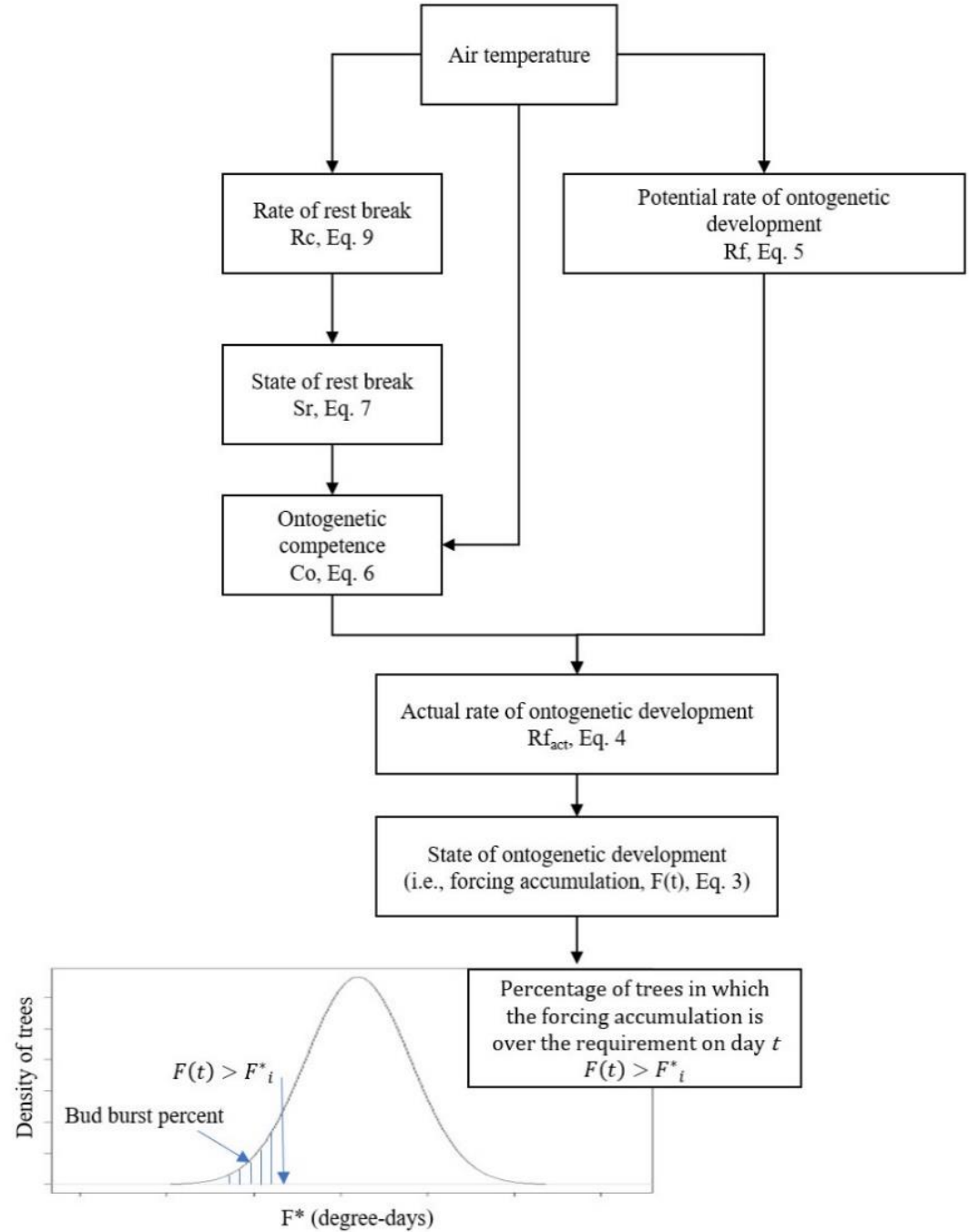
Fig. S2. Response of (a) the rate of chilling accumulation, (b) the rate of forcing accumulation to temperature, and (c,d,e) the response of ontogenetic growth (Co) to state of rest break (Sr) for the eight tree populations in the WPV model. Different colors represent the different species. Because of the same threshold of chilling accumulation (T_c) for hornbeam and oak, we changed here T_c slightly for hornbeam (from 10.5°C to 10.4°C) for sake of figure clarity. To illustrate the response of Co to the interaction between Sr and prevailing temperatures, we set a gradient of the prevailing temperatures (0°C, 10°C, and 20°C in subplots c to e).
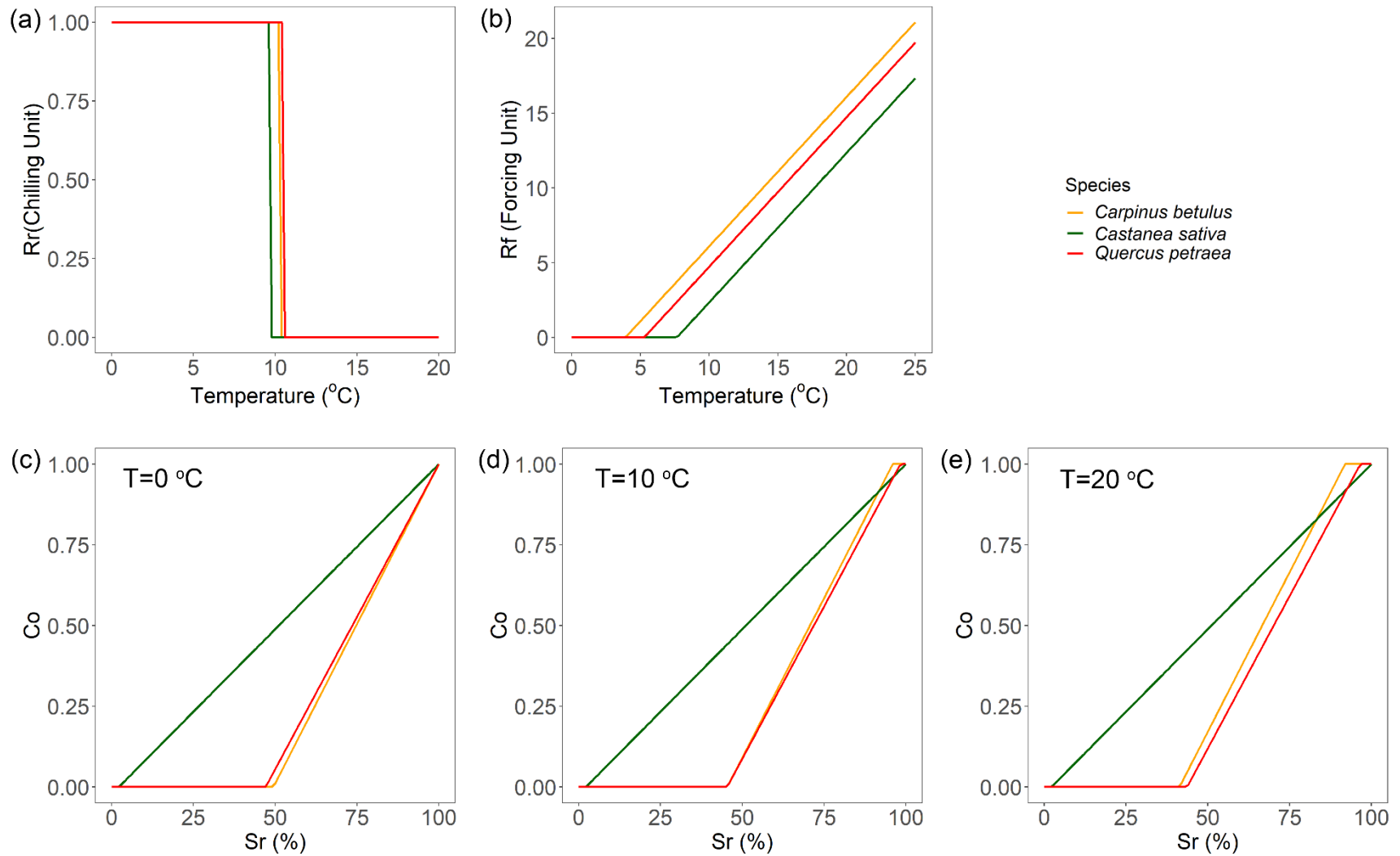
Fig. S3. Calculation of the root mean square error (RMSE) illustrated over two dimensions. $RMSE_{BP}$ is calculated over the percentage of budburst (BP) in the tree population (i.e., comparing the difference, in percent, between the observation and prediction of the budburst percent on the same day of the year, DoY). $RMSE_{DoY}$ is calculated over dates (i.e., comparing the difference, in number of days, between the observation and prediction for the same percentage of budburst).
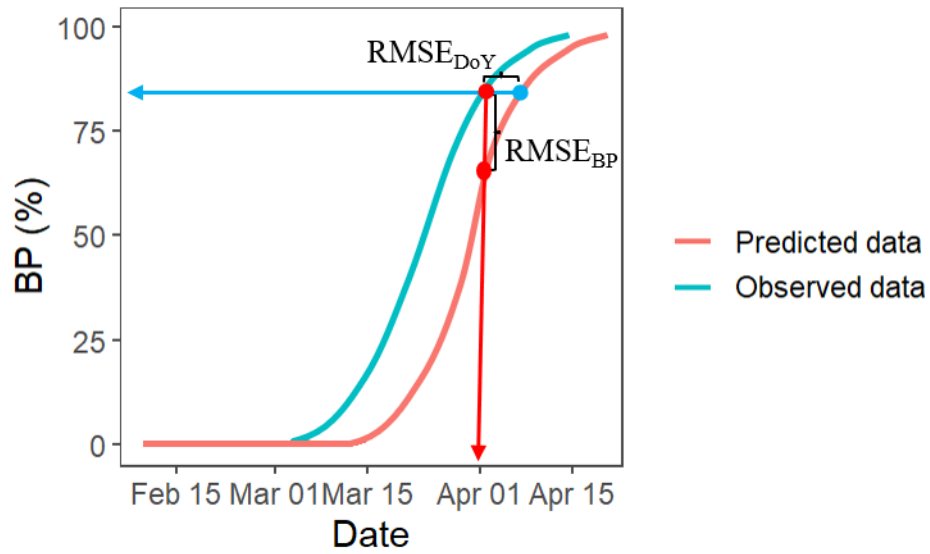
Fig. S4. Dynamics of budburst percent (BP) in five tree populations during the period 2000-2022. The blue points and blue lines are simulated by WPV model. The red points and red lines are observation data.
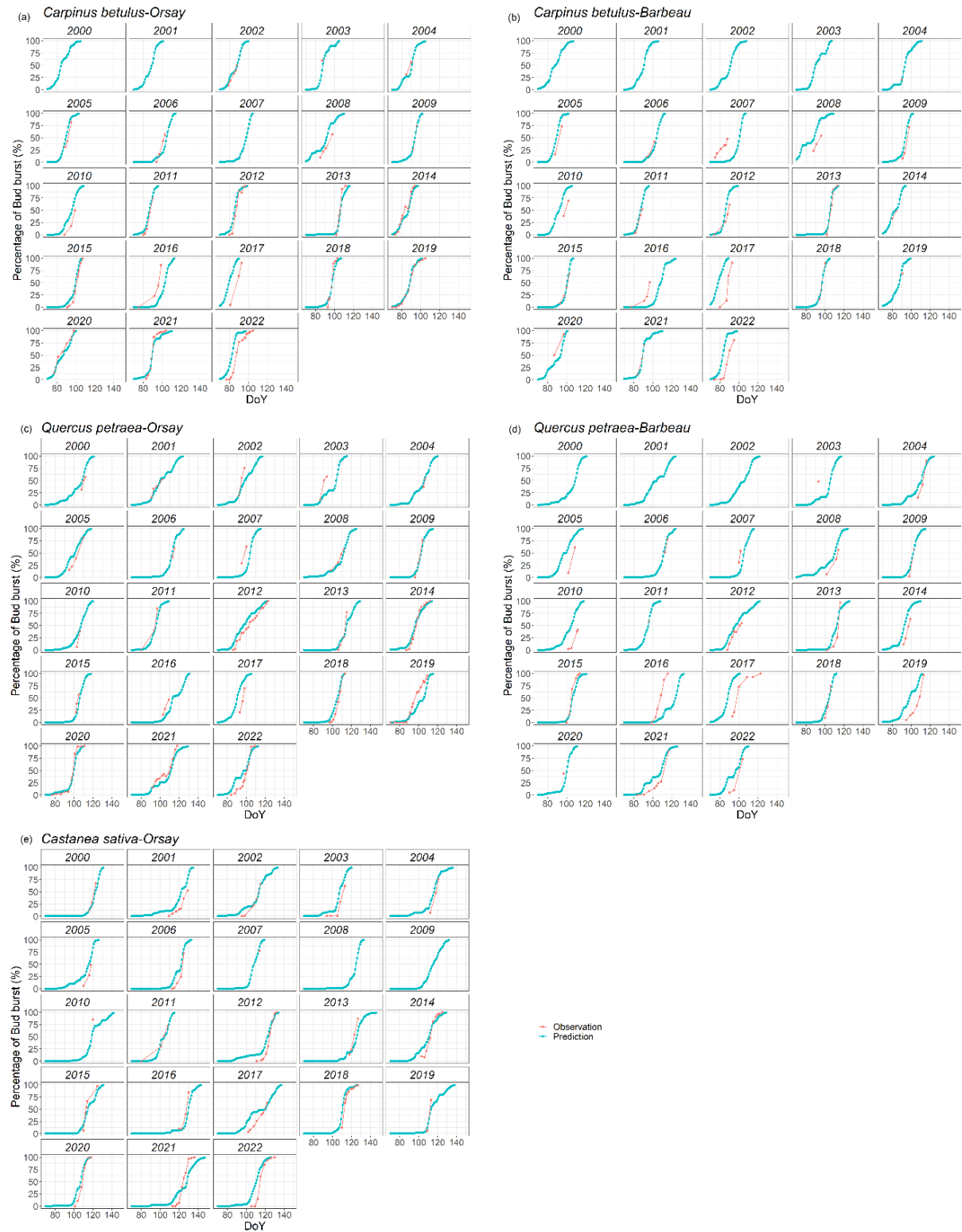
Fig. S5. Mean spring (January to May) air temperature in Barbeau and Orsay during the periods 1961-2022.
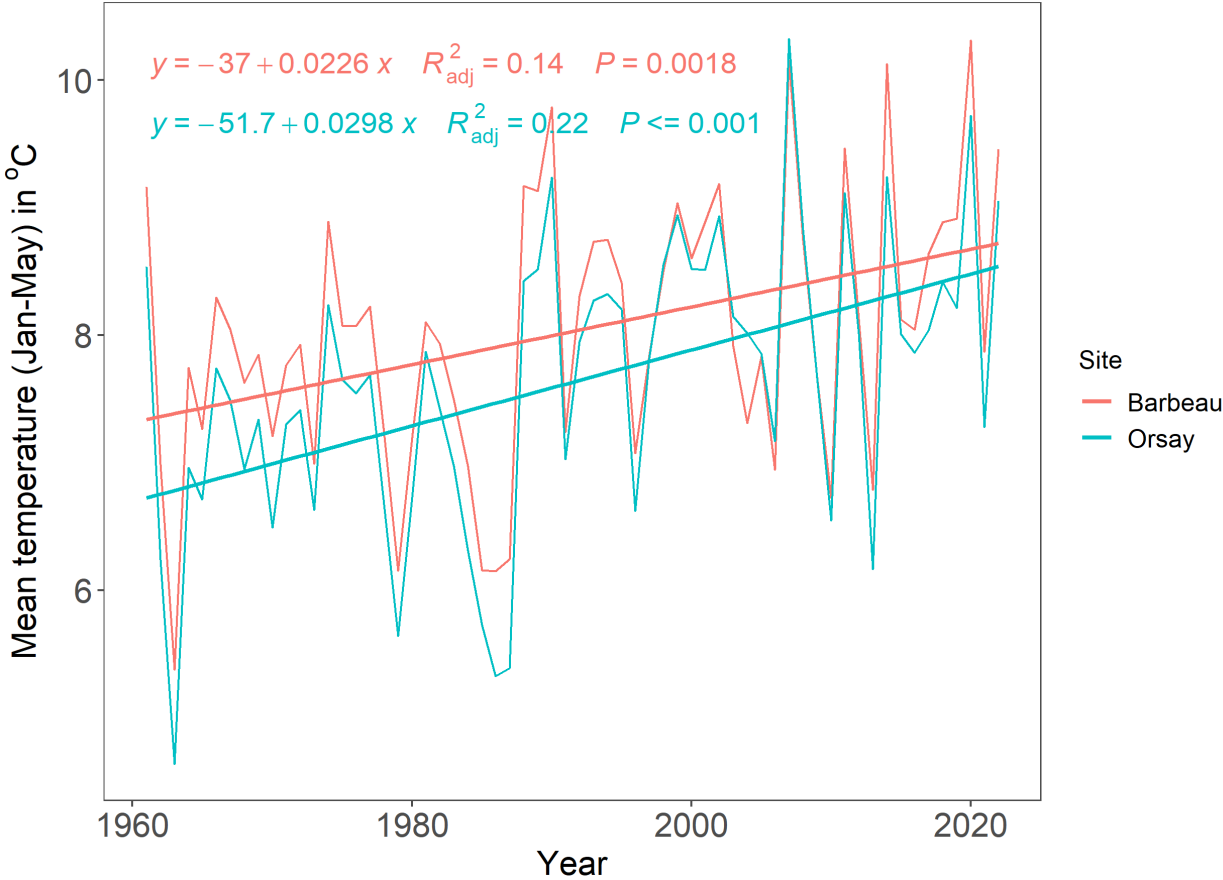
Fig. S6. Evaluation of the within-population variability (WPV) model, assuming that the WPV of budburst stems from the threshold of the forcing temperature (T_b) following a normal distribution. Validation data are in blue, and calibration data are in red. A point represents observed data on one day for the population in a given year. The one-to-one relation is shown as the black line. RMSE is root mean square error for the budburst percentage.
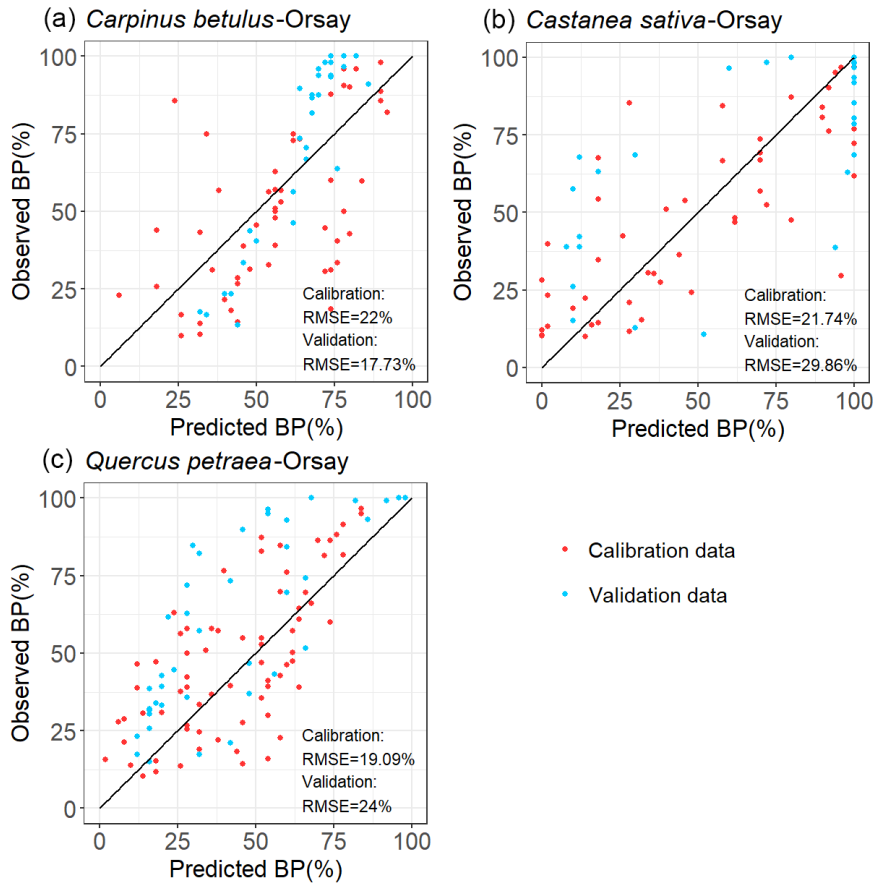
Fig. S7. Evaluation of the within-population variability (WPV) model, assuming that the WPV of budburst stems from the threshold of the forcing temperature (T_b) following a normal distribution. Validation data are in blue, and calibration data are in red. A point represents observed data on one day for the population in a given year. The one-to-one relation is shown as the black line. RMSE is root mean square error for the day of budburst (in days).
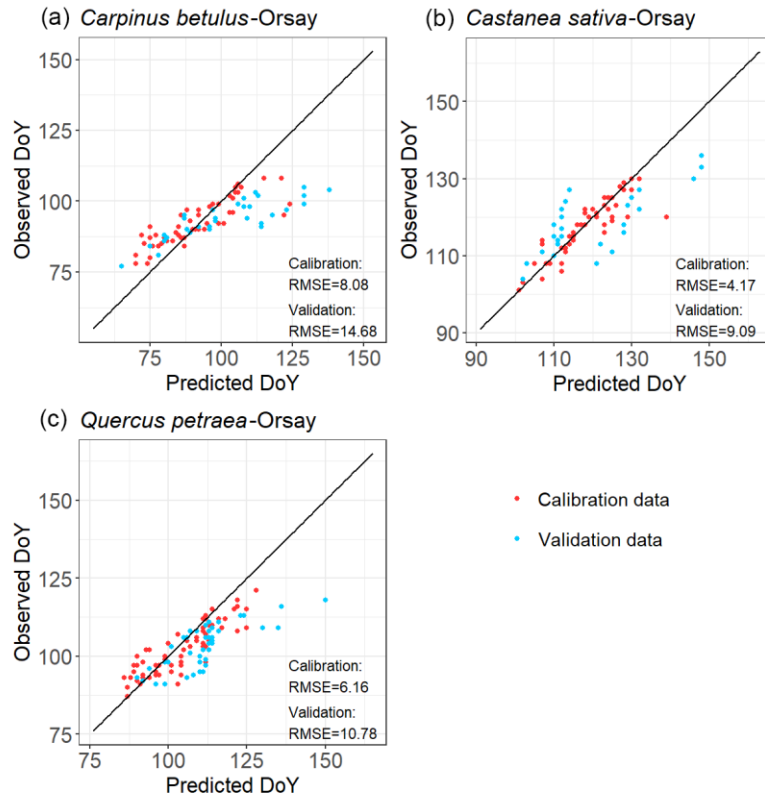
Fig.S8. Mean air temperature during budburst period (BP20 to BP80) in Orsay during the periods 1961-2022. Remember that the time period from BP20 to BP80 changes from year to year, as simulated by the WPV model (see Fig. 5).