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1 Declining global warming effects on the phenology of spring 2 leaf unfolding

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29

1 Earlier spring leaf unfolding is a frequently observed response of northern trees to climate
2 warming^{1,2,3,4}. Many deciduous tree species require chilling for dormancy release, and
3 warming-related reductions in chilling may counteract the advance of leaf unfolding in
4 response to warming^{5,6}. Empirical evidence for this, however, is limited to saplings or twigs
5 in climate-controlled chambers^{7,8}. Using long-term *in situ* observations of leaf unfolding for
6 seven dominant European tree species at 1,245 sites, we show here that the apparent
7 response of leaf unfolding to climate warming (S_T , expressed in days advance per °C) has
8 significantly decreased from 1980 to 2013 in all monitored tree species. Averaged across all
9 species and sites, S_T decreased by 40% from 4.0 ± 1.8 days °C⁻¹ during 1980-1994 to $2.3 \pm$
10 1.6 days °C⁻¹ during 1999-2013. The declining S_T was also simulated by chilling-based
11 phenology models, albeit with a weaker decline (24%-30%) than observed *in situ*. The
12 reduction in S_T is likely to be partly attributable to reduced chilling. Nonetheless, other
13 mechanisms may also play a role, such as ‘photoperiod limitation’ mechanisms that may
14 become ultimately limiting when leaf unfolding dates occur too early in the season. Our
15 results provide empirical evidence for a declining S_T , but also suggest that the predicted
16 strong winter warming in the future may further reduce S_T and therefore result in a
17 slowdown in the advance of tree spring phenology.

18
19 The phenology of spring leaf unfolding influences regional and hemispheric-scale carbon
20 balances², the long-term distribution of tree species⁹, and plant-animal interactions¹⁰. Changes in
21 the phenology of spring leaf unfolding can also exert biophysical feedbacks on climate by
22 modifying the surface albedo and energy budget^{11,12}. Recent studies have reported significant
23 advances in spring phenology as a result of warming in most northern hemisphere regions^{1,3,4}.
24 Climate warming is projected to further increase¹³, but the future evolution of the phenology of
25 spring leaf unfolding remains uncertain — in view of the imperfect understanding of how the
26 underlying mechanisms respond to environmental stimuli^{12,14}. In addition, the relative
27 contributions of each environmental stimulus, which together define the apparent temperature
28 sensitivity of the phenology of spring leaf unfolding (advances in days per degree Celsius
29 warming, S_T), may also change over time^{6,8,15}. An improved characterization of the variation in

1 phenological responses to spring temperature is thus valuable, provided that it addresses temporal
2 and spatial scales relevant for regional projections.

3 Numerous studies have reported advanced spring leaf unfolding which matches warming trends
4 over recent decades^{1,3,4}. However, there is still debate regarding the linearity of leaf unfolding
5 response to the climate warming^{6,7}. Recent experimental studies of warming using saplings have
6 shown that S_T weakens as warming increases⁷. Experimental manipulation of temperature for
7 saplings or twigs, however, might elicit phenological responses that do not accurately reflect the
8 response of mature trees^{16,17}. We therefore investigated the temporal changes in S_T in adult trees
9 monitored *in situ* and exposed to real-world changes in temperature and other climate variables.
10 These long-term data series were obtained across Central Europe from the Pan European
11 Phenology Project (<http://www.pep725.eu/>). Data were collected from 1,245 sites for seven
12 dominant tree species (see methods in Supplementary information and the distribution of the sites
13 in Extended Data Fig. 1). The aims of our analysis are to determine the temporal changes in S_T at
14 the species level during 1980-2013, a period during which Europe has substantially warmed¹³,
15 and to relate these changes in S_T to differences in other physiological and environmental factors.

16
17 For each species at each observation site, we first determined the preseason length as the period
18 before leaf unfolding for which the partial correlation coefficient between leaf unfolding and air
19 temperature was highest (see methods in Supplementary information). We used a gridded climate
20 dataset, including daily maximum and minimum air temperature, precipitation and absorbed
21 downward solar radiation, with a spatial resolution of 0.25° (approximately 25 km)¹⁸. The
22 optimal length of the preseason ranged between 15 days and four months across the seven species
23 (Extended Data Fig. 2), in agreement with earlier results^{1,14}. We then calculated the average
24 temperature during the preseason for each year at each site and calculated S_T using ordinary least
25 squares linear regression for the entire period and for two 15-year periods, namely 1980-1994 and
26 1999-2013, that had slight difference in preseason lengths (Extended Data Fig. 3a). The leaf
27 unfolding dates were negatively correlated with the preseason temperature, with a mean linear
28 correlation coefficient of -0.61 ± 0.16 , determined using the preseason defined from the time
29 period 1980-2013. Almost all individual tree-level correlations were negative (99.7%) and the
30 vast majority of these correlations was statistically significant at $P < 0.05$ (93.4%) (Extended Data

1 Fig. 4). In line with previous studies^{1,4}, the timing of leaf unfolding substantially advanced in all
2 species for 1980-2013, with an average advancing rate of 3.4 ± 1.2 days $^{\circ}\text{C}^{-1}$ across all species-
3 sites (hereafter, a positive value indicates advancement) (Fig. 1a). But the surprising result is that
4 S_T significantly decreased by 40.0% from 4.0 ± 1.8 days $^{\circ}\text{C}^{-1}$ during 1980-1994 to 2.3 ± 1.6 days
5 $^{\circ}\text{C}^{-1}$ during 1999-2013 ($t=-37.3$, $df=5473$, $P<0.001$) (Fig. 1b). All species show similar
6 significant decreases in S_T (Fig. 1a), although the extent of reduction was species-specific. For
7 example, *Aesculus hippocastanum* (see caption to Fig. 1 for English common names) had the
8 largest decrease in S_T (-2.0 days $^{\circ}\text{C}^{-1}$), while S_T decreased only slightly (but still significantly) in
9 *Fagus sylvatica* (-0.9 days $^{\circ}\text{C}^{-1}$) (Fig. 1a). Similar results were also obtained using a fixed
10 pre-season length determined either in the time period 1980-1994 or in 1999-2013 (Extended Data
11 Fig. 3b and 3c). The declining S_T could, however, also have been an artifact resulting from the
12 ‘encroachment’ of leaf unfolding dates into the pre-season period that was used to calculate the
13 temperature sensitivity. We therefore calculated the number of ‘encroachment days’ and found it
14 is very small compared to the pre-season length even in the warmest period (Extended Data Fig.
15 3d and 3e). Because the time scale of the analysis could affect the estimates of S_T ¹⁹, we also
16 calculated S_T using 10-year intervals (instead of 15 years) and found consistent results, i.e., S_T
17 significantly decreased between the 1980s and the last decade for all species except *Tilia cordata*
18 (Extended Data Fig. 5a). We further calculated S_T with a 15-year moving window from 1980 to
19 2013 and found a significant decrease ($P<0.01$) for each of the seven species (Fig. 1c). S_T
20 decreased by an average of 0.7 days $^{\circ}\text{C}^{-1}$ per decade across all species. Similar results were also
21 reached when a 10-year interval was used (Extended Data Fig. 6). These results suggest a
22 significant change in the response of leaf unfolding to the ongoing climate warming in all studied
23 tree species in Central Europe.

24
25 Since there is no single accepted theory to account for the decreased S_T over the period 1980-
26 2013, we propose three mutually non-exclusive hypotheses: (1) adaptation to increased variance
27 in spring temperature, (2) photoperiodic limitations (due to earlier leaf unfolding) overriding
28 temperature controls, and (3) reduced duration and/or sum of cold temperatures during dormancy,
29 a ‘lost chilling’ mechanism.

30

1 The first hypothesis relates to possible effects of an increased variance in temperature. A recent
2 study reported substantial spatial differences in S_T , with smaller absolute values at sites with a
3 higher variance of local spring temperature²⁰. Trees may indeed develop conservative strategies
4 (or higher phenological plasticity) of spring leaf unfolding in places where temperature fluctuates
5 more, in order for instance to avoid spring frost damage²¹. The observed declining S_T could
6 therefore partly result from an increase in the variance in spring temperature. However, the
7 variance in spring temperature only significantly increased at sites of two species and decreased
8 for all the other species except *Fraxinus excelsior* (Fig. 2a). This suggests that increased variance
9 in spring temperature cannot account for the decreased S_T . We further studied the fluctuations in
10 daily mean temperature and diurnal temperature amplitude ($T_{\max} - T_{\min}$) over the preseason for
11 the two periods 1980-1994 and 1999-2013, and for three groups of sites with comparable mean
12 annual temperature (MAT). The fluctuations in daily temperature and diurnal temperature
13 amplitude during the preseason were similar during the two time periods between which S_T
14 declined (Extended Data Fig. 7), suggesting that altered temperature variability is not an obvious
15 cause for the declining apparent temperature sensitivity of leaf unfolding.

16
17 Precocious leaf unfolding in warm springs may increase the risk of late frost events for trees²¹. To
18 overcome this risk during warm springs, many species have evolved a protective mechanism
19 related to photoperiod²², which hinders the warming response when days are still short and the
20 risk for subsequent frost events is thus high. Our second, alternative, hypothesis to account for
21 the observed decrease in S_T in recent decades is therefore a change in the relationship between
22 chilling accumulation and heat requirement, due to the shortening days as warming advances leaf
23 unfolding. However, we did not observe changes in S_T with latitude, neither across all species,
24 nor for individual species (Extended Data Fig. 8), as one may expect if photoperiod was a strong
25 co-limitation of leaf unfolding. Nonetheless, we have no evidence to exclude photoperiod as a
26 controlling mechanism for the decline of S_T since different populations may have different
27 genetic adaptations to photoperiod²³. In addition, the lack of relation between S_T and latitude may
28 have been because the response of spring phenology to photoperiod can be associated with many
29 confounding factors, such as tree age¹⁷, successional niche²³ (although there is some
30 contradictory evidence⁸), xylem anatomy²⁴, or chilling conditions⁸. We can therefore not

1 conclude that photoperiod did not influence S_T , but how it might directly or indirectly affect
2 spring phenology still remains unclear and is currently under debate^{6,15,22}.

3
4 The third hypothesis to explain for the decreased S_T is based on the control of spring phenology
5 by cold temperatures during the dormancy period. In general, temperate and boreal trees require a
6 certain amount of heat (heat requirement) after they come out of the rest period to initiate leaf
7 unfolding in spring²⁵. Logically, this heat requirement is met sooner during warmer springs,
8 which explains the advance of leaf unfolding in response to global warming. The heat
9 requirement, however, is negatively correlated with chilling^{7,8,25}, i.e. the accumulation of cold
10 temperatures during the dormancy period. Since the dormancy period warmed during the study
11 period, the accumulated chilling is progressively reduced, thereby increasing heat requirement
12 and slowing down the advance of leaf unfolding. The net effect of lost chilling can thus be a
13 reduced S_T . This effect may be further exacerbated by the non-linearity of the negative
14 correlation between the heat requirement and the chilling accumulation^{7,25}.

15
16 To test this hypothesis, we calculated the accumulated chilling that was defined as the sum of
17 days when daily air temperature was within the range between 0 and 5 °C from 1st November in
18 the year prior to leaf unfolding (see methods in Supplementary information), and found a
19 significant decrease ($P<0.001$) in chilling accumulation for all species (Fig. 2b). Chilling
20 accumulation was 10% lower for 1999-2013 than for 1980-1994. Chilling accumulation was also
21 significantly decreased with a 15-year moving window (Extended Data Fig. 9a) and when
22 defined by different temperature thresholds (Extended Data Fig. 9b). To further test the
23 importance of the ‘lost chilling’ hypothesis, we applied three chilling-based phenology models to
24 the data (See methods in Supplementary information). All three models captured the declining S_T
25 after their calibration at each site and their integration with observed climate forcing, irrespective
26 of species (Fig. 3). The modelled relative reductions in S_T between the two periods 1980-1994
27 and 1999-2013 were, however, smaller than the observed decline, i.e. simulated S_T was reduced
28 by 28.8 %, 24.4% and 30.4% for the Sequential, Parallel and Unified chilling-based models,
29 respectively, whereas the observed S_T was reduced by 40.0%. This may suggest that either other
30 protective or adaptive mechanisms, such as photoperiod or adaptation mechanisms, are affecting

1 the decline in S_T , or that the three models do not completely accurately represent all chilling
2 mechanisms. There are also uncertainties related to the 0.25° gridded climate product that may
3 not represent local air temperature at each site (snow effects, shading, slope, elevation).
4 Furthermore, using the Unified model, we applied idealized stepwise increases of winter
5 temperature over the period 1980-2013 by $+1^\circ\text{C}$ to $+5^\circ\text{C}$, and consistently obtained a decrease in
6 S_T induced by the loss of chilling in these idealized tests (Extended Data Fig. 9c). However, we
7 did not find marked differences in S_T between years with more chilling days and years with less
8 chilling days (Extended Data Fig. 10a-c), which can probably be explained by the different
9 climate conditions between years with more and less chilling days. For example, the relatively
10 high spring radiation sum in years with less chilling days might buffer the effects of less chilling
11 days (Extended Data Fig. 10d), and eventually resulted in a similar S_T , but this remains
12 speculation. Clearly, further studies are needed to support these inferences and their role in the
13 control over phenology. Overall, these results support the third hypothesis that the decline in
14 chilling accumulation is, at least partly, driving the decline in S_T , although the possible constraint
15 of photoperiod/radiation could not be excluded.

16
17 Changes in spring phenology associated with climate warming have direct impacts on regional
18 and global carbon cycling¹². Studies have reported that an extension of the growing season can
19 increase the photosynthetic production of forests by 0.5-1% per day^{26,27,28}. We found that the
20 apparent sensitivity of spring phenology to warming for seven temperate tree species in Central
21 Europe has declined significantly as winter and spring temperatures increased over the past three
22 decades. These findings indicate that the early spring phenologically-driven increases in carbon
23 uptake may slow down for temperate forests under future conditions of climate warming. On the
24 other hand, the declining apparent temperature sensitivity of spring phenology may be beneficial
25 for the trees. Extreme climatic events have dramatically increased in recent decades, especially
26 warm winters and springs²⁹, and the decreased apparent temperature sensitivity would thus
27 reduce the risk of late spring frost damage by avoiding premature leaf unfolding.

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7 **Supplementary Information** is linked to the online version of the paper at
8 www.nature.com/nature.

9

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21

22 **Author contributions**

23 S.L.P., Y.H.F. and I.A.J. designed the research; H.F.Z., Y.H.F., M. P., S.S.P. and G.Y.Z
24 performed the analysis; Y.H.F., S.L.P. and I.A.J. drafted the paper; and all authors contributed to
25 the interpretation of the results and to the text.

26

27 **Author Information**

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2 have no competing financial interests. Correspondence and requests for materials should be
3 addressed to S.L.P. (slpiao@pku.edu.cn).

4

5 **Figure Legends**

6 **Figure 1. Changes of apparent temperature sensitivity of leaf unfolding (S_T , advances in**
7 **days per degree Celsius warming) over time.** (a) Species-specific S_T and its standard deviation
8 (in brackets) across all sites in three periods and its difference between 1999-2013 and 1980-
9 1994. The S_T was determined using the pre-season fixed at the time period 1980-2013 and using
10 ordinary least squares linear regression. The colour scale indicates magnitude of S_T . AG, alder
11 (*Alnus glutinosa*); BP, silver birch (*Betula pendula*); AH, horse chestnut (*Aesculus*
12 *hippocastanum*); FS, beech (*Fagus sylvatica*); TC, lime (*Tilia cordata*); QR, oak (*Quercus*
13 *robur*); FE, ash (*Fraxinus excelsior*). The number of sites for each species are in brackets under
14 the species name. (b) The distribution of S_T across all species and sites in two different periods
15 and the mean S_T and standard deviations (in brackets). The asterisk indicates a significant
16 difference of S_T between the two periods at $P < 0.05$. (c) Temporal change of S_T for each and all
17 species across all sites with a 15-year moving window from 1980 to 2013. The black line
18 indicates the average across all species, and the grey area indicates one standard deviation either
19 side of the mean. The dotted line indicates the linear regression.

20

21 **Figure 2. Changes of chilling and spring temperature variation (Tstd) between 1980-1994**
22 **and 1999-2013.** Species-specific Tstd (a) and chilling accumulation (b) across all sites over two
23 periods, 1980-1994 and 1999-2013. The Tstd was calculated as the standard deviation of mean
24 spring temperature during the pre-season over these two periods. The pre-season was defined as the
25 period before leaf unfolding for which the correlation coefficient between leaf unfolding and
26 temperature was highest. The chilling accumulation was calculated as chilling days when daily
27 temperature was between 0 and 5 °C from 1 November to the average date of leaf unfolding. The
28 asterisks indicate significant differences at $P < 0.05$.

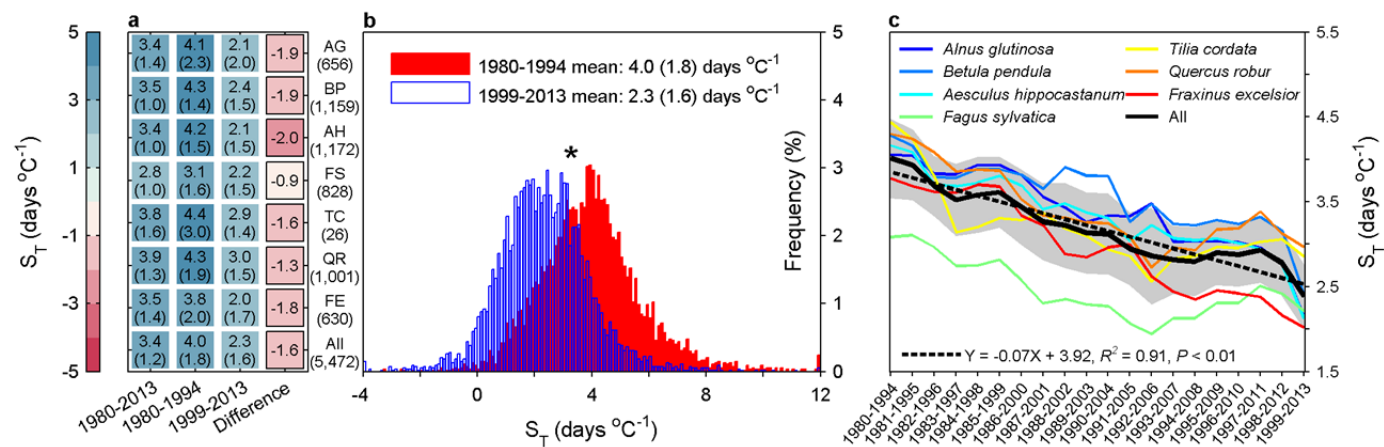
1

2 **Figure 3. Changes of modeled apparent temperature sensitivity of leaf unfolding (S_T ,**
3 **advances in days per degree Celsius warming).** As in Fig. 1a, panels a-c show the modelled
4 species-specific S_T , including the standard deviations (in brackets), across all sites during three
5 periods and its difference between 1999-2013 and 1980-1994. (a) Sequential model, (b) Parallel
6 model and (c) Unified model. As in Fig. 1c, panels d-f show the modelled temporal change of S_T
7 for each and all species across all sites with a 15-year moving window from 1980 to 2013. (d)
8 Sequential model, (e) Parallel model and (f) Unified model. The model performance is provided
9 in (g). The S_T was determined using the pre-season fixed at the time period 1980-2013 and using
10 ordinary least squares linear regression. The colour scale indicates magnitude of S_T . RMSE, root
11 mean square error; AG, alder (*Alnus glutinosa*); BP, silver birch (*Betula pendula*); AH, horse
12 chestnut (*Aesculus hippocastanum*); FS, beech (*Fagus sylvatica*); TC, lime (*Tilia cordata*); QR,
13 oak (*Quercus robur*); FE, ash (*Fraxinus excelsior*). The number of sites for each species are in
14 brackets under the species name.

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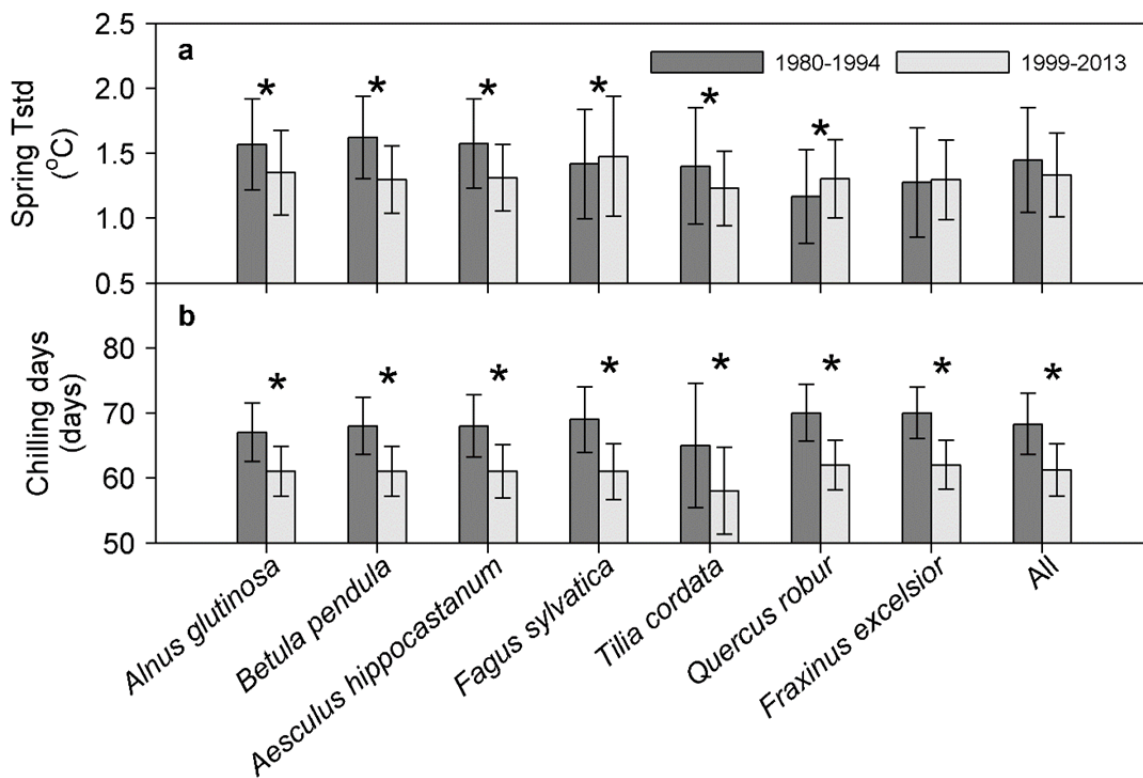
1 **Figure 1**

2

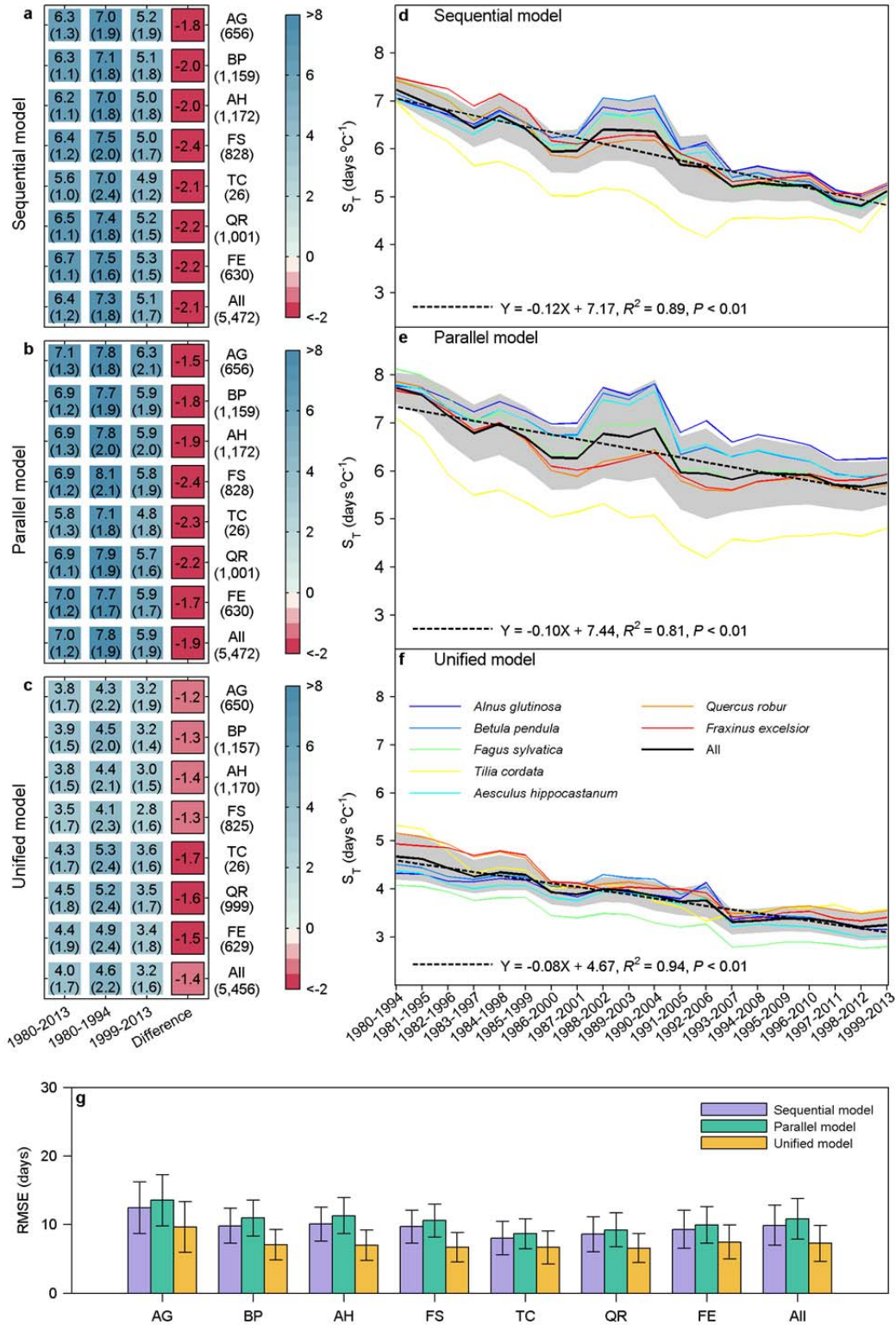


1 **Figure 2**

2



1 **Figure 3**



2

1 **Extended Data Figure Legends:**

2 **Extended Data Figure 1. The distribution of the sites.** The data were obtained from the Pan
3 European Phenology network (<http://www.pep725.eu/>).

4 **Extended Data Figure 2. The distribution of preseason length for each and all species.** The
5 optimal preseason was defined as the period before leaf unfolding for which the correlation
6 coefficient between leaf unfolding and temperature was highest. The numbers in the brackets are
7 the mean dates of leaf unfolding across all sites.

8 **Extended Data Figure 3. Changes of apparent temperature sensitivity of leaf unfolding (S_T ,
9 advances in days per degree Celsius warming) between 1980-1994 and 1999-2013.** Same as
10 Fig. 1, but the S_T was calculated based on the preseason that was determined either in the time
11 period 1980-1994 (b) or in 1999-2013 (c). The differences in preseason lengths are provided for
12 each and all species (a), and the figures above bars are the mean absolute preseason difference
13 between two periods. For b and c, species-specific S_T and its standard deviation (in brackets)
14 across all sites in three periods and its difference between 1999-2013 and 1980-1994. The colour
15 scale indicates magnitude of S_T . AG, *Alnus glutinosa*; BP, *Betula pendula*; AH, *Aesculus*
16 *hippocastanum*; FS, *Fagus sylvatica*; TC, *Tilia cordata*; QR, *Quercus robur*; FE, *Fraxinus*
17 *excelsior*. The number of sites for each species are in brackets under the species name. (d) The
18 distribution of the proportion and corresponding days (e) of the encroachment of phenology dates
19 into the preseason temperature that the preseason was determined on the period 1980-2013. The
20 proportion was defined as the difference of the mean leaf unfolding dates (diff MSOS) between
21 the period 1999-2013 and 1980-2013 (which is the end date of the preseason temperature that
22 was used to calculate the S_T) divided by the preseason length in days. The mean values and its
23 standard deviation (in brackets) are provided for each and all species.

24 **Extended Data Figure 4. The distribution of partial correlation coefficients between
25 preseason temperature and leaf unfolding dates over the time period 1980- 2013.** The mean
26 (and standard deviation: STD) of the correlation coefficients across all species and sites are

1 provided. The percentages of negative correlations and statistically significant negative
2 correlations (Neg(Sig)) are also provided.

3 **Extended Data Figure 5. Changes of apparent temperature sensitivity of leaf unfolding (S_T ,**
4 **advances in days per degree Celsius warming) determined by different methods.** The S_T
5 were analyzed in two 10-year periods (a), were calculated using the reduced major axis (RMA)
6 regression (b), or were calculated based on another climate forcing dataset (CRU-NCEP v5, c).
7 Species-specific S_T and its standard deviation (in brackets) across all sites in three periods and the
8 difference two study periods are provided. The colour scale indicates magnitude of S_T . AG, alder
9 (*Alnus glutinosa*); BP, silver birch (*Betula pendula*); AH, horse chestnut (*Aesculus*
10 *hippocastanum*); FS, beech (*Fagus sylvatica*); TC, lime (*Tilia cordata*); QR, oak (*Quercus*
11 *robur*); FE, ash (*Fraxinus excelsior*). The number under the species name is the number of sites.
12 The histograms show the distribution of S_T across all species and sites in two different periods
13 and the mean S_T and standard deviations (in brackets). The asterisk indicates a significant
14 difference of S_T between the two periods at $P < 0.05$.

15 **Extended Data Figure 6. Changes of apparent temperature sensitivity of leaf unfolding (S_T ,**
16 **advances in days per degree Celsius warming) over time.** Same as Fig. 1c, but temporal
17 change of S_T with 10-year moving windows from 1980 to 2013. The S_T was calculated using
18 simple linear regression. The black line indicates the average across all species, and the grey area
19 indicates one standard deviation either side of the mean. The dotted line indicates the linear
20 regression.

21 **Extended Data Figure 7. The differences in climatology over the pre-season.** The fluctuations
22 in mean daily temperature (left panels) and diurnal variation temperature ($T_{max} - T_{min}$, right
23 panels) over the pre-season across all sites during the time period 1980-1994 and 1999-2013 in
24 three MAT groups, i.e. (top panels) 6- 8°C, (middle panels) 8-10°C and (bottom panels) 10-12°C.
25 The pre-season was determined over the period 1980-2013.

26 **Extended Data Figure 8. Spatial difference in apparent temperature sensitivity of leaf**
27 **unfolding (S_T , advances in days per degree Celsius warming) reduction.** The difference of S_T

1 for each species and across all species studied between two time periods, 1999-2014 and 1980-
2 1994, at different latitudes (bin: 0.5°) and chilling conditions (bin: two chilling days). The colour
3 scales indicate the differences of S_T between the two periods.

4 **Extended Data Figure 9. Changes in chilling accumulation and modeled correlation**
5 **between chilling and apparent temperature sensitivity of leaf unfolding (S_T , advances in**
6 **days per degree Celsius warming).** (a) Chilling accumulation for each and all species with 15-
7 year moving windows from 1980 to 2013. The chilling accumulation was calculated as chilling
8 days when daily temperature was between 0 and 5 °C from 1 November to the average date of
9 leaf unfolding. The black line indicates the average across all species, and the grey area indicates
10 one standard deviation either side of the mean. The dotted line indicates the linear regression. (b)
11 Same as Fig. 2b, but chilling accumulation was calculated as chilling days when daily
12 temperature was below 5°C from 1 November to the average date of leaf unfolding. The asterisks
13 indicate significant differences at $P < 0.05$. (c) The modelled (Unified model) S_T under different
14 artificial winter warming conditions. The temperature in winter, defined as the period from the 1
15 November to 31 January, was warmed by +1°C to +5°C over the period 1980-2013. The points
16 with most chilling days indicate the real winter temperatures, and each of the other points
17 indicate one winter warming treatment. The lines indicate simple linear regressions.

18 **Extended Data Figure 10. Changes in apparent temperature sensitivity of leaf unfolding**
19 **(S_T , advances in days per degree Celsius warming) between years with more or less chilling.**
20 S_T for years with (a) less chilling and (b) more chilling with a 20-year moving window for 1980-
21 2013. For each 20-year series, we divided the 20 years into two groups based on the mean
22 chilling accumulation (Chilling was accumulated when daily temperature within the temperature
23 range between 0°C and 5°C from 1st November to the day of leaf unfolding). The 10 years with
24 chilling higher than the overall mean were defined as more chilling, and the other 10 years were
25 defined as less chilling. The black lines indicate the average across all species, and the grey area
26 indicates one standard deviation either side of the mean. The dotted lines are the linear
27 regressions. (c) Chilling accumulation for years with less chilling (red line) and more chilling
28 (blue line) with a 20-year moving window for 1980-2013. (d) The mean radiation sum over the

- 1 preseason for years with less chilling (red line) and more chilling (blue line) with a 20-year
- 2 moving window for 1980-2013. The preseason was determined over the period 1980-2013.

