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A 14-year series of leaf phenological data collected for European beech (*Fagus sylvatica* L.) and silver fir (*Abies alba* Mill.) from their geographic range margins in south-eastern France

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Key message

Phenology is of increasing interest to climate change science and adaptation ecology. Here, we provide bud development, leafing, and leaf senescence data, collected on 772 European beech and silver fir trees between 2006 and 2019 on Mont Ventoux, France. Dataset access is at https://doi.org/10.15454/TRFMZN. Associated metadata are available at https://metadata-afs.nancy.inra.fr/geonetwork/srv/fre/catalog.search#/metadata/a33c8375-9a90-4bc3-a0d7-19317160b68f.

Keywords Phenology, Forest, Bud development, Leaf senescence, Marginal population, Climate change

1 Background

Here, we present a dataset of leaf phenology observations for two major European forest tree species, European beech (*Fagus sylvatica* L.) and silver fir (*Abies alba* Mill.) in the Mont Ventoux Mountain in south-eastern France. Due to its biogeographical situation at the southern margin of various temperature forest tree species and its steep altitudinal gradients, Mont Ventoux is of particular interest to study the impact of climate change on forest stands. Observations were carried out weekly over 14 consecutive years (2006–2019) on 772 trees distributed along the northern and southern sides of the mountain, yielding 30,933 observations for 3 phenological events (bud development, leafing, and leaf senescence). The protocol used for the observations followed the BBCH standards. The dataset was thoroughly harmonized and curated and is now easily usable by the scientific community. Associated with micro-local temperature data, this phenological dataset offers a unique opportunity to explore the local responses of trees to climate change.

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2 Study site, species, and methods

2.1 Study site

Mont Ventoux, our study area (highest point at 1912 m; 44.174 N/5.27794 E), is a mountain located at the southern (Fig. 1A), dry margin of the French distribution of the two species studied, as illustrated in Fig. 1D, E.

The Mont Ventoux mountain is oriented east-west and is characterized by a gentle slope on its southern side and a steep slope on its northern side (Melki et Briola 2007). This geomorphology results from the same north-south compression that gave rise to the Pyrenees during the late Cretaceous. Composed mainly of a parent rock of Urgonian limestone, water infiltration contributed strongly to its karstic topography. In addition, the action of freezing and thawing during the Pleistocene glacial cycles led to the formation of scree with a high coarse element load. As a result, soil water reserve is low but can be compensated by the presence of numerous faults in which tree roots can find water (Nourtier 2011). Because of intense grazing and logging, Mont Ventoux was thinly wooded until the middle of the nineteenth century when forest restauration programs were initiated. Mont Ventoux is now mostly wooded with a mixed beech—fir forest on its northern side and a mixed European beech—black pine forest on its southern side above 800 m.

Silver fir is not present on the southern side of Mont Ventoux while European beech is present on both its northern and southern sides (Fig. 1B, C).

2.2 Ecology and distribution of studied tree species

European beech is a major deciduous tree species distributed from southern Italy and Greece to Sweden and from Western Spain to Ukraine (Caudullo et al. 2017). It can be found both in lowlands, in the northern part of its range and in mountains, mostly in the southern part of its range. It can also be occasionally observed at the base of the subalpine belt. This shade-tolerant species requires well-drained, moderately deep soils, and relatively high atmospheric humidity and annual precipitations (Packham et al. 2012). It is sensitive to late spring frosts (Vitasse et al. 2018). European beech has been the subject of numerous studies on the environmental determinants of budburst (Caffarra and Donnelly 2011) and leaf senescence (Qiang et al. 2020; Vitasse et al. 2009b) as determinants of forest ecosystem productivity (Pilegaard and Ibrom 2017; Wu et al. 2013).

Silver fir (*Abies alba* Mill.) is a major montane conifer of the European temperate and continental zones, distributed from France to Poland and northern Spain to Romania (Caudullo et al. 2017). At its southern range margin, from Spain to Greece through Italy, and particularly in the Mediterranean area, silver fir is often present as isolated and colonizing individuals in the subalpine belt. Silver fir is very sensitive to summer drought (Cailleret 2011). It particularly appreciates shade in its young age (Valladares and Niinemets 2008) and is indifferent to the nature of the parent rock (siliceous or calcareous) as long as soils are not too compact or hydromorphic (Dobrowolska et al. 2017). Under the combined effects of several factors (climate change, bark beetle attacks…), dieback and mortality has been observed in the mountains of southern France (Cailleret et al. 2014), Spain (Oliva and Colinas 2007; Linares and Camarero 2012), and central Europe (Elling et al. 2009).

2.3 Sampling design

The observed trees are distributed along two altitudinal gradients located on the northern (Fig. 2A) and southern (Fig. 2B) slopes of Mont Ventoux.

The first transect is located in the communal and state forests of Beaumont du Ventoux on the north side of the mountain (from 968 to 1522 m). It includes 169 silver fir and 513 beech trees (Fig. 2A). Sampled trees are located either along a continuous gradient or in five plots at different elevations: 973 m (plot N1) 1110 m (N2), 1261 m (N3), 1395 m (N4), and 1521 m (N5). Among them, 40 silver firs and 40 beech trees in particular (20 trees/species at plot N2, 20 trees/species at plot N4), were the focus of long-term monitoring.

The second transect is located in the communal forest of Bedoin on the south side of the mountain (from 875 to 1537 m) and includes 90 beech trees (Fig. 2B). The trees are located in three plots at different elevations: 901 m (plot S1), 1128 m (S3), and 1545 m (S5).

Temperature measurements were carried out thanks to climate data loggers (HOBO Pro V2® micro-loggers)

(See figure on next page.)

Fig. 1 Location of Mont Ventoux in the French geographical distribution range (**A**–**C**) and in the bioclimatic niche (**D**, **E**) of the two studied species. **A** In France, distribution range of beech alone in green, silver fir alone in orange. The black circles represent Mont Ventoux. **B** A beech-fir forest on the north side of Mont Ventoux. **C** A beech forest on the south side of Mont Ventoux. **D** Each green dot represents a beech stand from the French National Inventory (https://inventaire-forestier.ign.fr/) in the climate space defined by mean annual temperature (*x*-axis) and summer precipitation (y-axis). The triangles represent the climate of the 8 portable climate data loggers located across the study area (blue for north and red for south). **E** Same as **D** but for silver fir (orange dots)

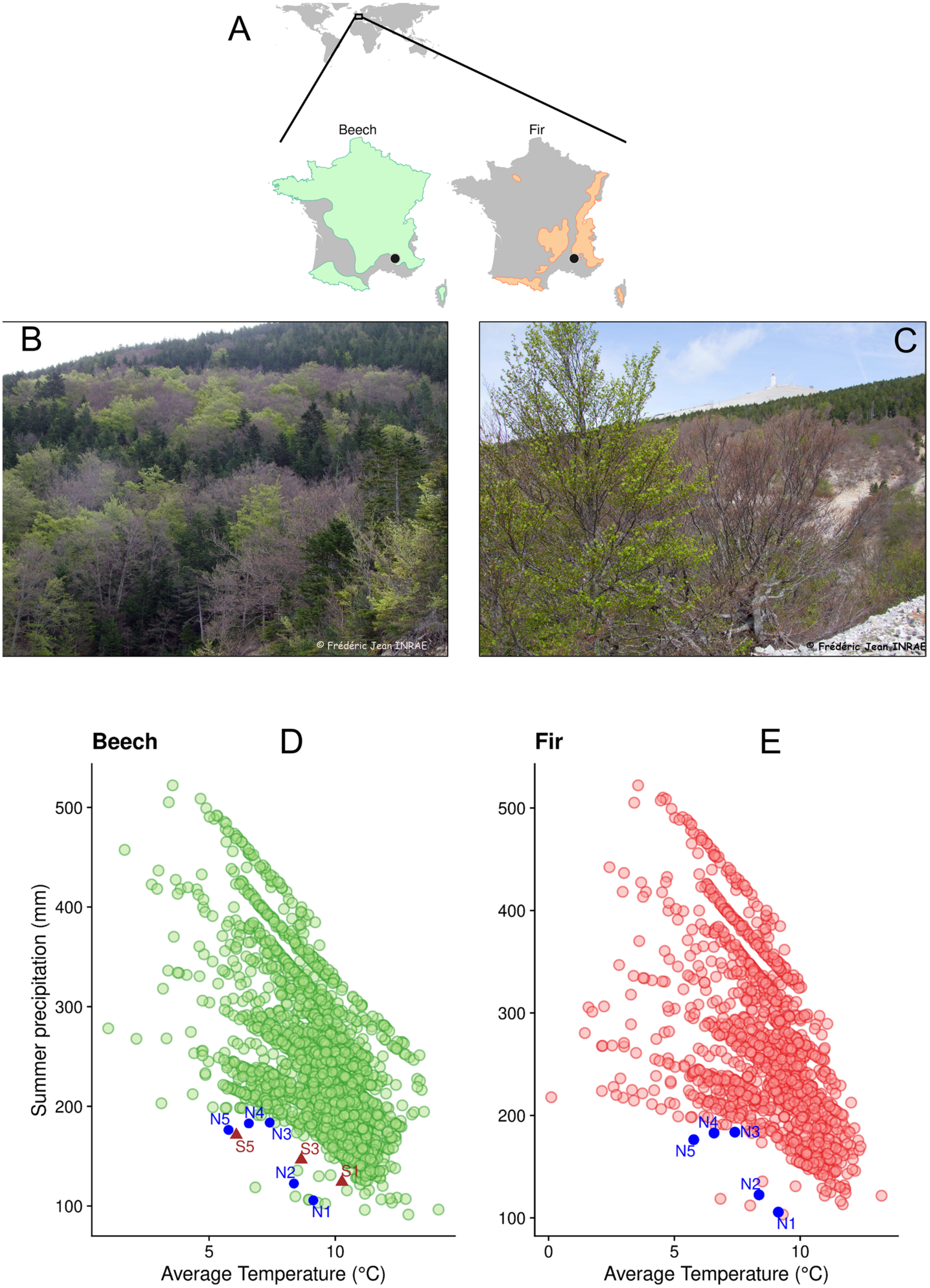


Fig. 1 (See legend on previous page.)

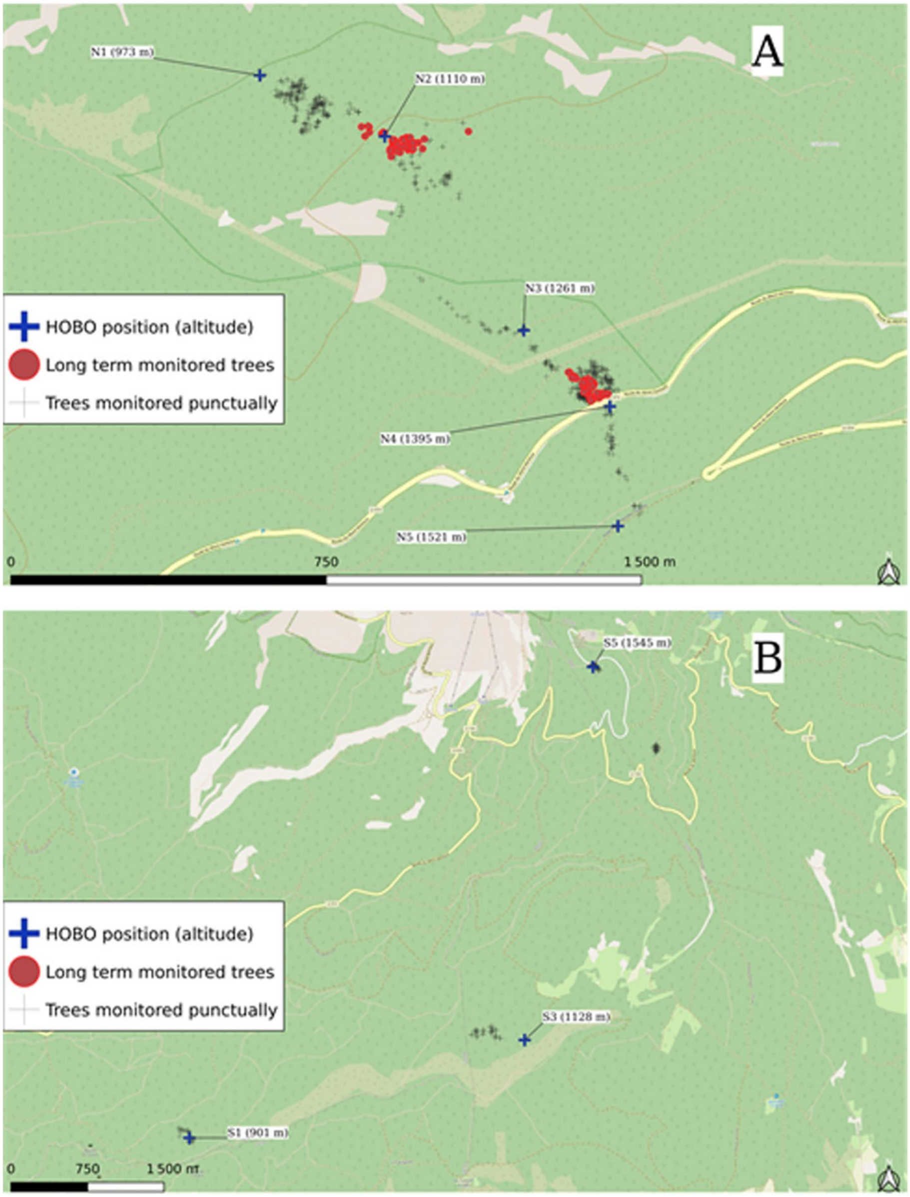


Fig. 2 Precise positioning of the monitored trees along the two altitudinal gradients, respectively north (**A**) and south (**B**) sides. The blue crosses indicate the location of the climate data loggers (called "HOBO"), the red circles, the trees monitored every year over the study period and the grey crosses, the trees monitored occasionally over the study period

that were installed in standardized radiation shelters at 1.5 m from the ground in each of the 8 plots.

2.4 Measurement of phenological events

2.4.1 Protocol

Three different phenological events were observed: bud development, leafing and leaf senescence. We used the recent work from Badeau et al. (2022) to define these three phenological events (see next sections). The stages of development of each phenological event were determined with dedicated score assigned at the level of the whole-tree crown. Phenological scores were assessed from the ground using binoculars by two observers, each observing the tree at two different positions. When the observers' scores differed, they were reviewed by both observers until an agreement was reached and a single score provided. The previous week's score was also checked to avoid irrelevant phenological dynamics. When higher than the new one, two options were possible:

(i) if the observers suspected that the new score was underestimated as compared to the previous week, they assigned the same score as the previous week.
(ii) if the observers were certain that the score of the previous week was overestimated, they assigned the originally intended score.

Moreover, to minimize observer effect, intercalibrations (Liu et al. 2021) were carried out every 2 years on average and before an observation campaign, according to the standards set by the TEMPO network (https://tempo.pheno.fr/soere-tempo_eng/).

Most of the observations were made weekly except in a few cases as shown in variable named "Observation_periodicity".

Phenological stage details are illustrated in the document: Description_BBCH_stages.pdf, accessible with the dataset.

2.4.2 Bud development

Bud development is the set of spring phenological stages from the beginning of bud swelling to the appearance of young individualized leaves.

Bud development monitoring started after the first half of March, except in 2007 (end of February) and 2008 (beginning of April). On average over the study period, leaf out occurred early April for both species.

Five bud development stages were used:

- Stage BBCH 0: all buds are in winter dormancy
- Stage BBCH 1: at least 50% of the buds are swelling
- Stage BBCH 3: at least 50% of the buds have finished swelling and are ready to break, and the scales may have changed color
- Stage BBCH 7: at least 50% of the leaf or mixed buds have undergone breaking (the tips of the leaves should appear at the distal extremity of the bud, with the scales spread out for beech or the needles beginning to be visible for silver fir)
- Stage BBCH 9: at least 50% of the buds have their first leaves that began to individualize: the tips of these first leaves are clearly visible and are taller than the tips of the scales, if these are still present, for beech or at least 50% of the buds show individualized needles in a closed brush for silver fir.

2.4.3 Leafing

Leafing is the phenological event during which the leaves appear as spread out without necessarily having reached their adult size.

For beech, the leafing stage was reached at the earliest during the second half of April, whereas for silver fir this stage of leaf development was observed during the second half of May. Leafing monitoring ended in mid-June for both species. One leafing stage was used: Stage BBCH 10 where first leaves are spread out for beech or first buds are showing the needles in an open brush for silver fir.

2.4.4 Leaf senescence

Finally, leaf senescence is the annual phenological event characterized by a certain proportion of leaf discolouration from green to yellow and/or leaf fall in deciduous trees.

The first signs of this phenological event were mostly observed in August. It ended during the second half of October, at the latest at the beginning of November. In 2012 and 2013, only the BBCH90, 91 and 95 stages were observed. From 2014, all stages (from BBCH90 to BBCH99) were noted according to the progress of the event: stage BBCH 90: first leaves are colored or fallen, stage BBCH 91–>99: at least 10–>90% of the leaves are colored or have fallen.

2.5 Presentation of the dataset

2.5.1 Phenology dataset

The dataset file is named "Phenological_data_Ventoux.tab" (Jean et al. 2023).

It contains three types of leaf phenology data: bud development, leafing, and leaf senescence.

Observations for bud development and leafing for beech and silver fir were carried out from 2006 until 2019. Observations of leaf senescence, for beech only, were carried out from 2012 until 2019. Between 2006 and 2019, 30,933 observations were recorded mainly on the north side of Mont Ventoux: 18,475 individual bud development scores, 2234 leafing scores and 10,224 leaf senescence scores. A total of 7258 observations were made on 169 silver fir trees and 23,675 observations on 603 beech trees (Table 1).

On the northern side, among the 513 beech trees observed, 497 trees were observed at least once for bud development and leafing, 16 beech trees were only observed for senescence and 212 beech trees were observed for bud development, leafing and senescence. In total, on the northern side, to assess the length of the growing season and the environmental determinants involved, we observed 849 trees-years, i.e. the sum of the number of trees observed each year for both bud development and senescence. On the southern side, only 90 trees were monitored in 2007 for bud development and leafing.

Table 1 Total number of trees observed, tree-year observations and total number of observations over the period (2006–2019) by species, phenological events, and exposure

Species	Phenological events	Exposure	Tree number	Tree-year observations	Total observations number
Silver fir	Bud development	north	169	739	6627
Silver fir	Leafing	north	163	615	631
European beech	Bud development	north	497	1526	10,976
European beech	Bud development	south	90	90	872
European beech	Leaf senescence	north	228	1351	10,224
European beech	Leafing	north	495	1527	1530
European beech	Leafing	south	71	71	73
Total			772	5919	30,933

"Tree number" is the total number of different trees observed at least 1 year; "tree-year observation" is the sum of the number of trees observed each year (a given tree can be observed several years); "Total observations number" is the sum of all observations over individual trees and years (several observations each year)

For silver fir, we observed a total of 169 trees for bud development along the north gradient, representing 739 tree-year observations. Most of these tree-year observations also had leafing observations (N_Obs_Tree-Year = 615).

The number of tree-year observations varies from 1 to 14 years (Figure 5 in Appendix). Because of mortality (Davi and Cailleret 2017; Durand-Gillmann et al. 2014), the majority of fir trees (114) were monitored during fewer than 5 years for bud development, whereas 32 trees were monitored at least during 10 years. For beech, the majority of trees (N_Obs_beech = 481) were monitored during less than 5 years for bud development, and 40 trees were monitored during at least 12 years. For senescence, large parts of the beech trees (N_Obs_beech = 95 out of 228) were monitored during 8 years.

2.6 Long-term monitoring and one-off measurement campaigns

The variability in the number of sampled trees over time is the consequence of several different field campaigns whose measurements were merged in the current dataset (Fig. 3B, C). While on average, 260 trees (silver fir and beech) per year were observed for bud development and/or senescence, a high disparity is visible (sd = 121.1) among years. Before 2008, bud development and leafing were observed on 65 silver fir trees in 2006 and 63 in 2007, and on 64 beech trees in 2006 and 2007 (Fig. 3B).

In 2008, in consideration of the need to optimize field observations and to concentrate them at 2 altitudinal levels (1100 m and 1350 m), we decided to select 40 trees per species equally distributed at 2 altitudinal levels and called long-term monitoring (Fig. 3A). Every year since 2008, we observed bud development and leafing for the two species and senescence for beech trees. Because of mortality, the number of fir trees observed is decreasing, especially at lower altitude.

In 2009, sampling effort for bud development and leafing was increased for beech in plots N1, N2, and N4 on the north transect (Fig. 3B) as a consequence of a PhD thesis on the evolutionary potential of a common beech populations (Bontemps 2012).

Observations of leaf senescence began in 2012. On average, 169 beech trees per year were observed in senescence with low disparities (sd = 9.1) (Fig. 3C). Of these beech trees, 40 are long-term monitoring, also in bud development and leafing.

2.7 Dataset curation

As projects have evolved, so have the protocols used. We wanted to present here the main steps to normalize the dataset.

In 2006, 2007, 2009, and 2010, 2 scores per tree were recorded for a given date, corresponding to the majority development stages at the bottom and top of the crown. The corresponding data in the dataset were tagged respectively with "Nh" and "Nb" in the variable named "value_warning". In order to provide a consistent dataset, we also merged these scores at the tree level in the variable named "Phenological_Stage_Code". Merging of low and high crown observations was therefore based on logical heuristical rules shown in Table 2 in Appendix. The resulting variable was named "Selected_BBCH_code".

Before 2011, a BBCH-modified protocol following the BBCH standard published by Meier (1997) was used: 5

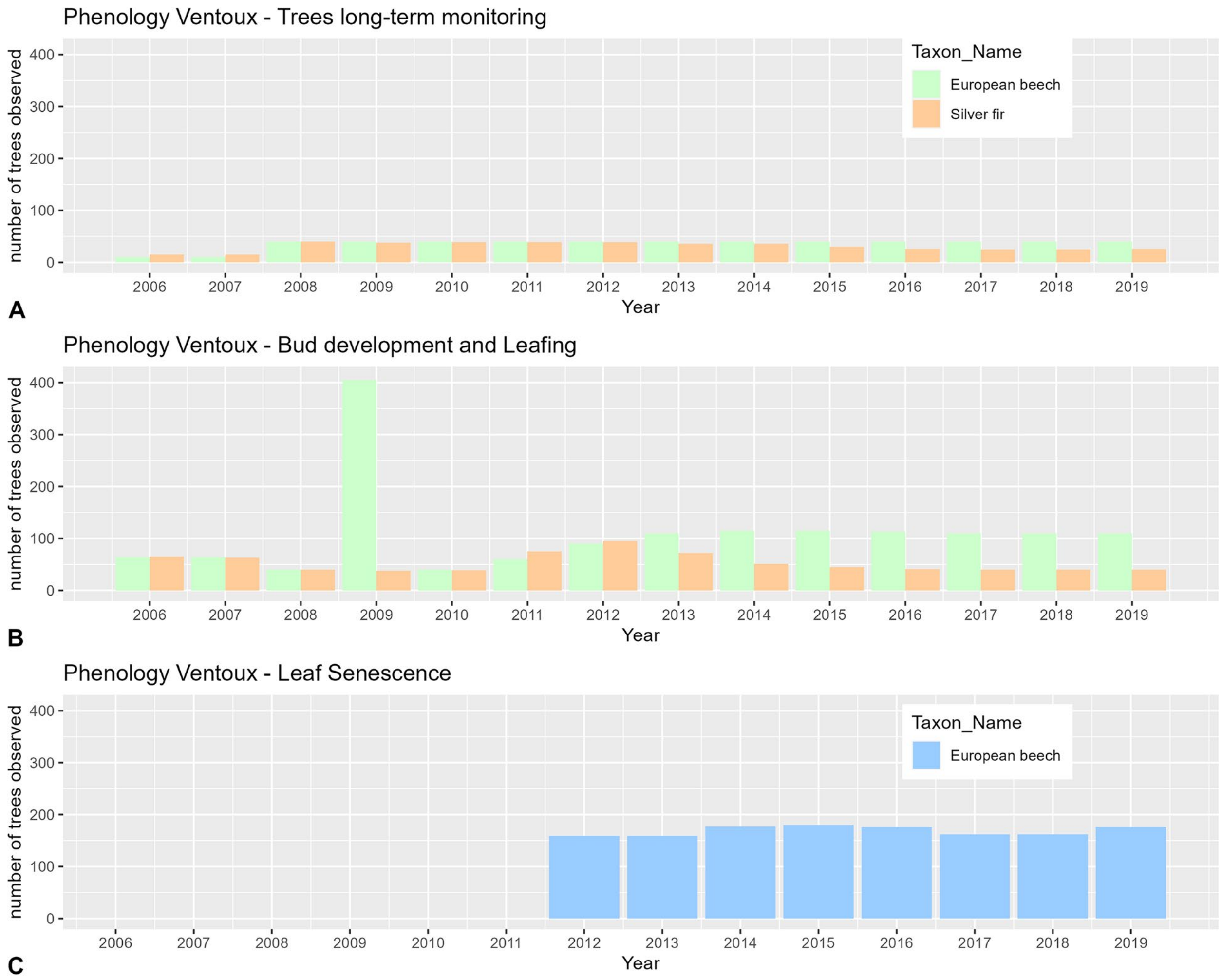


Fig. 3 Graphical representations of the number trees observed each year on Ventoux. **A** Number of silver fir and beech trees "long-term monitoring" observed for bud development from 2006 to 2019 on the north side of Mont Ventoux. **B** Number of beech trees observed for bud development and leafing from 2006 to 2019 on the north side of Mont Ventoux. **C** Number of beech trees observed, including "long-term monitoring", for senescence from 2012 to 2019 on the north side of Mont Ventoux

phenological stages were observed from bud development to leafing and noted with scores ranging from 1 to 5. These scores did not correspond to the current BBCH scores described in the reference scoring scale (Badeau et al. 2022) used within the TEMPO network. We have created a table to convert the data from before 2011 (Table 3 in Appendix). The involved data in the dataset are tagged with "converted" in a particular variable named "value_warning".

Finally, we reported potential bias in our data, when BBCH stage was lower than previous BBCH, which is not biologically relevant, we reported those value by "rear_kinetic" in the variable named "value_warning" in the dataset (9 cases for senescence scores and 30 for bud development scores).

2.8 Climate

Along with photoperiod, temperature is the main driver of the spring phenology (Flynn and Wolkovich 2018) and senescence (Vogel 2022) for forest trees. The hourly air temperature data recorded at different altitudes of the Mont Ventoux gradient are available. This dataset is accessible at https://doi.org/10.57745/OQNIT1 and contains the temperature data and metadata for each of the 8 sites.

3 Technical validation

The graphical representations carried out for validating the data were performed using R Version 4.2.2 (R Core Team (2022)).

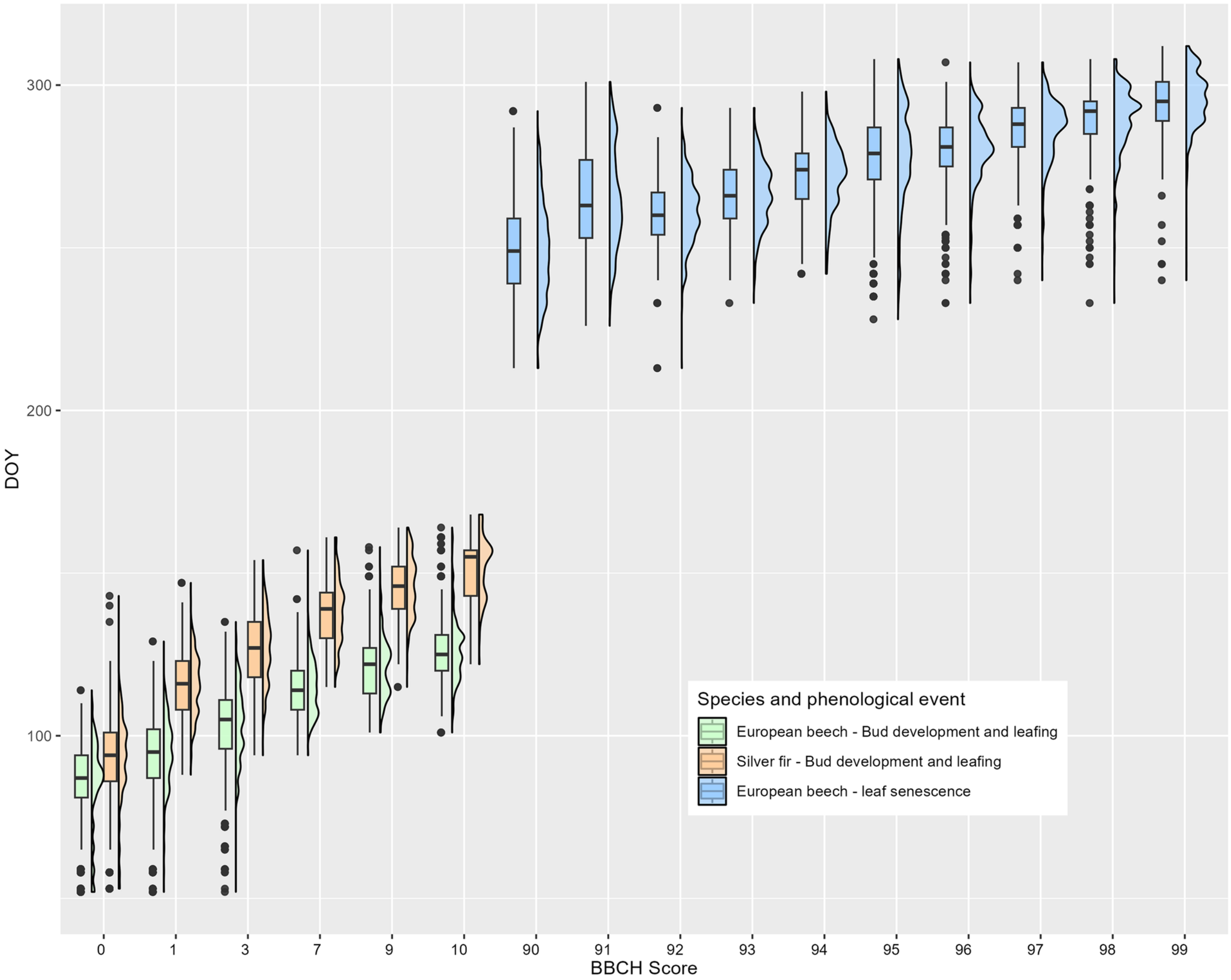


Fig. 4 Graphical representation (violin plot) of the dates (in calendar days, day of year) of bud development, leafing, and leaf senescence (BBCH score) for European beech (green and blue respectively) and silver fir (orange). Whisker boxes represent the median (median bar), bounded by the first and third quartiles. The lower and upper whiskers extend to the lowest and highest value, not exceeding 1.5 times the interquartile range (distance between the first and third quartiles). Outlier data beyond the end of the whiskers are plotted individually (dots). The width of the violins represents the amount of data for each date for each BBCH score

Figure 4 represents for each tree, the dates (day of year) at which phenological stages were observed. For bud development and leafing, and in most cases, we observed an overall variability of 50 to 100 days, which seems plausible if we take into account the accumulation of spatial variability (Richardson et al. 2006; Vitasse et al. 2009a), inter-annual variability (Vilhar et al. 2018) and inter-individual variability (Denéchère et al. 2019) along an altitudinal gradient of this magnitude. Overall, we observed a later bud break for silver fir than for European beech which is consistent with the literature (Davi et al. 2011) and can be compared with the results of studies conducted under controlled conditions (Laube et al. 2014) or in common gardens (Vitasse et al. 2009a). Leaf senescence started very early during the summer season (end of July), which is consistent with the environmental constraints of those specific years (Mariën et al. 2022).

Additional numerical and graphical analyses such as the distribution of sampling effort by year and elevation are shown (Figure 6 in Appendix).

4 Access to the data and metadata description

The dataset access is at https://doi.org/10.15454/TRFMZN and associated metadata are available at https://metadata-afs.nancy.inra.fr/geonetwork/srv/fre/

catalog.search#/metadata/a33c8375-9a90-4bc3-a0d7-19317160b68f.

The dataset (Phenological_data_Ventoux.tab) contains all phenology observations collected at the individual tree level. It includes 25 variables, in particular the date, geographical coordinates and BBCH score. The file "ANFS-D-23-00044-metadata.tab" contains variables description.

5 Reuse potential and limits

The dataset is particularly suitable for the study of the spatio-temporal variation of leaf phenology at landscape scale. Particularly, the "long-term monitoring" dataset can be used in modeling approaches aimed at predicting the distribution of species in a climate change context (Chuine 2010) or to calibrate forest dynamics models that include phenology as a predictive parameter.

In addition, the global data set, despite its heterogeneity, can be used to explore the impact of increasingly frequent and intense disturbances such as late frosts and droughts at the edge of the distribution range. Coupled with other European datasets, this dataset will allow to improve the understanding of the physiological mechanisms determining phenology (Davi 2015; Davi et al. 2011; Gauzere et al. 2017) such as water stress (Massonnet et al. 2020), but also the links between phenophases (Jiang et al. 2020) or growth and leaf senescence (Zohner and Renner 2019; Dox et al. 2020).

Since all the trees measured in this dataset are also characterized using genetic markers at loci potentially involved in adaptation, the dataset can be used to contribute to the study of local adaptation at short spatial scale across an elevation gradient (Brousseau et al. 2016; Csilléry et al. 2020; Roschanski et al. 2016; Gauzere et al. 2020a, b; Latreille and Pichot 2017; Petit-Cailleux et al. 2021).

The sampling effort has fluctuated with the many research projects that have funded these observations. All this reflects the constraints of project-based research and the difficulty of financing long-term monitoring in ecology: this is a real challenge for research laboratories today.

As climate is changing rapidly at the rear edge of European species, we expect outlier / unusual climate events to occur more frequently and we suggest that long term observations such as that provided here should be continued.

Appendix

Table 2 Description of the method used for assigning BBCH score when 2 scores (bottom and top of canopy) were assigned on the same day on the same tree (years 2006, 2007, 2009, and 2010)

NB	NH	DIFF	Mean	Number_ Observations	Selected _BBCH_ SCORE	Description
0	0	0	0	1727	0	The low and high scores are identical
0	1	1	0.5	29	0	The majority of the buds are in BBCH0 (=all buds are in winter dormancy stage), so it is considered that the majority of the buds are not in BBCH1
1	0	−1	0.5	2	0	The majority of the buds are in BBCH0 (=all buds are in winter dormancy stage), so it is considered that the majority of the buds are not in BBCH1
1	1	0	1	27	1	The low and high scores are identical
0	3	3	1.5	1120	1	The majority of the buds are considered to have started to swell
3	0	−3	1.5	18	1	The majority of the buds are considered to have started to swell
1	3	2	2	45	1	The majority of the buds are considered to have started to swell
3	1	−2	2	3	1	The majority of the buds are considered to have started to swell
3	3	0	3	2744	3	The low and high scores are identical
0	7	7	3.5	5	3	At least the majority of leaf or mixed buds are considered to have finished swelling and are ready to burst
3	7	4	5	342	3	At least the majority of leaf or mixed buds are considered to have finished swelling and are ready to burst
7	3	−4	5	24	3	At least the majority of leaf or mixed buds are considered to have finished swelling and are ready to burst

NB	NH	DIFF	Mean	Number_ Observations	Selected _BBCH_ SCORE	Description
3	9	6	6	3	7	At least the majority of leaf or mixed buds are considered to have burst
10	3	−7	6.5	1	7	At least the majority of leaf or mixed buds are considered to have burst, as only a few leaves are at the 'unfolded leaf' stage
7	7	0	7	611	7	The low and high scores are identical
7	NA	NA	7	1	7	Only one score was given on that day, and it is considered representative of the phenological stage at the tree crown level
7	9	2	8	175	7	At least the majority of leaf or mixed buds are considered to have burst
9	7	−2	8	108	7	At least the majority of leaf or mixed buds are considered to have burst
7	10	3	8.5	1	9	At least the majority of the leaf or mixed buds are considered to have the first leaves beginning to individualize
10	7	−3	8.5	6	9	At least the majority of the leaf or mixed buds are considered to have the first leaves beginning to individualize
9	9	0	9	668	9	the low and high scores are identical
9	NA	NA	9	54	9	Only one score was given on that day, it is considered representative of the phenological stage at the tree crown level
NA	9	NA	9	47	9	Only one score was given on that day, it is considered representative of the phenological stage at the tree crown level
9	10	1	9.5	100	9	At least the majority of leaf or mixed buds are considered to have the first leaves beginning to individualize
10	9	−1	9.5	93	9	At least the majority of leaf or mixed buds are considered to have the first leaves beginning to individualize
10	10	0	10	490	10	The low and high scores are identical
10	NA	NA	10	147	10	Only one score was given on that day, it is considered representative of the phenological stage at the crown level
NA	10	NA	10	116	10	Only one score was given on that day, it is considered to be representative of the phenological stage at the tree crown level

Table 3 Pre-2011 phenological scores are the scores used before 2011, and then converted to BBCH scores used in the dataset

Pre-2011 phenological scores	BBCH scores used in the dataset
0	0
1	0
1+	1
−2	3
2	3
2+	3
−3	7
3	7
3+	7
−4	9
4	9
4+	9
−5	10
5	10
5+	10

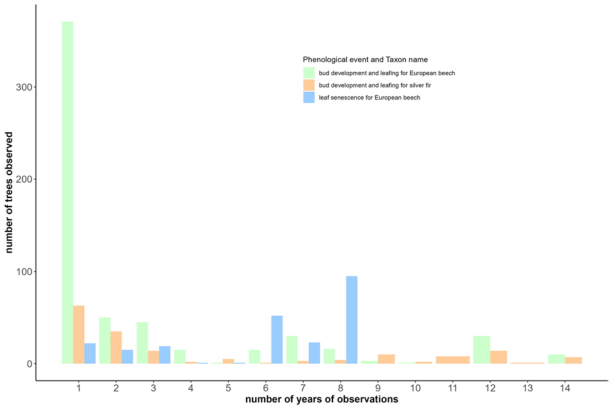
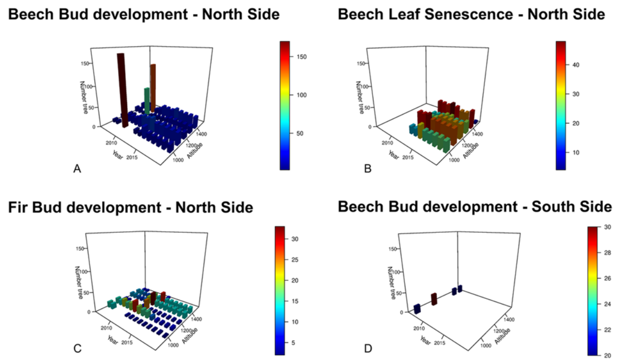


Fig. 5 Number of observed trees by number of observation years



Beech Bud development - North Side

Beech Leaf Senescence - North Side

Fir Bud development - North Side

Beech Bud development - South Side

Fig. 6 Graphical representations of number trees observed annually by altitude classes on Ventoux. **A** Number of beech trees observed for bud development and leafing from 2006 to 2019 on the north side of Mont Ventoux. **B** Number of beech trees observed for senescence from 2012 to 2019 on the north side of Mont Ventoux. **C** Number of silver fir trees observed for bud development and leafing from 2006 to 2019 on the north side of Mont Ventoux. **D** Number of beech trees observed for bud development and leafing in 2007 on the south side of Mont Ventoux

Sampling intensity varied among altitudes and between aspects

On average, 17 trees per year were observed by 100 m altitude classes with high disparities ($sd = 6.2$) according to the years. On the south side, 90 beech trees were also monitored (Fig. 6D) in 2007 (Davi et al. 2011). For leaf senescence, 19 to 48 individuals per 100 m altitudinal slice were observed, except at the top of the gradient (Fig. 6B).

Silver fir sampling peaked in 2012 with 95 trees measured. Since 2012, the number of surveyed individuals has decreased, due to progressing decline and mortality particularly at the base of the elevation gradient (Cailleret et al. 2014) (Fig. 6C).

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Authors' contributions

Conceptualization: HD, SOM, BF, JR, VJ, CP; methodology: PC, MC, OG; formal analysis and investigation: FJ, HD, SOM, BF, IS, ISS, JR, VJ, CP; writing—original draft preparation: FJ, HD; writing—review and editing: FJ, HD, SOM, BF, IS, ISS, JR, VJ, PC; funding acquisition: FJ, HD, SOM, BF, CP; supervision: HD; investigation: WB, MC, OG, MP, FR, JT, NT; validation: OM, OG. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets generated during and/or analyzed during the current study are available in the RECHERCHE.DATA.GOUV.FR repository, https://doi.org/10.15454/TRFMZN.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no conflict of interest.

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