# Higher sample sizes and observer intercalibration are needed for reliable scoring of leaf phenology in trees

Guohua Liu, Isabelle Chuine, Rémy Denéchère, Frédéric Jean, Eric Dufrêne, Gaëlle Vincent, Daniel Berveiller, Nicolas Delpierre

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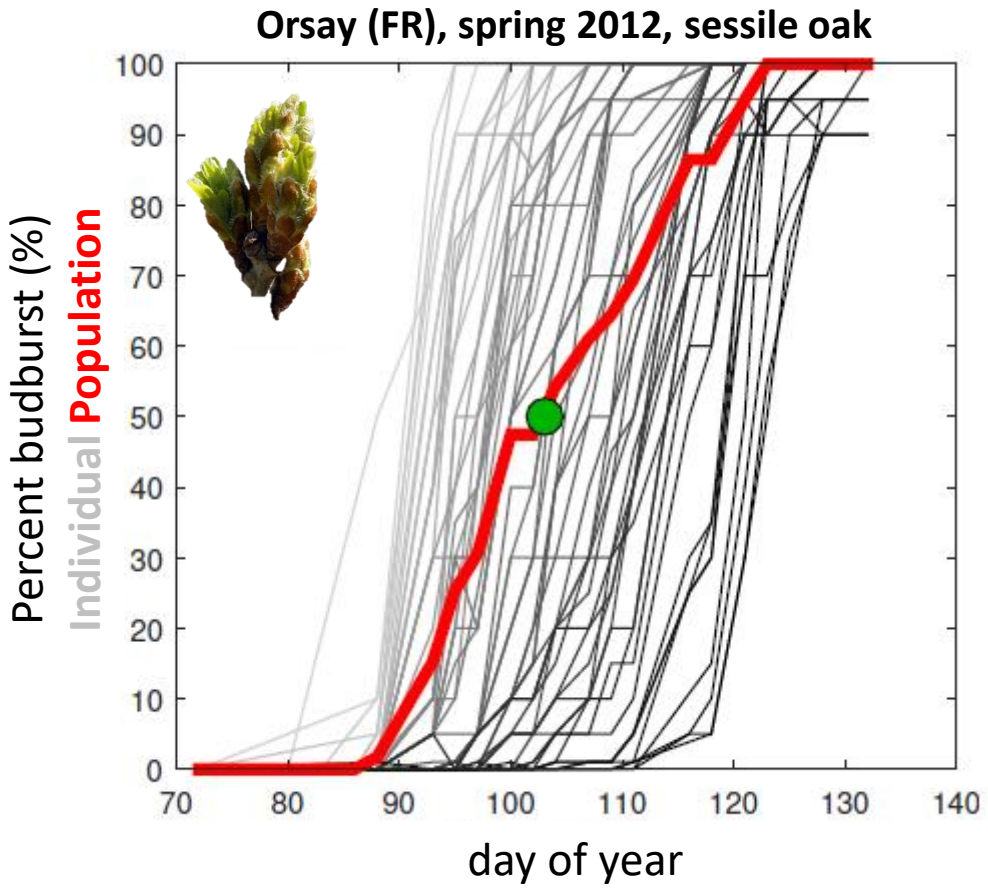
Barbeau forest (Paris area, France)
*Quercus petraea*, *Carpinus betulus*
Avril 12, 2019

# Tree-to-tree phenological variability

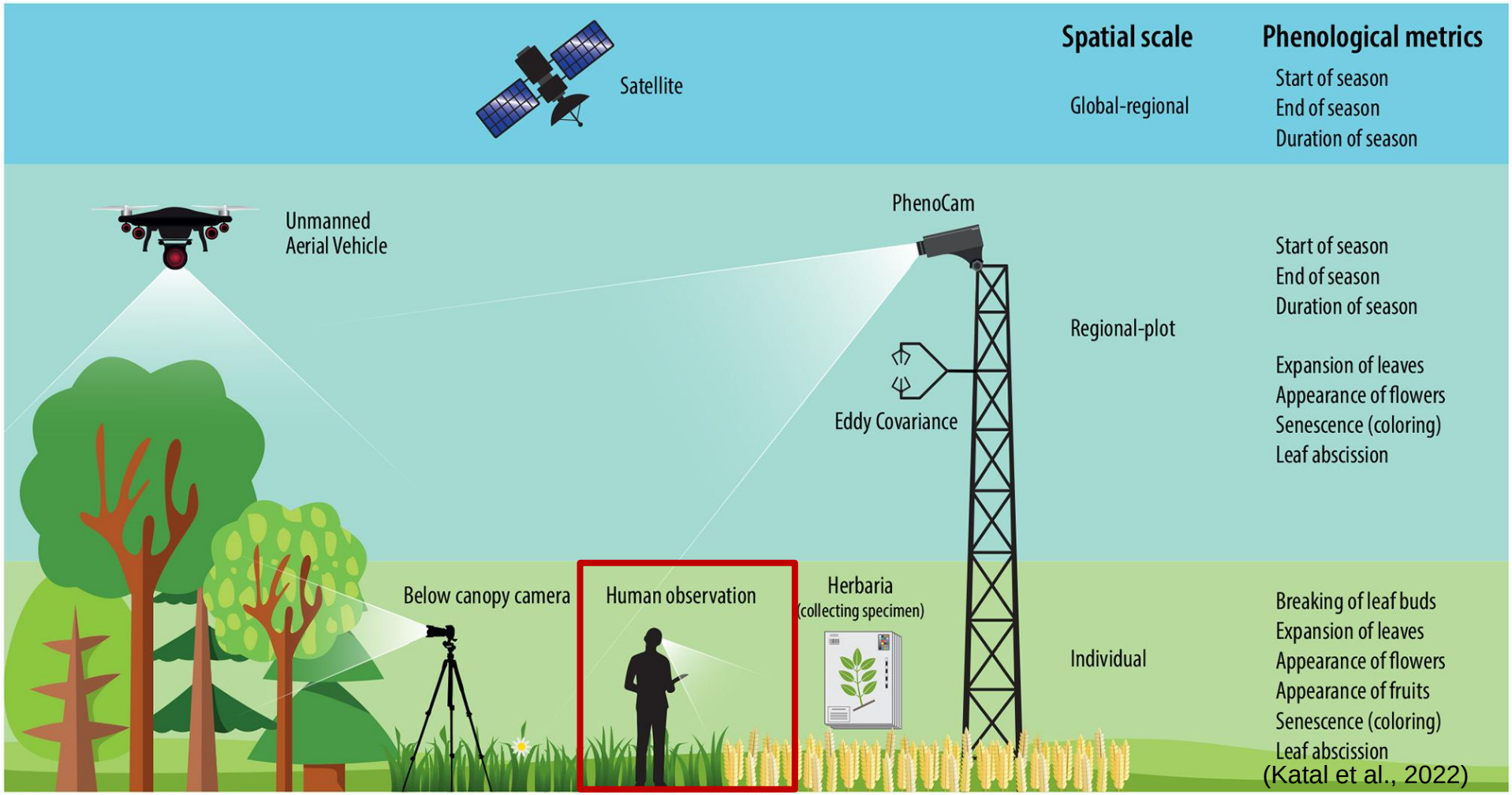



Within-population amplitude of **19 days** (budburst), **26 days** (leaf senescence)

**→ this is 30% of the continental amplitude**

Delpierre et al. (2017). Tree phenological ranks repeat from year to year and correlate with growth in temperate deciduous forests. *Agricultural and Forest Meteorology*, *234*, 1-10.

# Phenological observation




(Katal et al., 2022)

**observer bias**

The quality of the phenological observation is prone to subjective inaccuracy and depends heavily on the observational skills and effort of the observers.

# Uncertainty of phenological data

The « budburst / leaf senescence date » observed in forest is uncertain because:

- of the sampling of the tree population
- of the observer bias

This uncertainty can influence:

- phenological trends
- parameter inference in phenological models

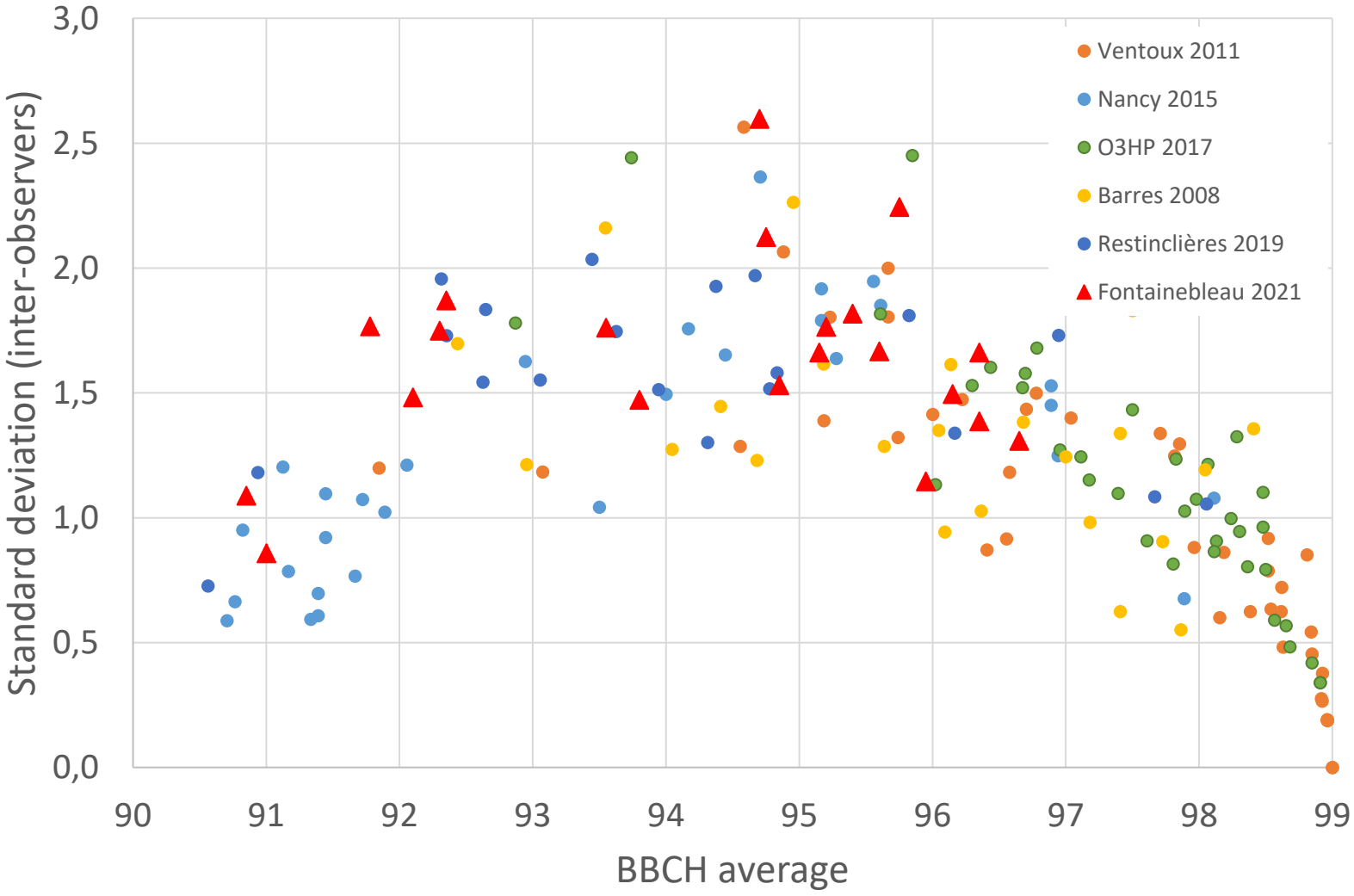

Observer intercalibration
Mont Ventoux (FR), 2011

# The observer inter-calibration sessions

| Phenophase | Site (lat., lon.) | Year | Number of observers | Number of trees observed |
|---|---|---|---|---|
| Budburst | Vincennes (48.8°N, 2.4°E) | 2007 | 12 | 35 |
| | Antibes (43.6°N, 7.1°E) | 2013 | 10 | 49 |
| | Bordeaux (44.8°N, 0.6°W) | 2014 | 22 | 12 |
| Leaf senescence | Nogent-sur-Vernisson (47.8°N, 2.8°E) | 2008 | 12 | 23 |
| | Mont Ventoux (44.2°N, 5.3°E) | 2011 | 27 | 44 |
| | Nancy (48.7°N, 6.2°E) | 2015 | 37 | 30 |
| | Saint-Michel-l'Observatoire (43.9°N, 5.7°E) | 2017 | 23 | 35 |

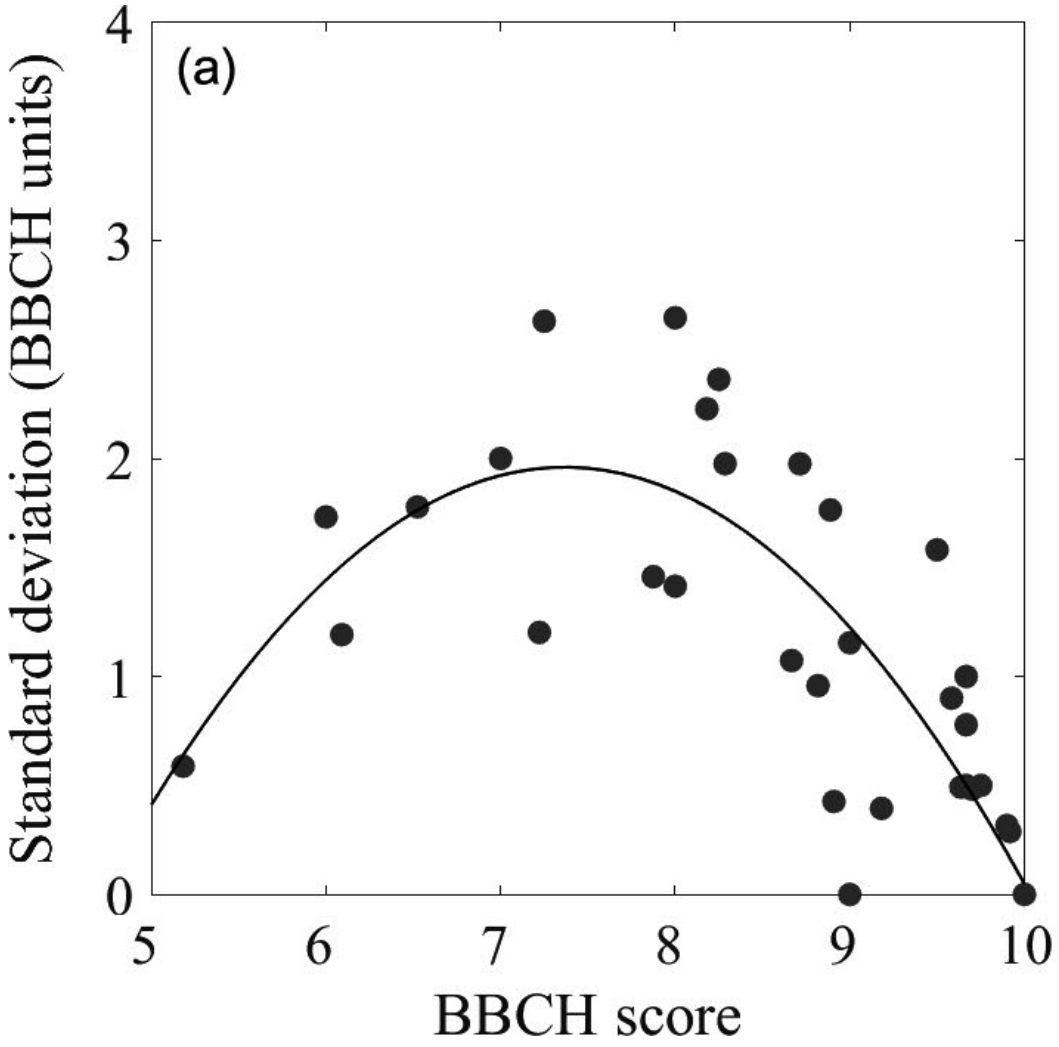
# Inter-observer variability

## Leaf senescence intercalibration data



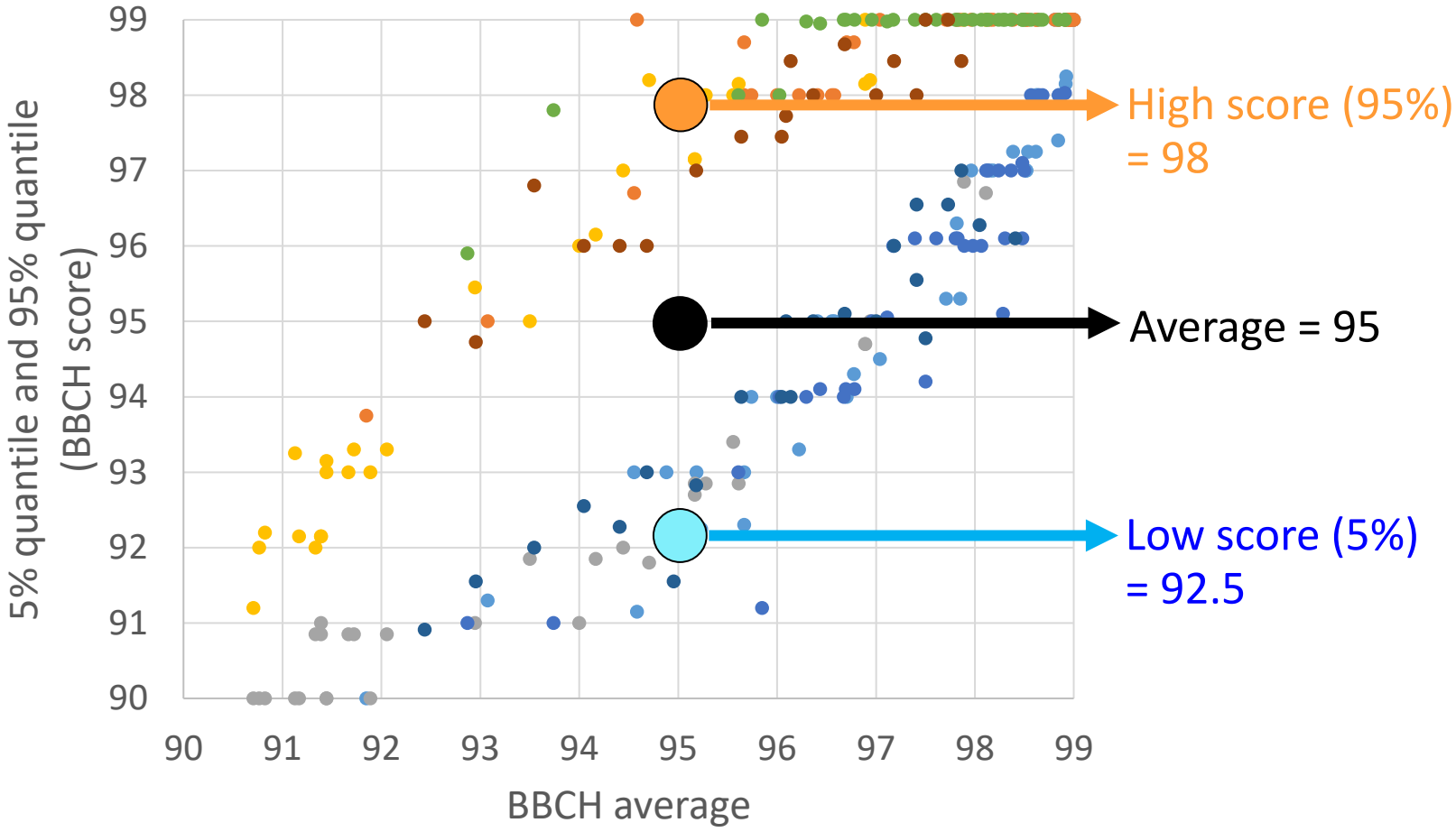
# Inter-observer variability

Budburst intercalibration data



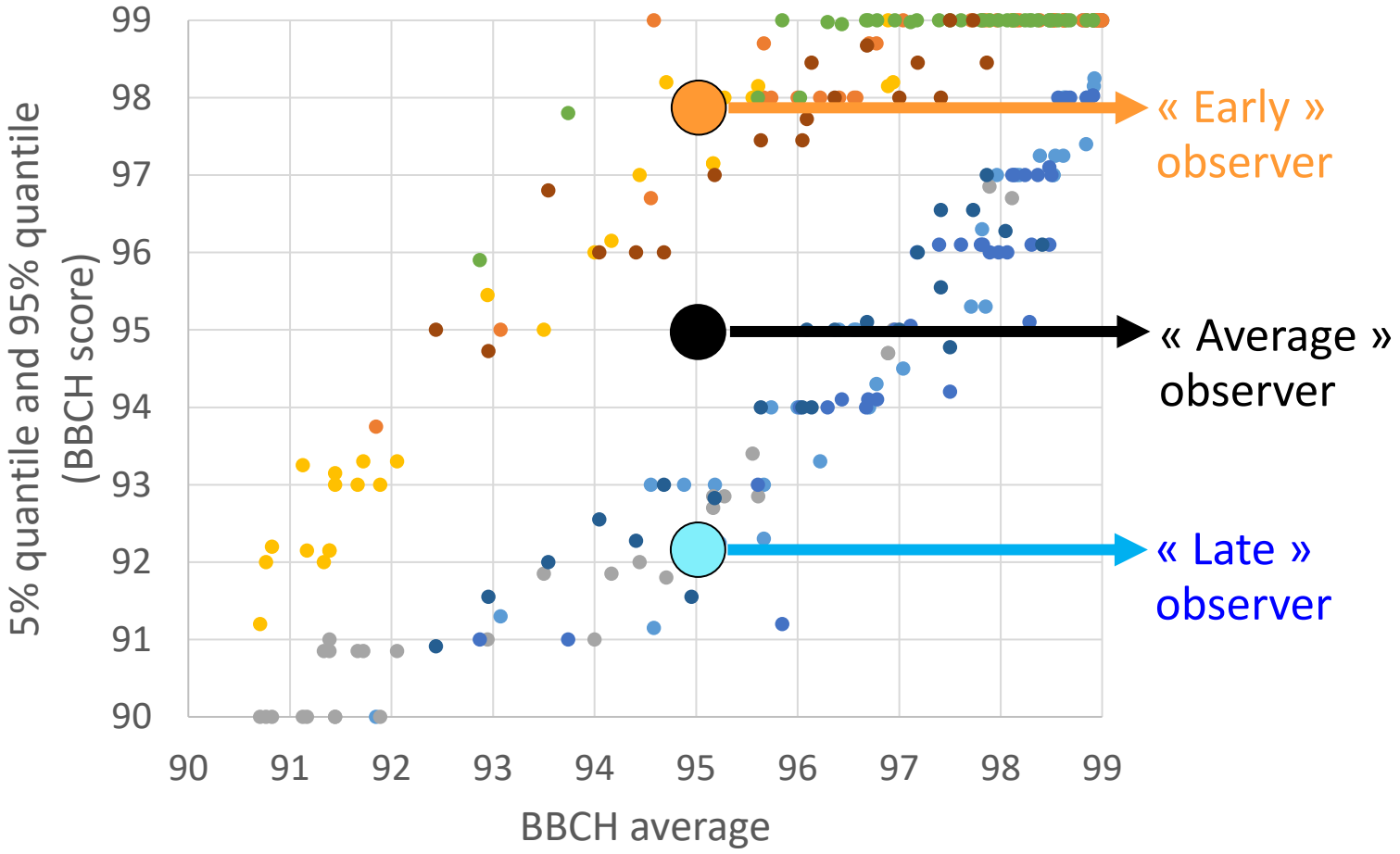
# Inter-observer variability

## Leaf senescence intercalibration data



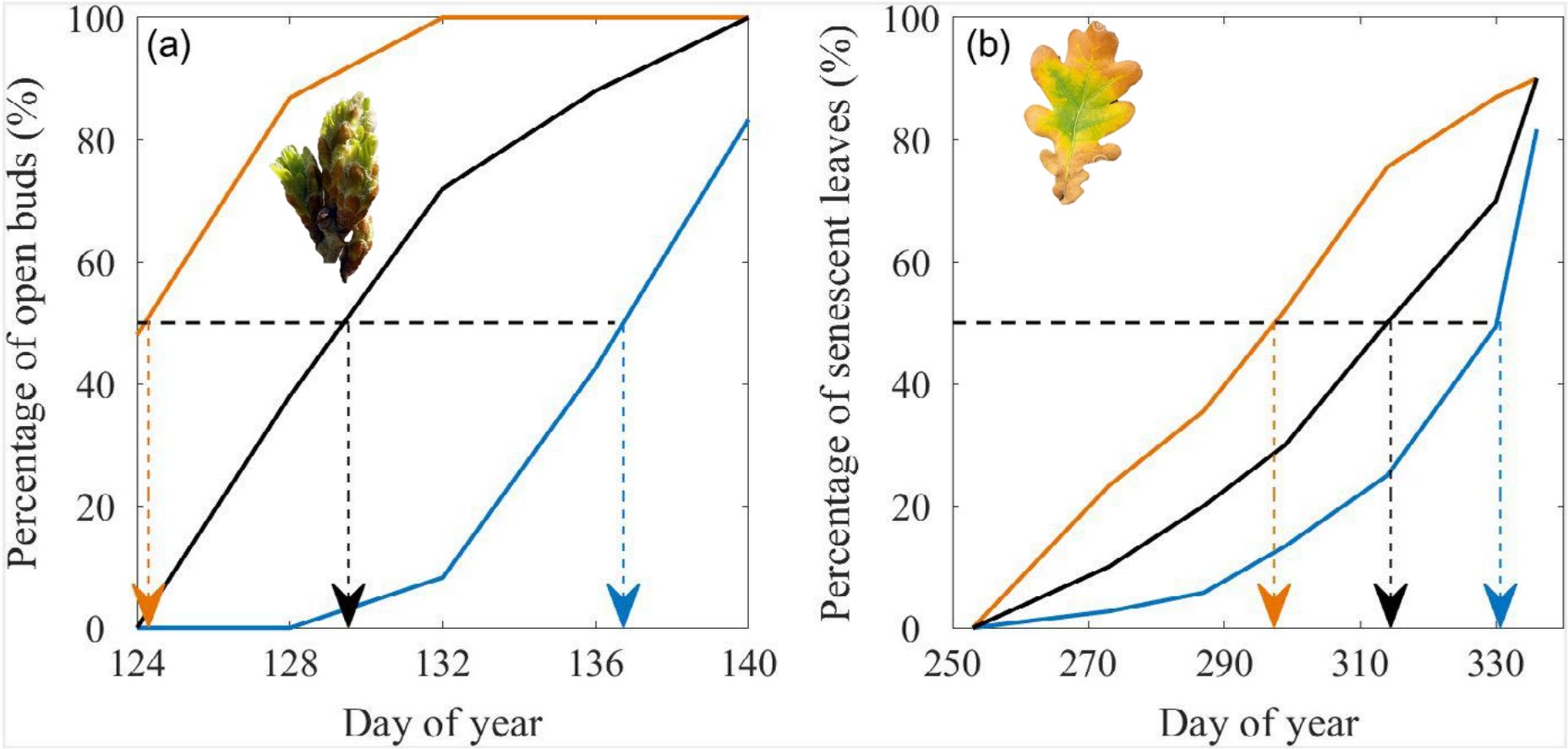
# Inter-observer variability

## Leaf senescence intercalibration data



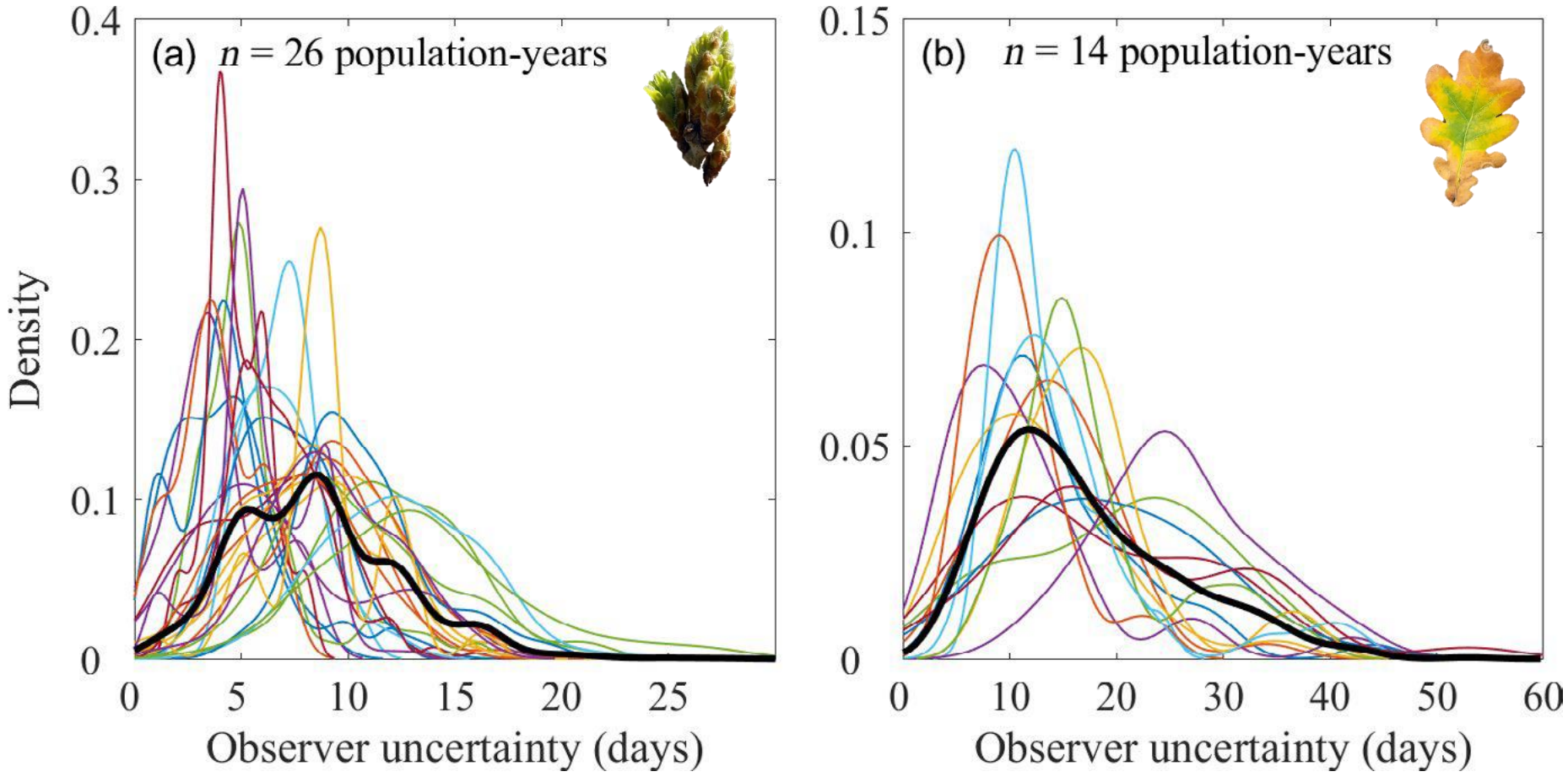
# Infer phenological dynamics

For an **average**, **early**, and **late** observer




Difference **late** – **early** = « inter-obsever variability»
(number of days)

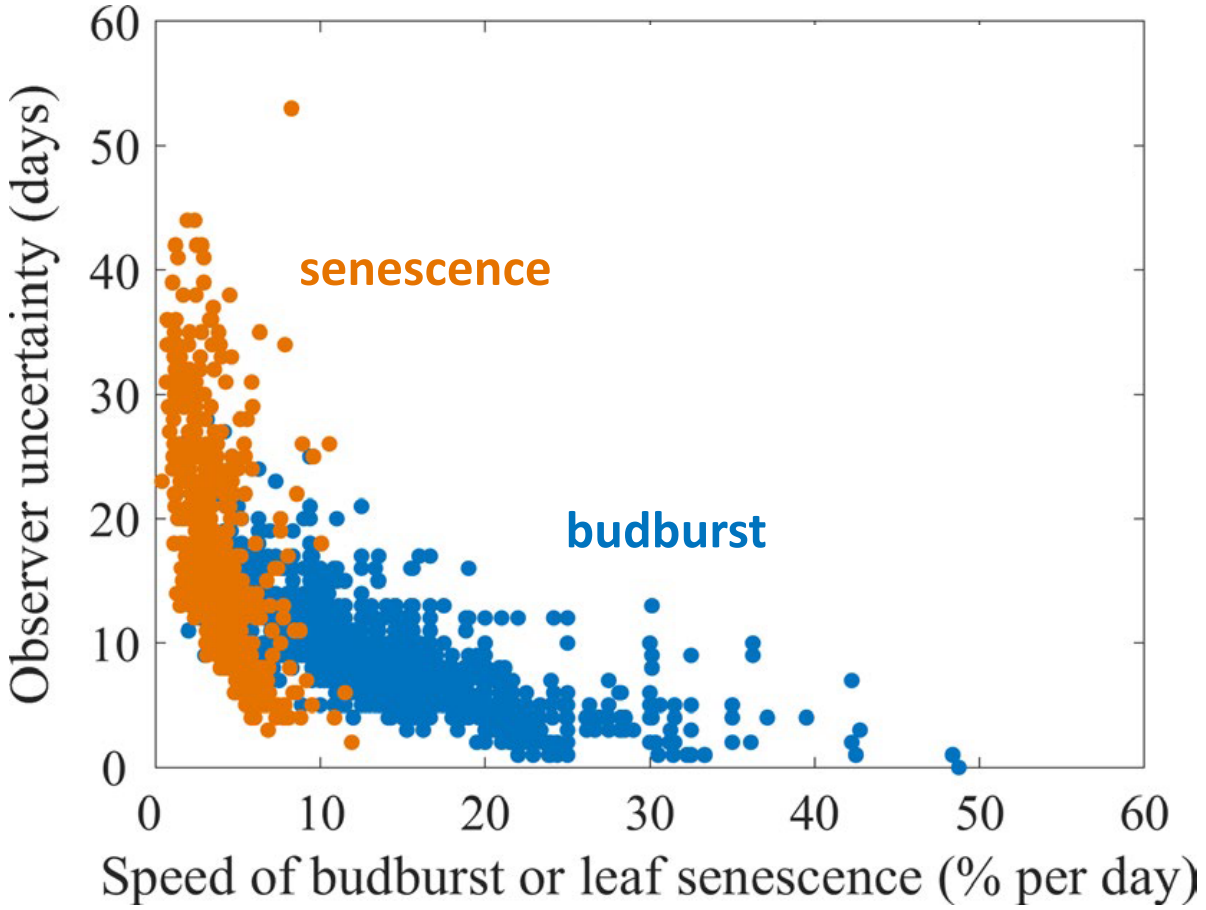
# Observer uncertainty




***Observateur uncertainty***

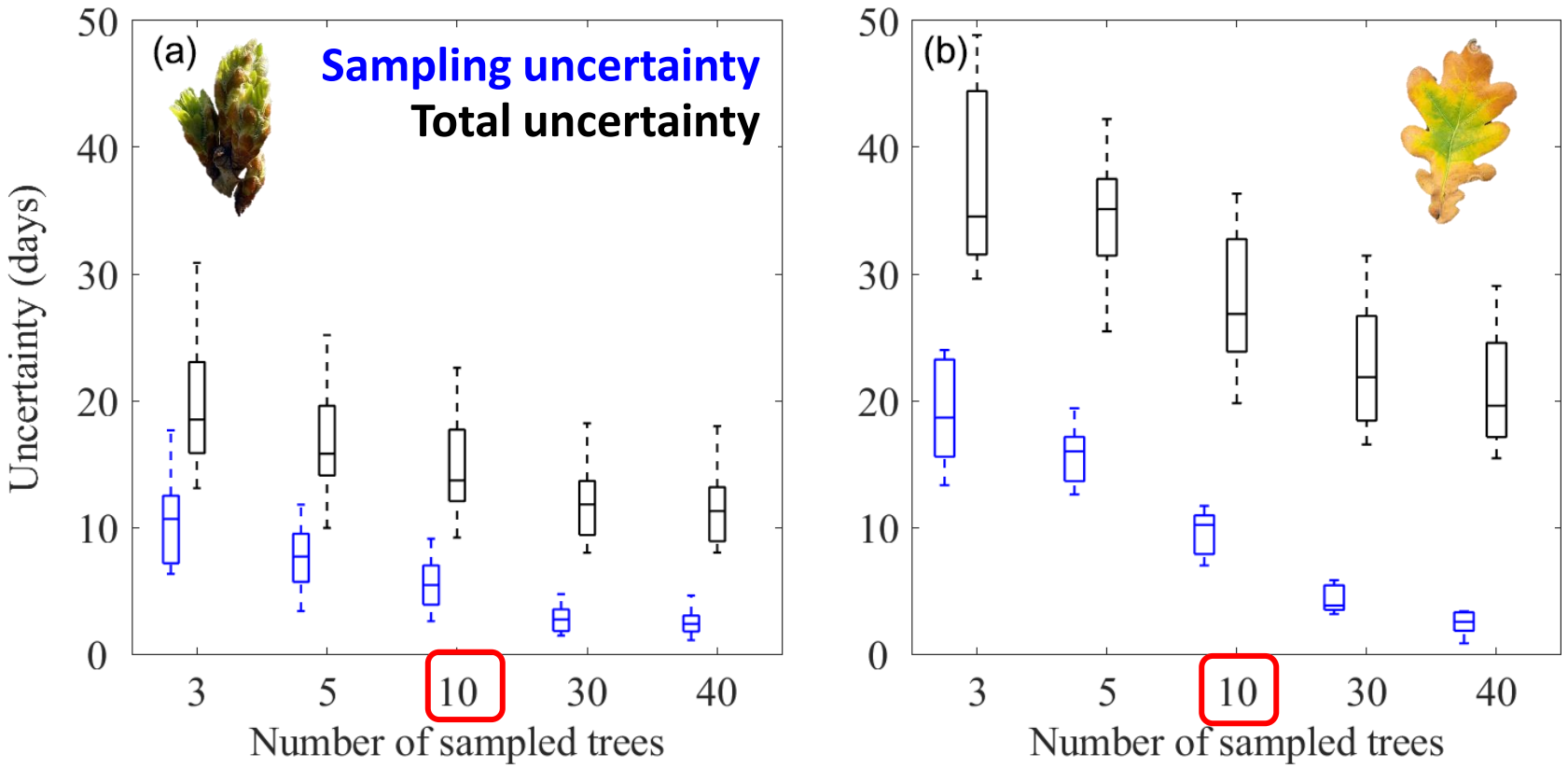
**8 days (budburst) / 15 days (senescence)**

# Observer uncertainty varies according to phenological stage




Observer uncertainty is larger for senescence (slower phase) than for budburst (faster phase)

# Quantifying combined uncertainty




***Sampling uncertainty*** (for n= 10 trees)
**6 days (budburst) / 10 days (senescence)**
<u>decreases</u> with a higher number of observed trees

# Conclusions

## Phenological observation in the field:

- Observer intercalibration is highly recommended,
- **Sample a minimum of:**
  - **30 trees** (at **budburst**, to get a precision of 3 days)
  - **20 trees** (at **senescence**, to get a precision of 7 days)

## When analysing pheno data:

- pay attention to data homogeneity (nb of trees, observers)
- consider data uncertainty when calibrating model parameters

# Special thanks:

## all contributors to the Observers' intercalibration sessions

RESEARCH ARTICLE

Journal of Ecology

**Higher sample sizes and observer inter-calibration are needed for reliable scoring of leaf phenology in trees**

Guohua Liu[1,2] | Isabelle Chuine[3] | Rémy Denéchère[2,4] | Frédéric Jean[5] | Eric Dufrêne[2] | Gaëlle Vincent[2] | Daniel Berveiller[2] | Nicolas Delpierre[2,6]

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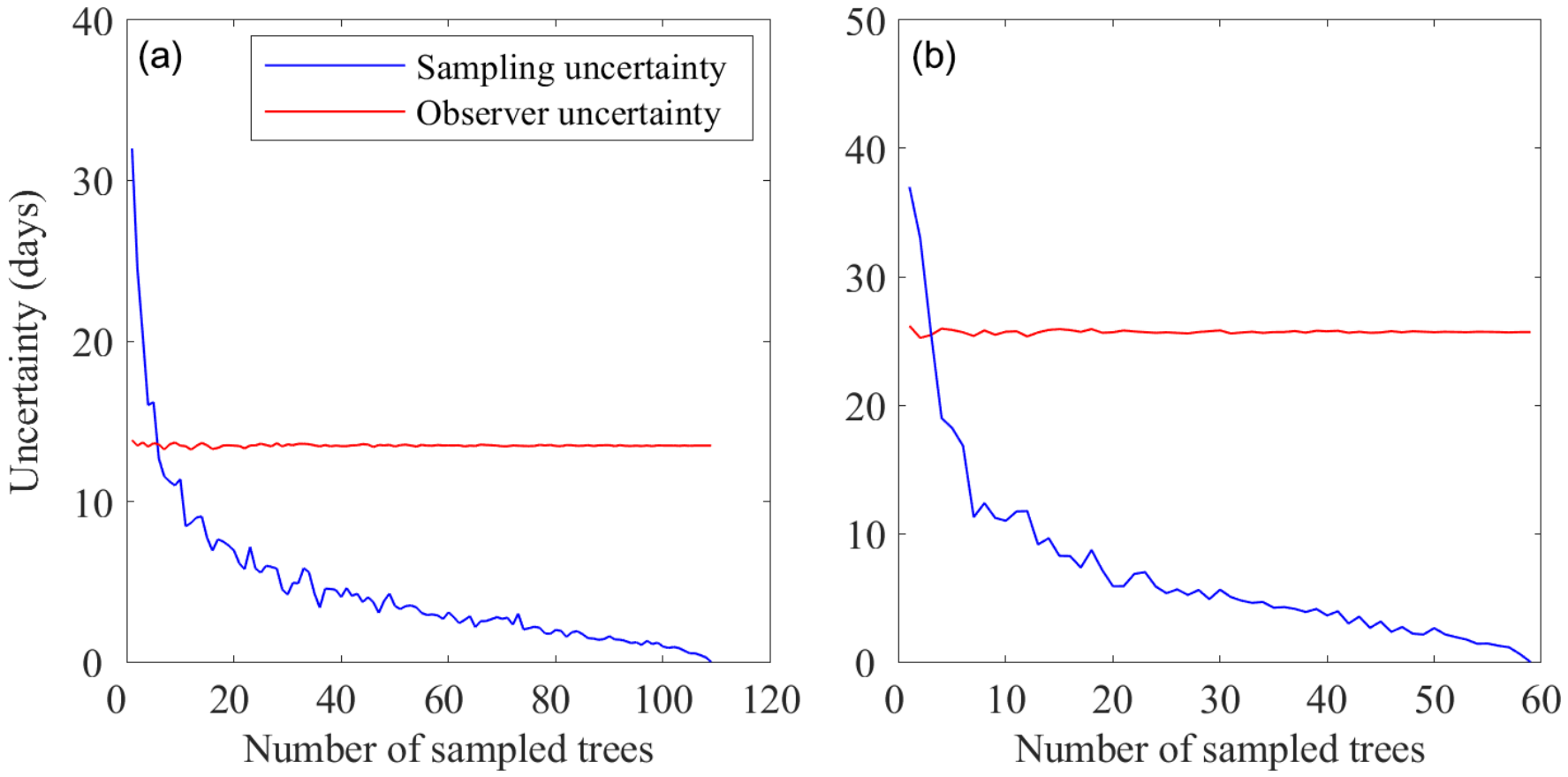
# Thanks for your attention!

**TABLE 4** Percentiles of sample size for budburst and leaf senescence in current phenological studies of trees. The percentiles are derived from the sample sizes of natural tree populations appearing in Table 1. The approximate values of sample size are shown in parentheses

| Percentile (%) | Sample size for budburst | Sample size for leaf senescence |
|---|---|---|
| 5 | 3 | 3 |
| 25 | 5 | 5 |
| 50 | 12 (~10) | 8 (~10) |
| 75 | 29 (~30) | 27 (~30) |
| 95 | 41 (~40) | 39 (~40) |

**Table S1 Phenological stages used in this study (modified BBCH scale).**

| Phenophase | BBCH Scale | Growth stages |
|---|---|---|
| Budburst | 5 | fewer than 10% buds are open |
| | 6 | 10% buds are open |
| | 7 | 50% buds are open |
| | 9 | 90% buds are open |
| | 10 | 100% buds are open |
| Leaf senescence | 90 | fewer than 10% leaves colored or fallen |
| | 91 | 10% leaves colored or fallen |
| | … | … |
| | 95 | 50% leaves colored or fallen |
| | … | … |
| | 99 | 90% or more leaves colored or fallen |


(a)
Sampling uncertainty
Observer uncertainty
Uncertainty (days)
Number of sampled trees
0
10
20
30
40
0
20
40
60
80
100
120
(b)
Number of sampled trees
0
10
20
30
40
50
0
10
20
30
40
50
60