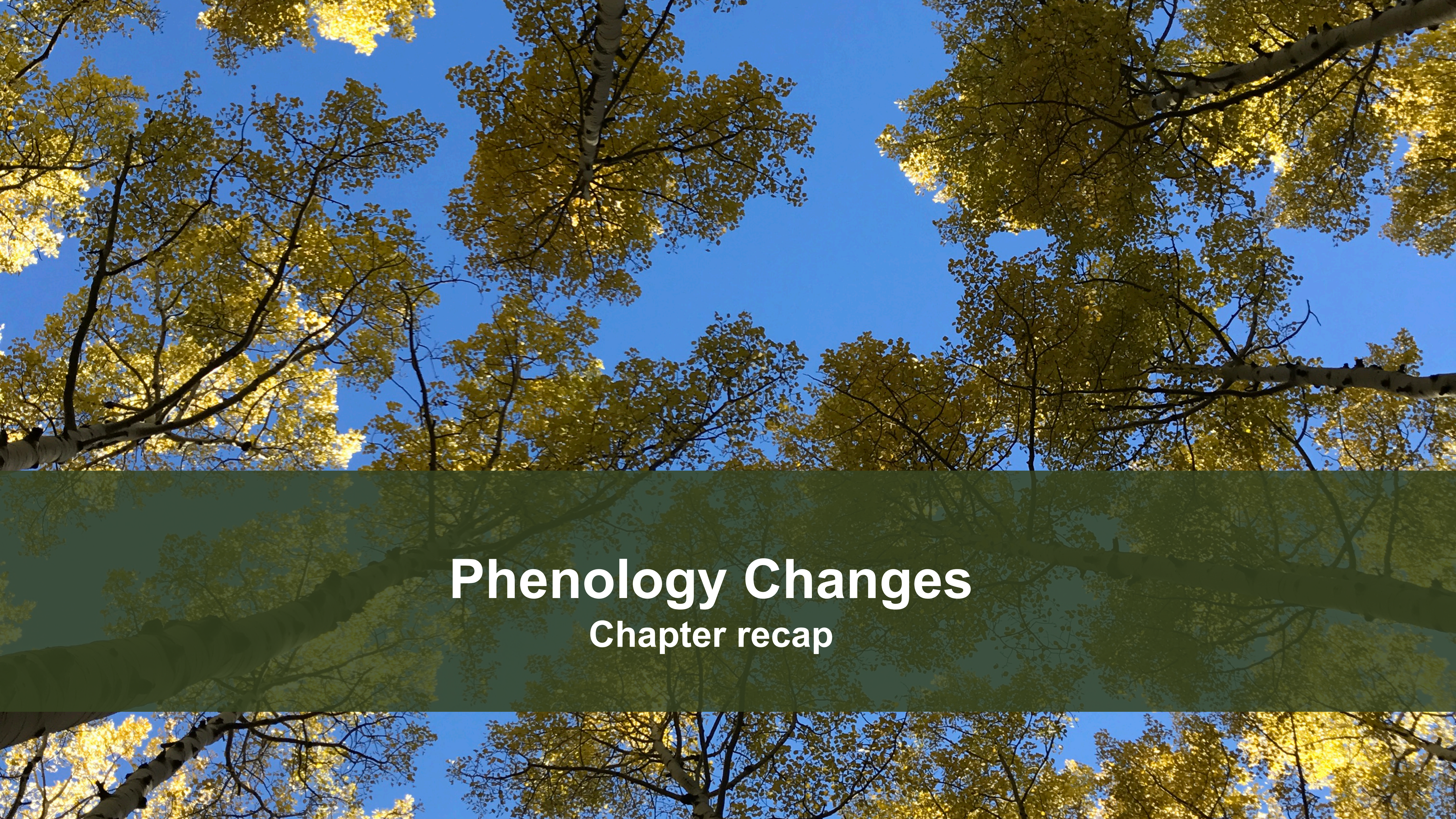
UNIVERSITÄT BERN

Land in the Earth System II - HS24

Session 25.11.2024

- CO_2 Fertilization chapter
- Recap on the Phenology Changes chapter
- Fun lecture on EOS phenology

Laura Marqués



Phenology Changes

Chapter recap

1. Plant phenology

Spring leaf unfolding
Start-of-the season
(**SOS**)

e.g. SOS ~ 20 April
→ DOY = 110

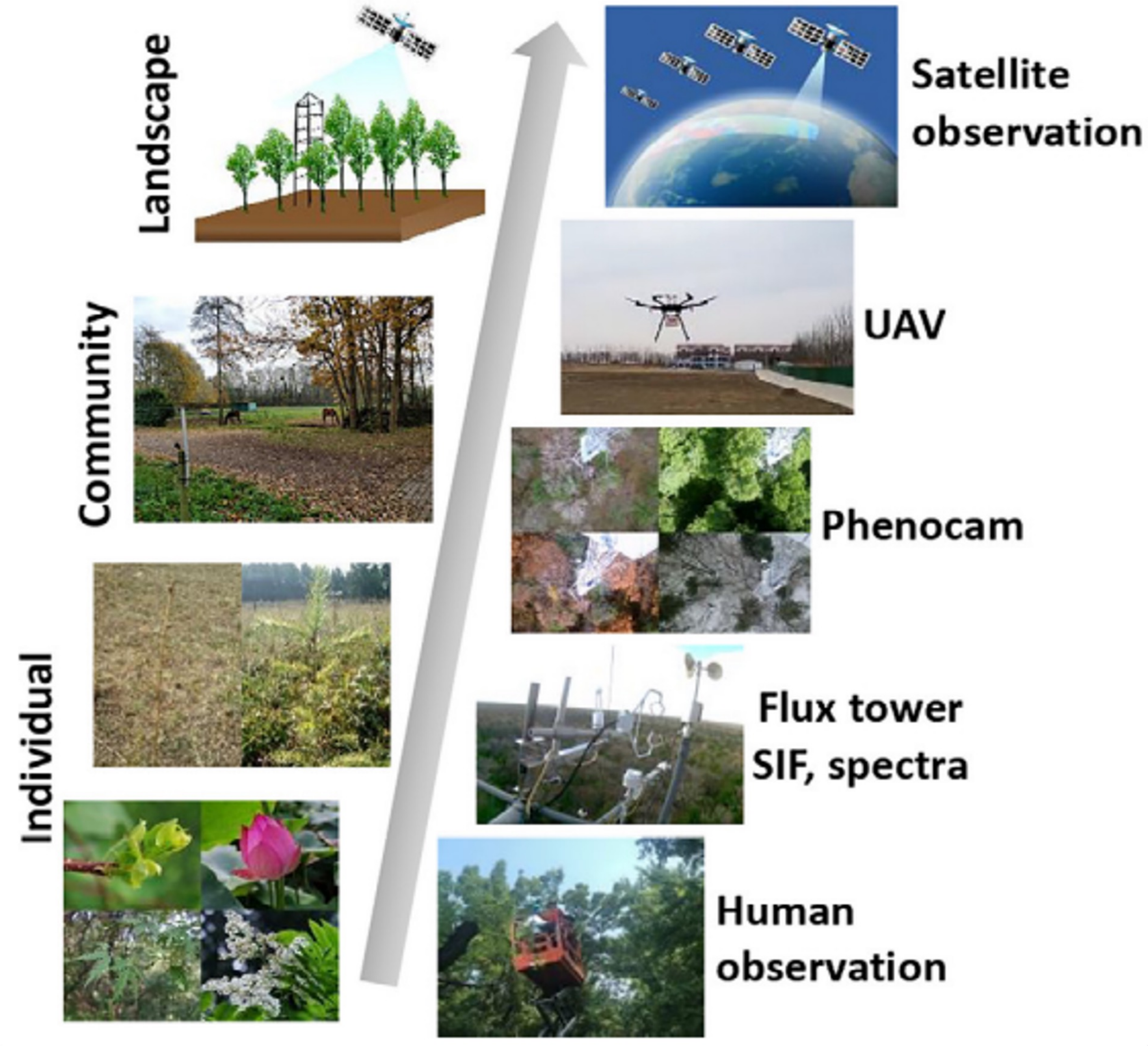
Day-of-Year, DOY

Autumn leaf senescence
End-of-the season
(**EOS**)

e.g. EOS ~ 20 Sept
→ DOY = 264

Photos: Swiss NFI

2. Methods of plant phenology



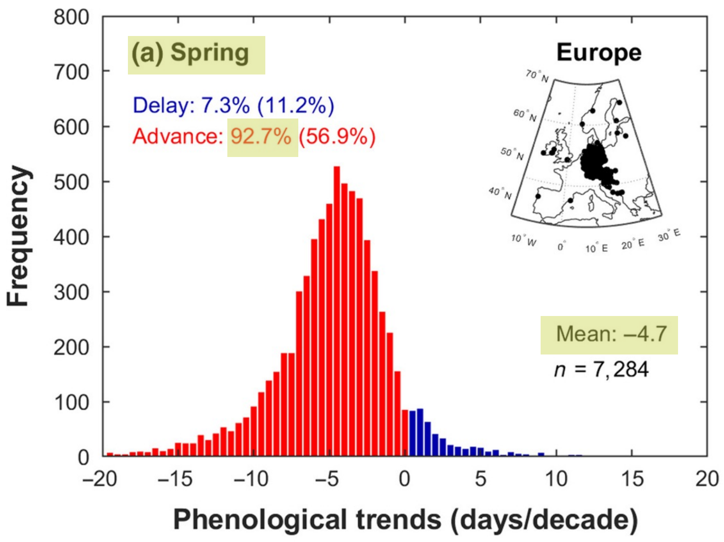
Multi-scale methods on plant phenology.
Piao et al. 2019. GCB.

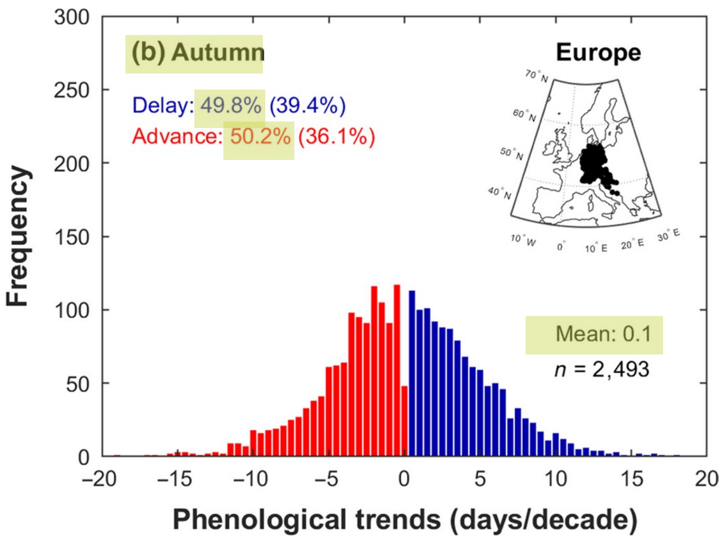
MODIS → NDVI and EVI → SOS and EOS

PEP725 (Pan European Phenology project)

3. Recent trends in plant phenology

Evidence from ground-based observations





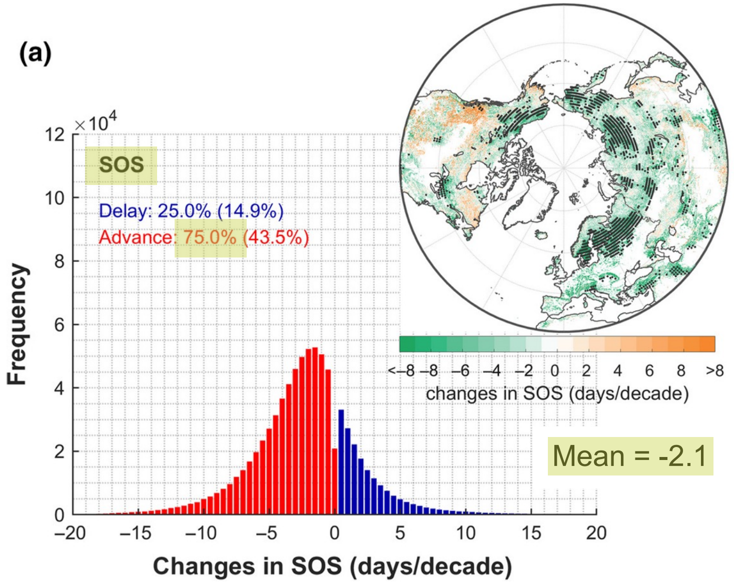
Phenological trends in Europe during the period 1982-2011 based on PEP725 ground observations.
Piao et al. 2019. GCB.

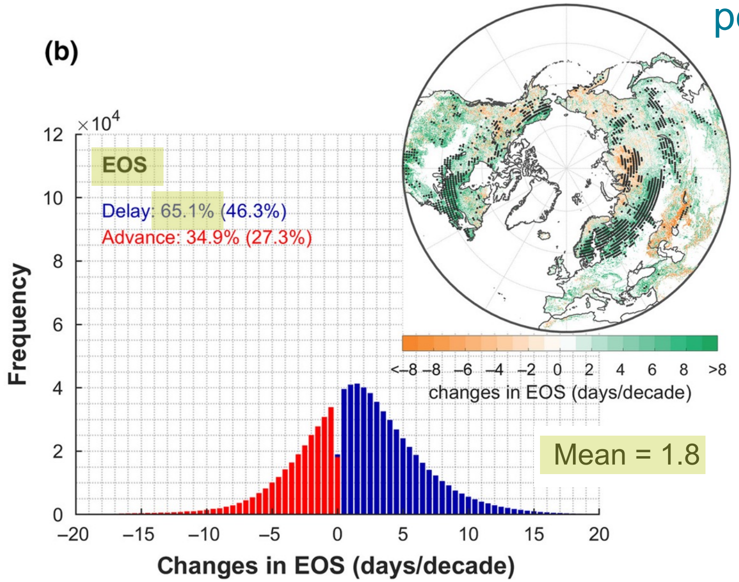
Ground- and satellite-based studies are consistent.

- SOS advances
- EOS delays (less clear)

Evidence from remote-sensing data

Changes in SOS and EOS differ by region, time periods, and plant species.





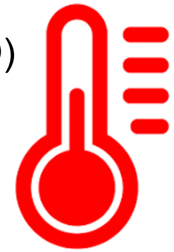
Phenological trends in the Northern Hemisphere for 1982-2011 based on remote-sensing observations.
Piao et al. 2019. GCB.

4. Main drivers of plant phenology

SOS

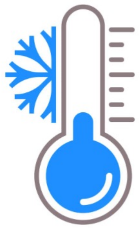
1. Temperature

Growing degree days (GDD) breaks the ecodormancy

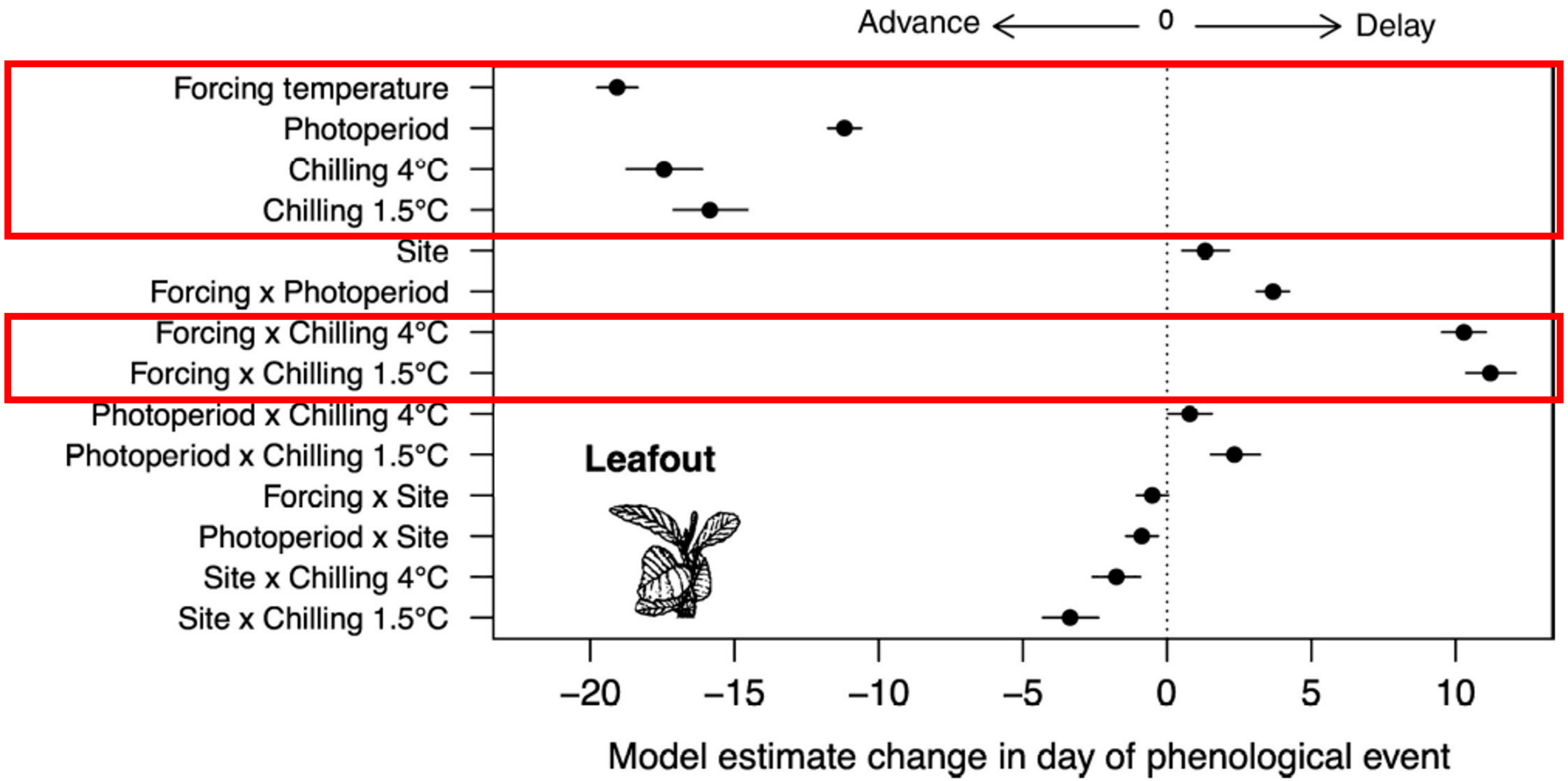


2. Photoperiod

3. Winter chilling



Chilling induces the two phases of dormancy (endo- and ecodormancy)



Effects of multiple environmental drivers and their interaction on spring leaf-out from an experimental study across 28 species. Flynn and Wolkovic 2018. New Phyto.

4. Main drivers of plant phenology

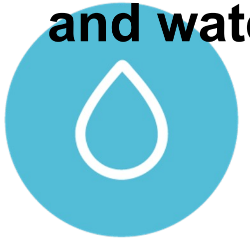
EOS

1. Photoperiod

2. Temperature

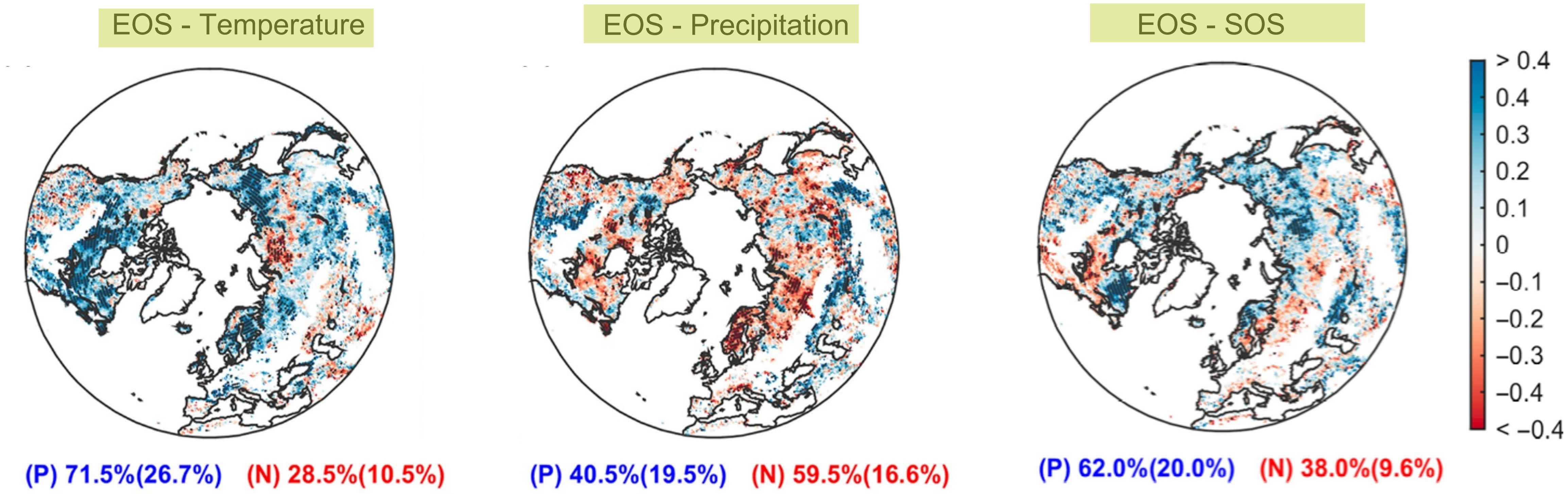
Warmer autumn temperatures

3. Nutrients and water



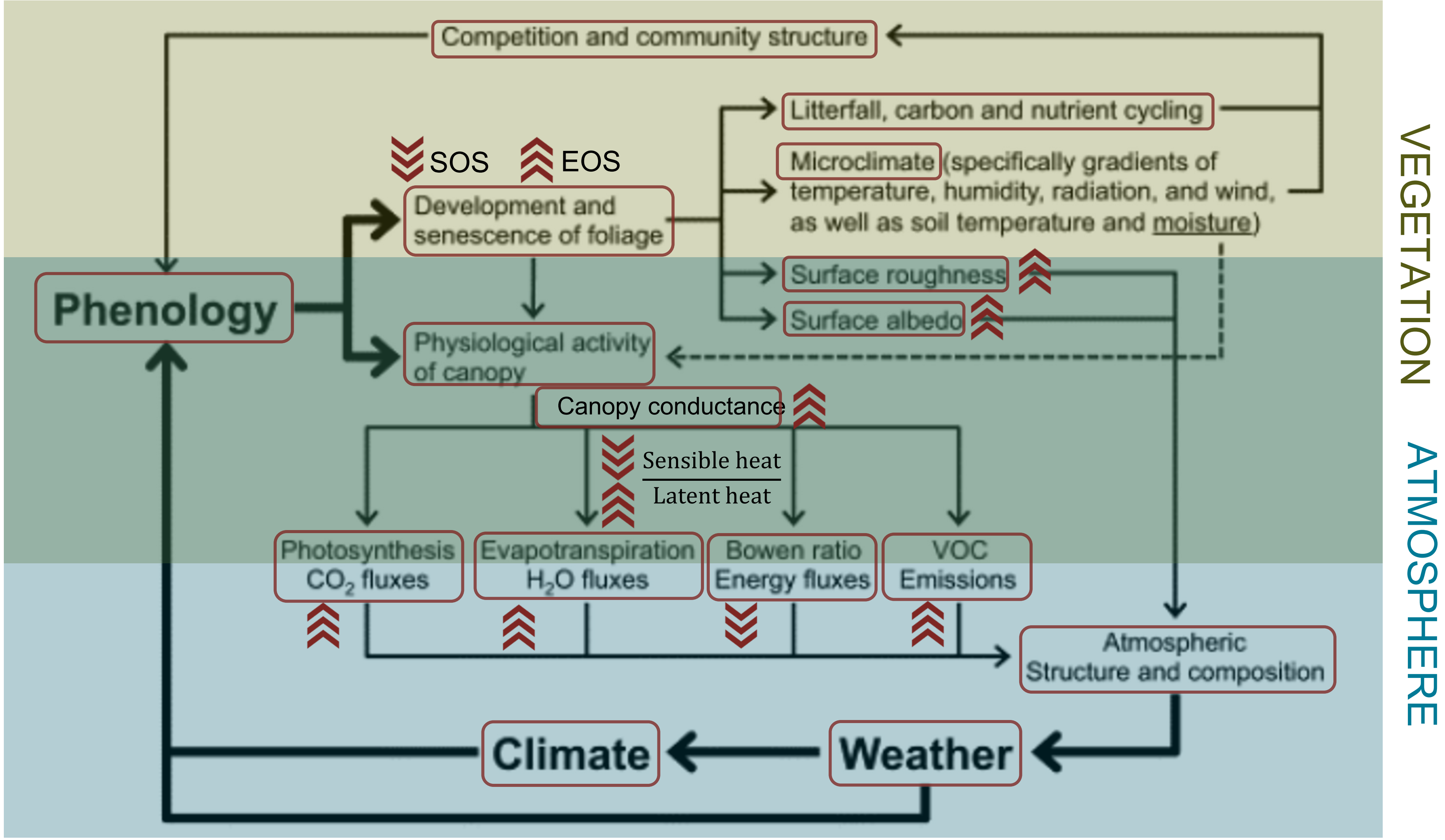
4. SOS

This can explain the less clear trends in autumn phenology in response to climate change.



Correlation of EOS with temperature, precipitation, and SOS from remote-sensing data. Partial correlation was calculated after controlling for other climatic factors. Figure adapted from Liu et al. 2016. GCB.

5. Phenology feedbacks on climate

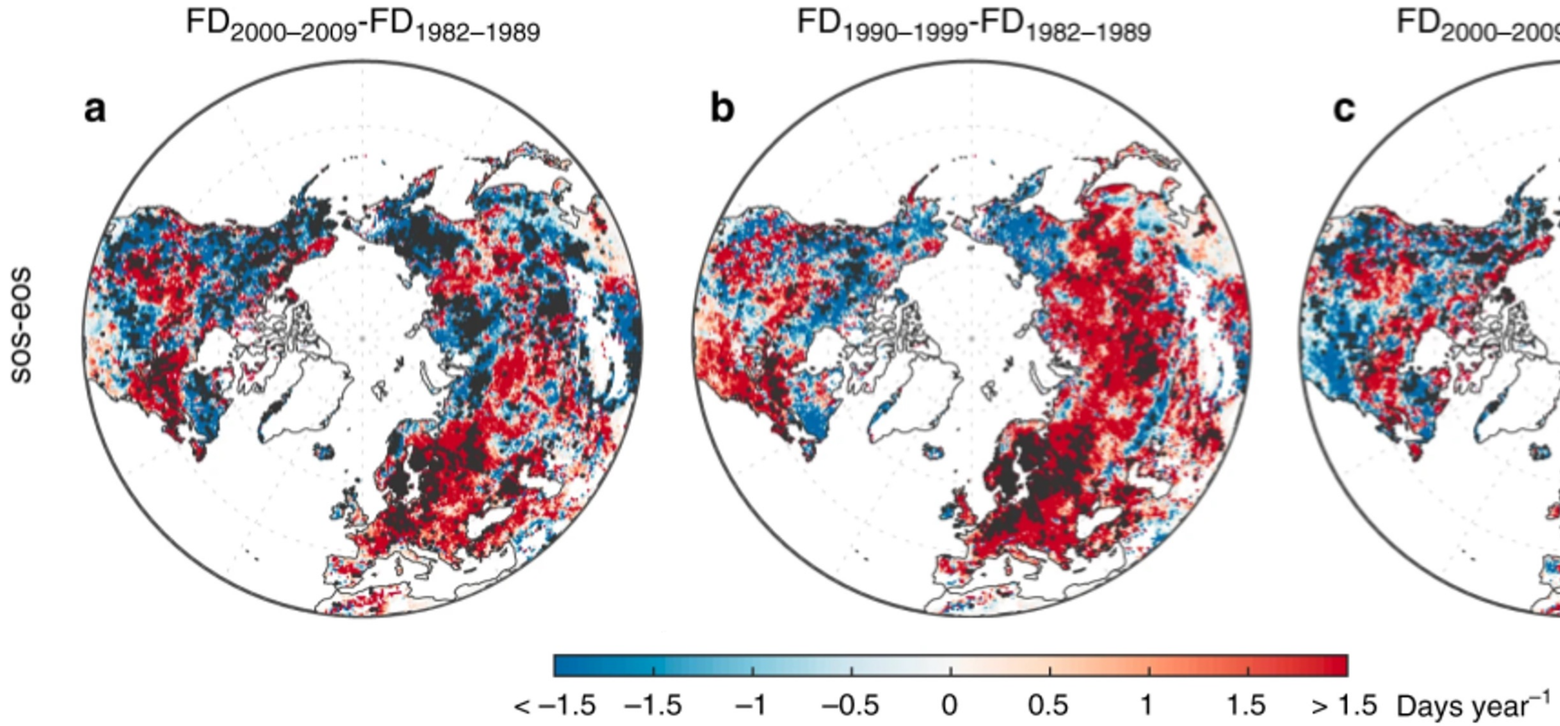


Conceptual model illustrating the primary feedbacks between vegetation and the climate system influenced by vegetation phenology.
Figure and caption from Richardson et al. 2013. AFM.

6. Other impacts of phenological changes

Increased frost events during the growing season

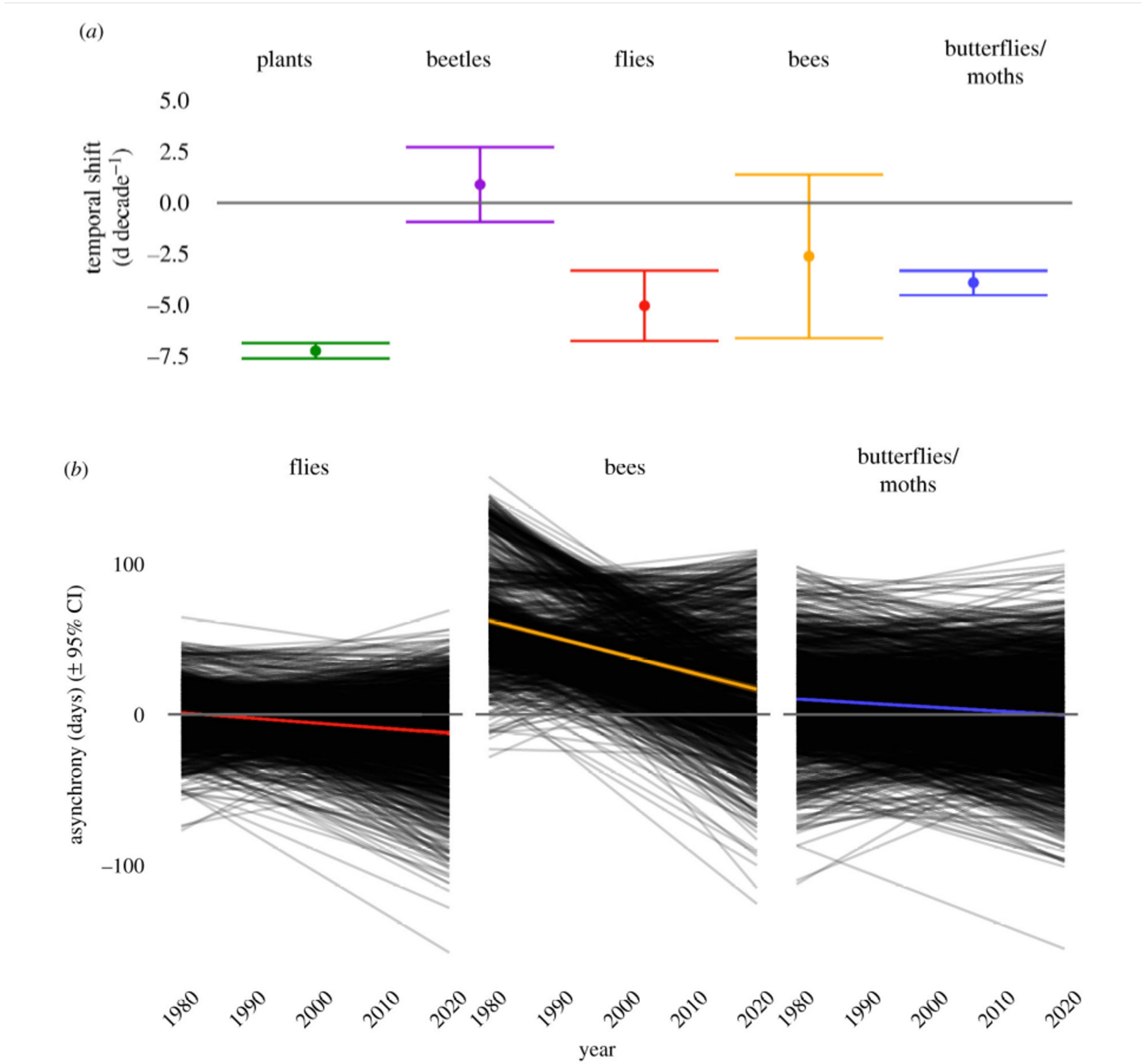
(Bigler and Bugmann 2018).



Changes in average frost days during the growing season (SOS-EOS) for (a) the entire period 1980s-2000s, and for the subperiods (b) 1980s-1990s and (c) 1990s-2000s. Figure adapted from Liu et al. 2018. Nat. Comm.

6. Other impacts of phenological changes

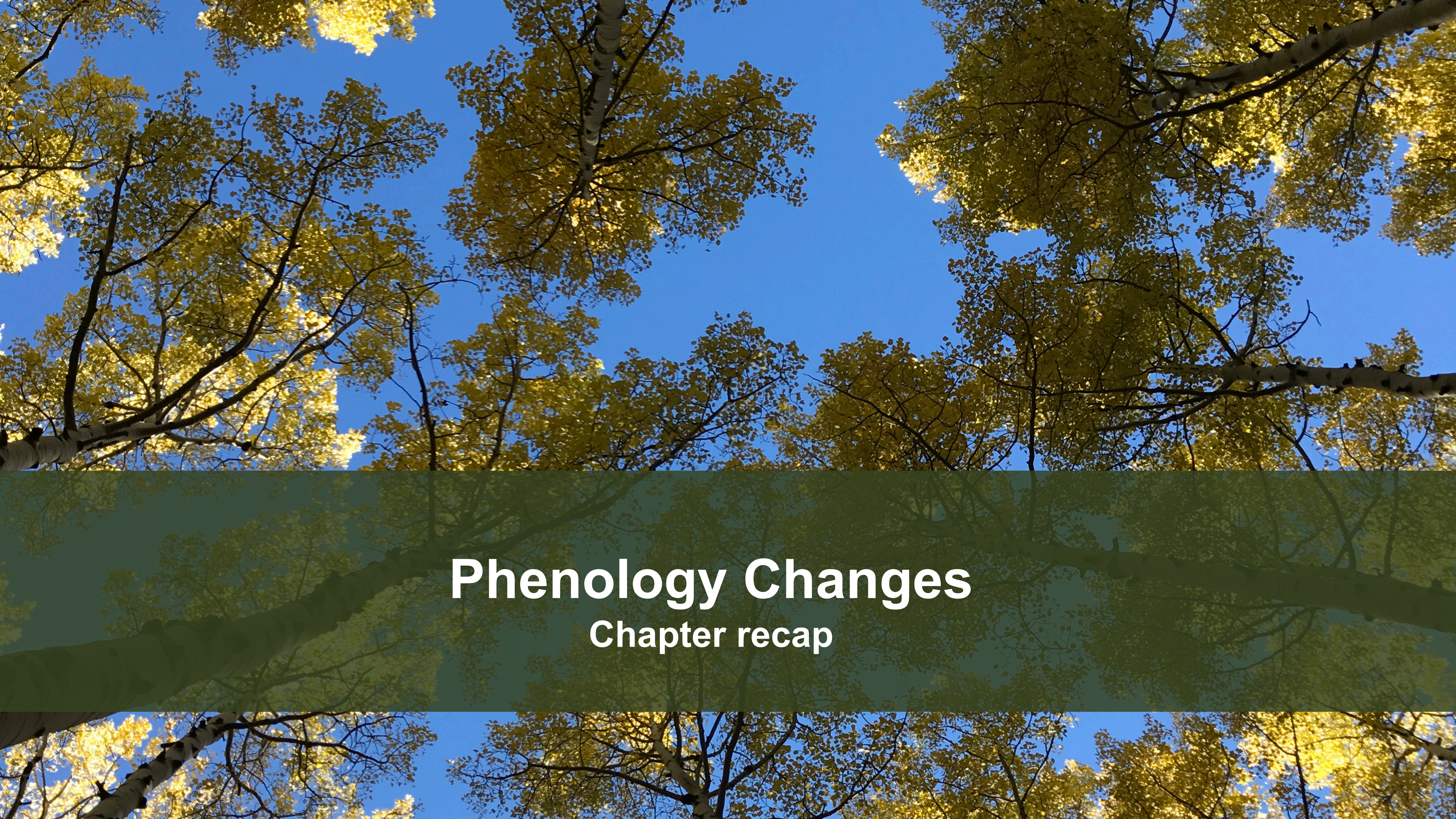
Plant–pollinator phenological mismatches



(Bartomeus et al. 2011).

Phenological shifts of plants and insect pollinators from an empirical study during 1980-2020. (a) Temporal trends of plants and pollinator groups. (b) Shifts in asynchrony of plant–pollinator interactions over time. Asynchrony is the difference in the estimated yearly mean DOY of activity between the plant and the pollinator species. Figure adapted from Freimuth et al. 2022. Proc. B.

Positive values of asynchrony in a given year describe asynchrony with pollinators active earlier than plants.


Phenology Changes
Chapter recap