Ecodormancy modelling some new clues after nine years of research

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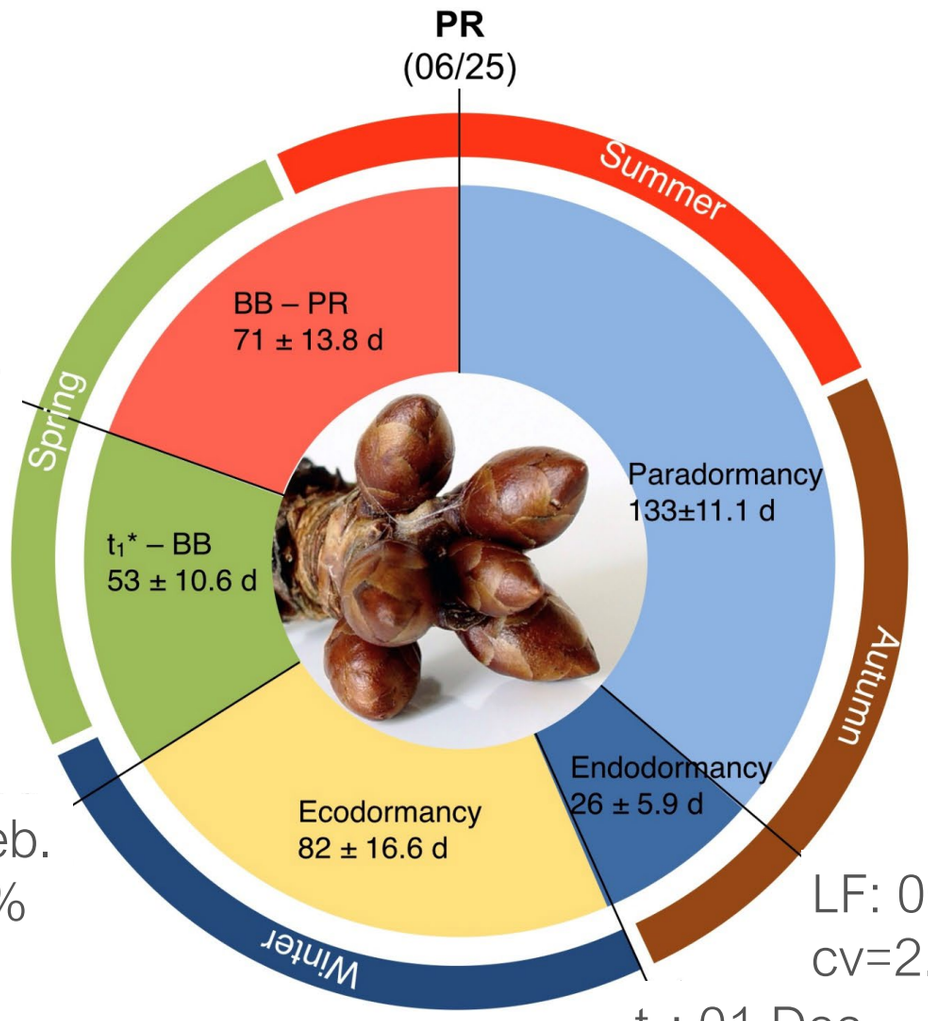
Cycle of bud development for ‘Summit’ at Berlin-Dahlem

basis for a physiological based modelling

Mean data of the sweet cherry cv. ‘Summit’, 2011/12 – 2019/20 season*



BB: 15 Apr.
cv=6.7%

t_1*: 21 Feb.
cv=28.7%

LF: 05 Nov.
cv=2.1%

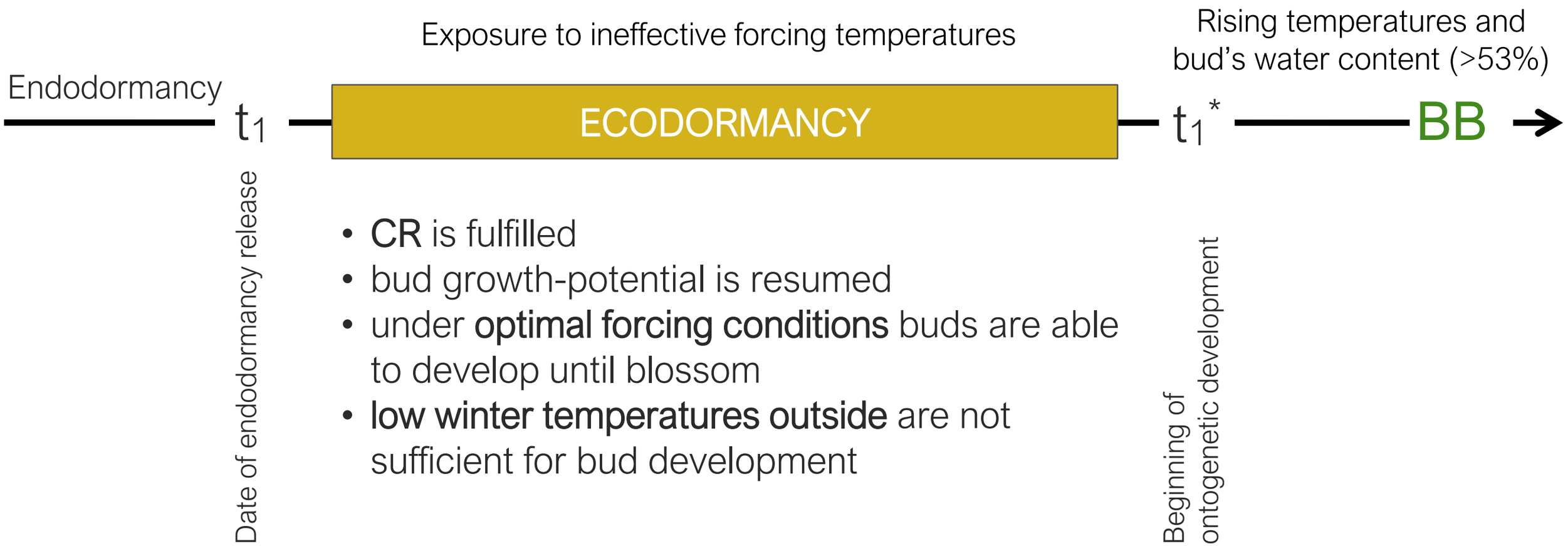
t_1: 01 Dec.
cv=2.0%
CR=42 CP

cv: coefficient of variation
CR: chilling requirement

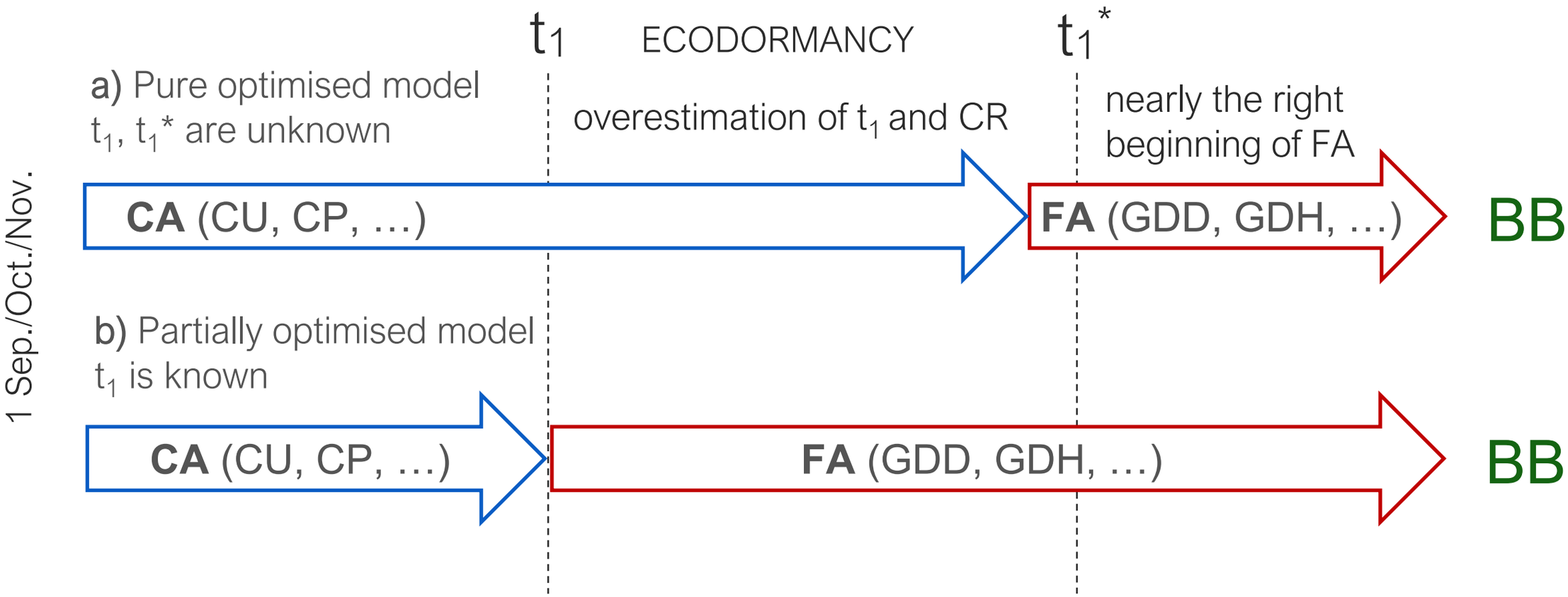
*Chmielewski & Götz, 2017 & 2022

What is Ecodormancy?

Ecodormancy is a phase in which bud development is suppressed by unfavorable environmental conditions.



Sequential phenology models



Q1: Is FA relevant during ecodormancy?
Q2: What is the right starting date for FA after t_1?

CA: Chill accumulation
FA: Forcing accumulation

Sequential phenology models

CA (CP) → t_1 → ECODORMANCY → t_1^* → **FA** (GDH) → BB

Season	CA(244-t_1) in CP	FA(t_1-t_1*) in GDH	FA(t_1*-BB) in GDH	BB in DOY
2011/12	42	642	3029	105
2012/13	43	645	3315	116
2013/14	40	802	3664	95
2014/15	40	744	3290	111
2015/16	41	2460	3050	111
2016/17	46	312	3378	97
2017/18	49	763	3998	108
2018/19	40	711	3850	99
2019/20	41	1899	3685	105
x	42.4	997.5	3473.1	105.2
s	3.1	699.4	343.3	7.1
cv (%)	7.4	70.1	9.9	6.7

5510 → 2015/16

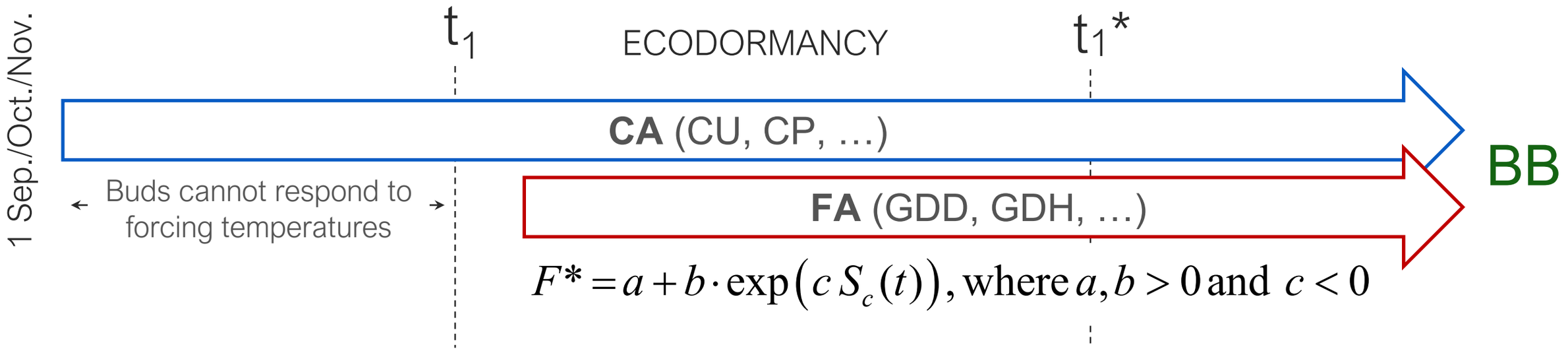
3690 → 2016/17

$r(t_1^*, BB) = 0.76$, $p < 0.05$

A1: Forcing temperatures during ecodormancy do not promote bud development in the same way as after t_1*. Thus, ecodormancy should be a separate phase in phenology models!

A2: t_1* must be the right starting date for FA!

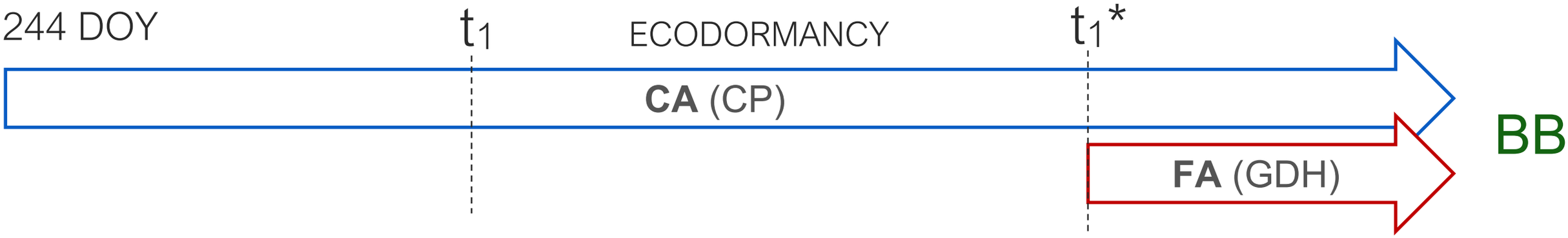
Parallel phenology models



Q3: Is there indeed a compensation between CA and FA, if we start FA at t_1*?

CA: Accumulation of chill units
FA: Accumulation of forcing units
F*: Forcing requirement until BB
$S_c(t)$: State of chilling

Parallel phenology models – chilling/forcing compensation



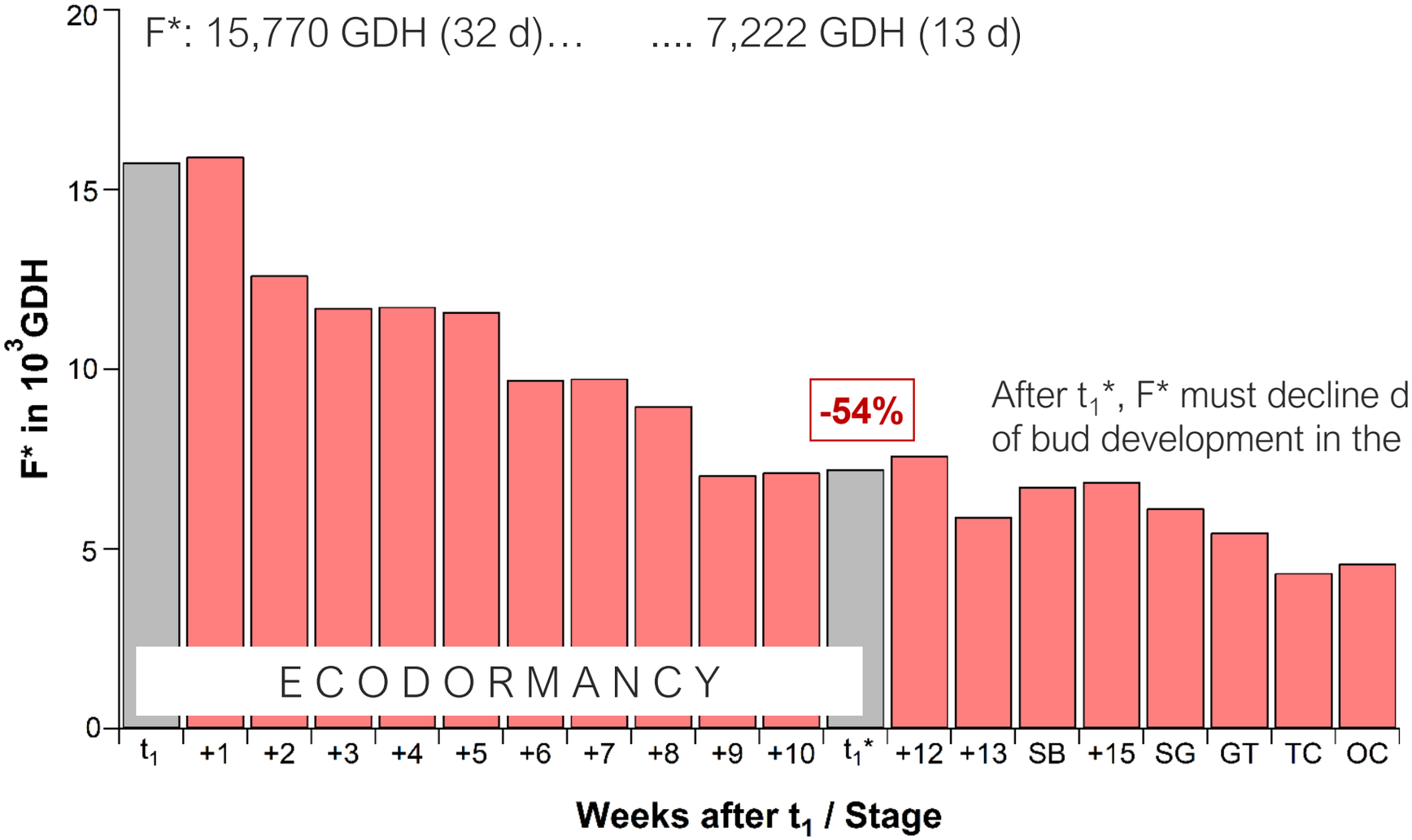
Season	CA(244-BB) in CP	FA(t_1*-BB) in GDH
2011/12	132	3029
2012/13	117	3315
2013/14	133	3664
2014/15	130	3290
2015/16	144	3050
2016/17	122	3378
2017/18	131	3998
2018/19	132	3850
2019/20	137	3685
x	130.9	3473.1
s	7.8	343.3
cv (%)	6.0	9.9

r(CA, FA) = -0.03^{ns}

A3: There is no compensatory effect between chilling and forcing, if one starts FA at t_1*.

Forcing experiment

Season 2018/19
After t_1, twigs were cut weekly and placed in a climate chamber at t~24°C, 12 h light, 70% relative humidity.

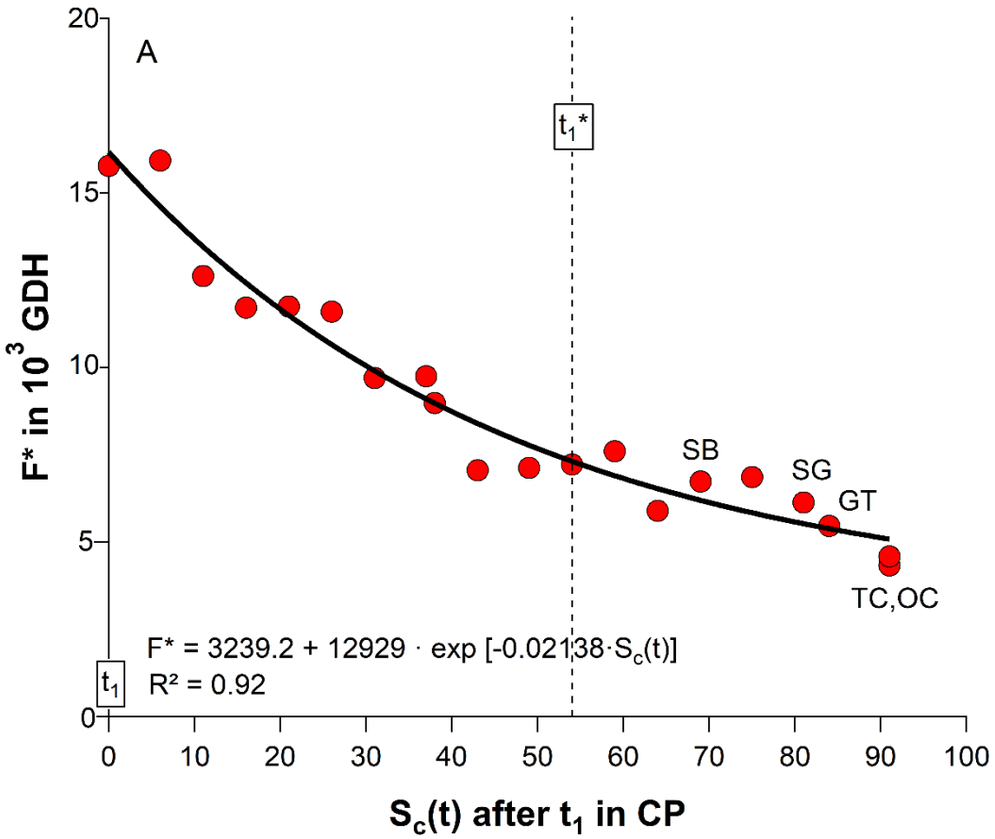


After t_1*, F* must decline due the start of bud development in the orchard!

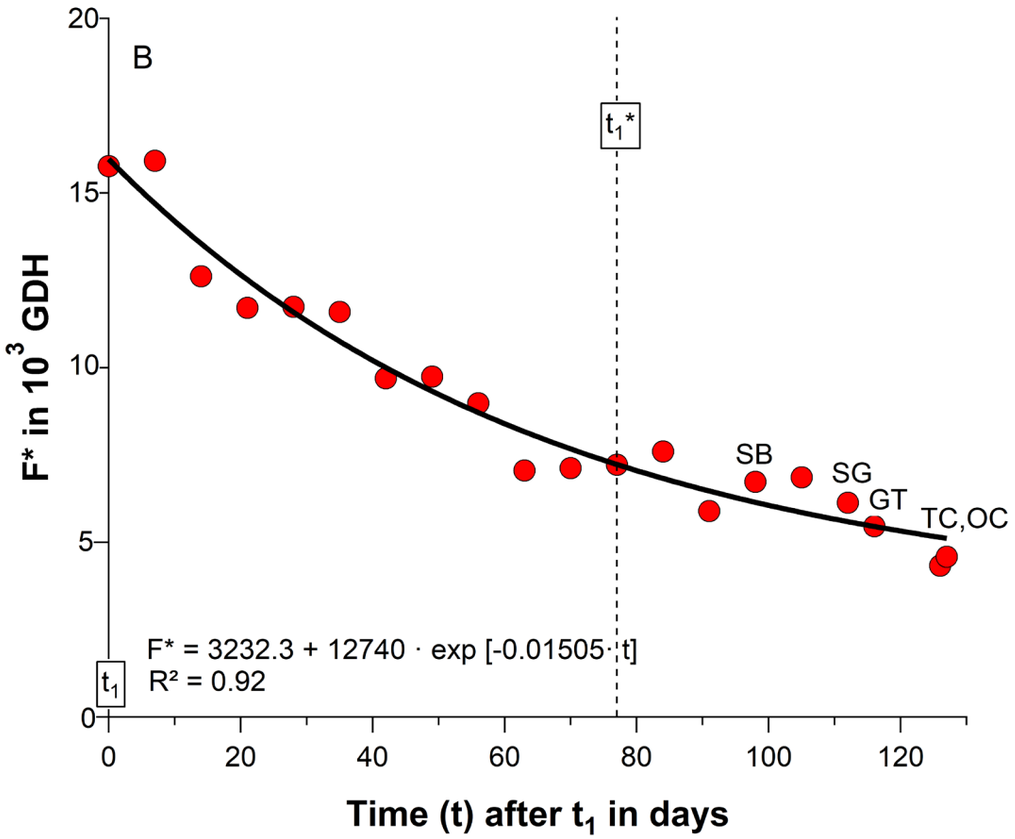
This result confirms many experimental studies, recently repeated by Kaufmann and Blanke, 2019; Menzel et al., 2020; Fadon et al., 2021. They all supposed that additional chilling during ecodormancy reduces F*.

The compensatory effect between chilling and forcing

F* is plotted against $S_c(t)$



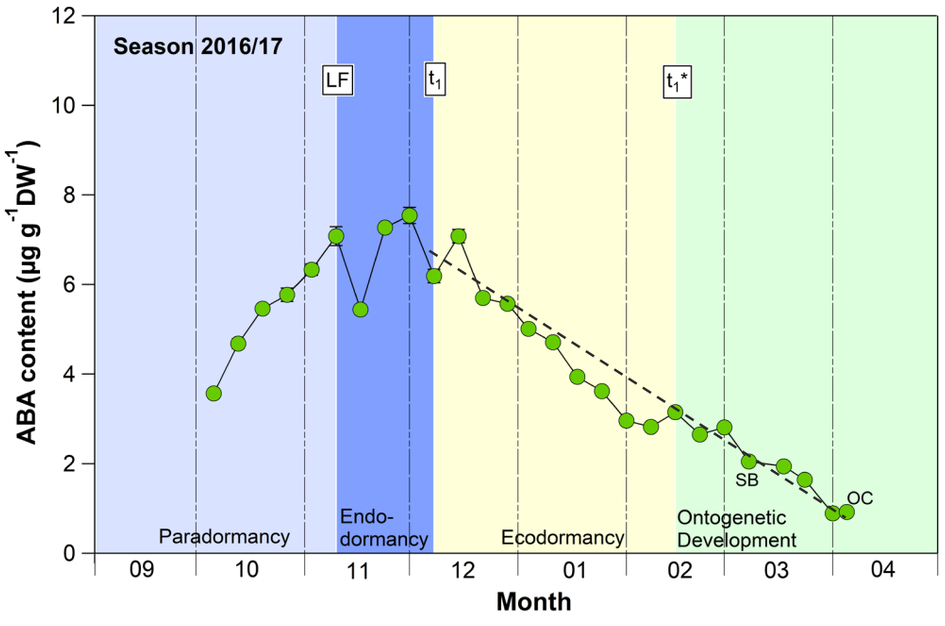
F* is plotted against t

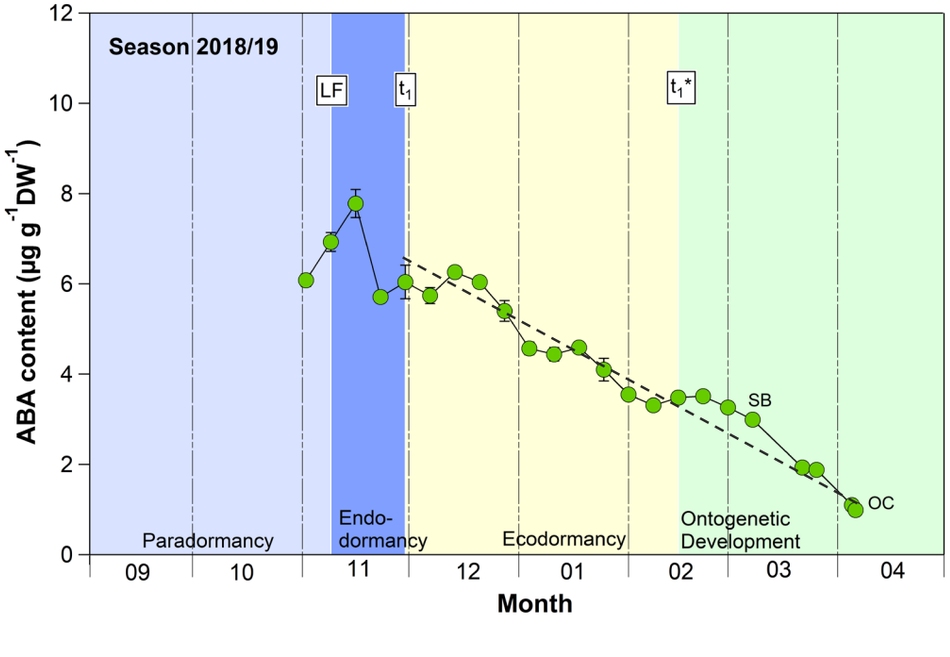


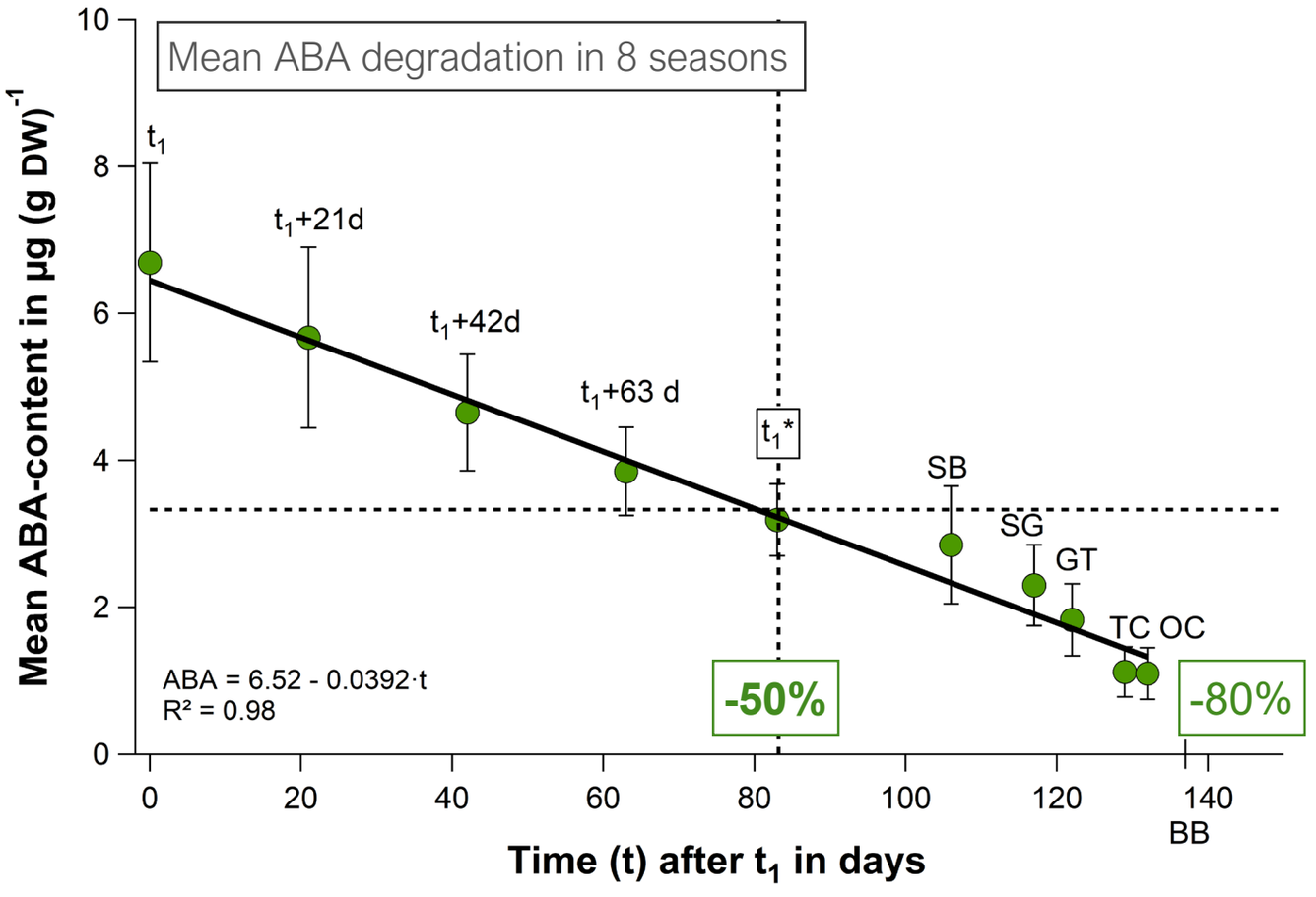
Q4: What else could reduce F*?

The role of ABA in buds

Meanwhile, physiological and transcriptomic studies have proposed the central role of ABA in the metabolic inhibition of bud ‘activity’ during winter rest*.

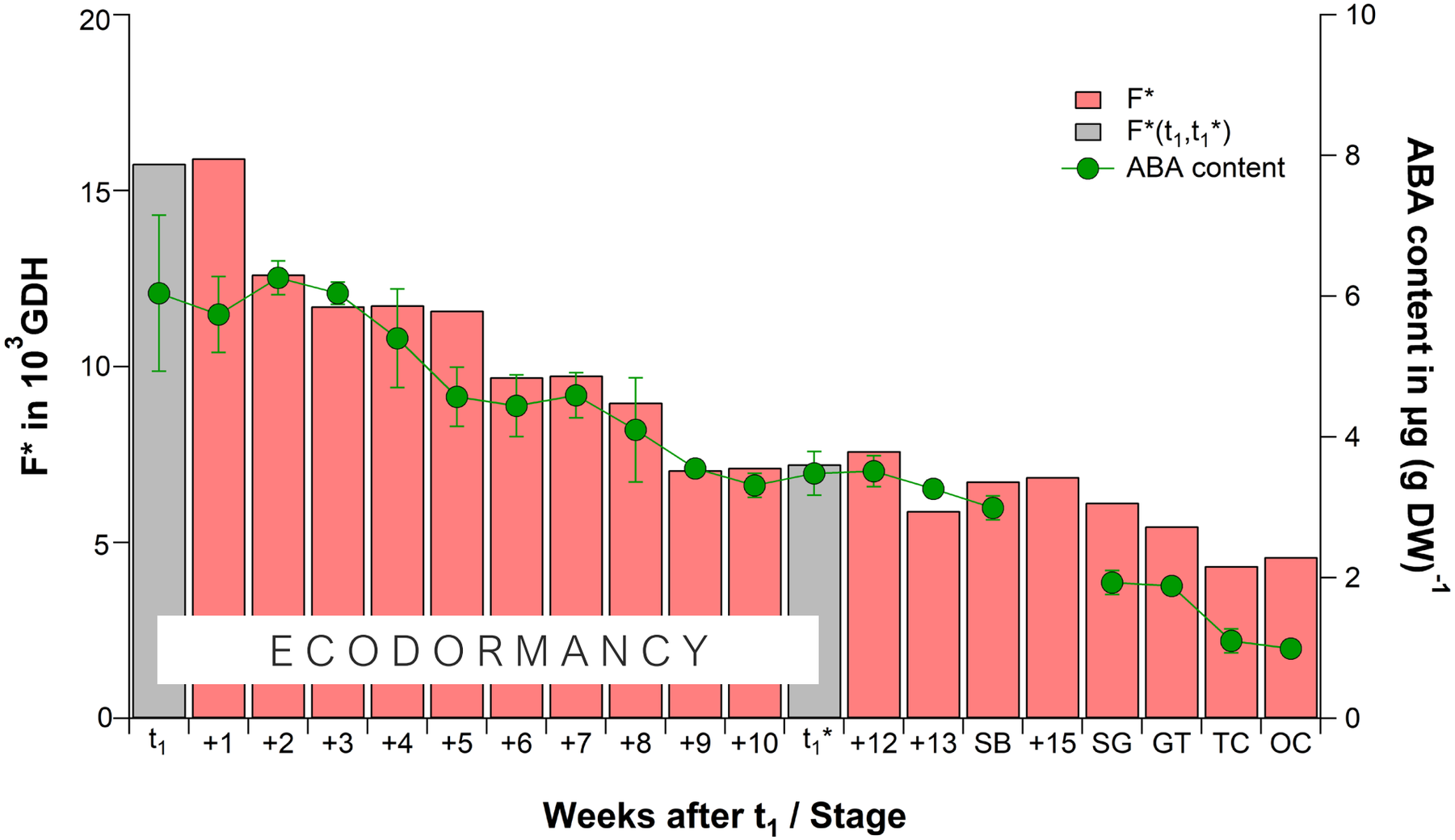






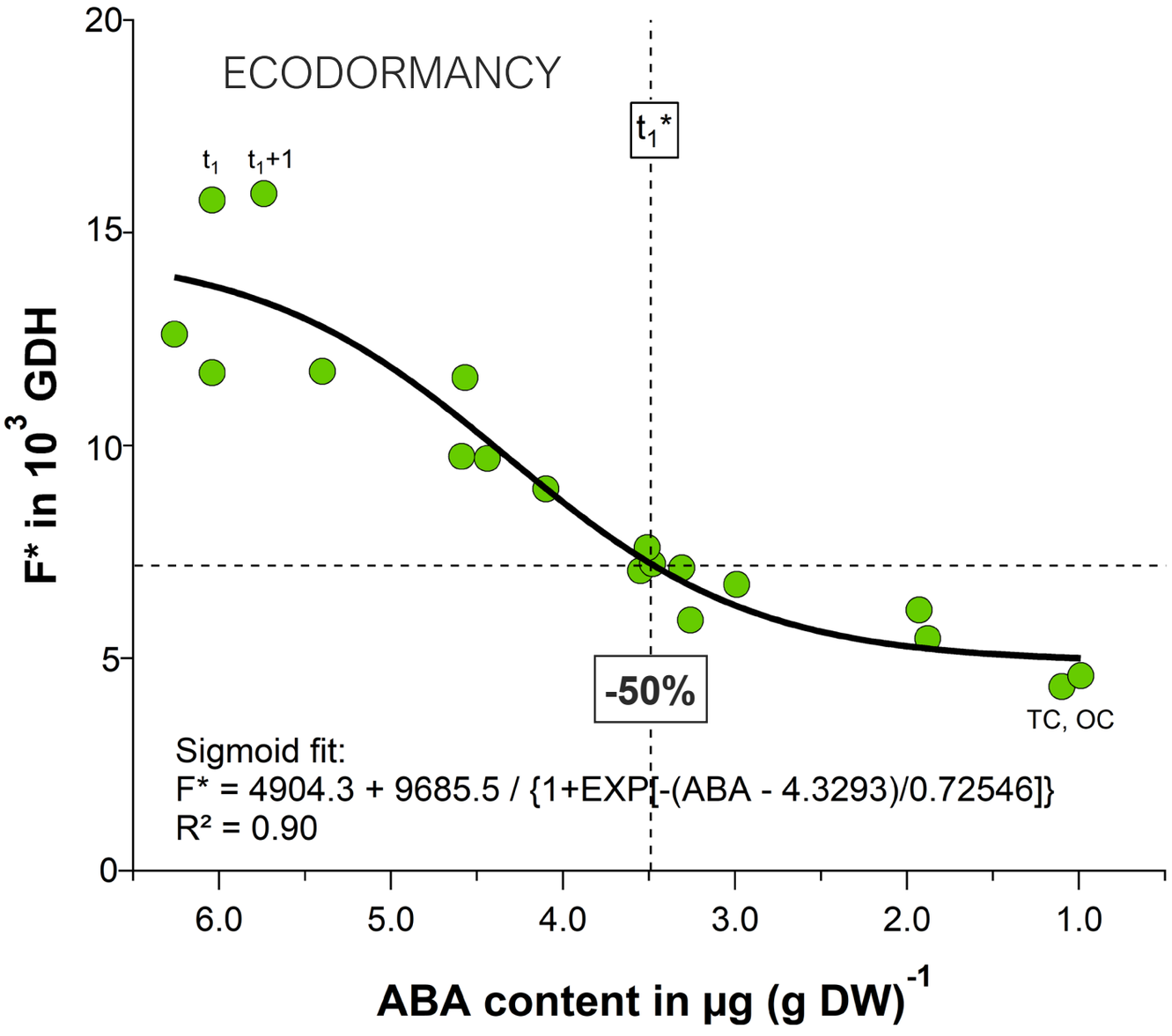
*Chmielewski et al., 2017; Chmielewski et al., 2018; Tylewicz et al., 2018; Liu and Sherif, 2019; Vimont et al., 2019, 2020; Yang et al., 2021, etc.

Relationship between ABA and forcing



ABA reduces F* after endodormancy release!

During ecodormancy both, ABA content and F* reduced significantly by ~50%!
There was no significant correlation between ABA and chilling in 8 seasons, $r(\Delta ABA, \Delta S_c(t)) = -0.15^{ns}$



Conclusion

According to these findings, **ecodormancy is a phase in which bud development is supressed by low temperatures AND a gradually declining ABA content in the buds**.
Both factors prevent premature bud burst and protect them from winter damages.

There is probably more than chilling and forcing ;-)!

Thank you very much for your attention!

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Progress in Phenological Modelling on the Basis of Metabolomic Approaches, 2014-2017 (CH 228/5-1)
Profiling as Method to Identify Relevant Metabolites for Phenological Modelling Purposes, 2019-2022 (CH 228/7-1)