Contribution of internal stresses release to the drying shrinkage of wood

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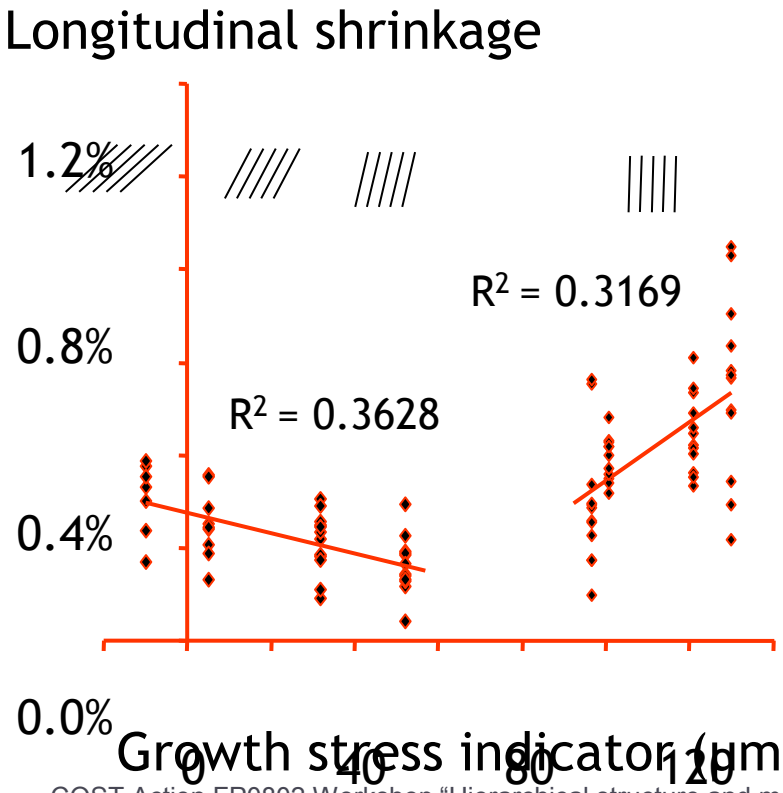
Paradoxical shrinkage in TW

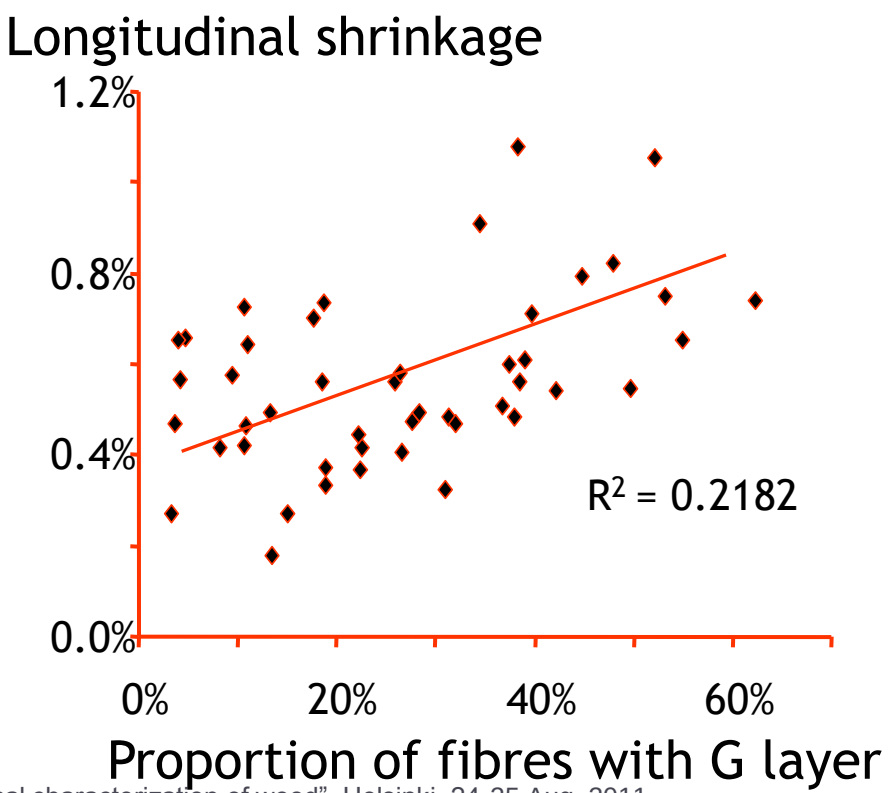
- Macroscopic level

– relation between L shrinkage and growth stresses

– paradoxal behaviour in tension wood

- the role of the G-layer in this behaviour

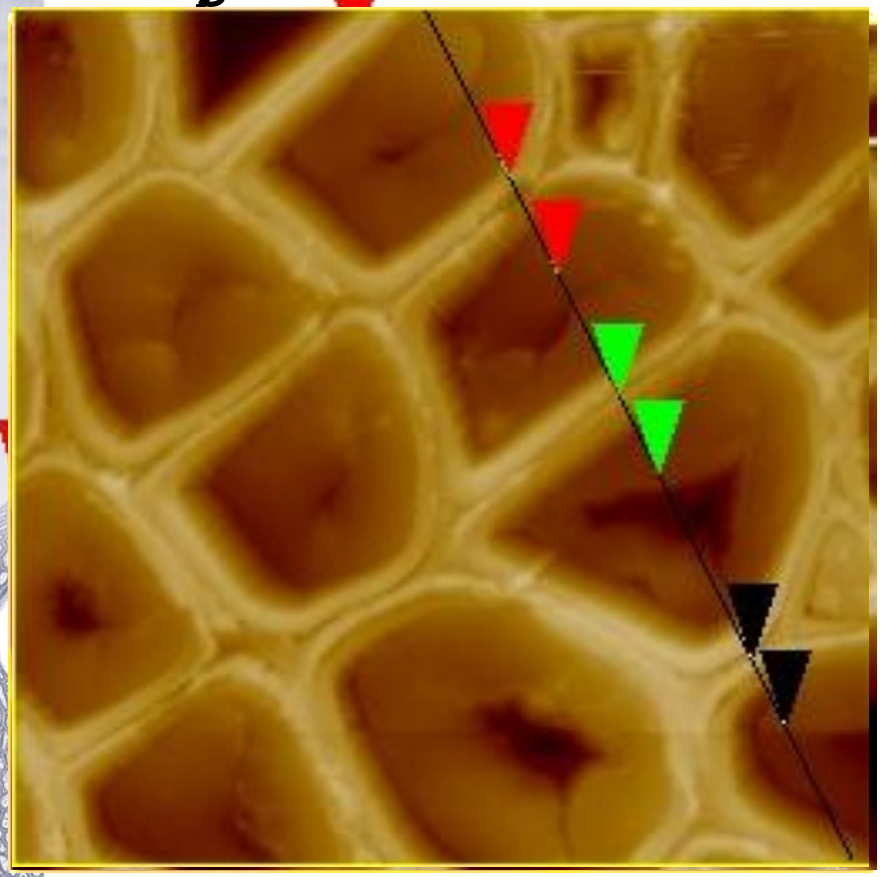


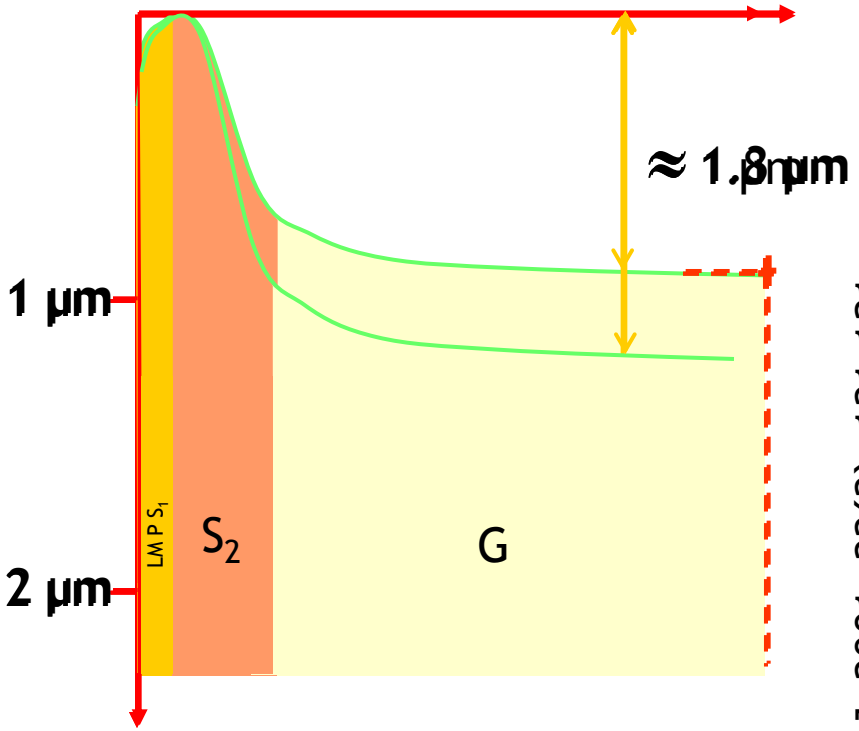


Holzforschung 2003, 57(2): 189-195.

Paradoxical behaviour in TW

- Microscopic level



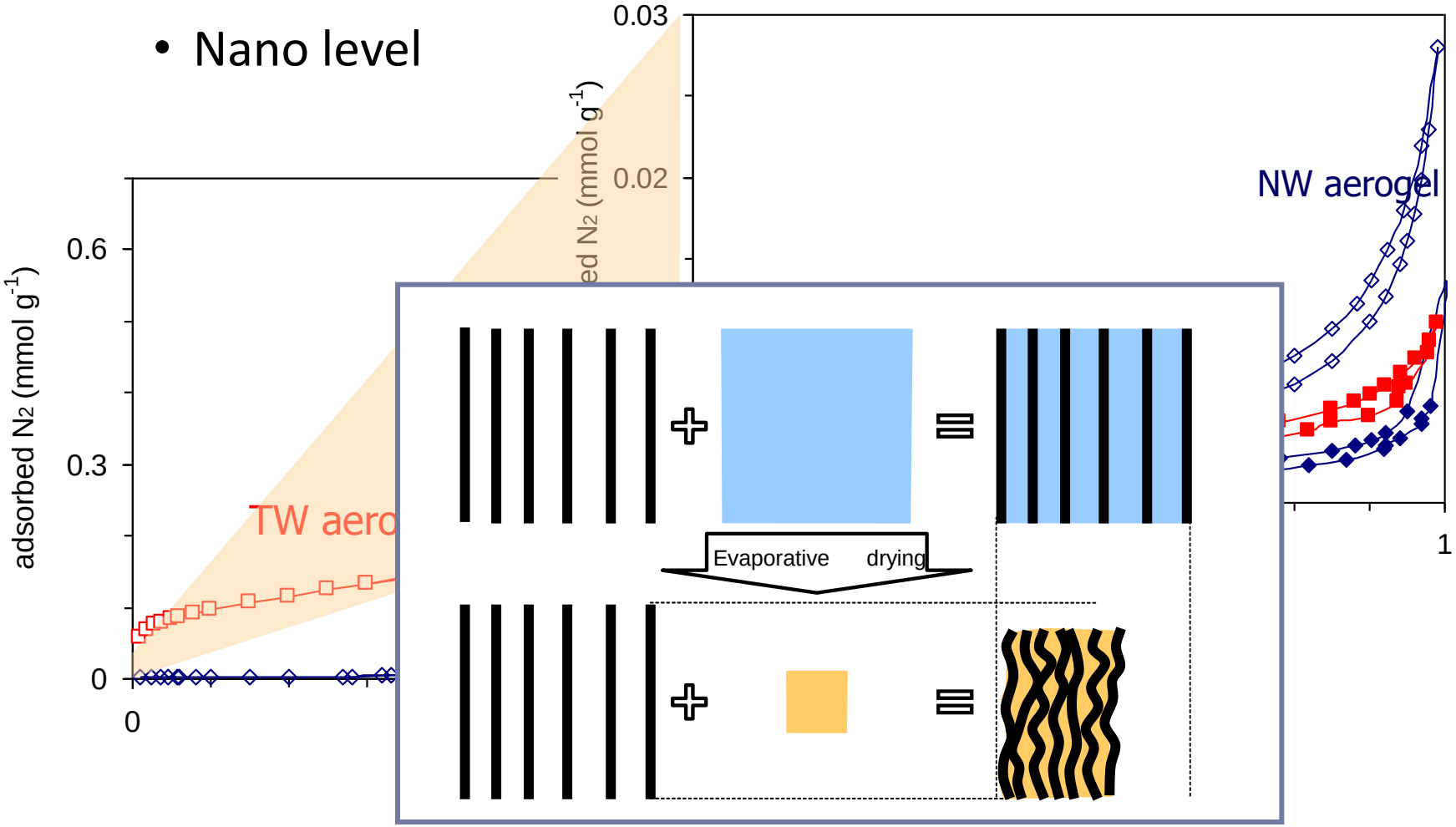


IAWA J. 2001, 22(2): 121-131.

G-layer itself shrink longitudinally during drying

Paradoxical behaviour in TW

- Nano level



Biomacromol. 2008. 9 (2), 494-498.

Gel collapse is the driving force of G-layer drying shrinkage

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Any other contribution?

- Tension wood without G-layer have high L shrinkage (Ruelle 2010)
- Observation of shrinkage with solvent (Chang et al.) without collapse of G-layer porosity

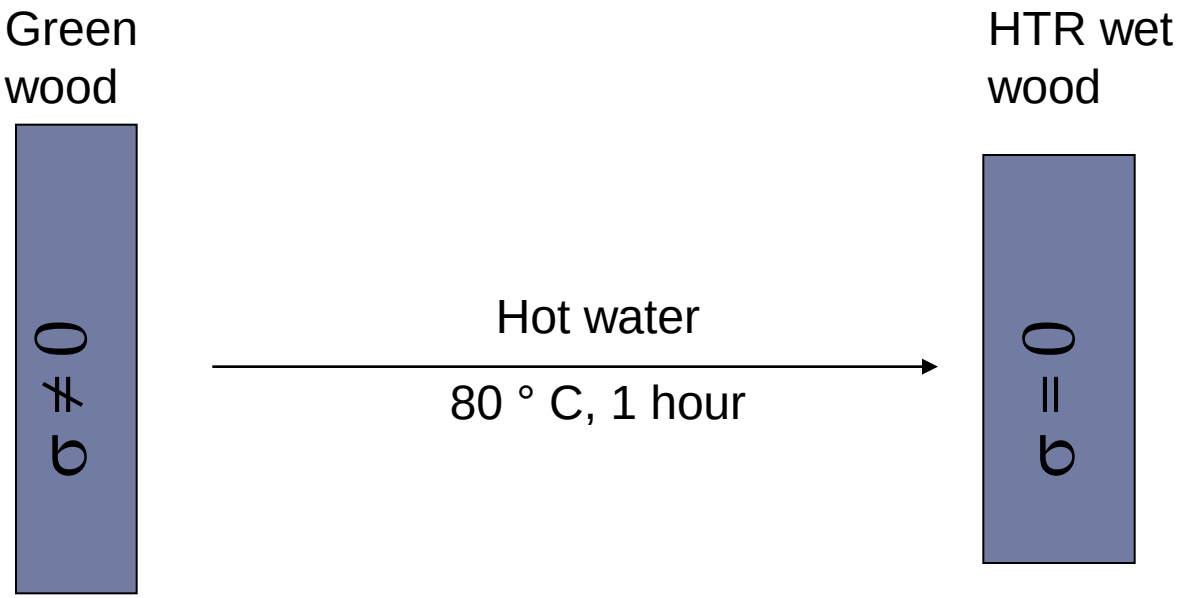
→Experiments on the contribution of stress release to the drying shrinkage

Use of hygrothermal treatment to release stress (hygro-thermal recovery, HTR)

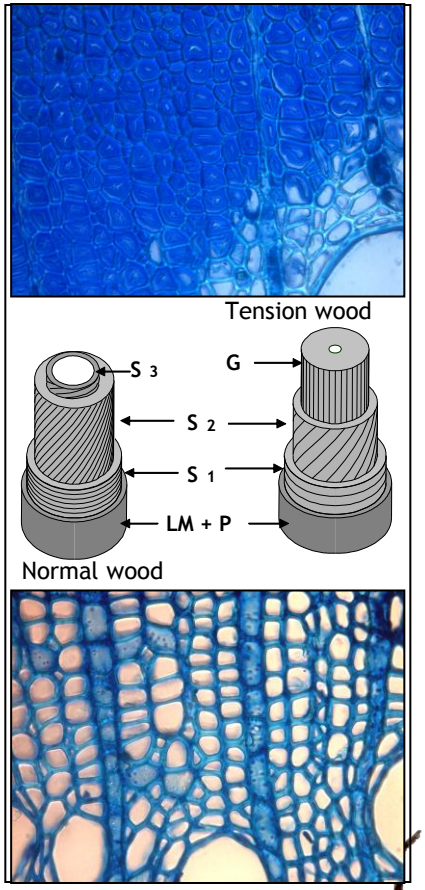
Hygro-thermal recovery (HTR)

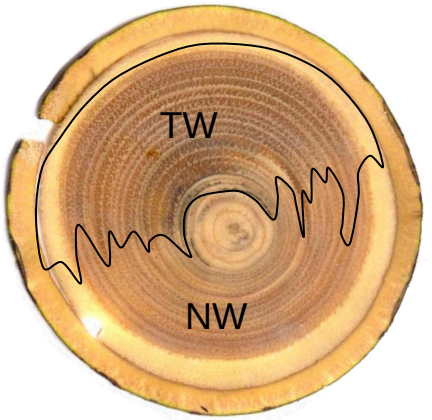
Use of hygrothermal treatment to release stress

Kübler 1987; Chafe 1992; Gril and Thibaut 1994; Jullien and Gril 1996



Material & methods

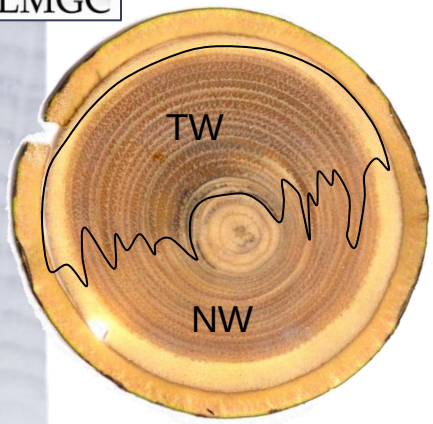


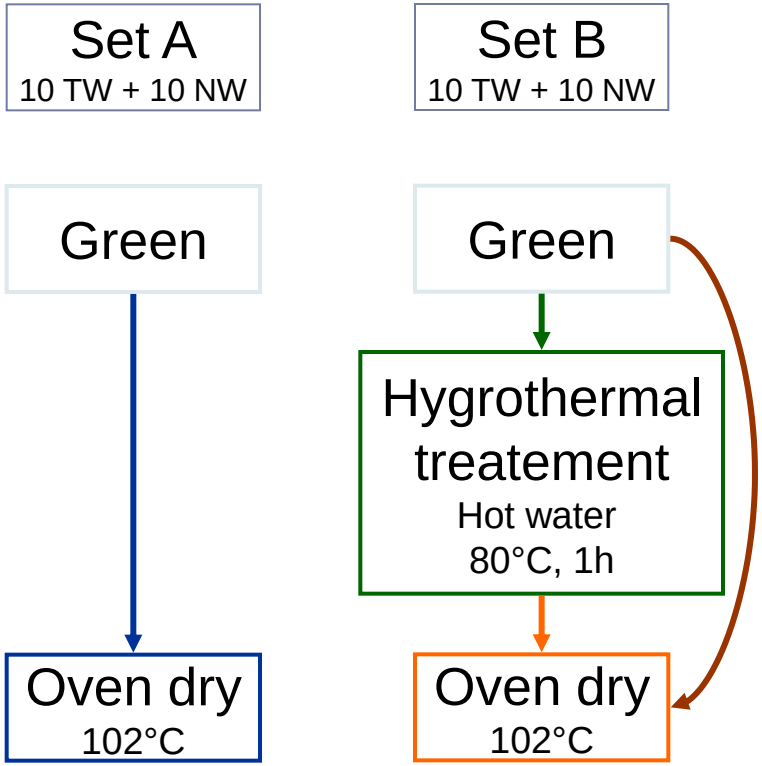


Chestnut
Castanea sativa Mill.

20 samples tension wood (TW)
20 samples normal wood (NW)
R= 2 mm T= 10 mm L= 60 mm

Material & methods

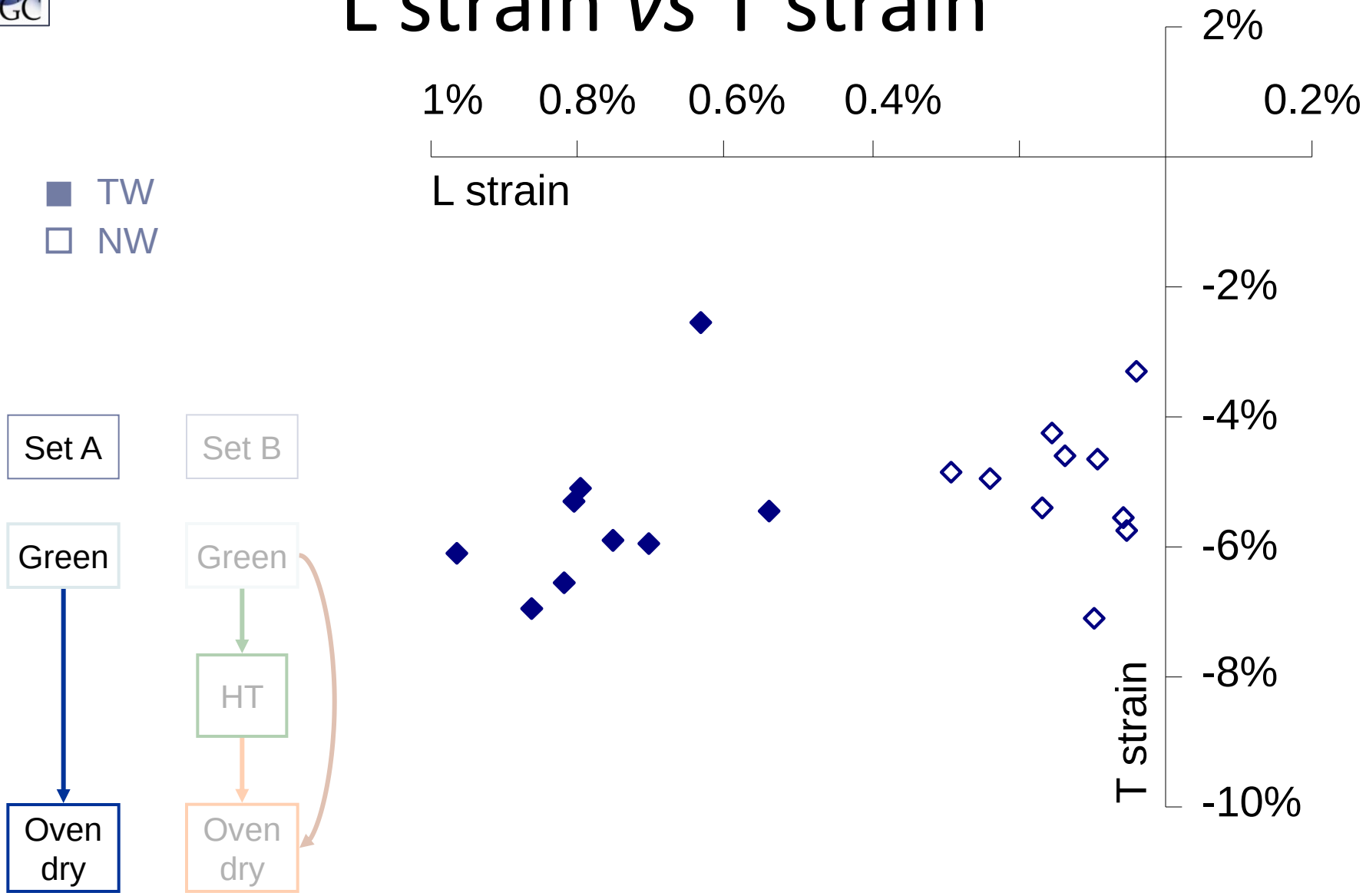




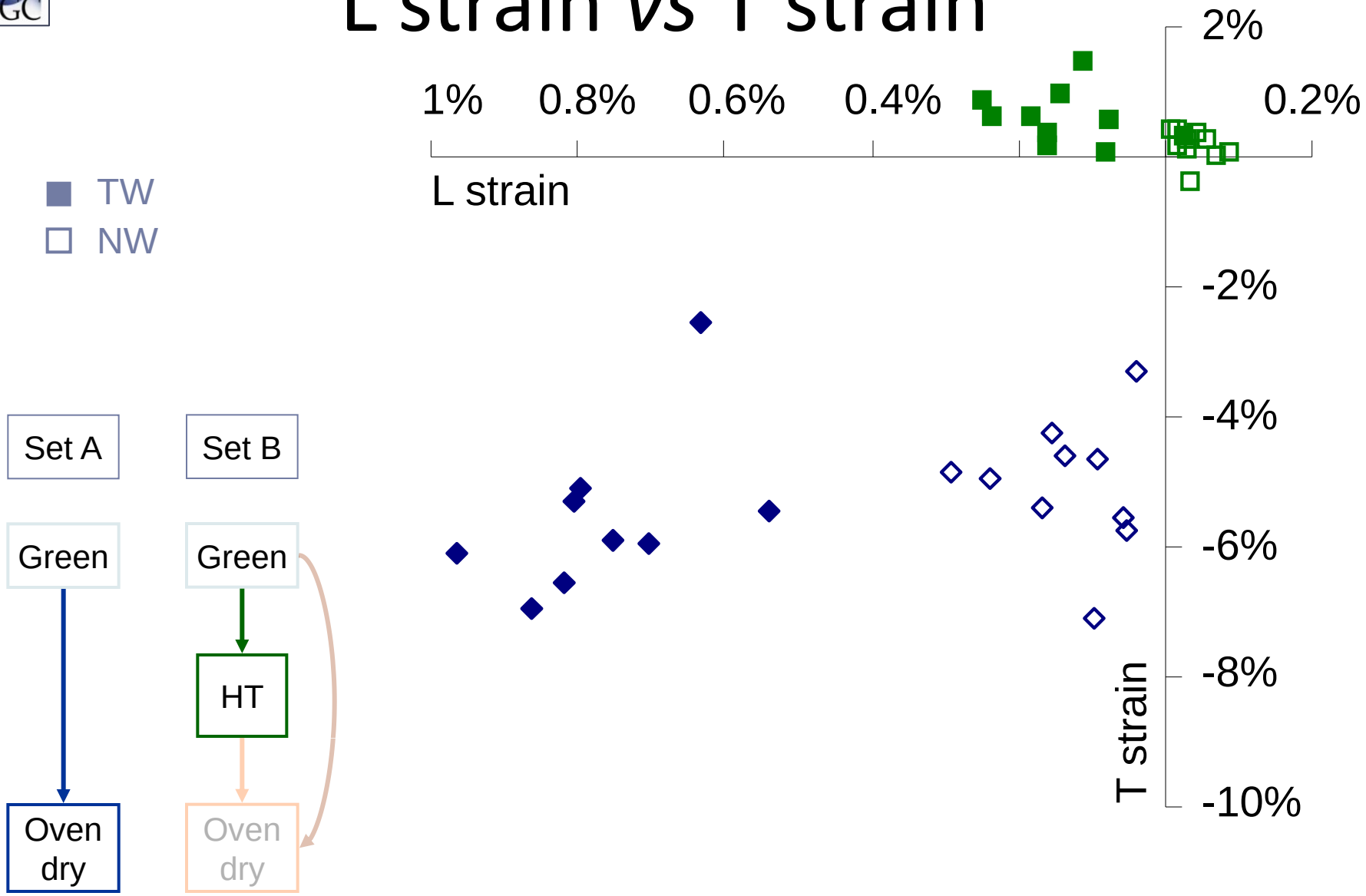
Macroscopic strains defined as:

- set A : - Total strain: $\varepsilon_{tot} = (D_{Oven\text{-}dry} - D_{green})/D_{green}$
- set B : - HT strain: $\varepsilon_{HT} = (D_{HT} - D_{green})/D_{green}$
  - Pure drying strain: $\varepsilon_{PD} = \varepsilon_{tot} - \varepsilon_{HT}$

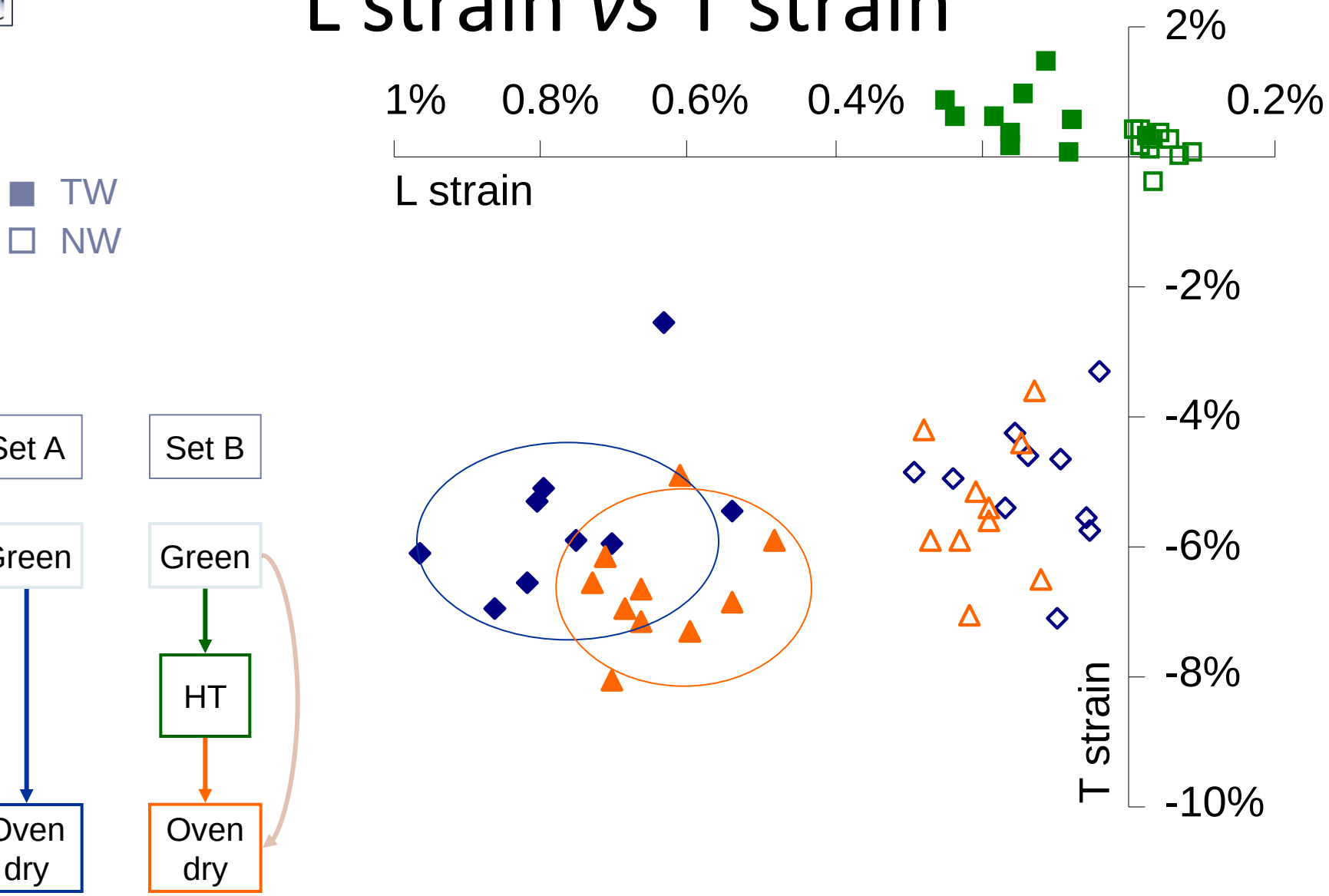
L strain *vs* T strain



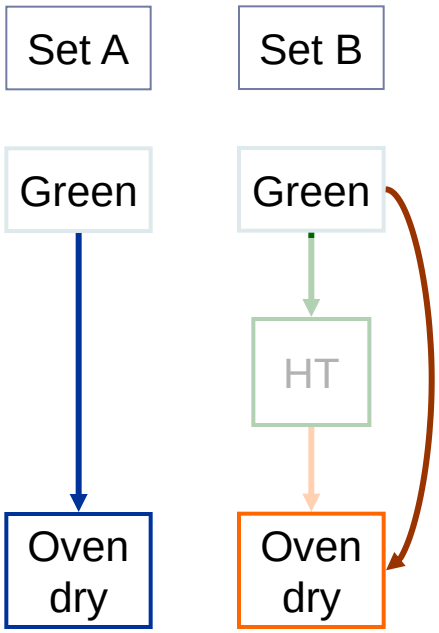
L strain *vs* T strain

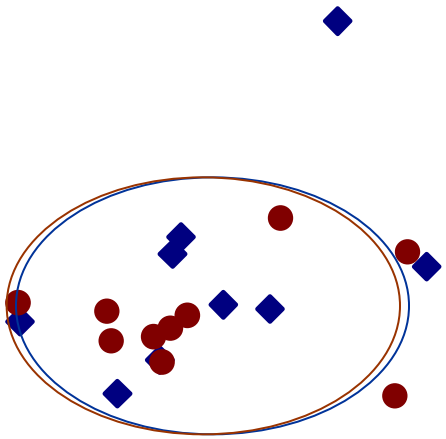


L strain *vs* T strain

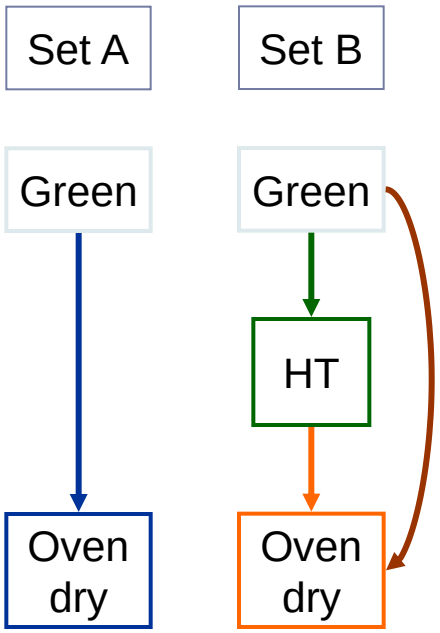


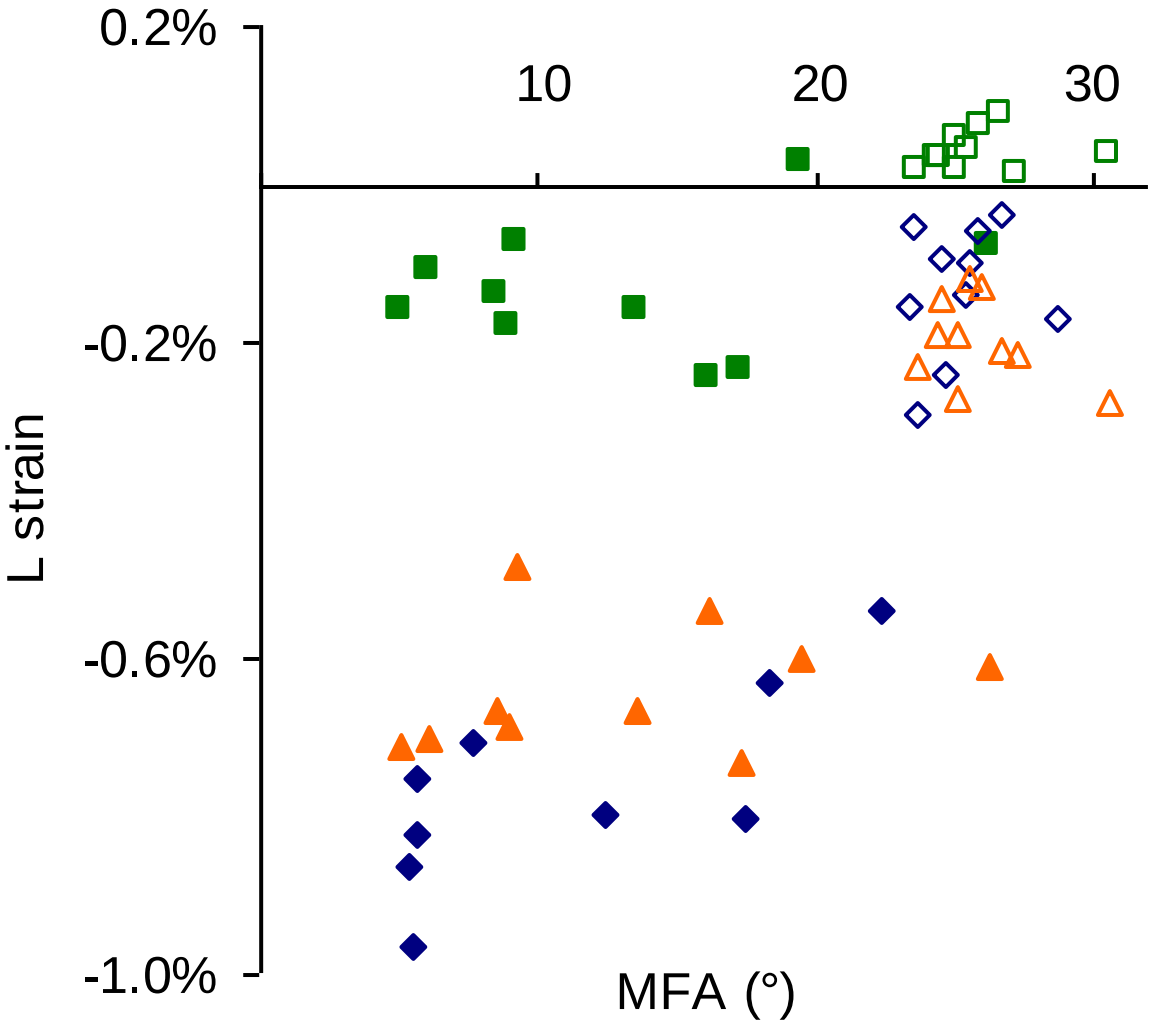
L strain *vs* T strain



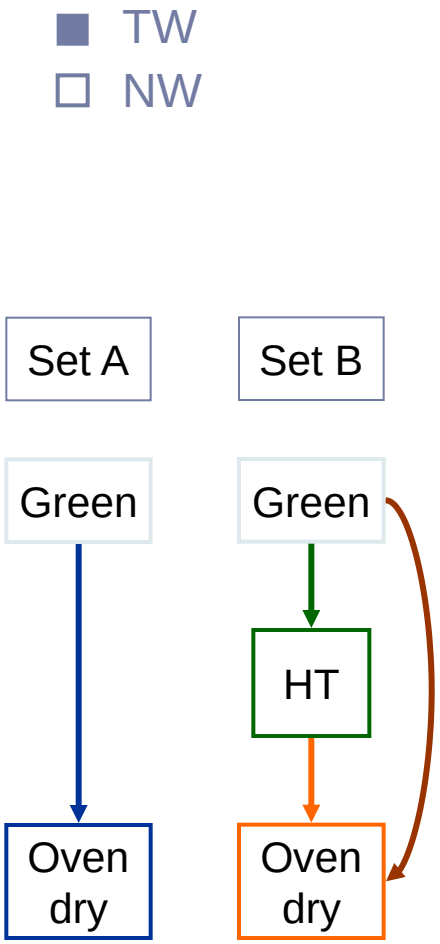


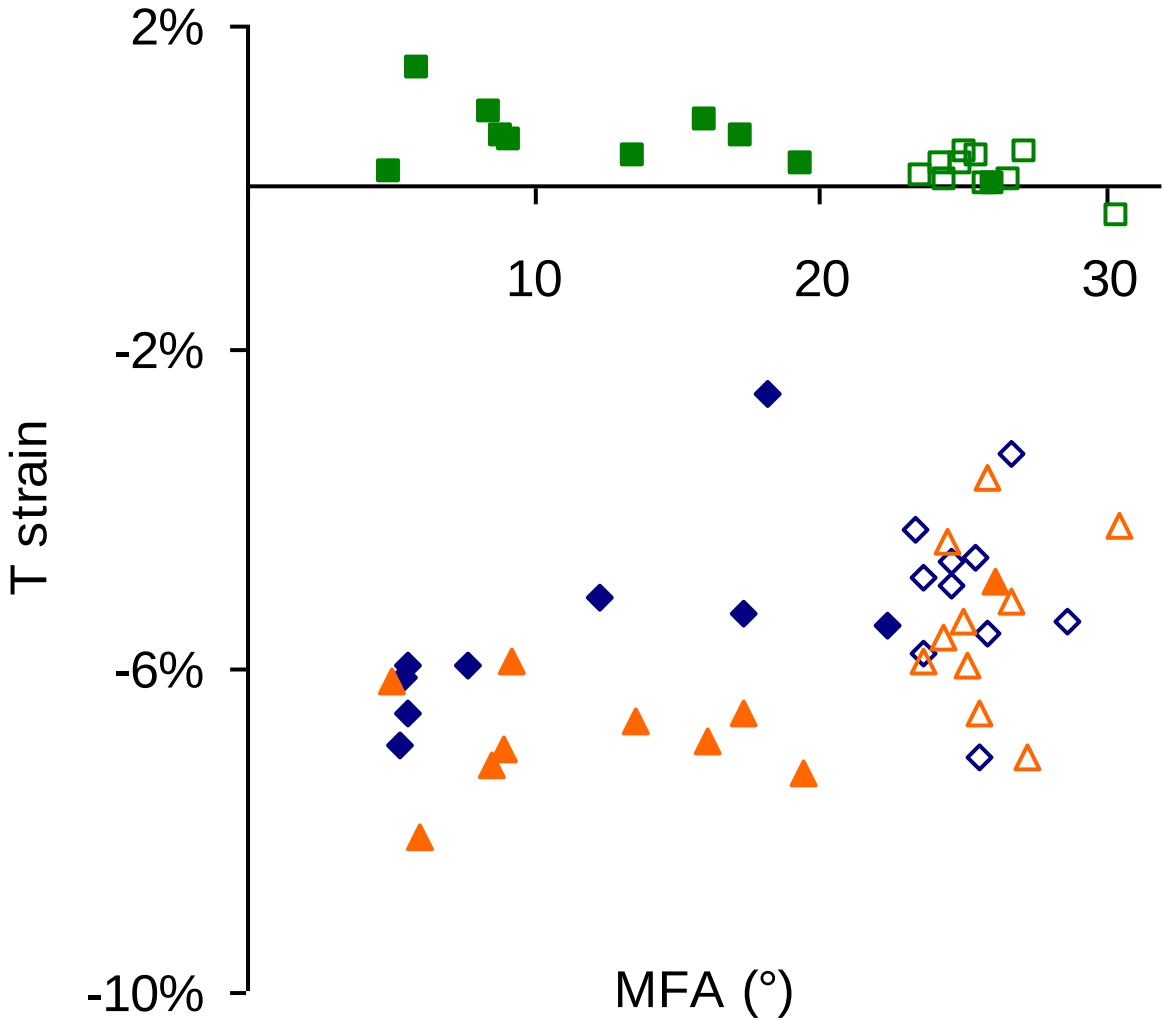
L strain *vs* MFA



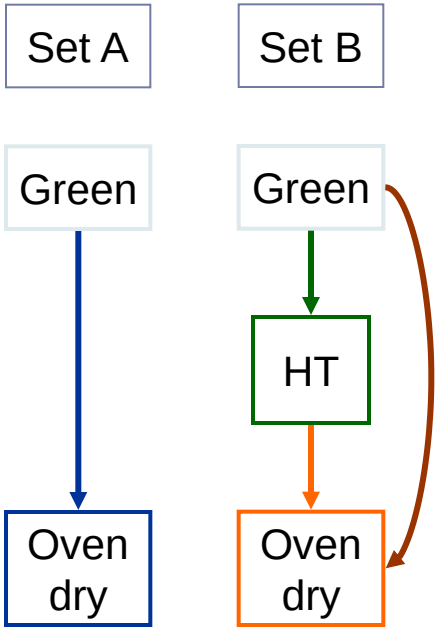


T strain *vs* MFA





Mean strain and confidence interval at 95%

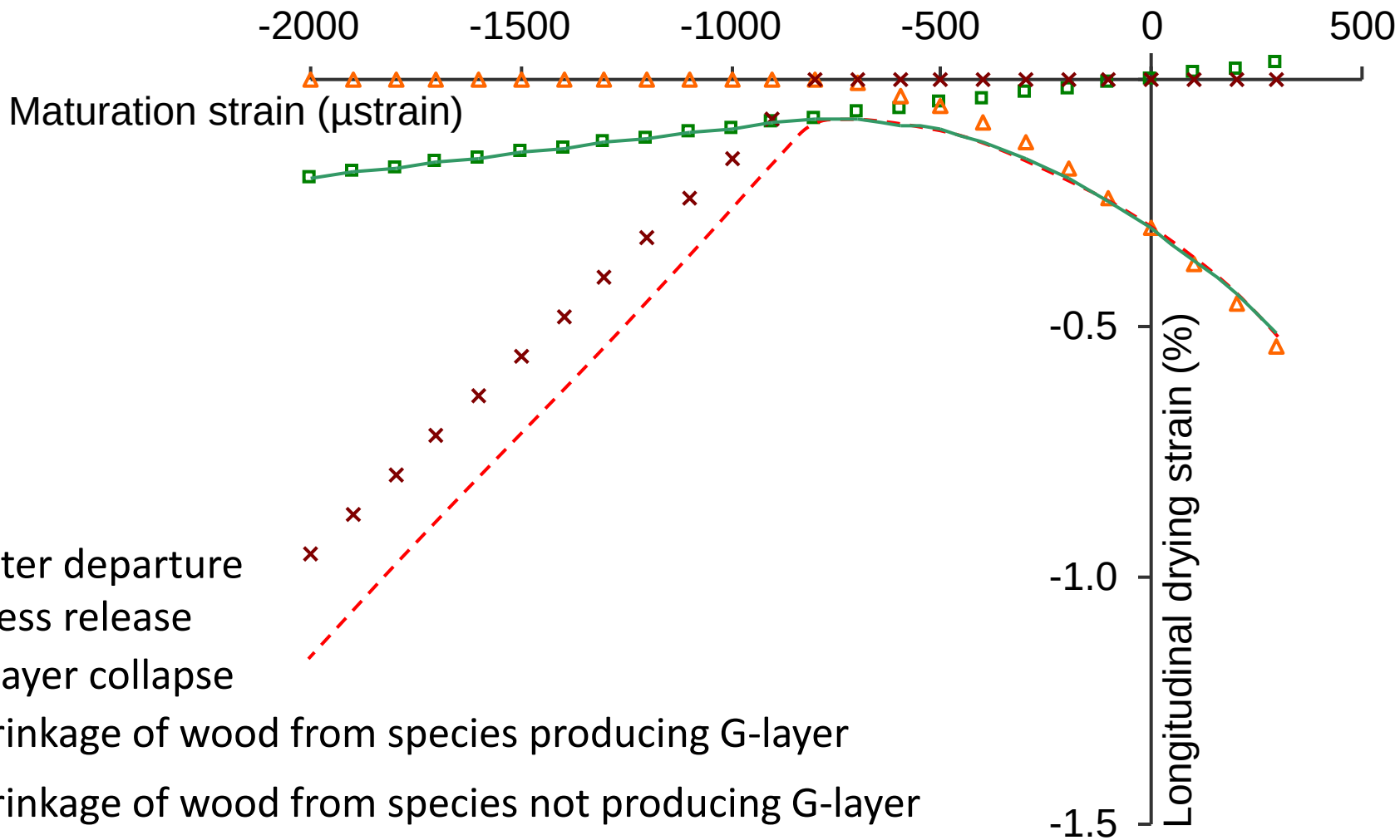


L	ε^{LA}_{tot} (%)	ε^{LB}_{HT} (%)	ε^{LB}_{PD} (%)	ε^{LB}_{tot} (%)
TW	$-0.76^{\pm 0.08}$	$-0.14^{\pm 0.05}$	$-0.64^{\pm 0.05}$	$-0.78^{\pm 0.08}$
NW	$-0.13^{\pm 0.05}$	$0.04^{\pm 0.02}$	$-0.20^{\pm 0.03}$	$-0.16^{\pm 0.04}$

T	ε^{TA}_{tot} (%)	ε^{TB}_{HT} (%)	ε^{TB}_{PD} (%)	ε^{TB}_{tot} (%)
TW	$-5.53^{\pm 0.82}$	$0.58^{\pm 0.26}$	$-6.64^{\pm 0.53}$	$-6.06^{\pm 0.38}$
NW	$-5.03^{\pm 0.62}$	$0.15^{\pm 0.15}$	$-5.37^{\pm 0.66}$	$-5.22^{\pm 0.55}$

Both in L and T, both in NW and TW, internal stress release contributes to drying strain

Schematic model of the cumulative contributions to longitudinal shrinkage



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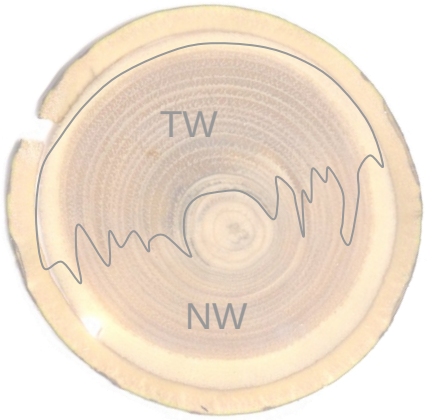
Conclusion

- The internal stress release contributes to drying strain of wood
  - both in L and T directions
  - both in NW and TW

- It could explain the high longitudinal shrinkage of tension wood without G-layer



Thank you.

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P. Cabrolier

B. Clair. accepted 2011. Evidence that release of internal stress contributes to drying strains of wood. *Holzforschung*


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