The intra-annual density fluctuation as an acclimation response to water use efficiency of tracheids in *Pinus sylvestris* L.

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Marek Fajstavr

WO1 - *Monitoring the xylem and phloem formation of LKWS*

- From microcores to microscopes

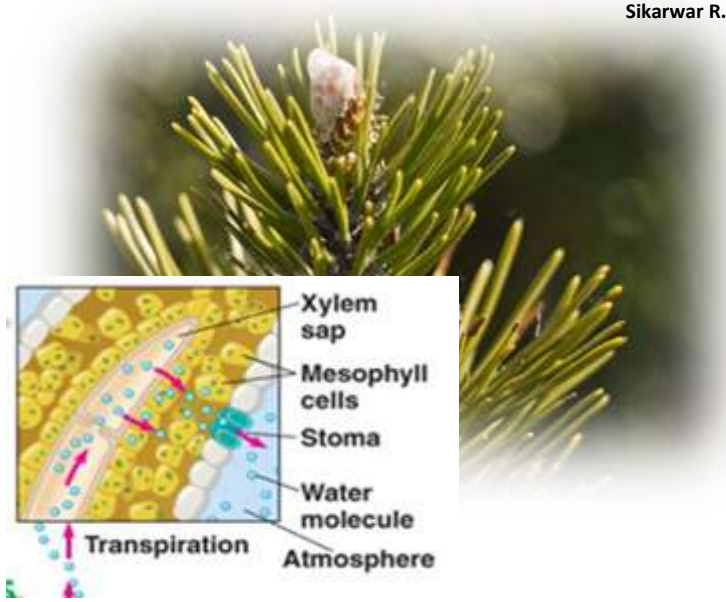
CzechGlobe

Mendel University in Brno

Faculty of Forestry and Wood Technology

1. INTRODUCTION
- Water status inside tree

Transpiration
=> Sap flow



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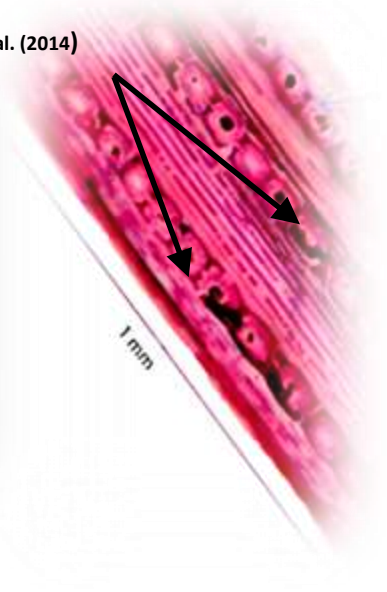
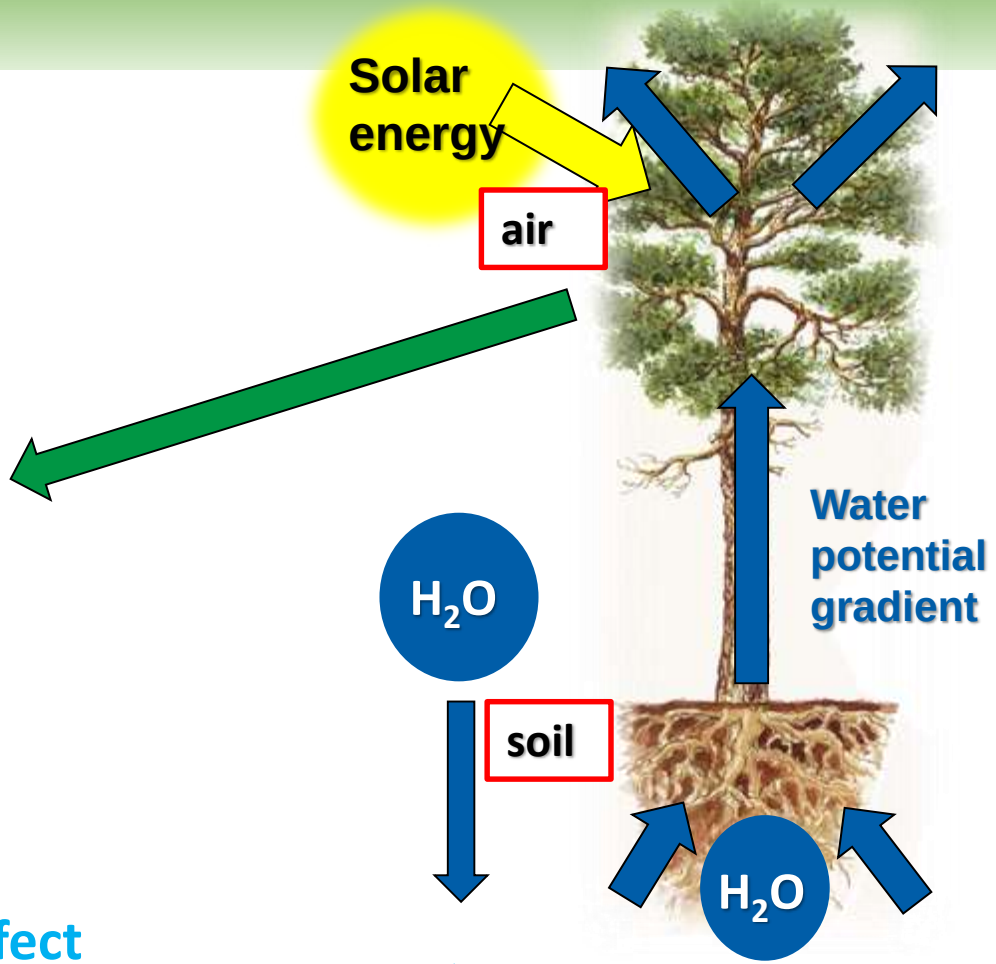
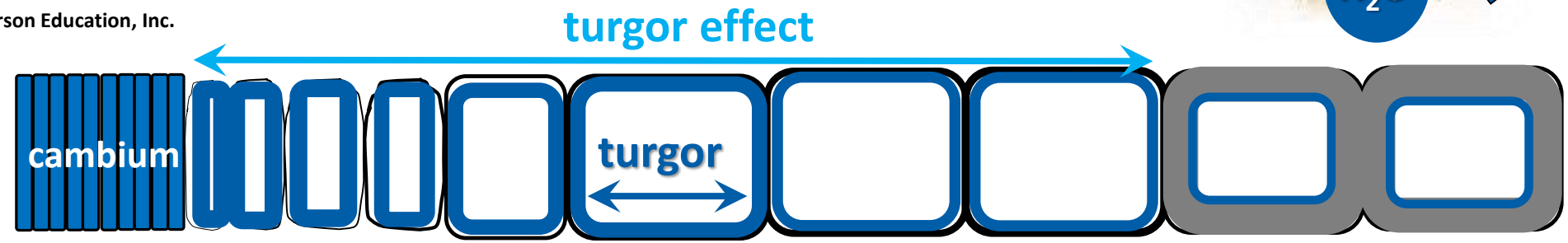
Stomatal rows

Sikarwar R. et al. (2014)





Annual xylem cell formation:



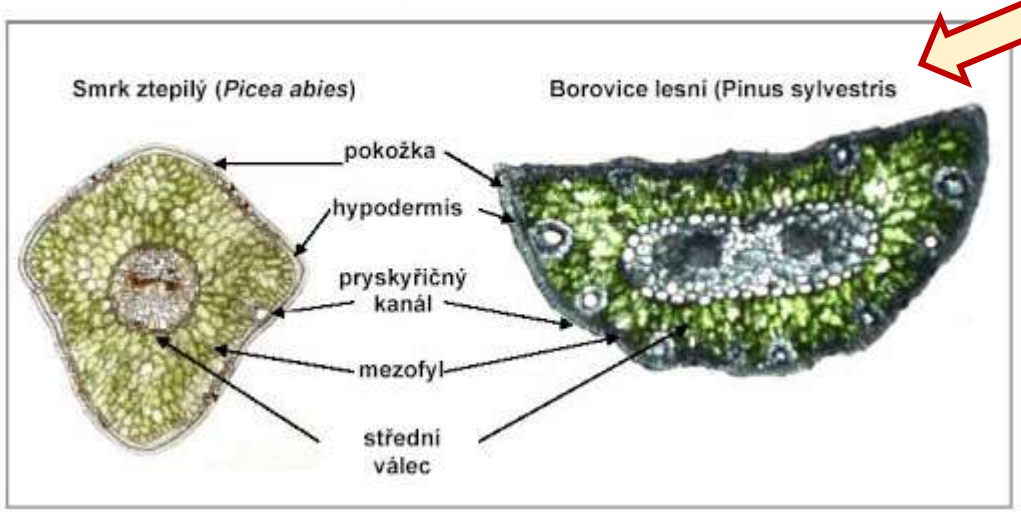
1. INTRODUCTION
- Carbon fixation and metabolic transformation

$6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

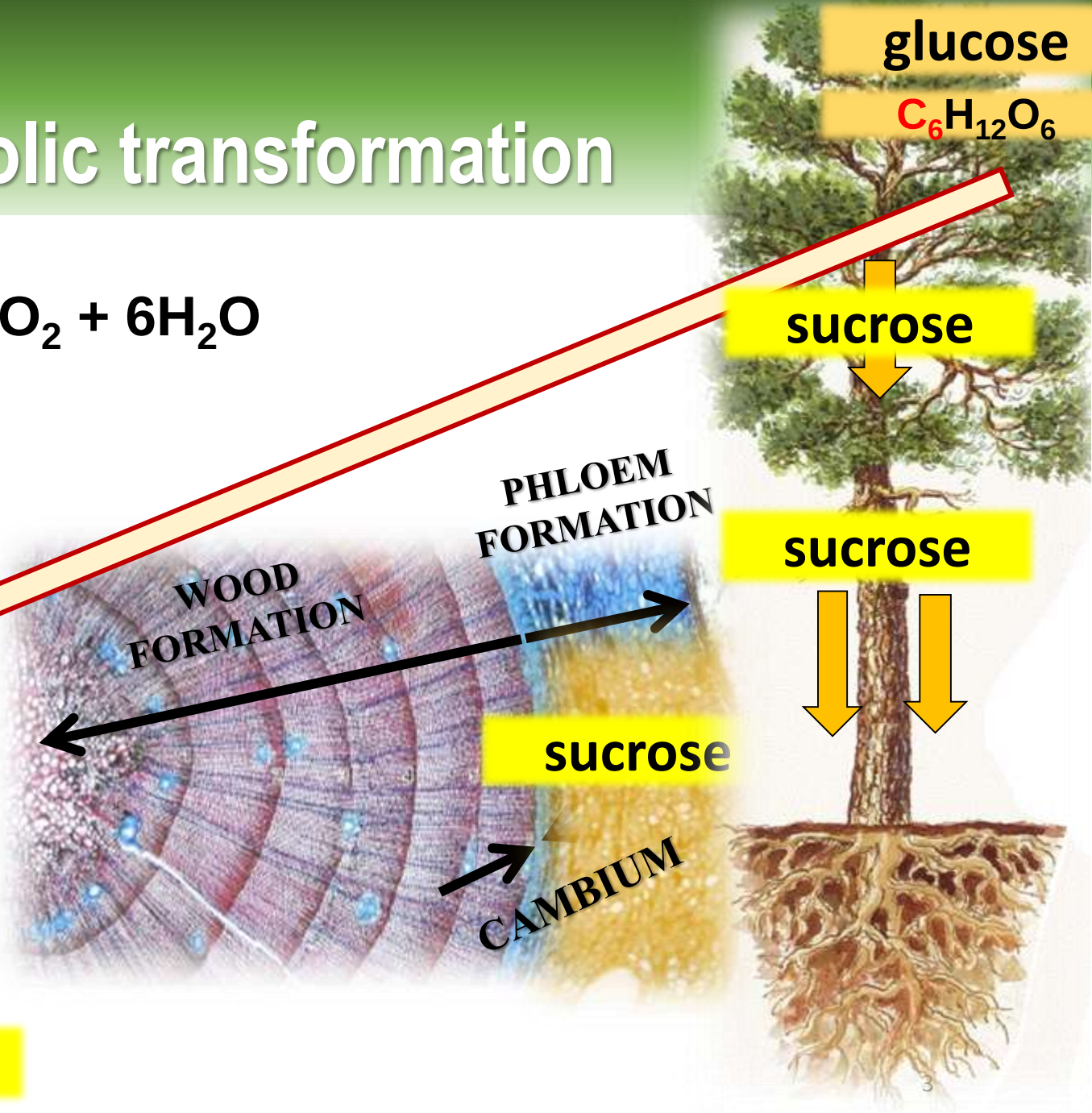
glucose

$C_6H_{12}O_6$

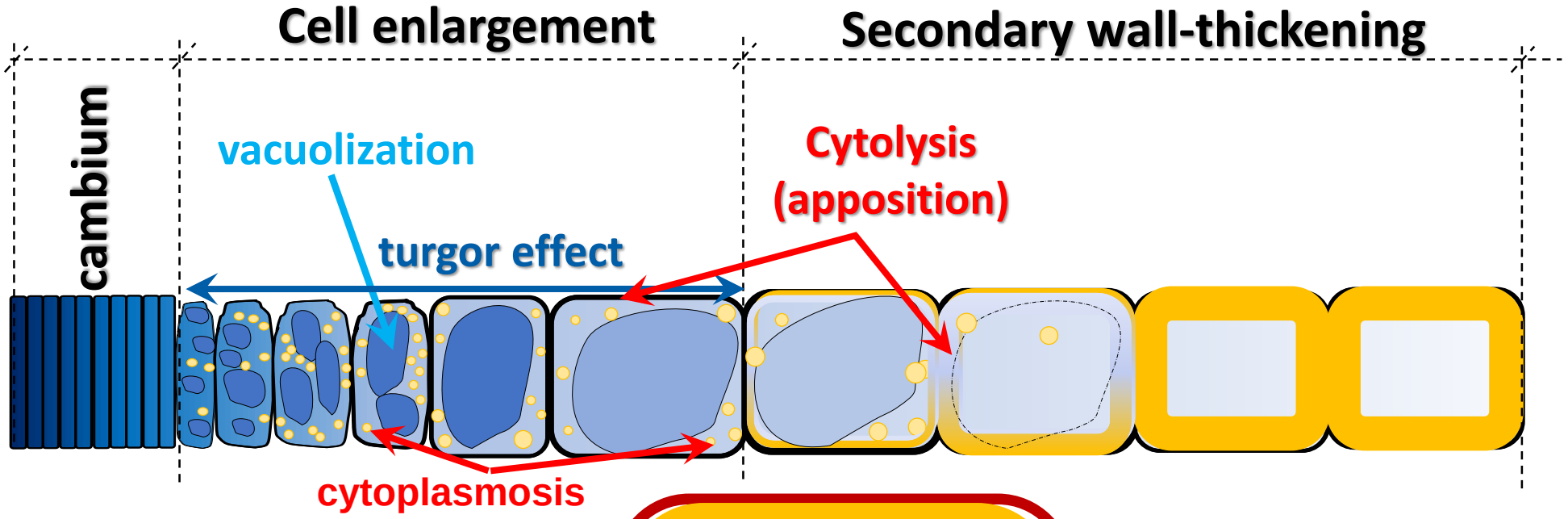
Anatomická stavba jehlice, celkový pohled na příčný řez



glucose → **sucrose**

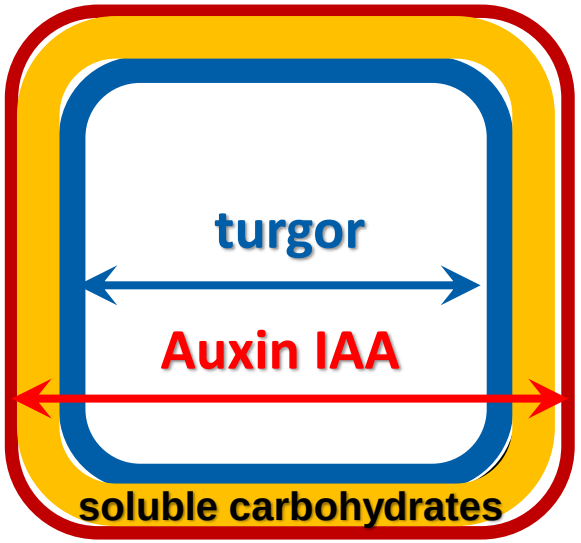


1. INTRODUCTION
- Cell formation and cell-wall material deposition



glucose + fructose

= soluble carbohyrates

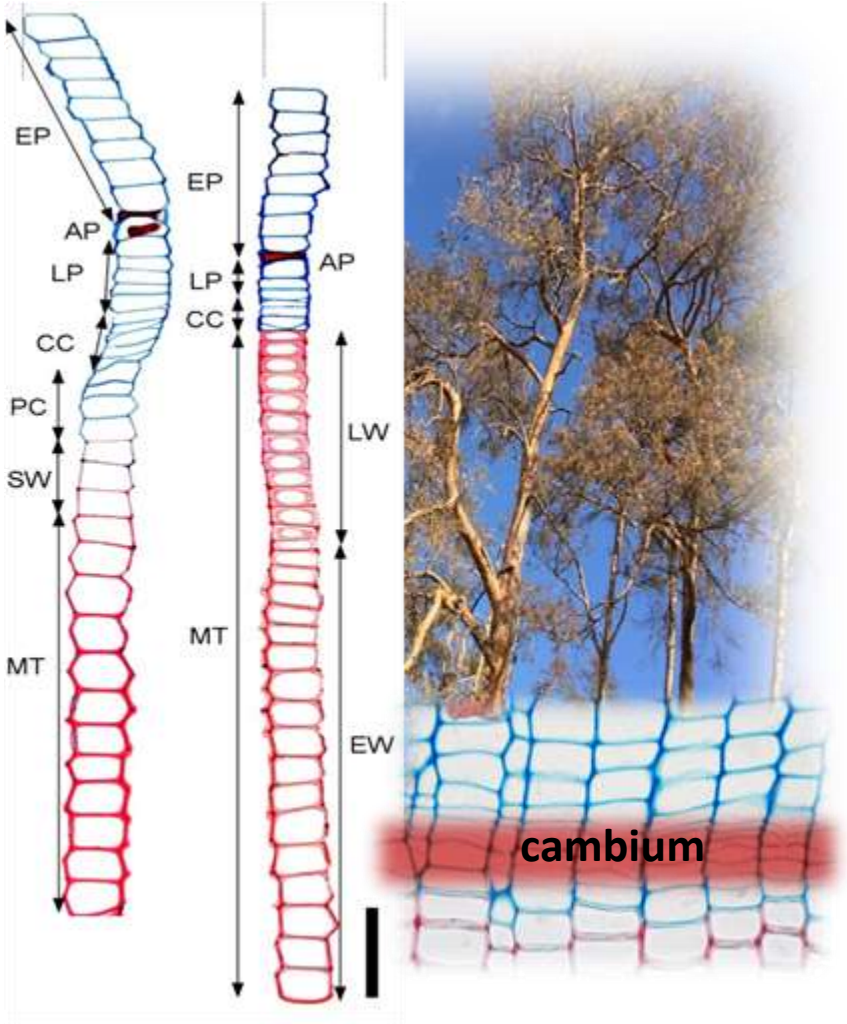


Schematic illustration of influence intensity:

Cytoplasmosis occurence

Tree water effect

1. INTRODUCTION - MAIN HYPOTHESES



Dry periode:

- non precipitation episode
- heat waves (daily maximum ≥ 5°C above long-term average maximum)
- Relative air humidity (< 70 %)

Hypotheses:

- Dry periode => affected pattern of precipitation distrubution
- **=> reducing sap flow** intensity

- Reduced sap flow **=> sensitive cambial responses =>** affected **daily rate** of forming cells
- **=> adjusted tracheid morphology**

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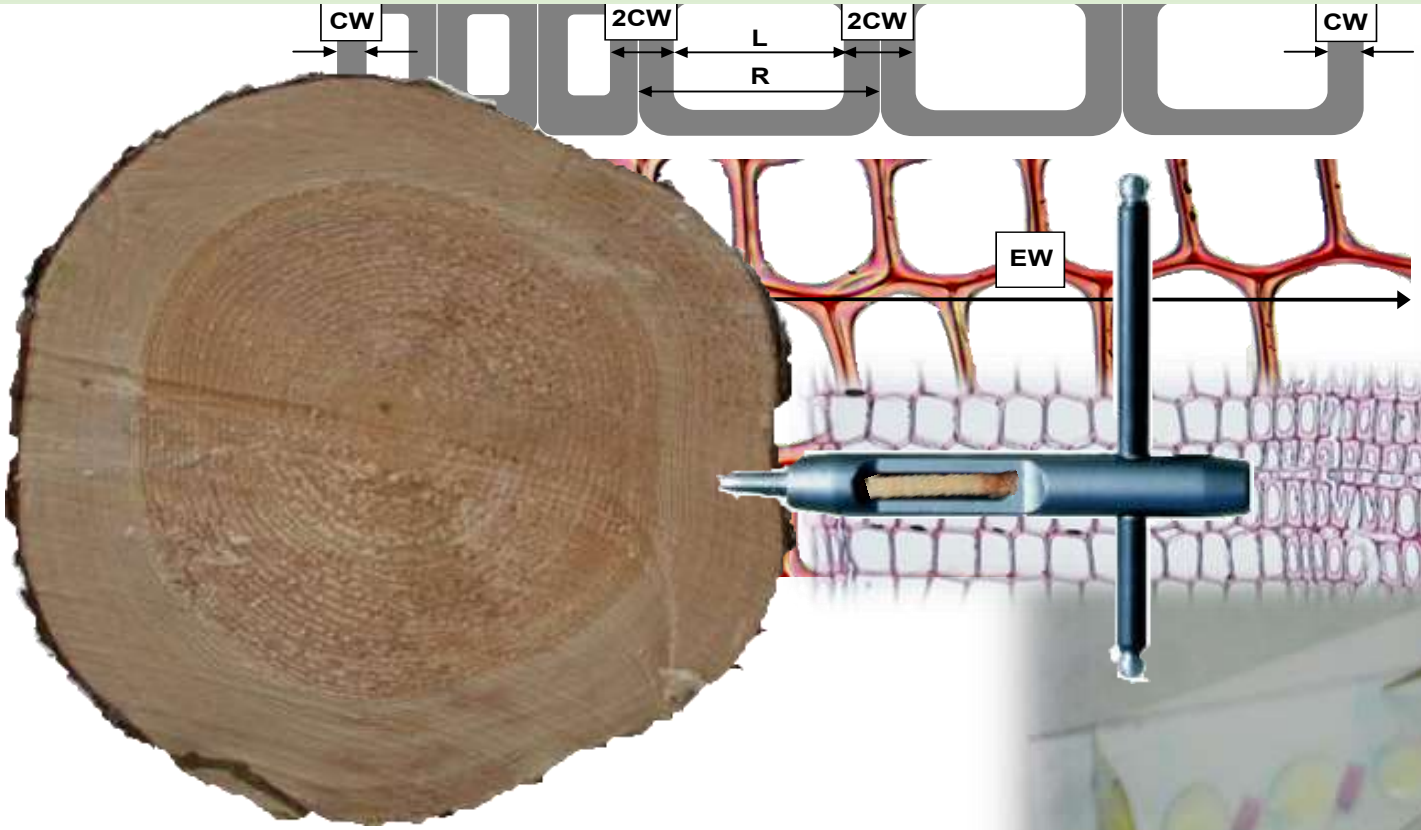
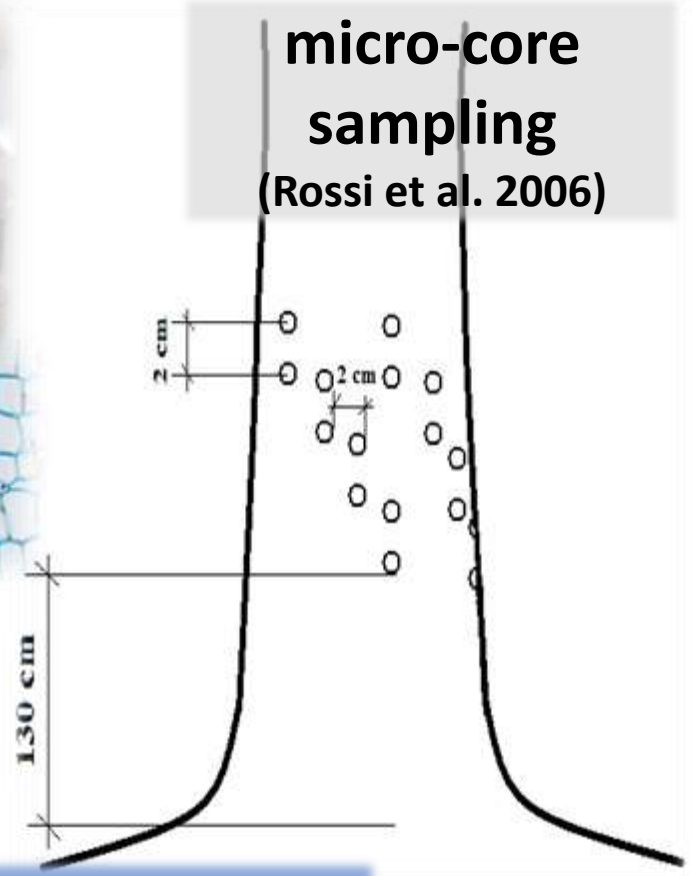
2. METHODOLOGY
- Research plot characteristics

Location	Altitude	Age of sampled trees	Average height	DBH
Soběšice	404 a. s. l.	80 years	25 m	36 ± 7 cm

2. METHODOLOGY

- meteorological, carbohydrate and water status monitoring => sampling, micro-slides making and measurement of morphological parameters



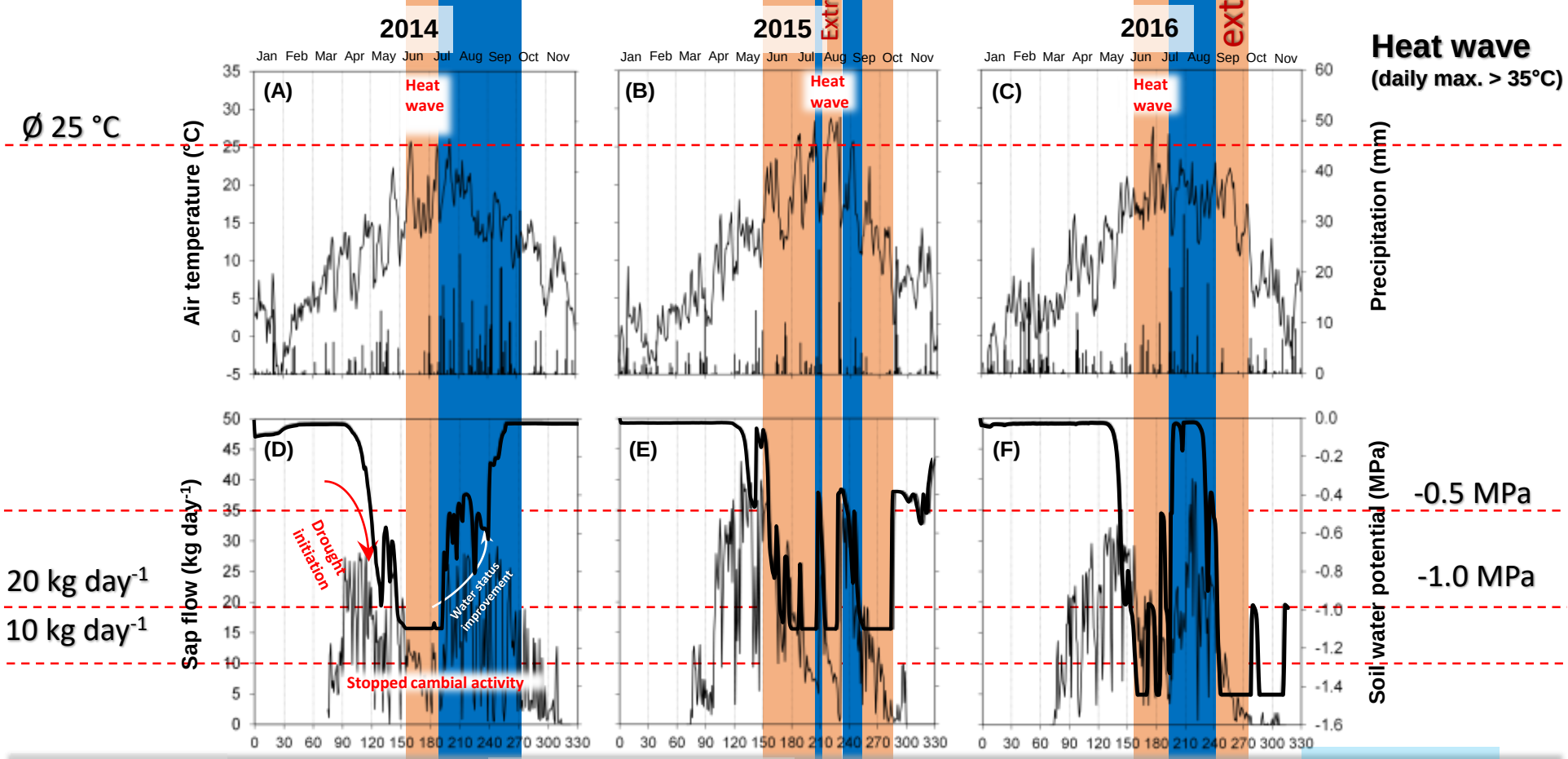


Monitored factors

- Air humidity
- Precipitation amount
- Sap flow
- Air temperature
- Soil water potential
- Spectrophotometric analysis of soluble carbohydrates

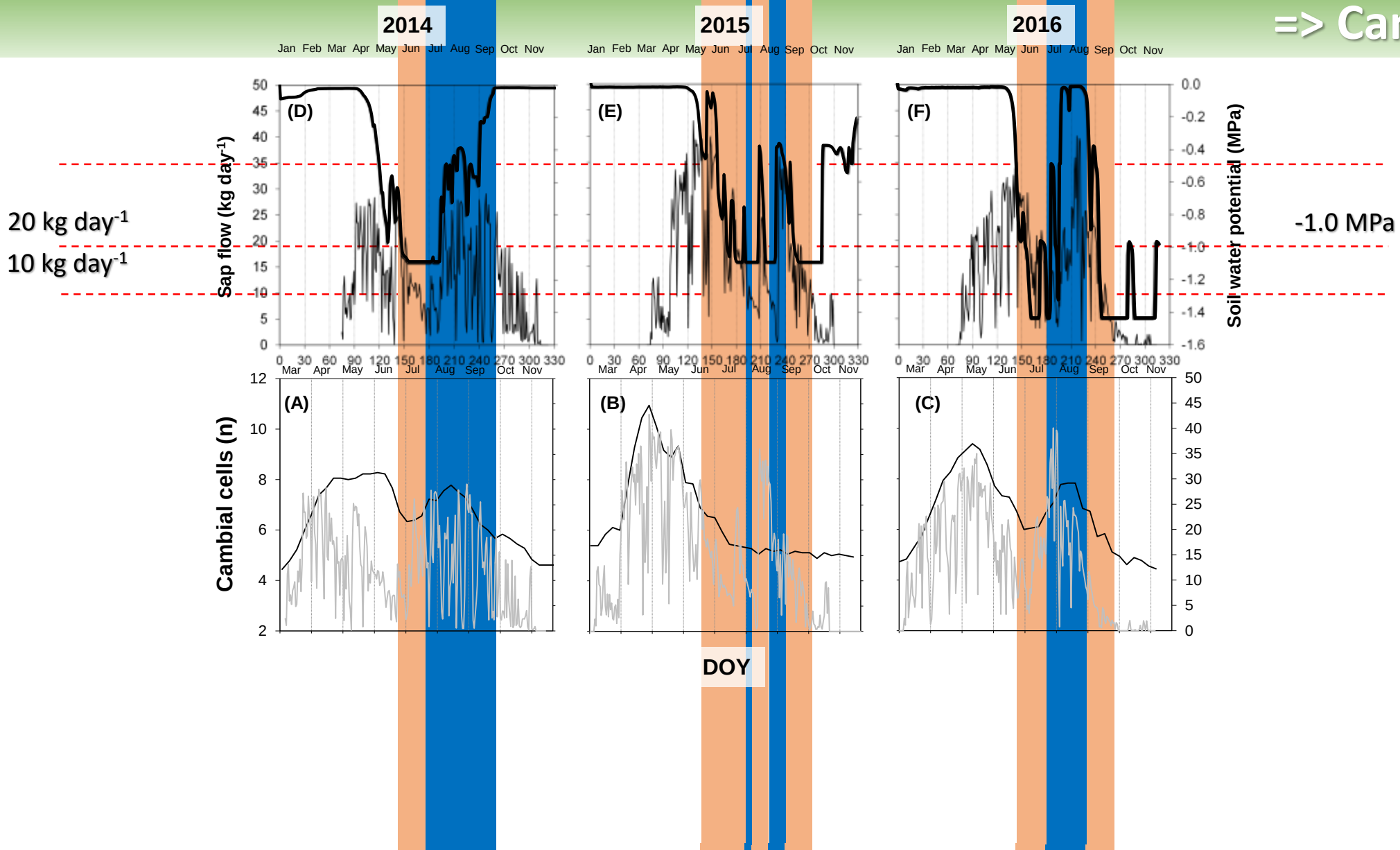
3. RESULTS

Meteorological observation



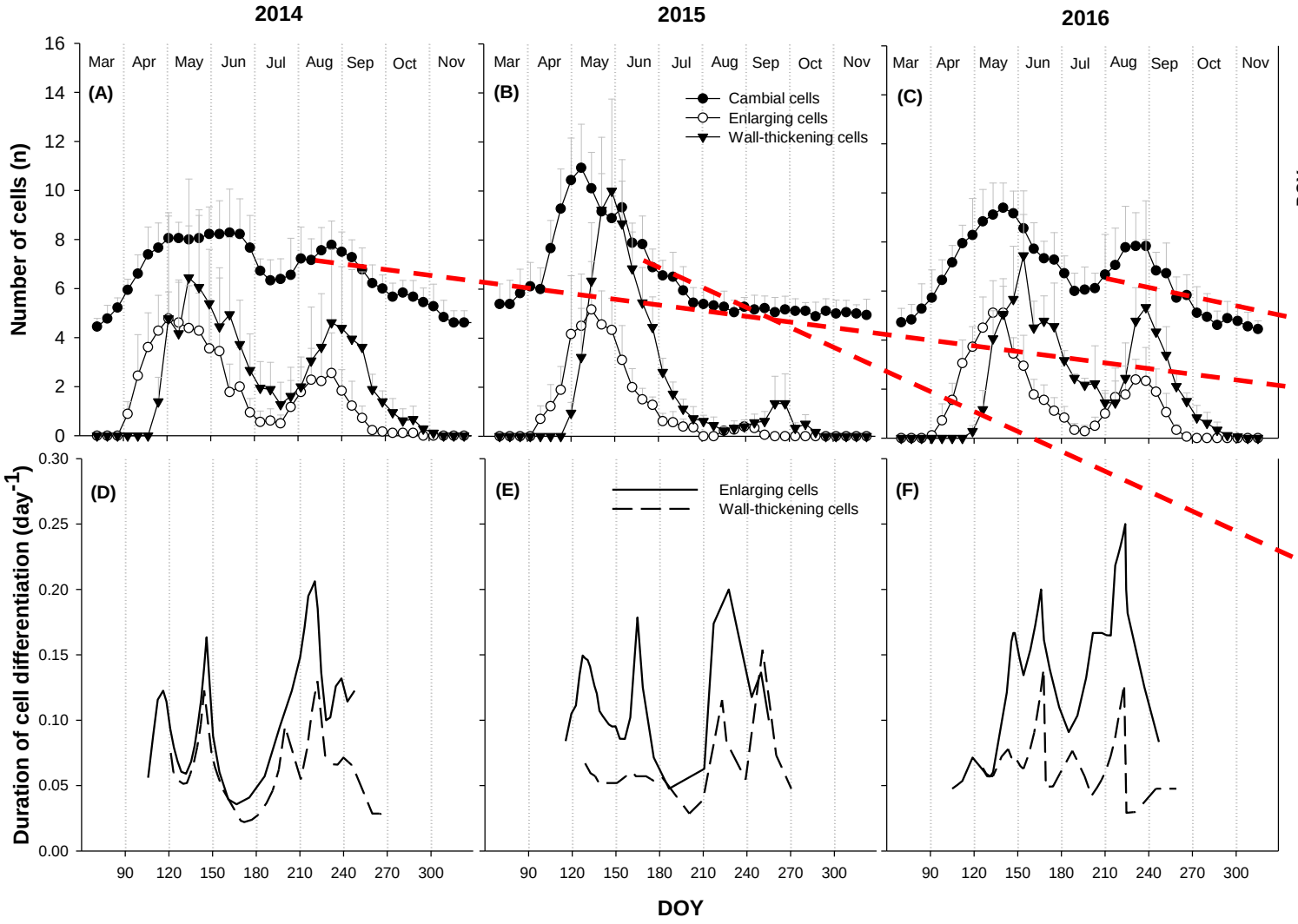
3. RESULTS

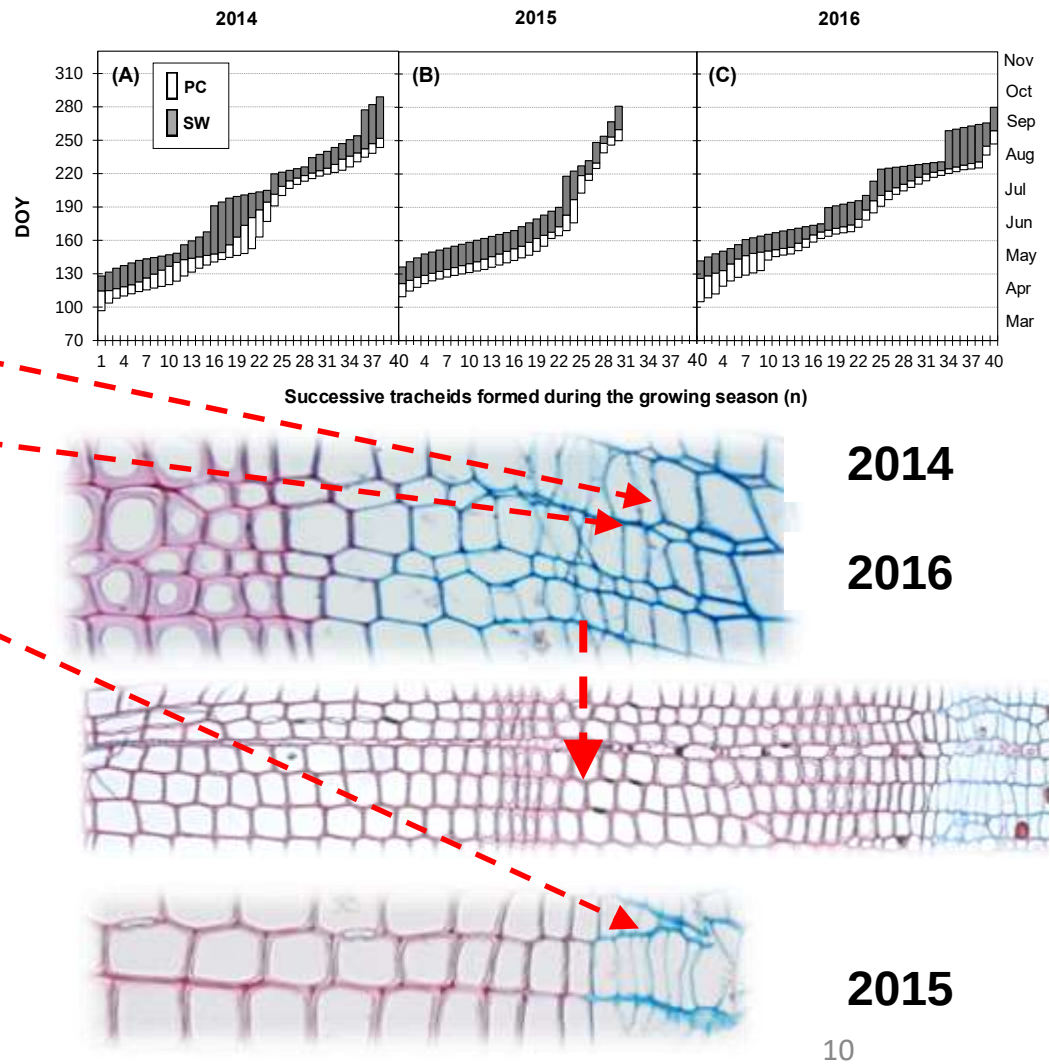
Meteorological observation => Cambial activity



3. RESULTS

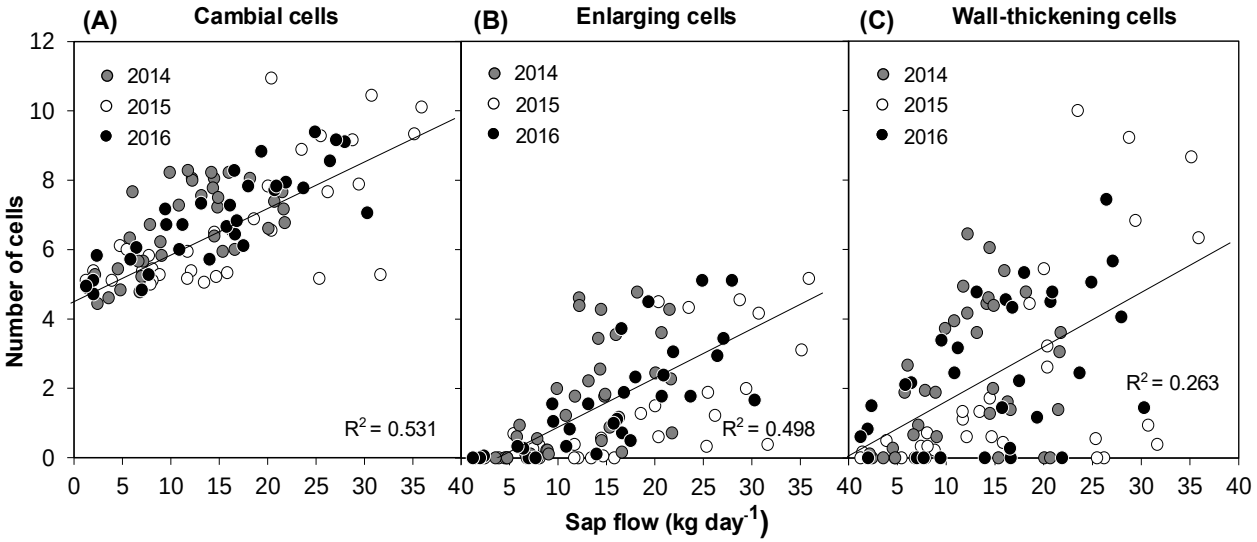
- Xylem cell formation and duration of differentiation

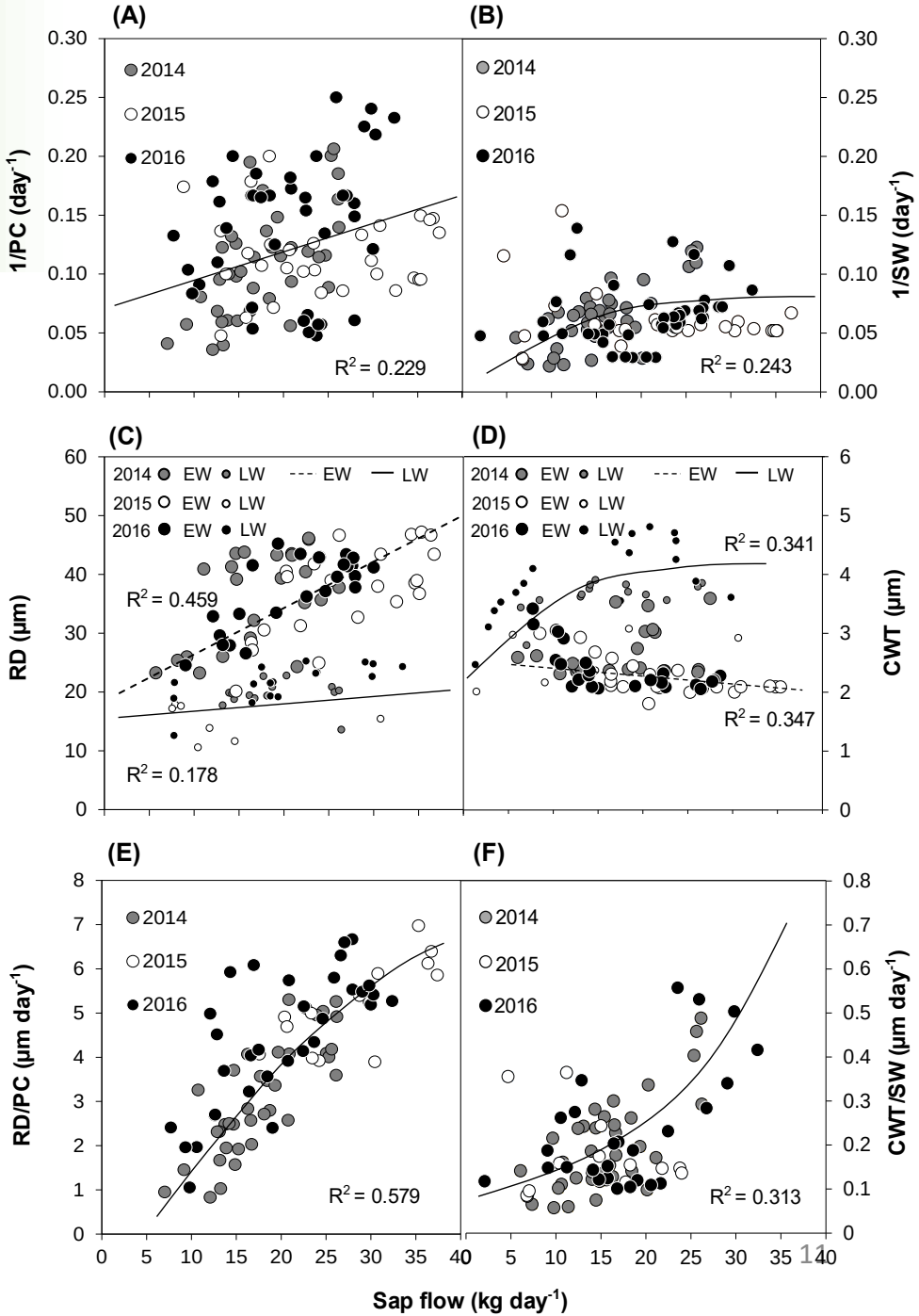




3. RESULTS

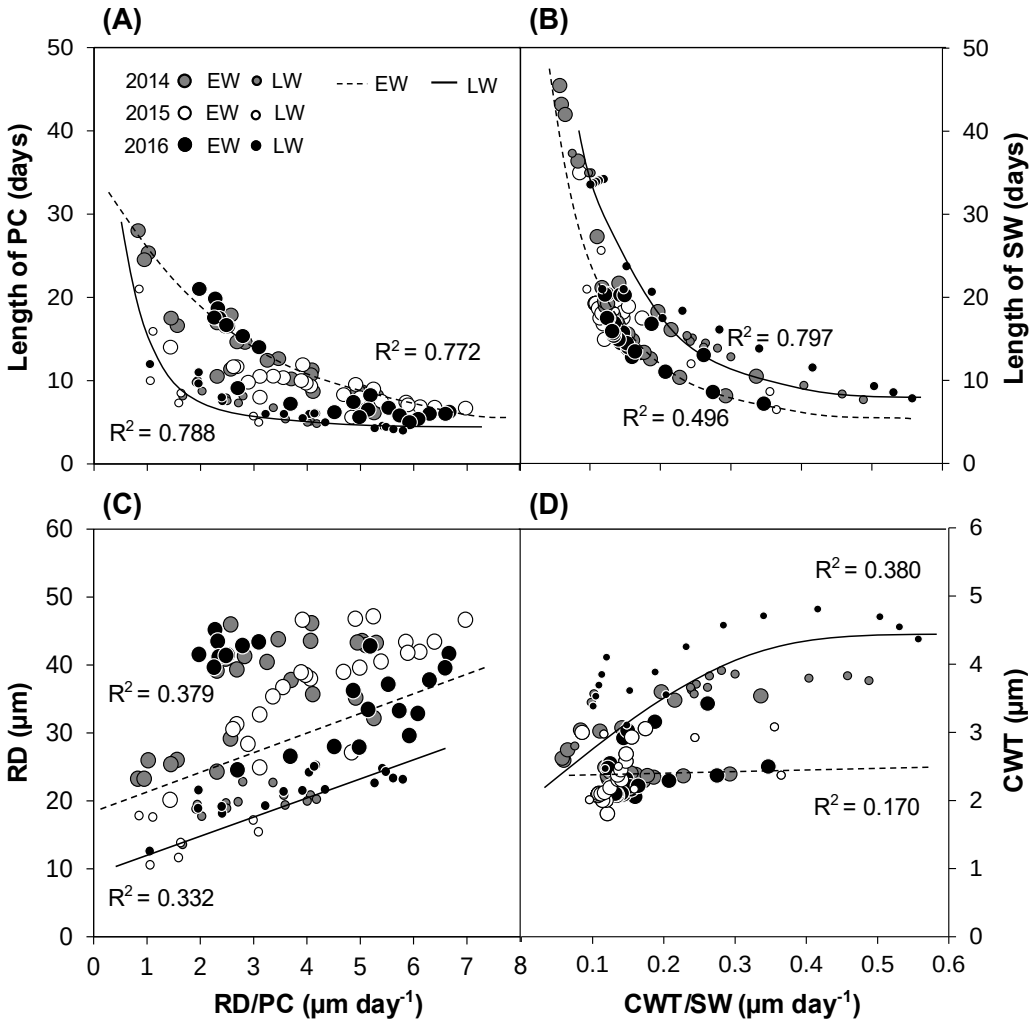
- Xylem cell production, morphogenesis rate and final tracheid morphology



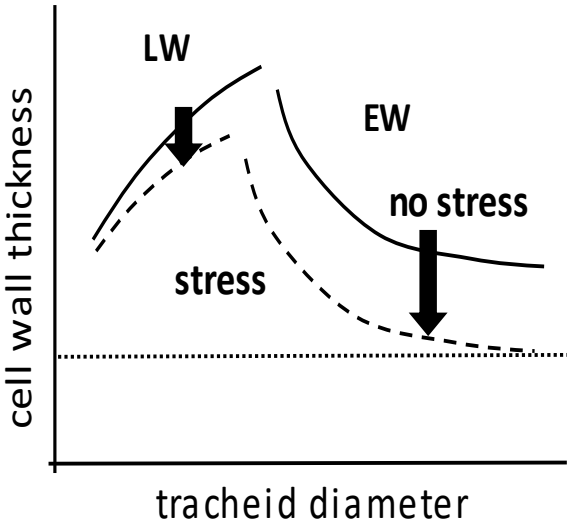


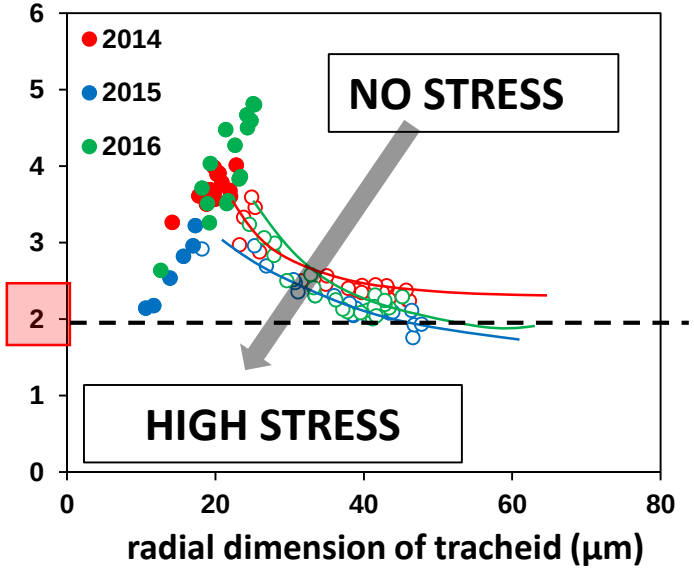
3. RESULTS

- Length of xylem differentiation and ratio between morphogenesis rate and final tracheid morphology



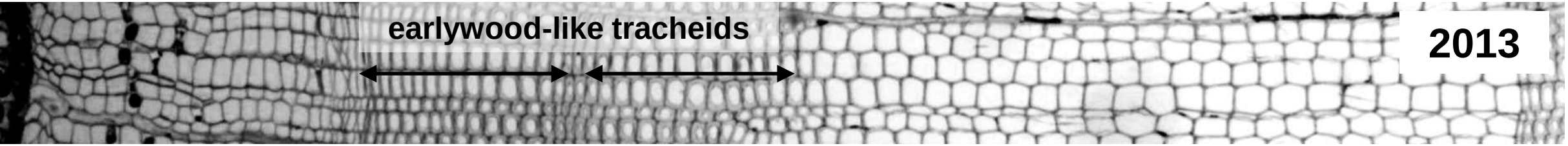
Anatomical variable	K-W test	PW t- test 2014	2015	2016
Radial dimension of earlywood tracheids	0.381			
Radial dimension of latewood tracheids	< 2.2e-16	*	**	*
Double cell wall thickness of earlywood tracheids	0.055			
Double cell wall thickness of latewood tracheids	< 2.2e-16	*	**	*

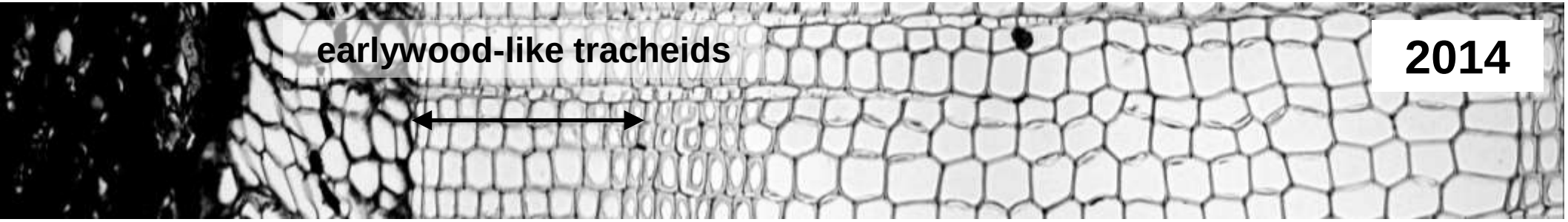


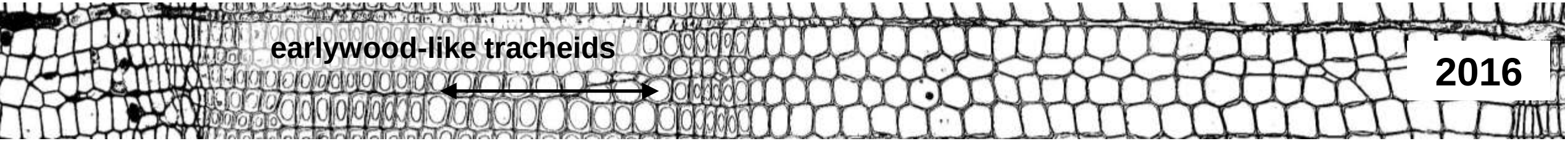


3. RESULTS
- Morphological structure of IADFs in last 4 years

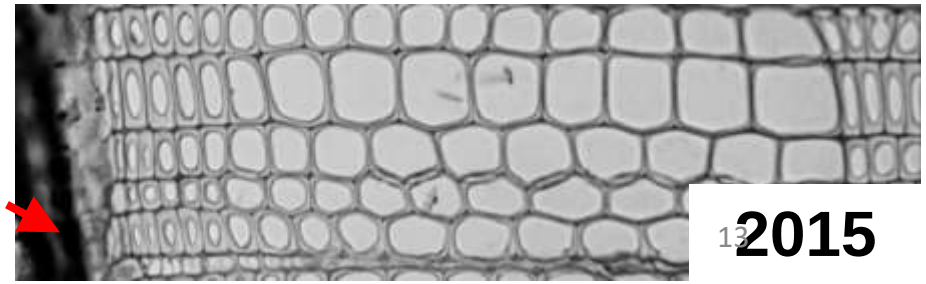
Recovered cell formation (reactivated cambium):



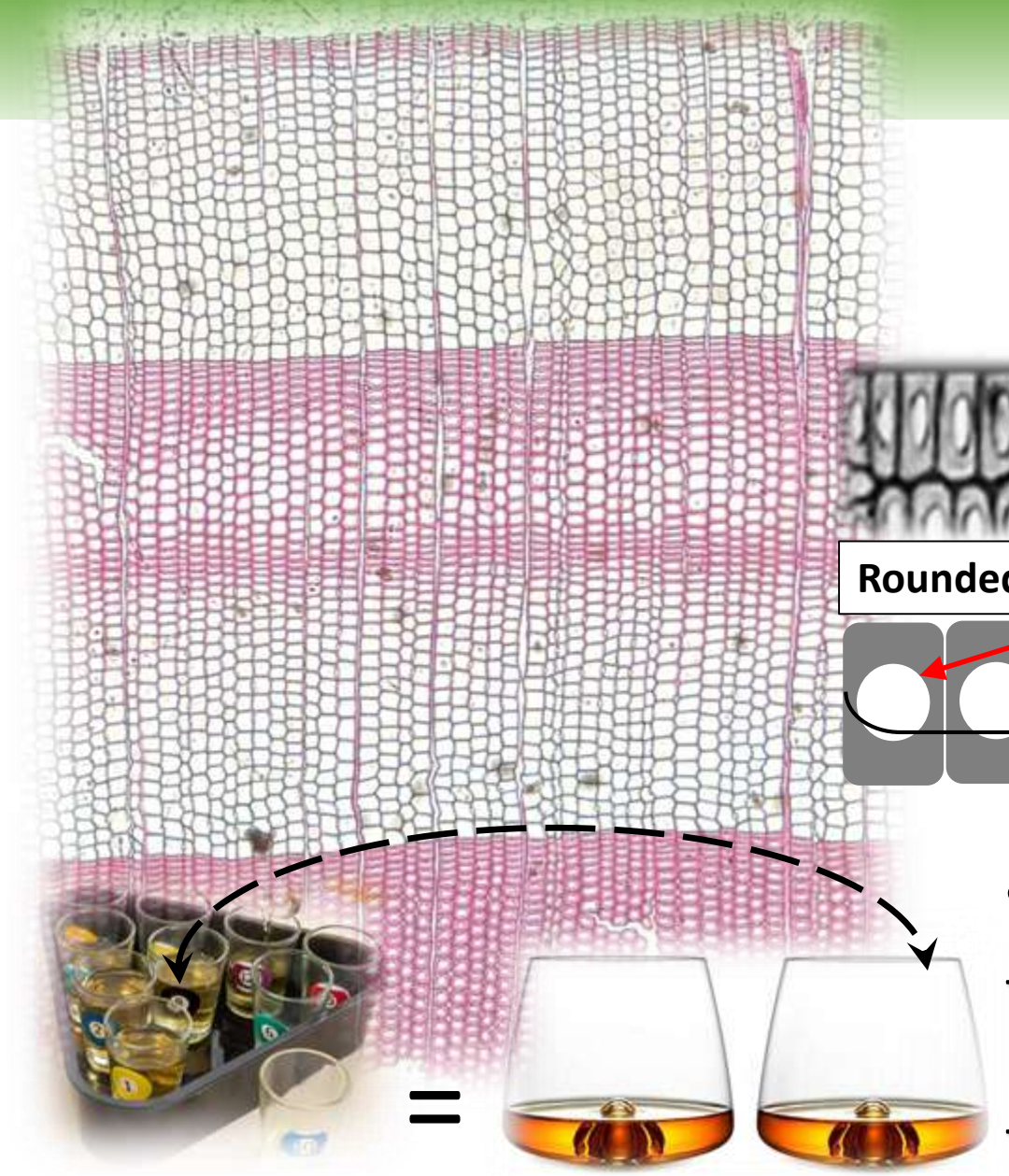




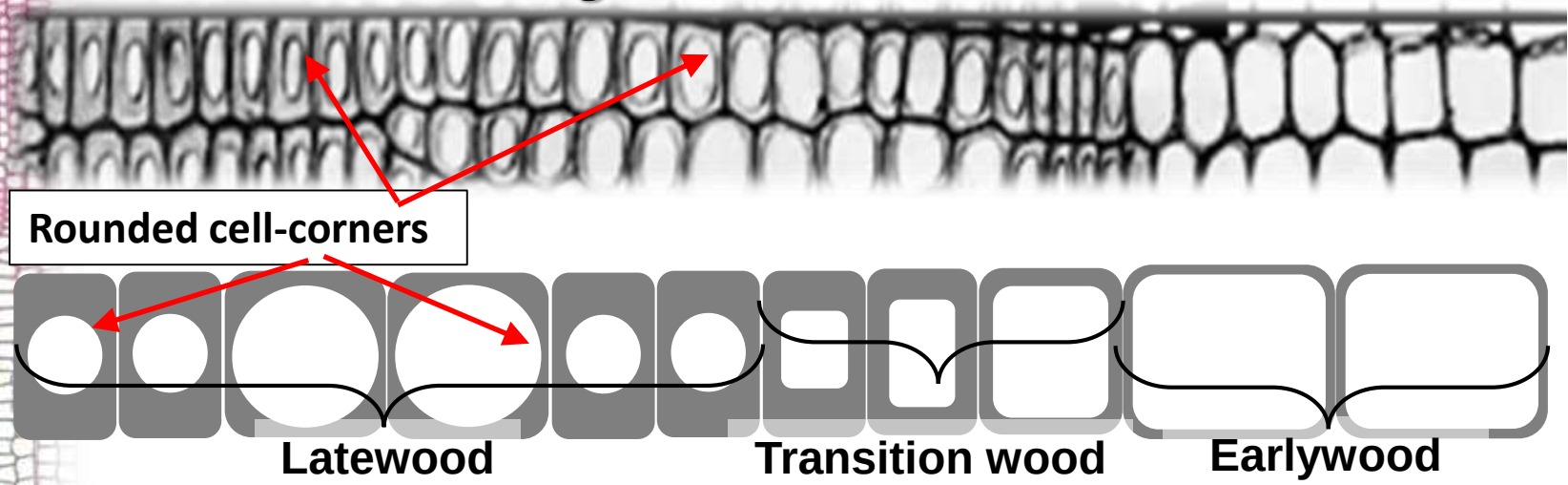
Abruptly stopped cell formation (end of cambial activity) after summer drought:



4. DISCUSSION – arising questions



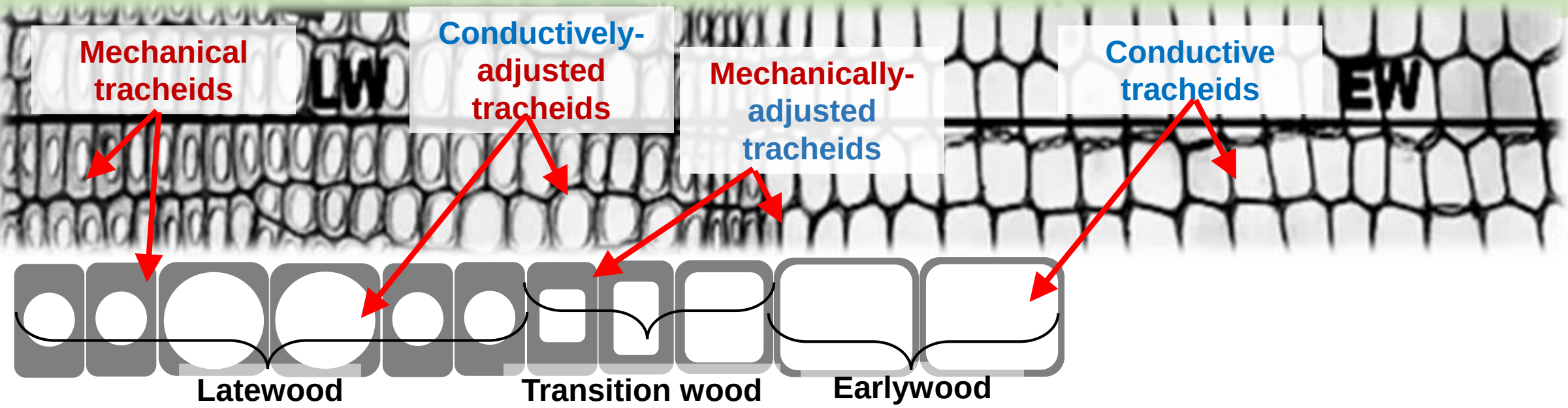
- **ADJUSTMENT** of functional wood anatomy within abnormal distribution of seasonal meteorological events



- **Mork's index (1928) validity???**

- "early" and "late" classification (=> date of the first occurrence thick-walled tracheid)?
- **Anatomical features matter!**

4. DISCUSSION – arising questions

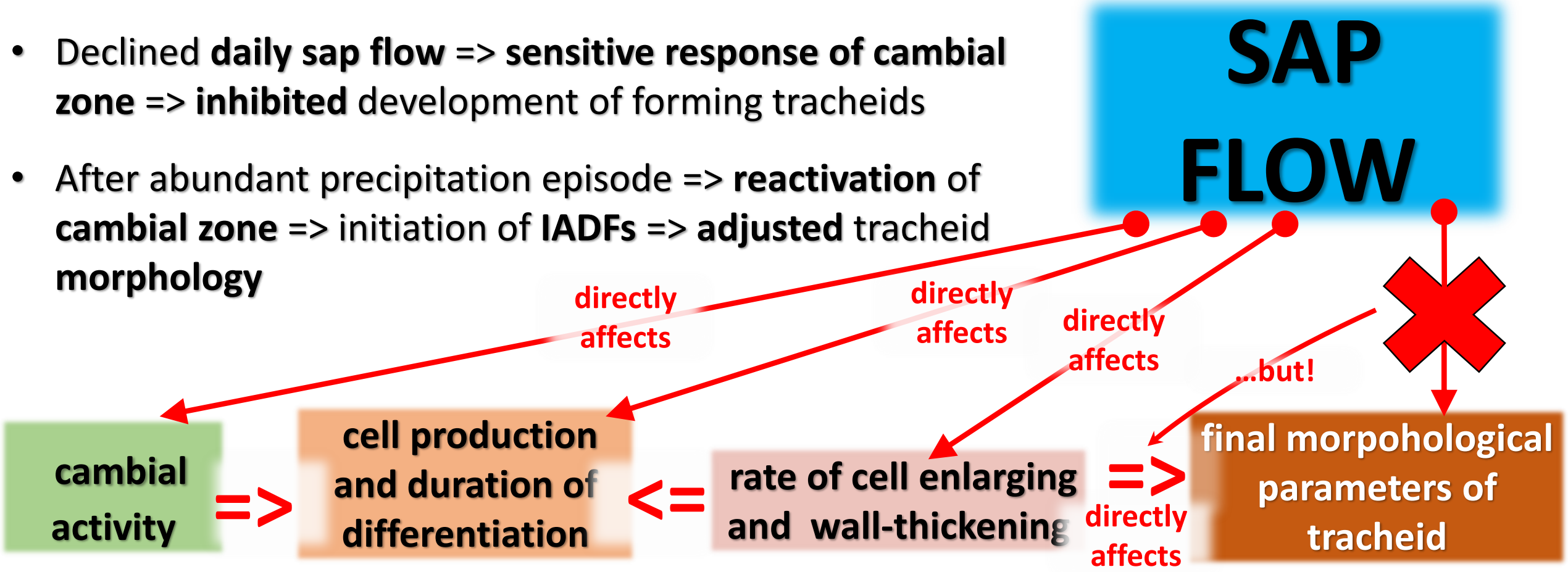


- **Combination of both predisposed anatomical features within one tracheid? ??**

- **TURGOR pressure** EXPLAINED BY => **SAP FLOW intensity** ASSUMING ? => **LOCKHART equation** (rate of cell enlargement in terms of the processes of wall expansion and water uptake)

5. CONCLUSSIONS

- **Dry periods** (non precipitation episodes combined with heat waves and low relative air humidity) **reduced the sap flow intenisty**
- Declined **daily sap flow** => **sensitive response of cambial zone** => **inhibited** development of forming tracheids
- After abundant precipitation episode => **reactivation** of **cambial zone** => initiation of **IADFs** => **adjusted** tracheid **morphology**



THANK YOU FOR YOUR ATTENTION