Better safe than sorry:

Non-stomatal mechanisms reduce loss in xylem conductance in Scots pine saplings under drought

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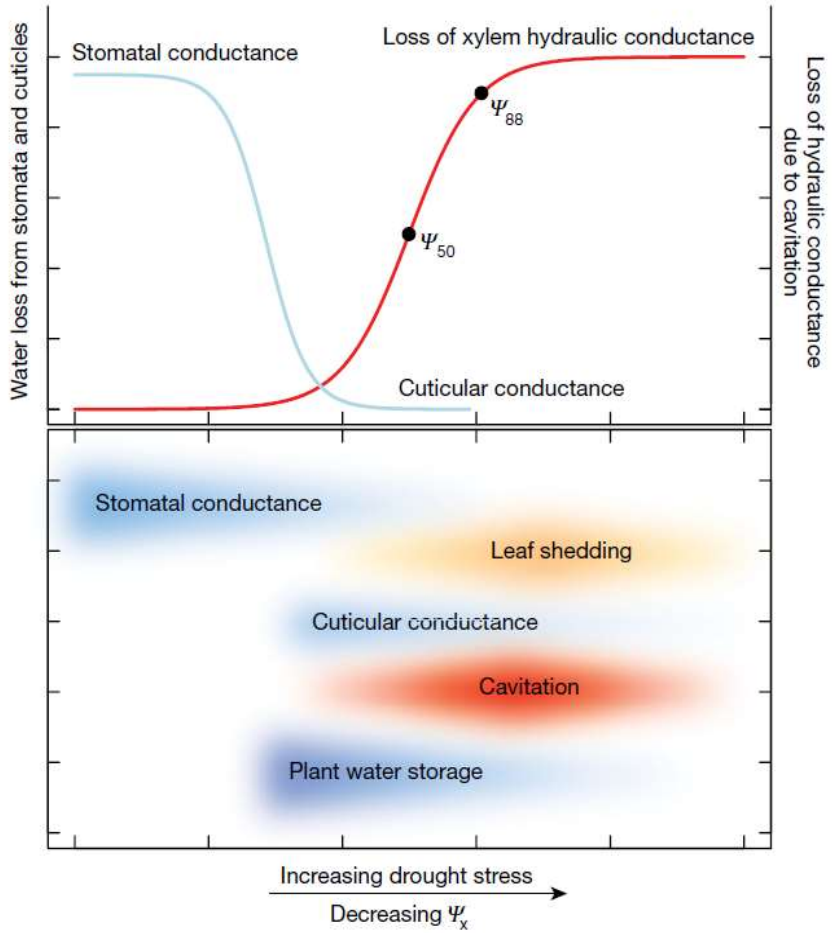
Main idea / Hypothesis

Non-stomatal mechanisms mitigate losses
in conductance under severe drought stress

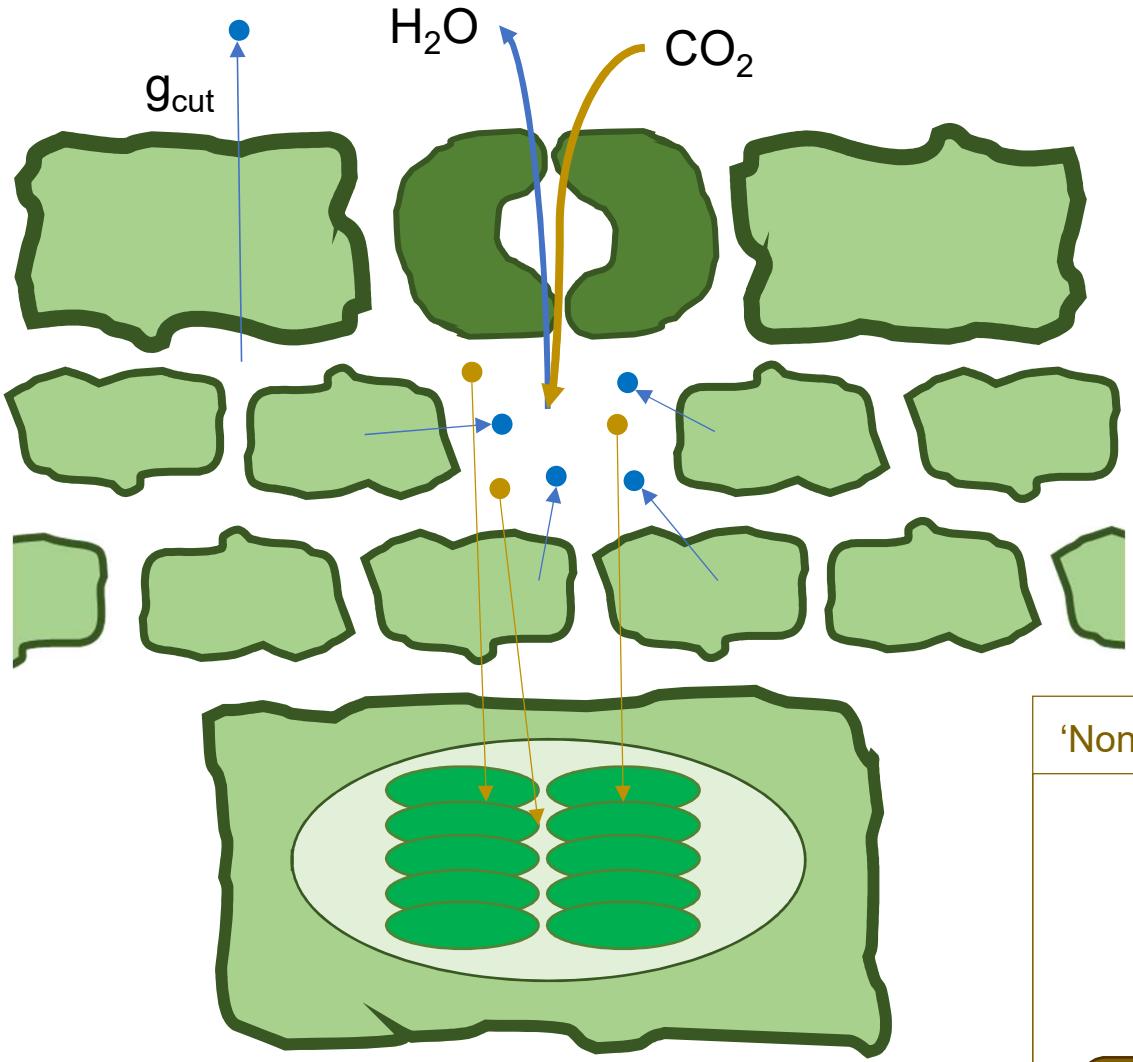
P. sylvestris pre drought

P. sylvestris after drought



Choat et al., 2018 (Nature)

Non-stomatal limitations of photosynthesis (NSL) also limit g_s



$$g_s = f(A_n, D, C_a, \Psi_{leaf})$$

$$C_i = f(A_n, C_a, gs)$$

$$C_C = f(C_i, g_m)$$

'Non-stomatal limitations of A_n

Stomata

$$A_n = f(C_c, V_{c,max}, Jmax_{, (\dots)})$$

Light-saturated photosynthesis

Drought stress

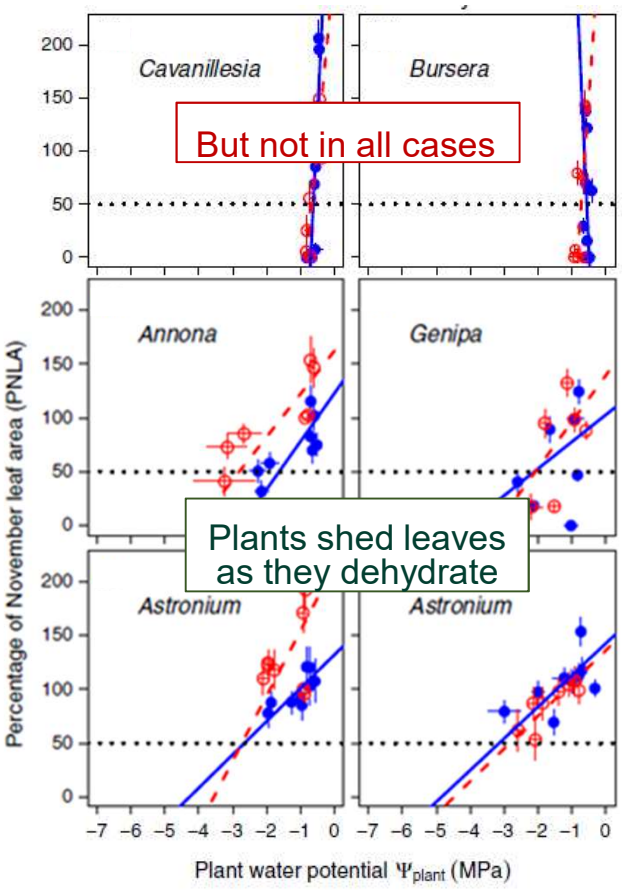
Leaf shedding as a mechanism of hydraulic safety

Pressure drop

$$\Psi_{leaf} - \Psi_{roots} = -\left(\frac{g_s * D * A_{leaf}}{k_s * A_{sapwood}}\right)$$

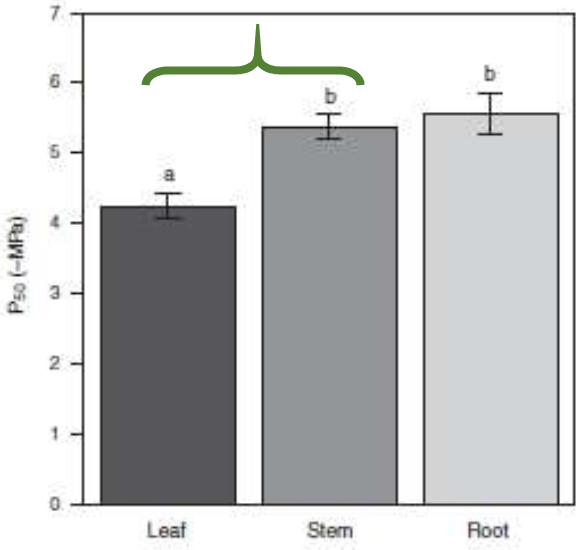
Martínez-Vílalta et al., 2014 (New Phytol.)

Decreasing A_{leaf} reduces pressure drop



Wolfe et al., 2016 (New Phytol.)

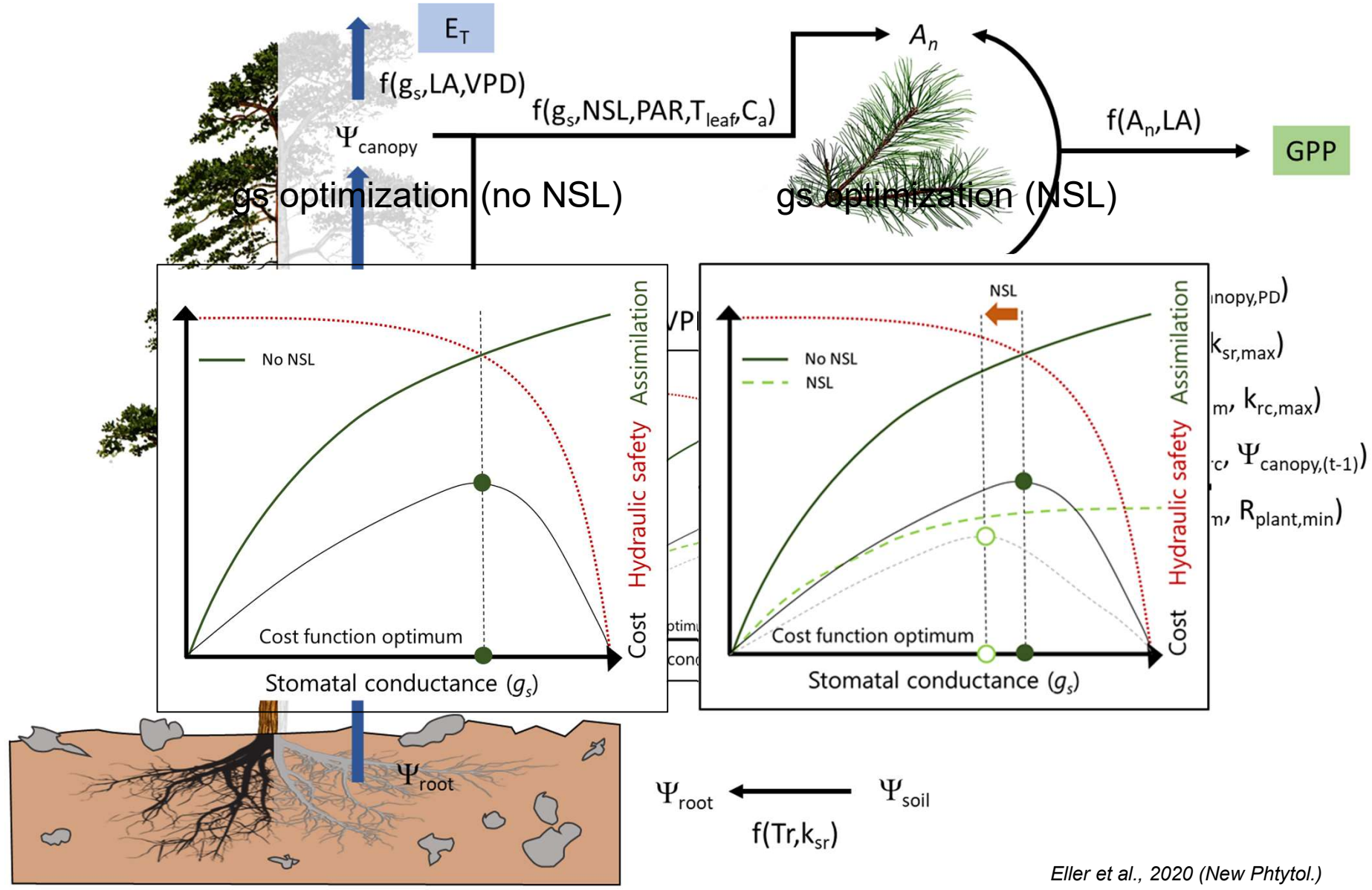
Leaf shed at higher Ψ



Cotton plant

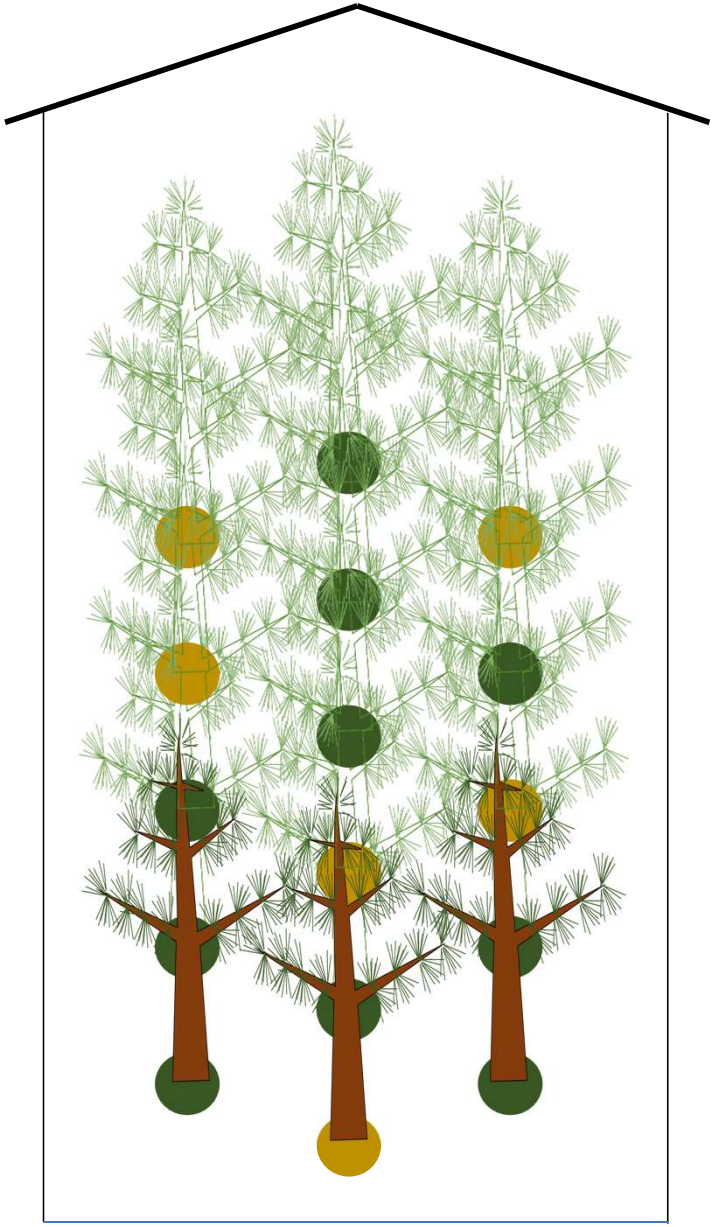
Li et al., 2020 (Funct. Plant Biol.)

SOX model (Stomata on xylem) hydraulic model



Eller et al., 2020 (New Phytol.)

Experimental setup (16 potted *Pinus sylvestris* L. saplings)



A_n / C_i curves (LICOR Li-6800)

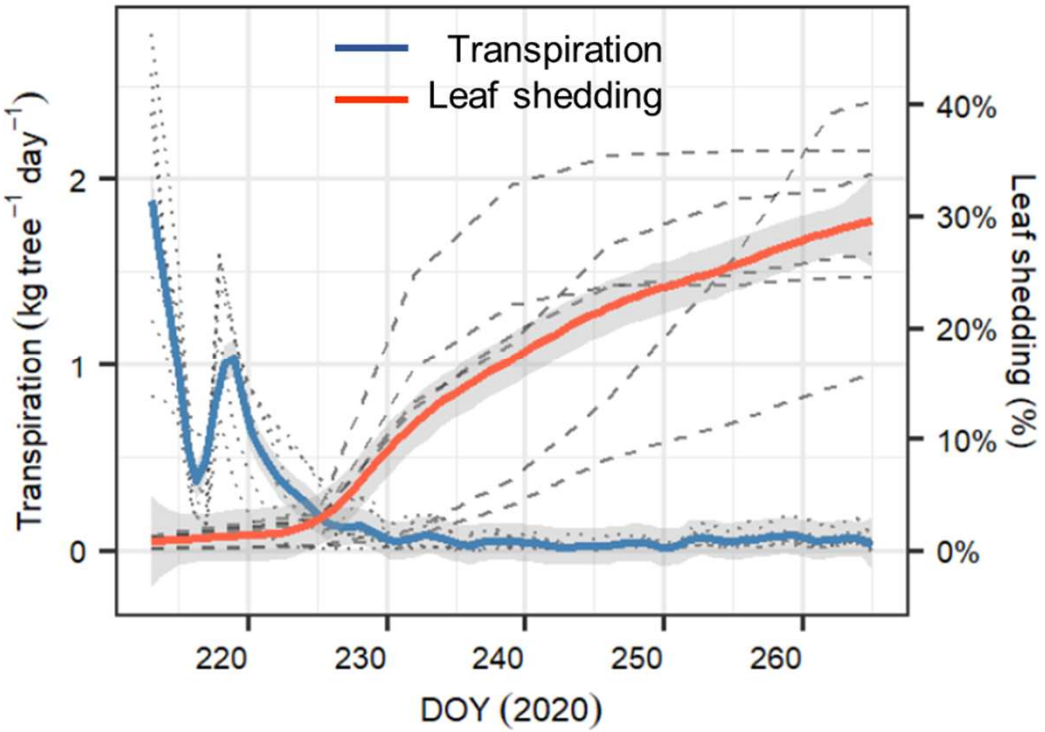
Sap flow upper canopy (EMS 62 sensors)

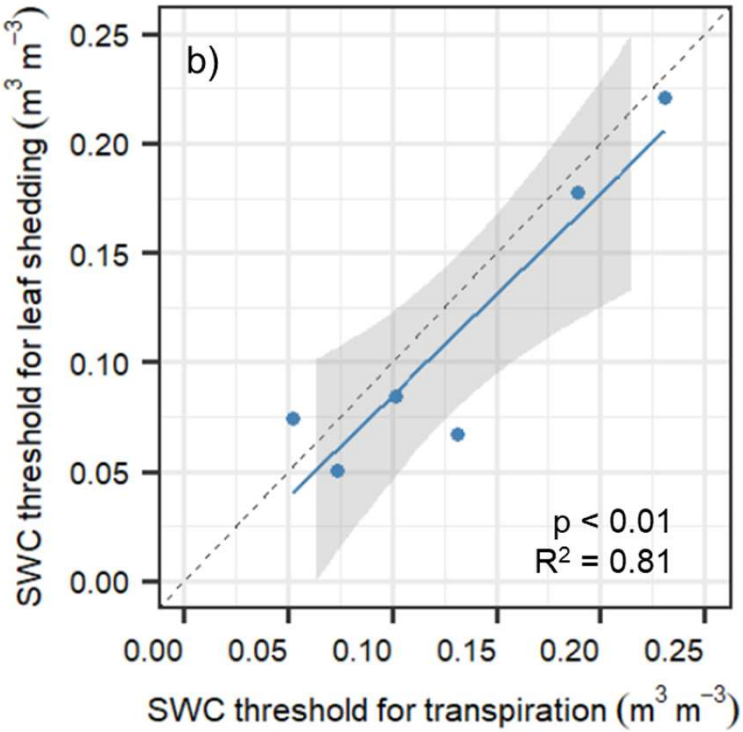
Xylem vulnerability (Cavitron)

Soil water content

Meteorological drivers

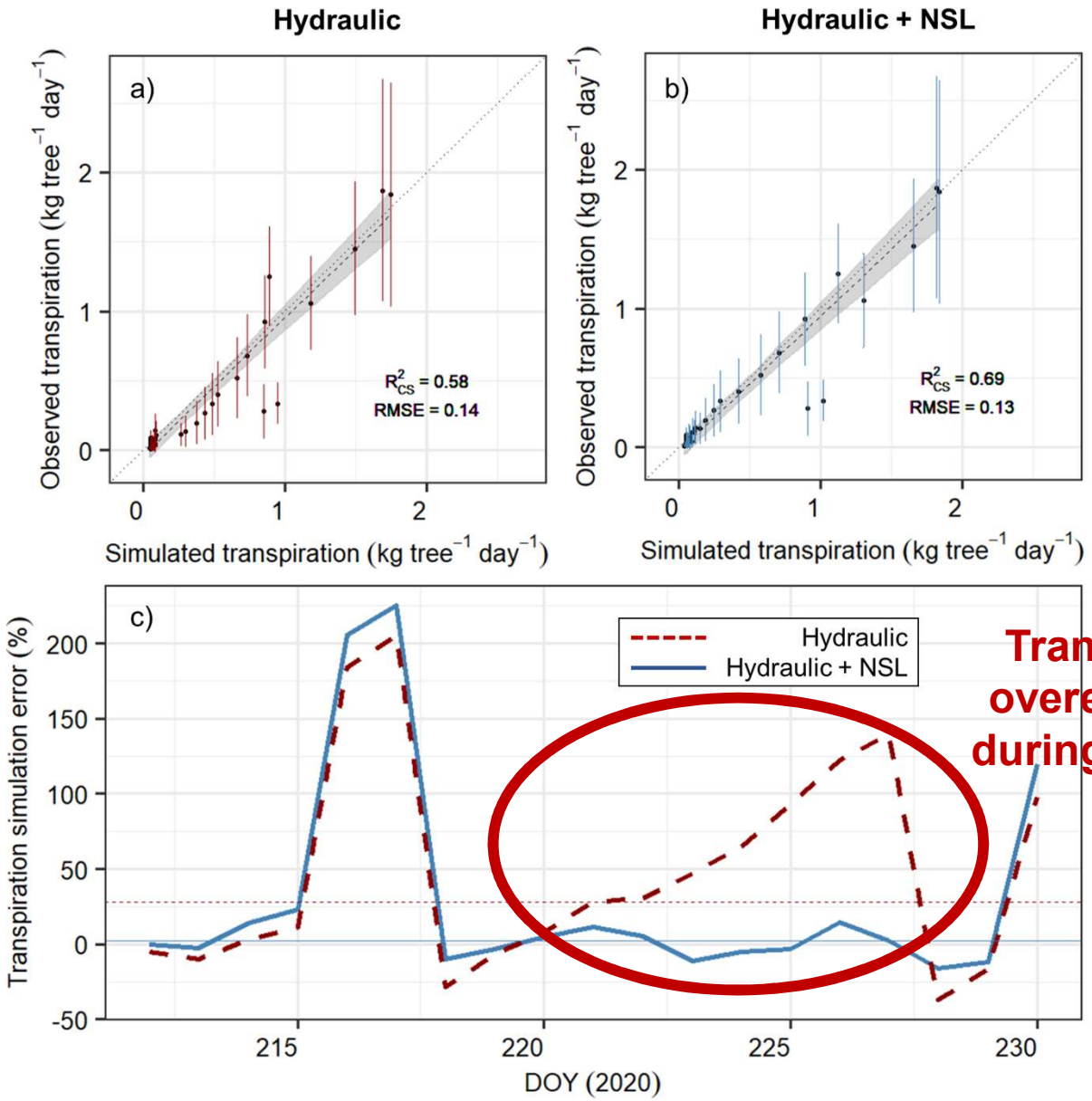
Drought-induced leaf shedding started after transpiration stopped





Nadal-Sala et al., (Accepted), Front. Plant Sci.

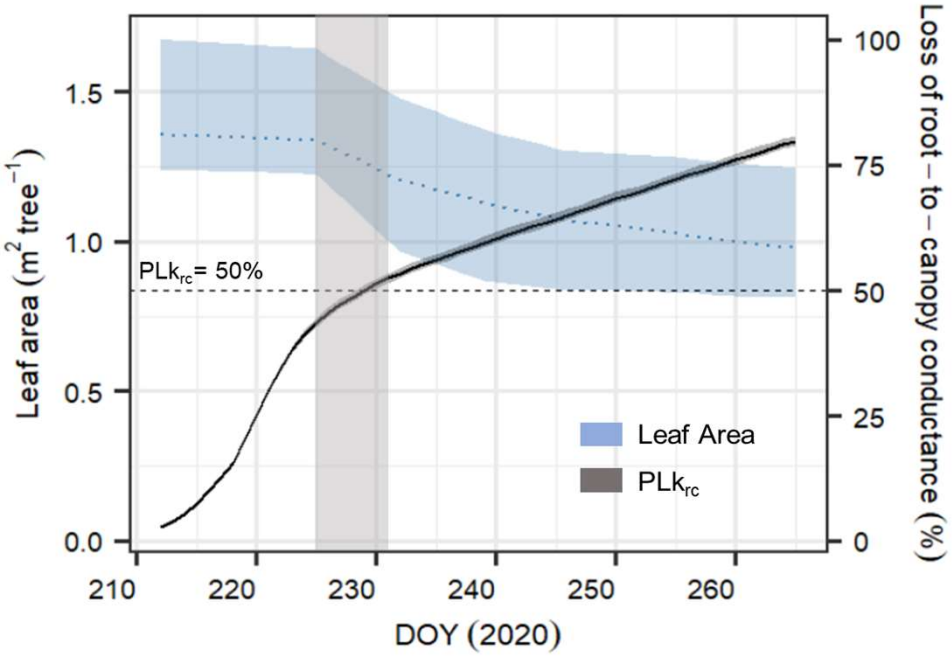
Including NSL improved SOX+ model performance



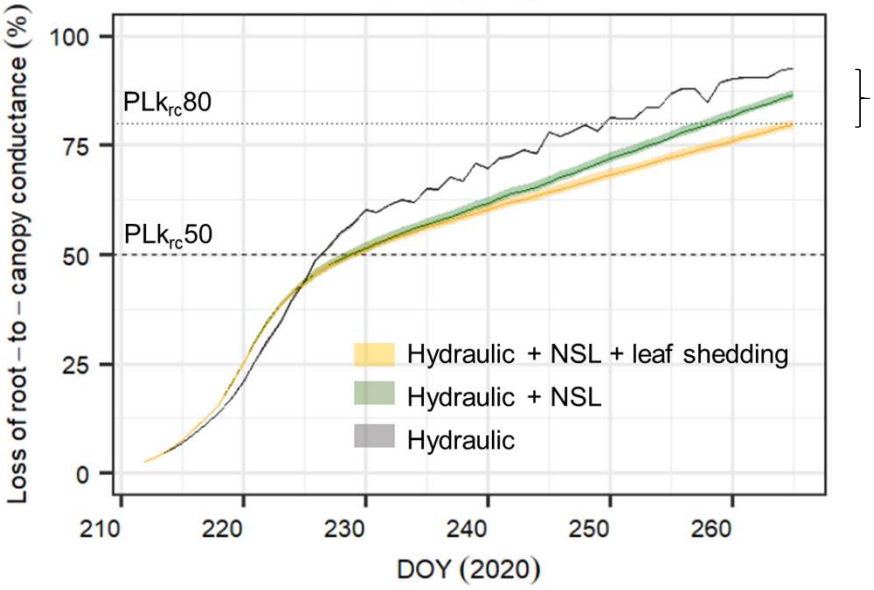
NSL >= 50%
When Ψ_{canopy} = -1.7 MPa

Transpiration overestimation during dry-down

NSL and leaf shedding mitigate conductance loss



Leaf shedding +300% when conductance loss was around 50%



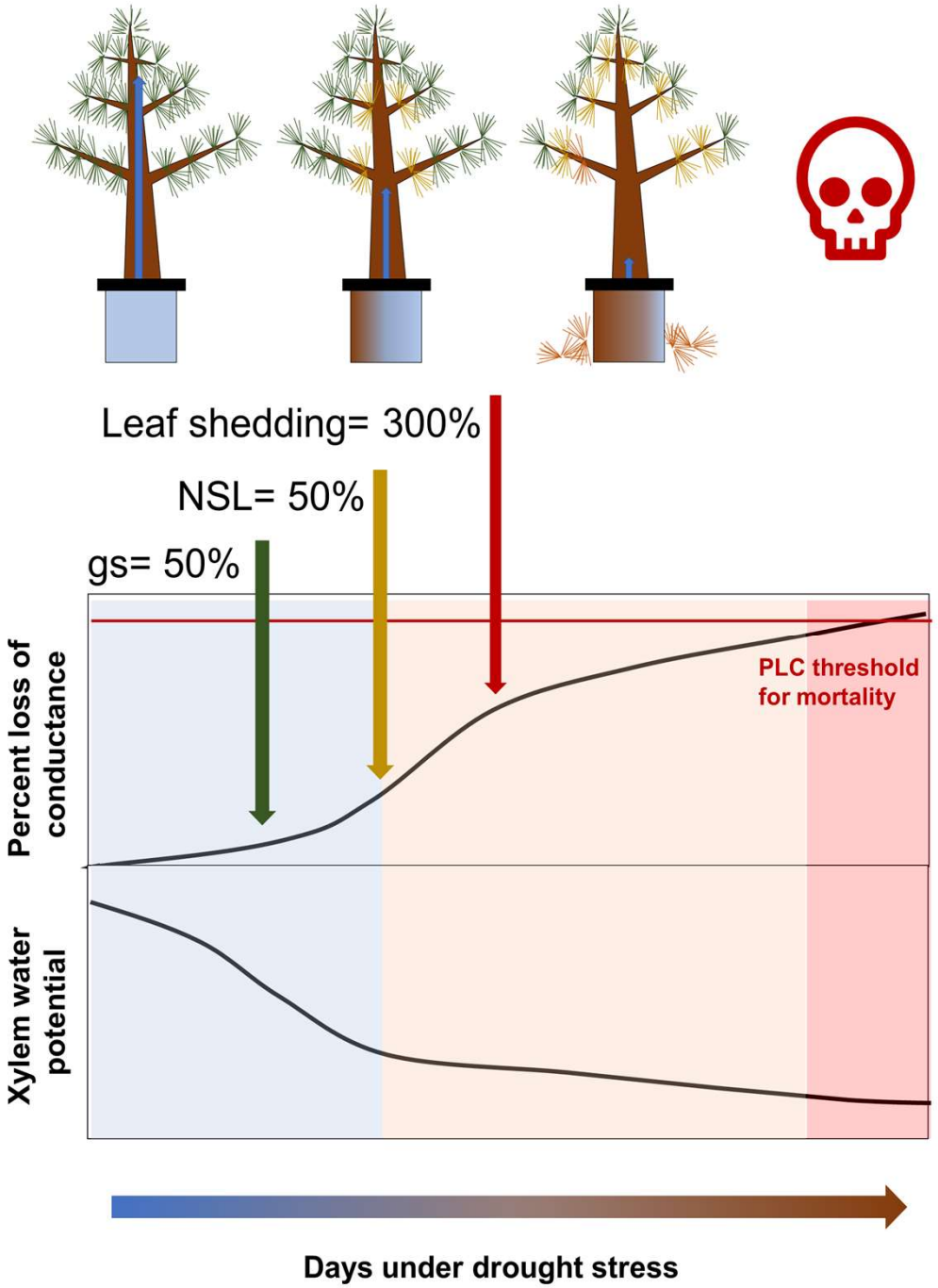
~13% reduction in conductance loss

Results summary

Sequential responses to drought

- Stomatal closure
- Photosynthesis downregulation
- Leaf shedding

Responses triggered at decreasing elasticity ->
Longer C balance recovery period



Final remark:

Hydraulic models performance improves by integrating **acclimation responses to drought such as physiological (NSL) and morphological (leaf shedding)** adjustments

Thank you for your attention

For further details, check: Nadal-Sala D, Grote R, (…), Ruehr NK (accepted). **Leaf shedding and non-stomatal limitations of photosynthesis mitigate hydraulic conductance losses in Scots pine saplings during severe drought stress**. Front. Plant. Sci.