

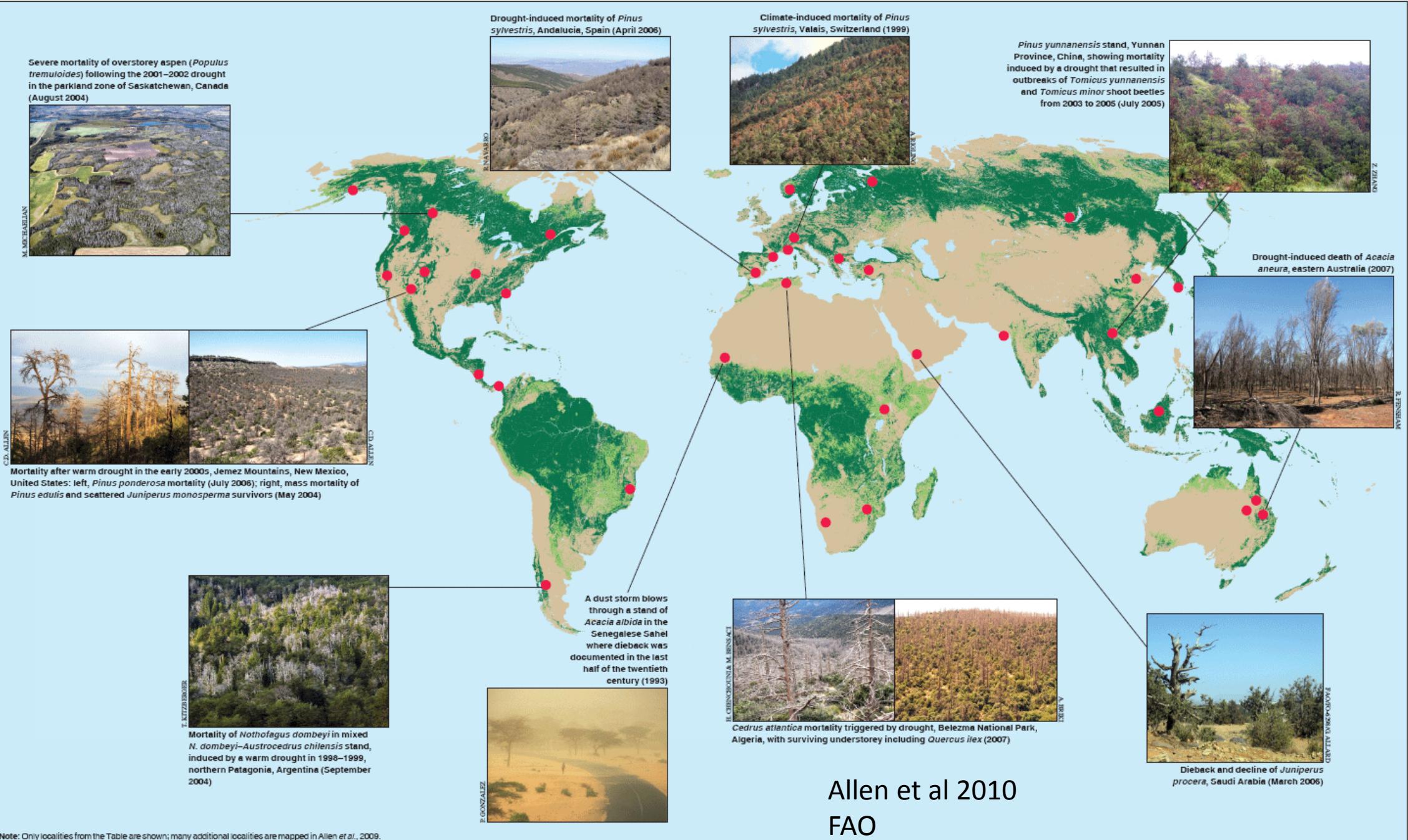


Predicting hydraulic failure with SurEau: description of the model and applications

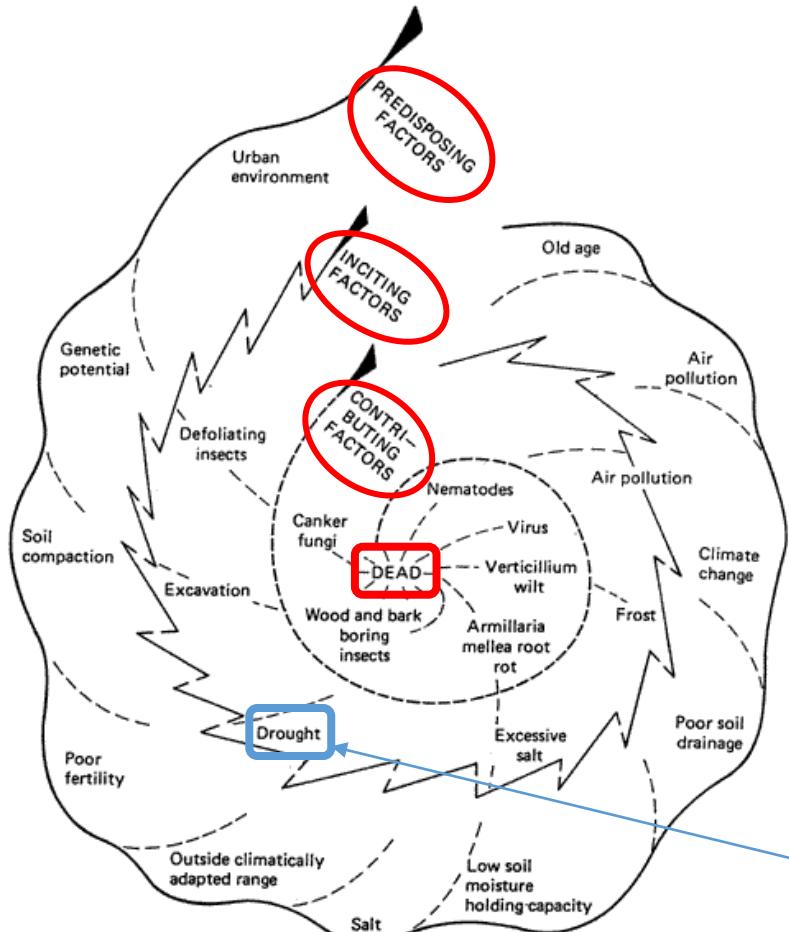


Nicolas Martin-StPaul

URFM [@NMartin_StPaul](https://twitter.com/NMartin_StPaul)



Factors inducing mortality

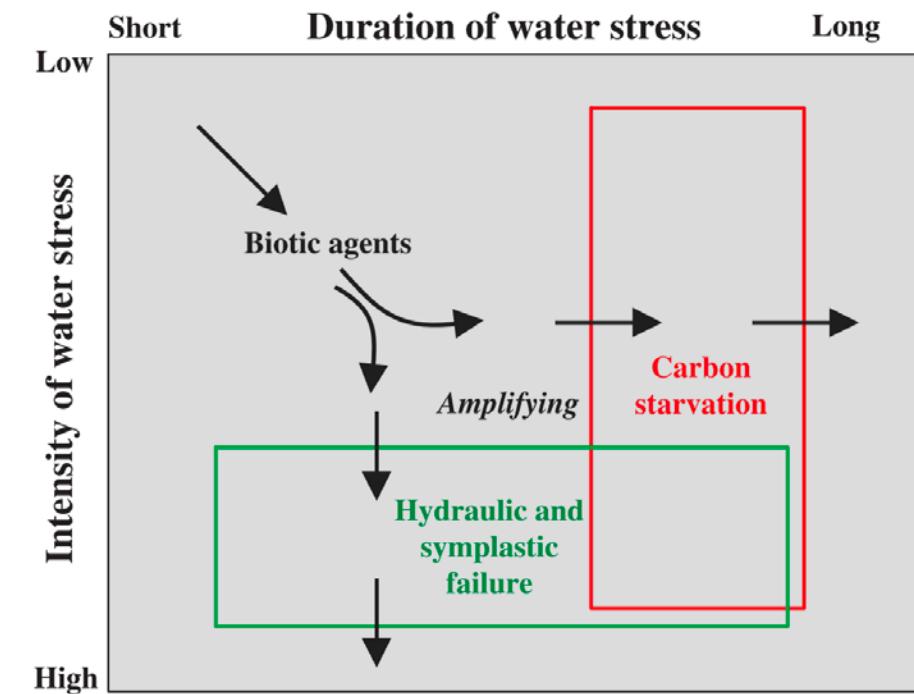
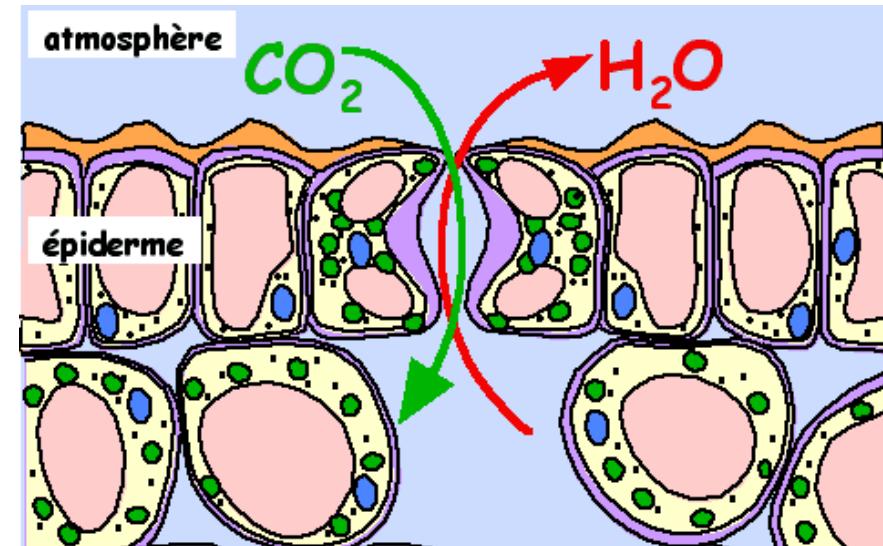
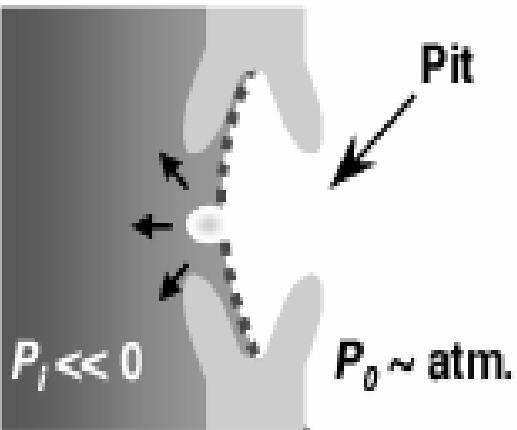
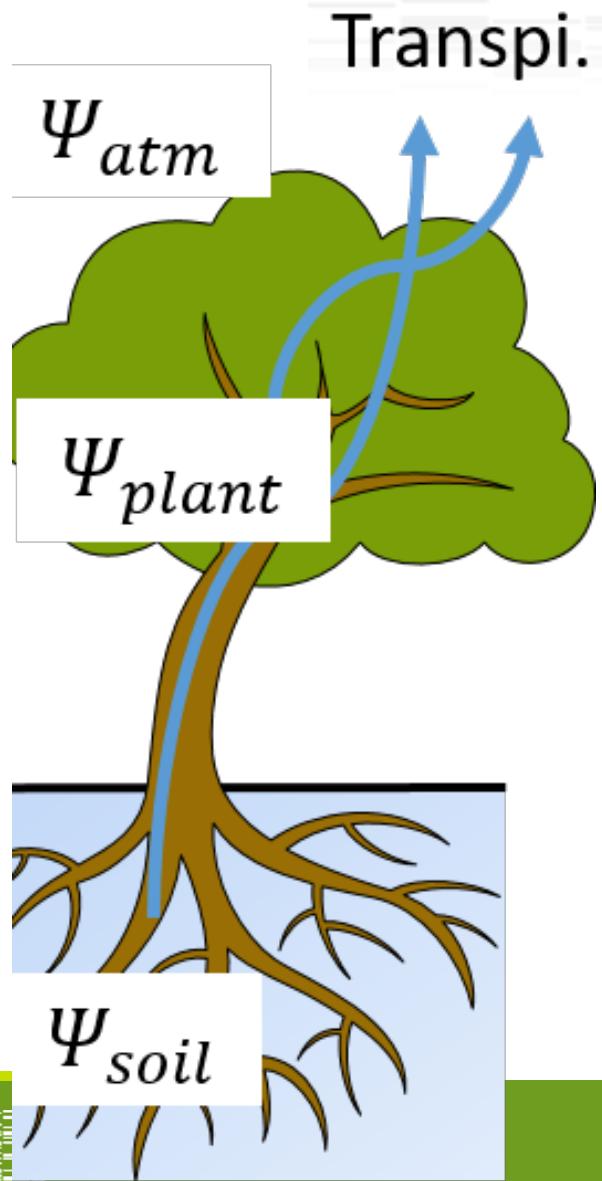


The decline-death spiral

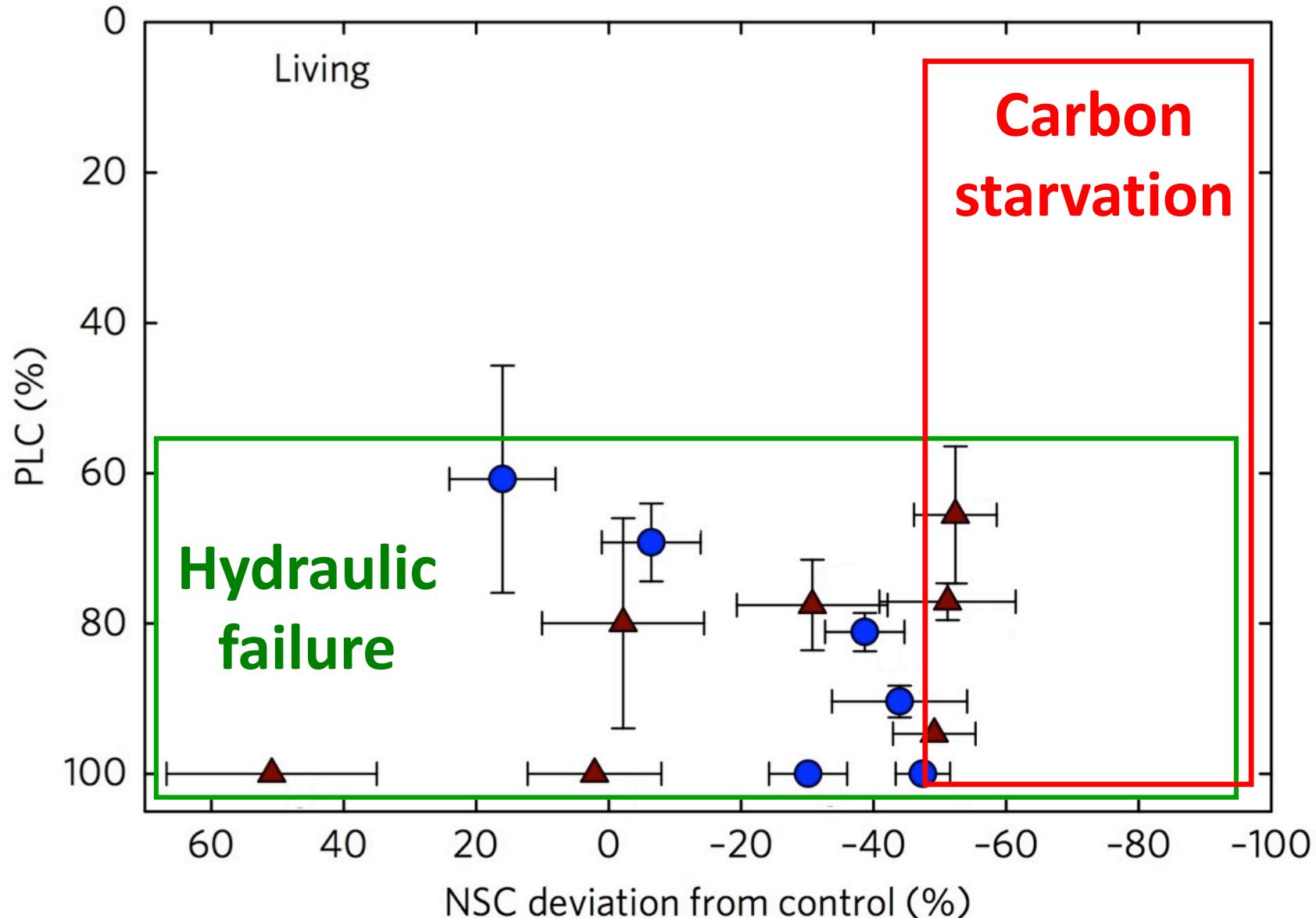
Manion 1981

Mechanisms of extreme drought/heat induced tree mortality

Hypothesis for drought induced mortality



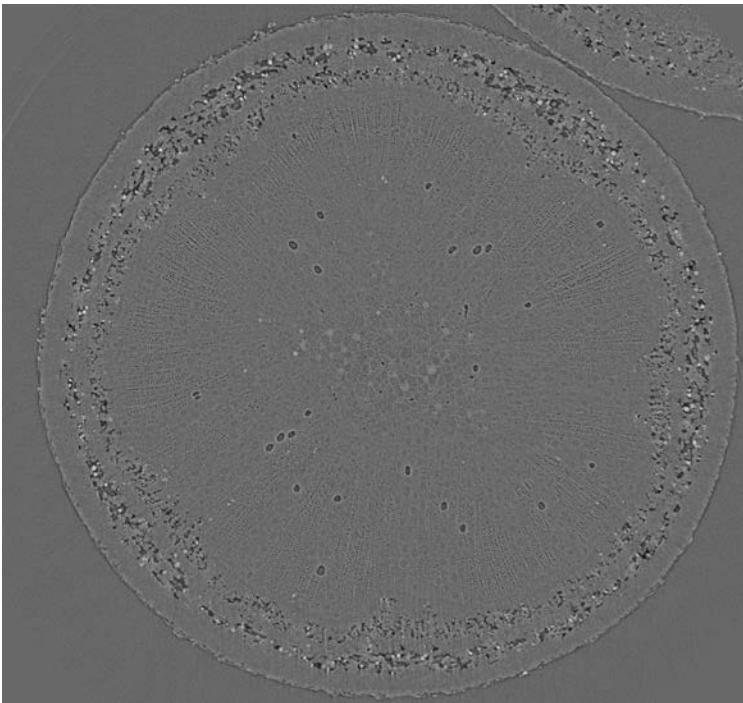
Hydraulic failure is a leading mechanism for drought mortality



Hydraulic failure is a leading meachanisms for drought mortality

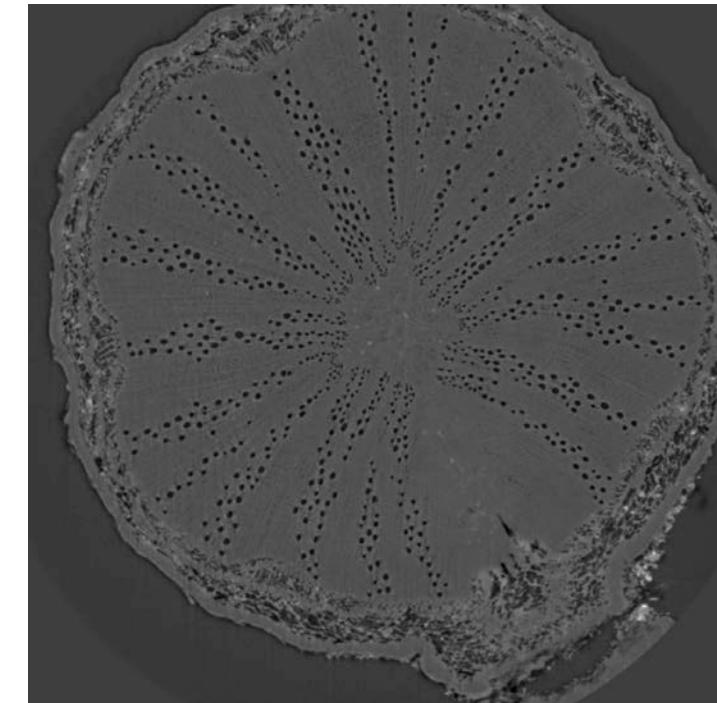
10 days of drought

$\Psi_{\min} = -4.9 \text{ Mpa}$, 10% Cavitation

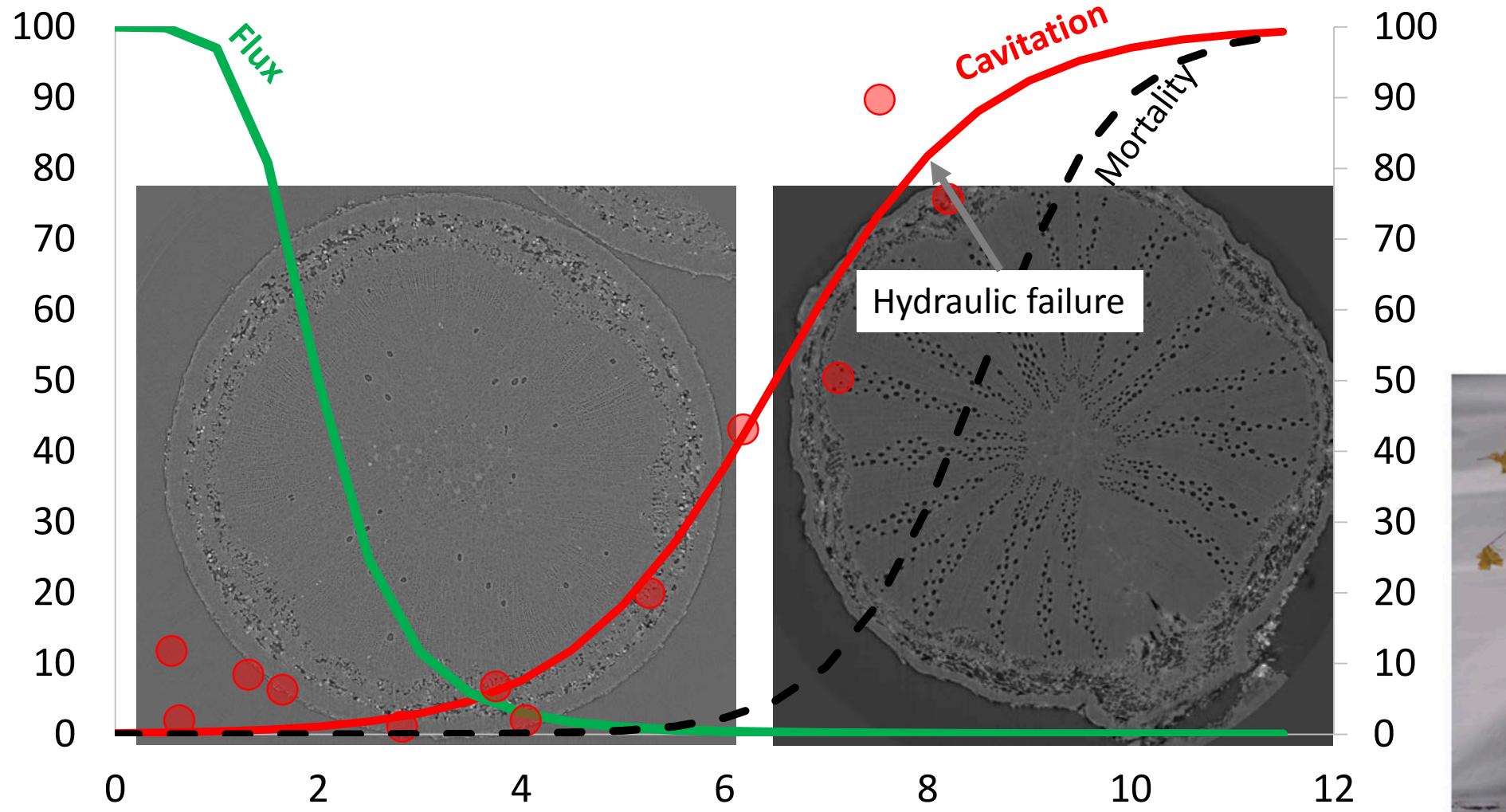


40 days of drought

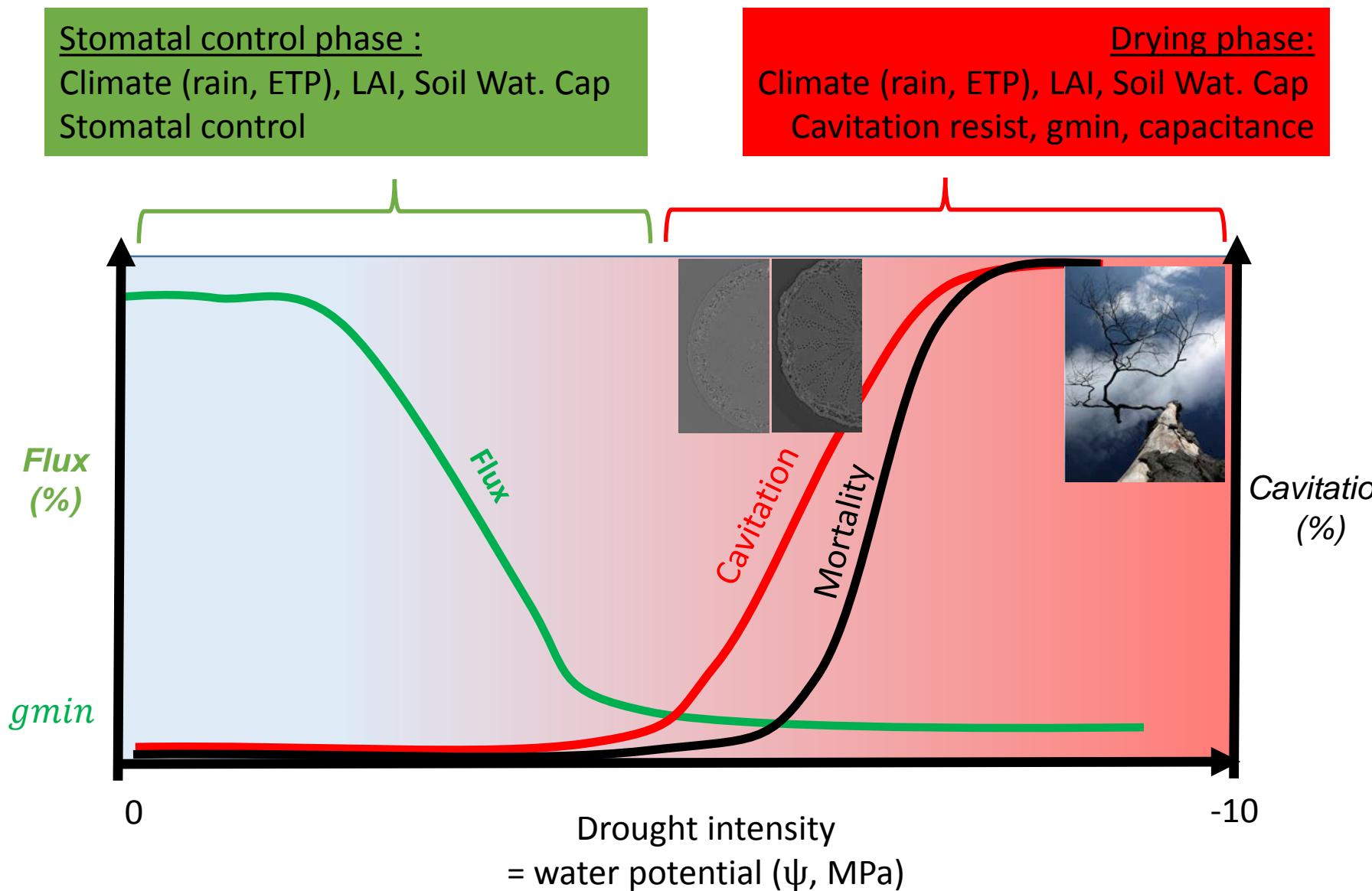
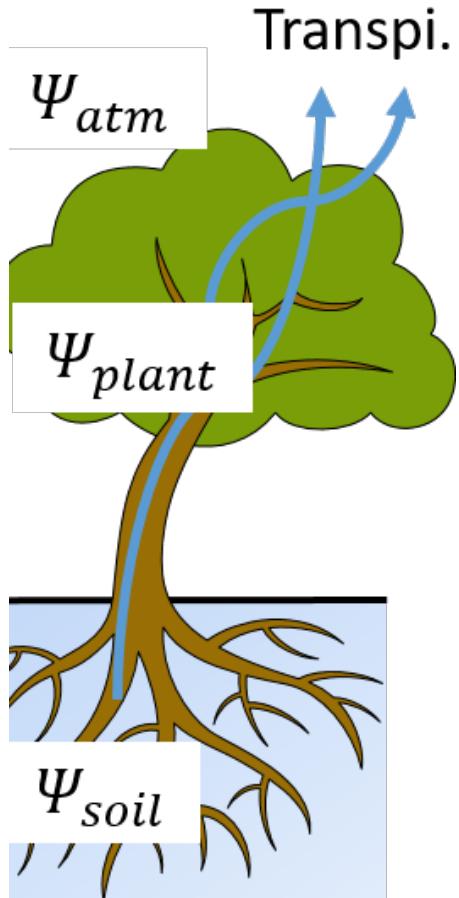
$\Psi_{\min} = -8.7 \text{ Mpa}$, 90% Cavitation



Hydraulic failure is a leading mechanism for drought mortality



Mechanisms behind hydraulic failure



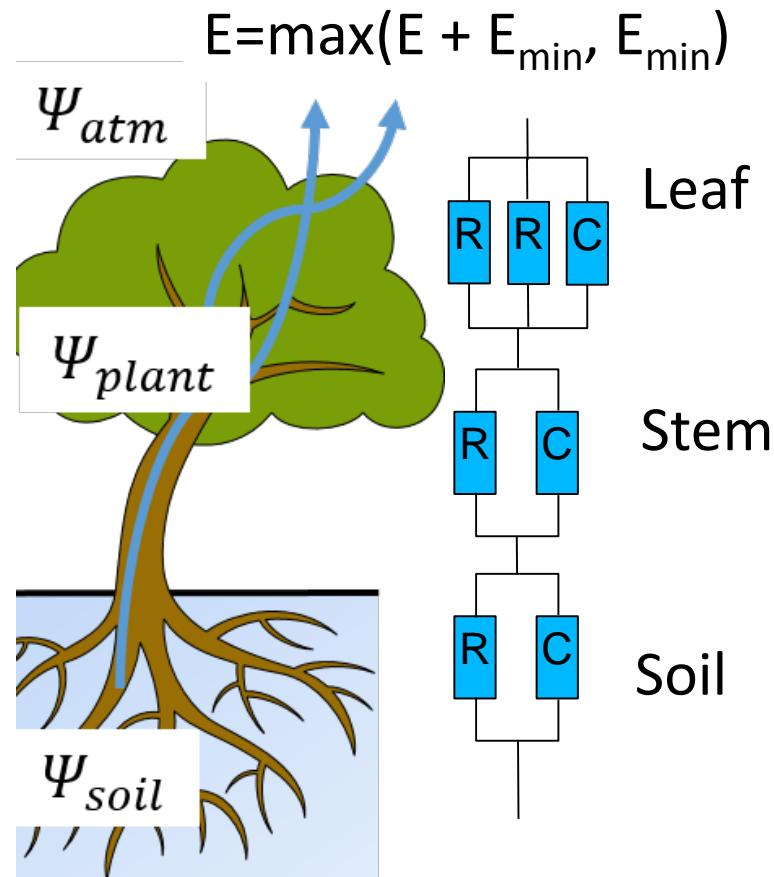
SurEau a mechanistic model for hydraulic failure

Parameters are traits

Leaf area
gs, gmin
Stomata regulation (PV curves)

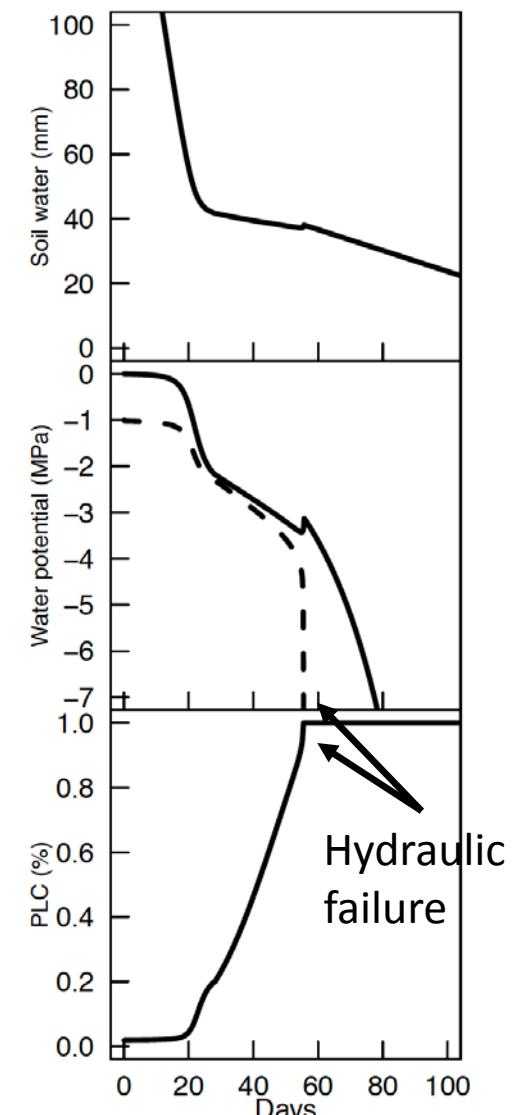
Cavitation resistance
Apo and Symp Water volume

Soil volume
Pedo transfer function
Van-Genuchten 1980 equations
Campbell 1954



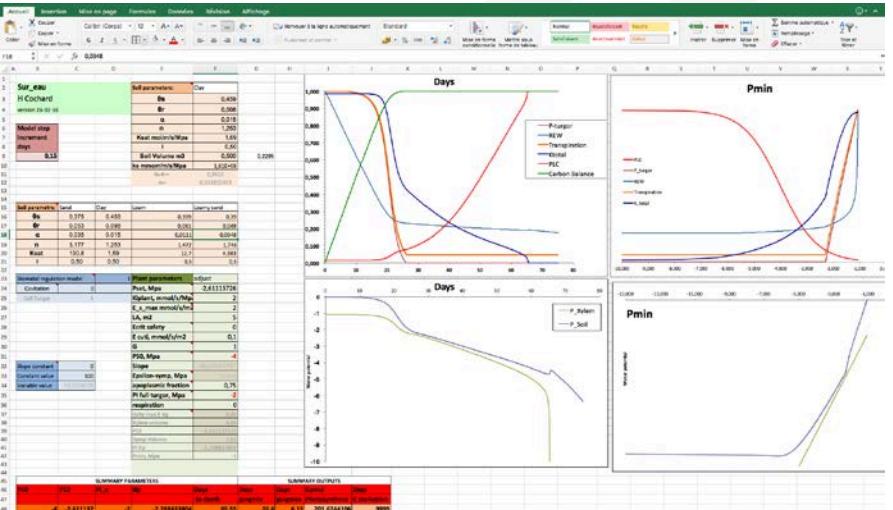
$$\Psi_{plant} = \Psi_{soil} * E / K_{plant}$$

Outputs are s/hourly/daily:

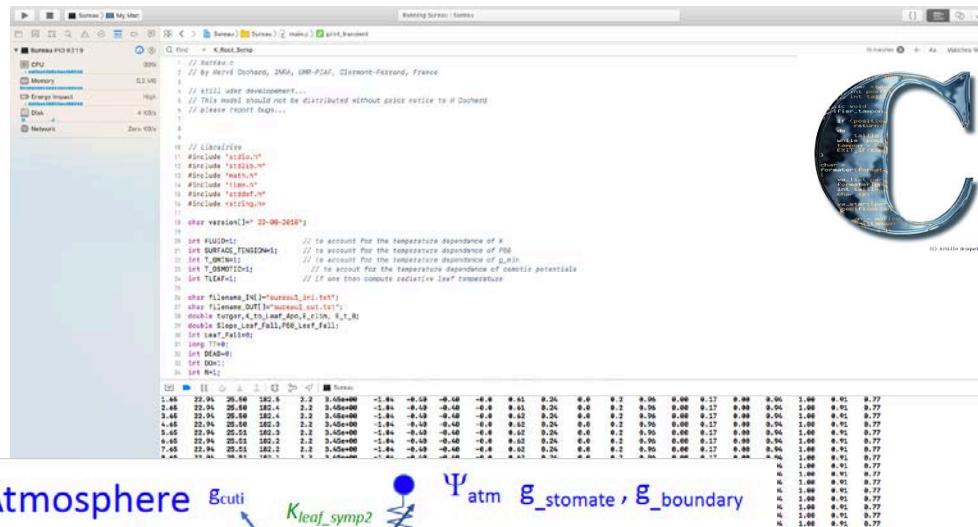


Different versions of SurEau: @ plant scale

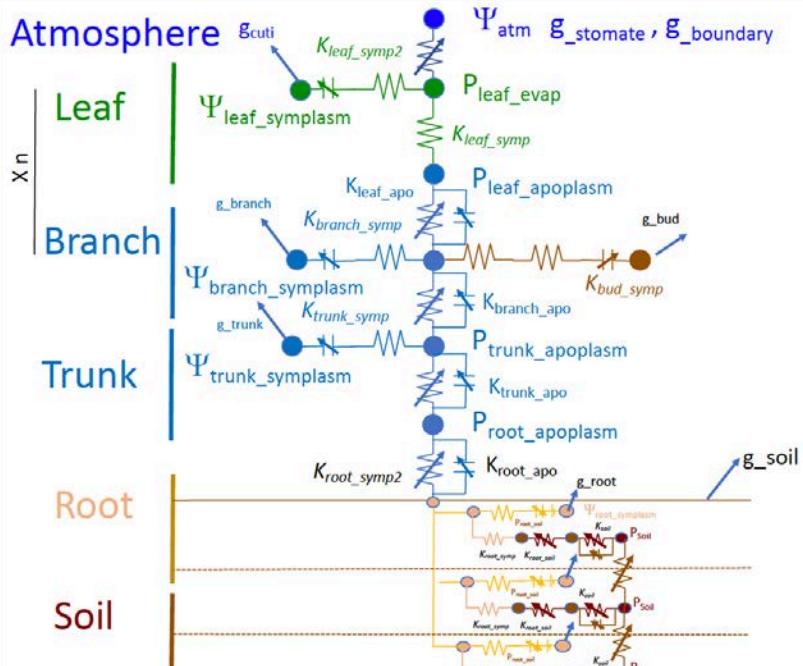
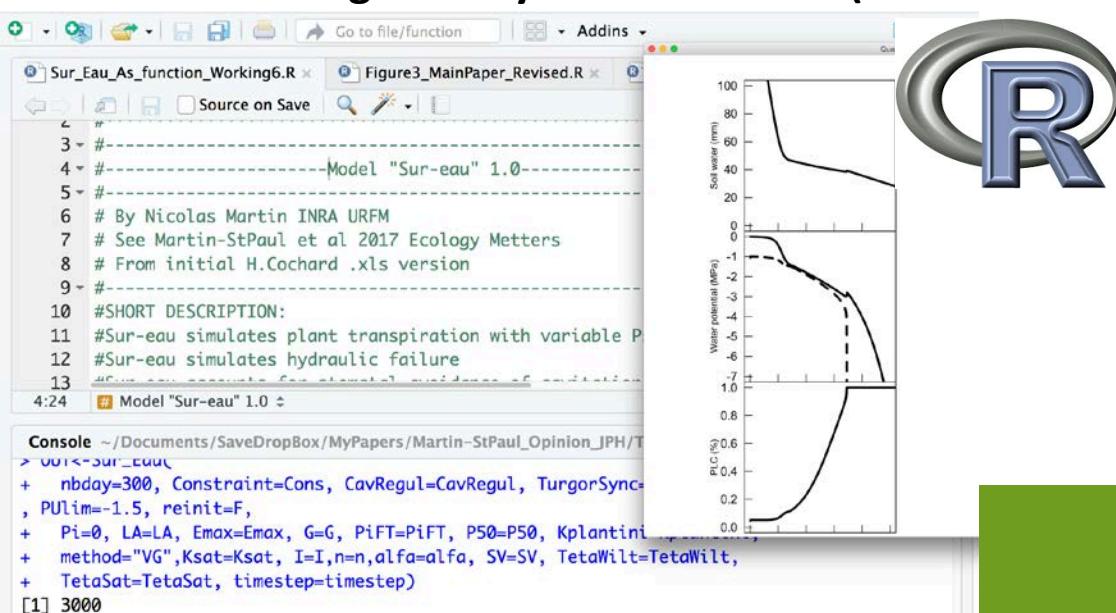
First Excel version one segment by Hervé Cochard (dt=d)



C version multi-segment by Hervé Cochard (dt=s/100)

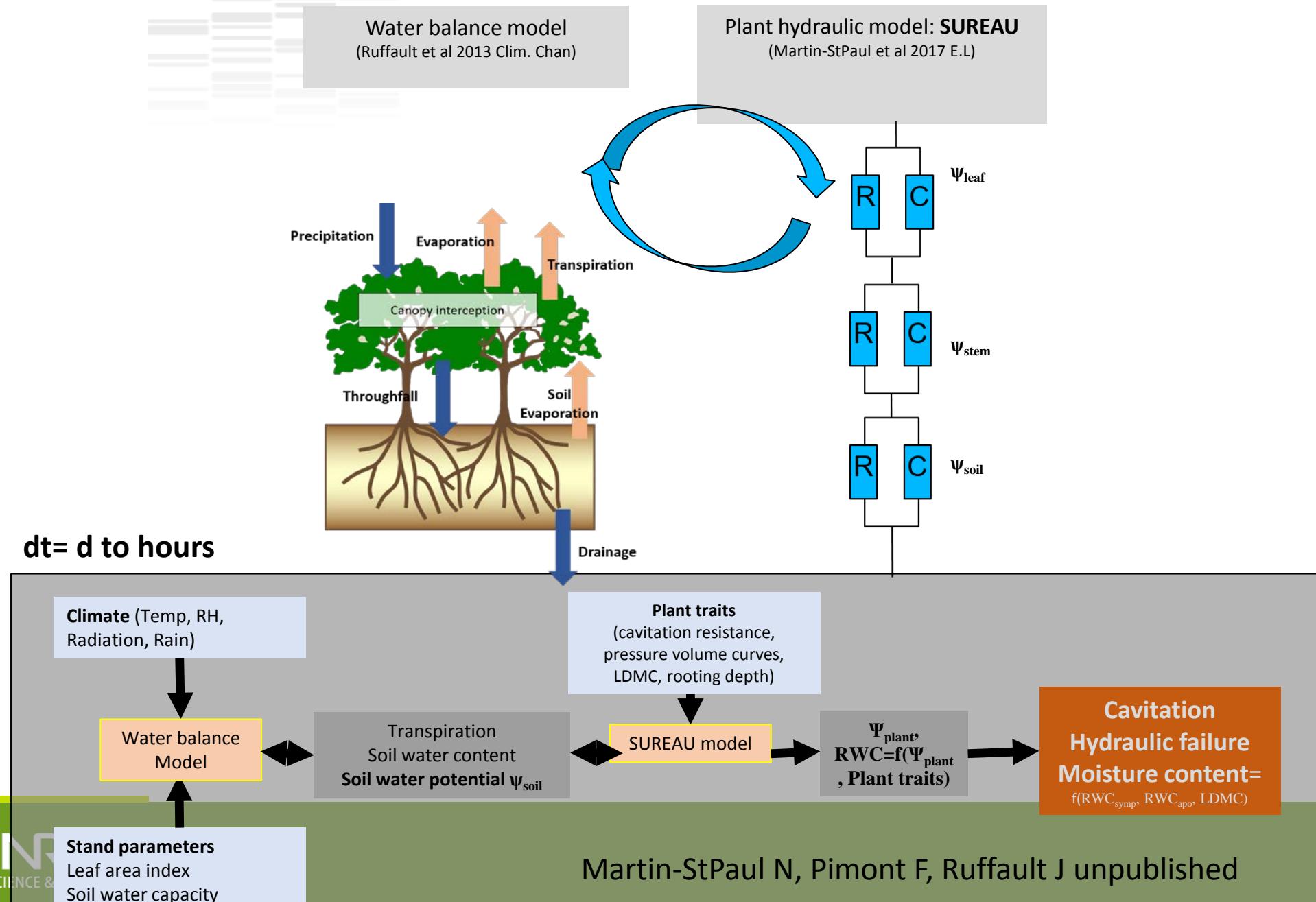


R version one segment by Nicolas Martin (dt= d to hours)

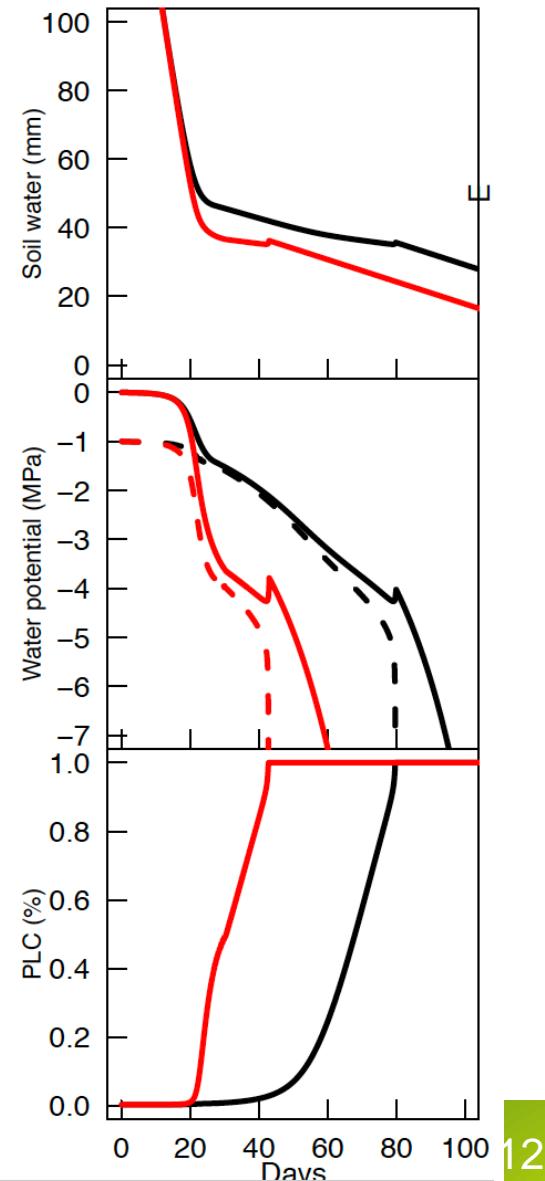
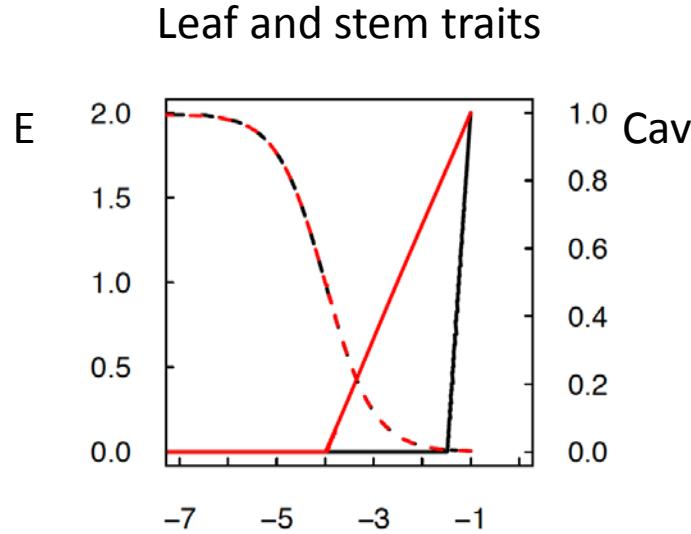
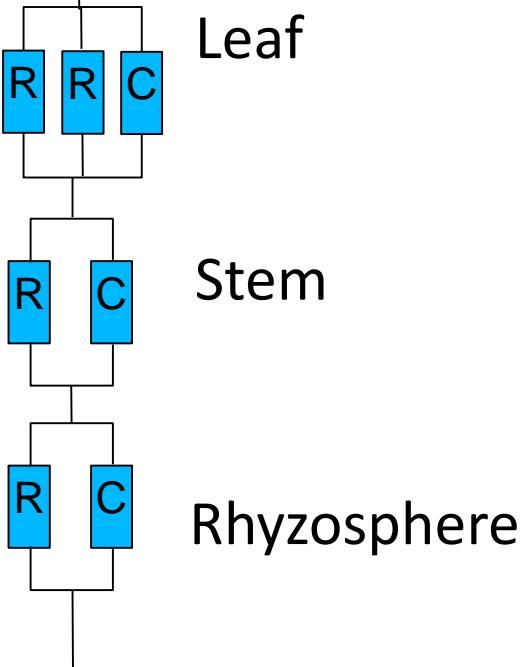
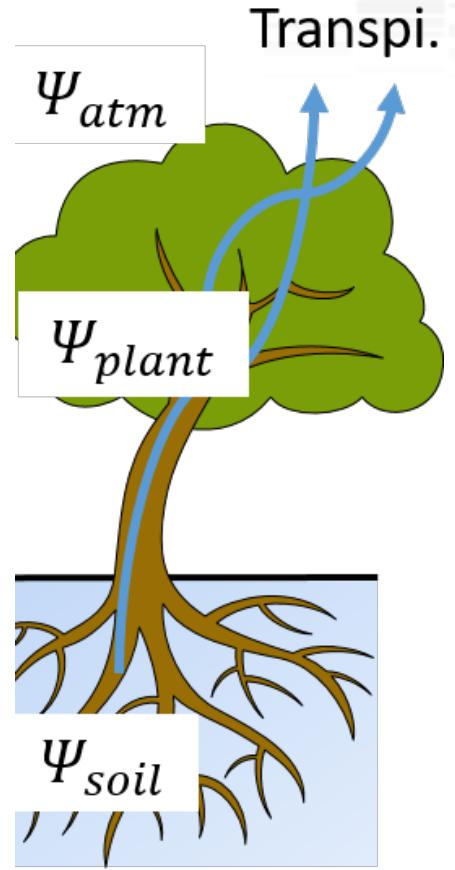


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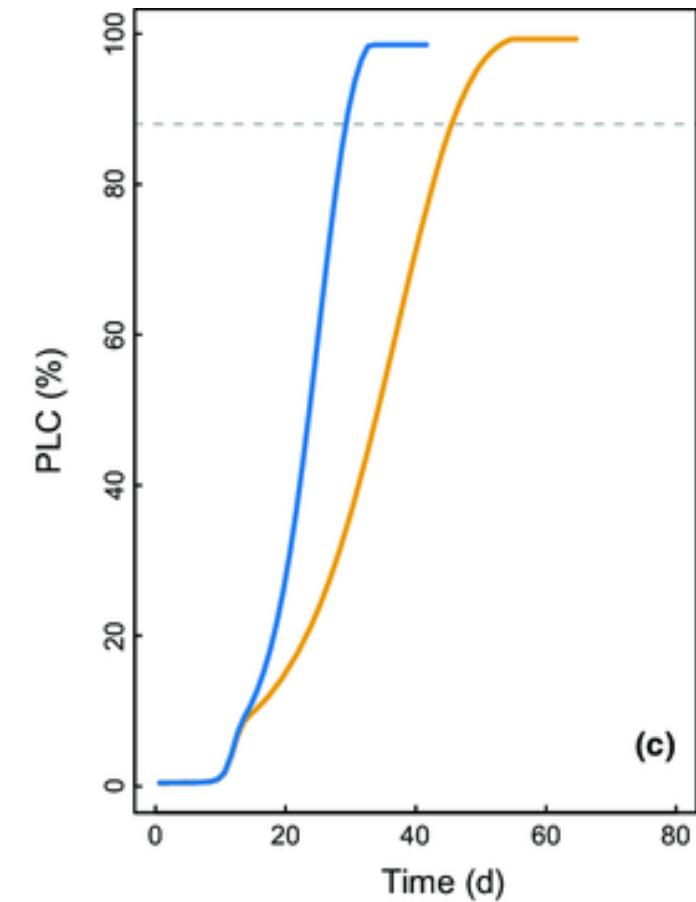
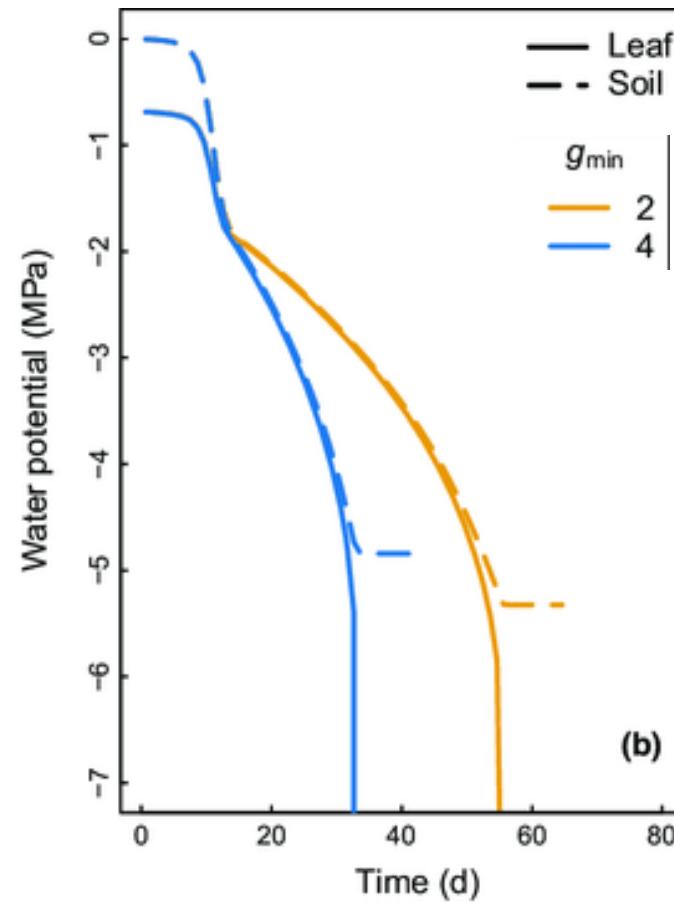
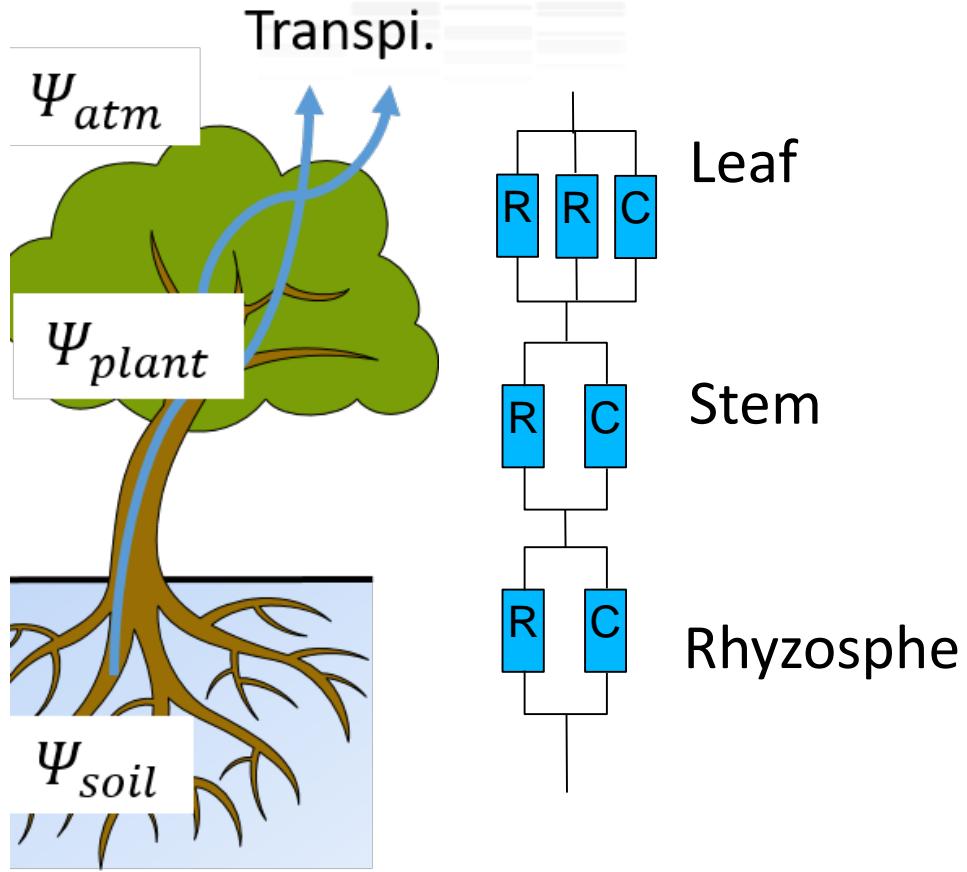
Different version of SurEau: simple version @Ecosystem-scale



Sensitivity to key hydraulic traits: cavitation resistance and gs closure



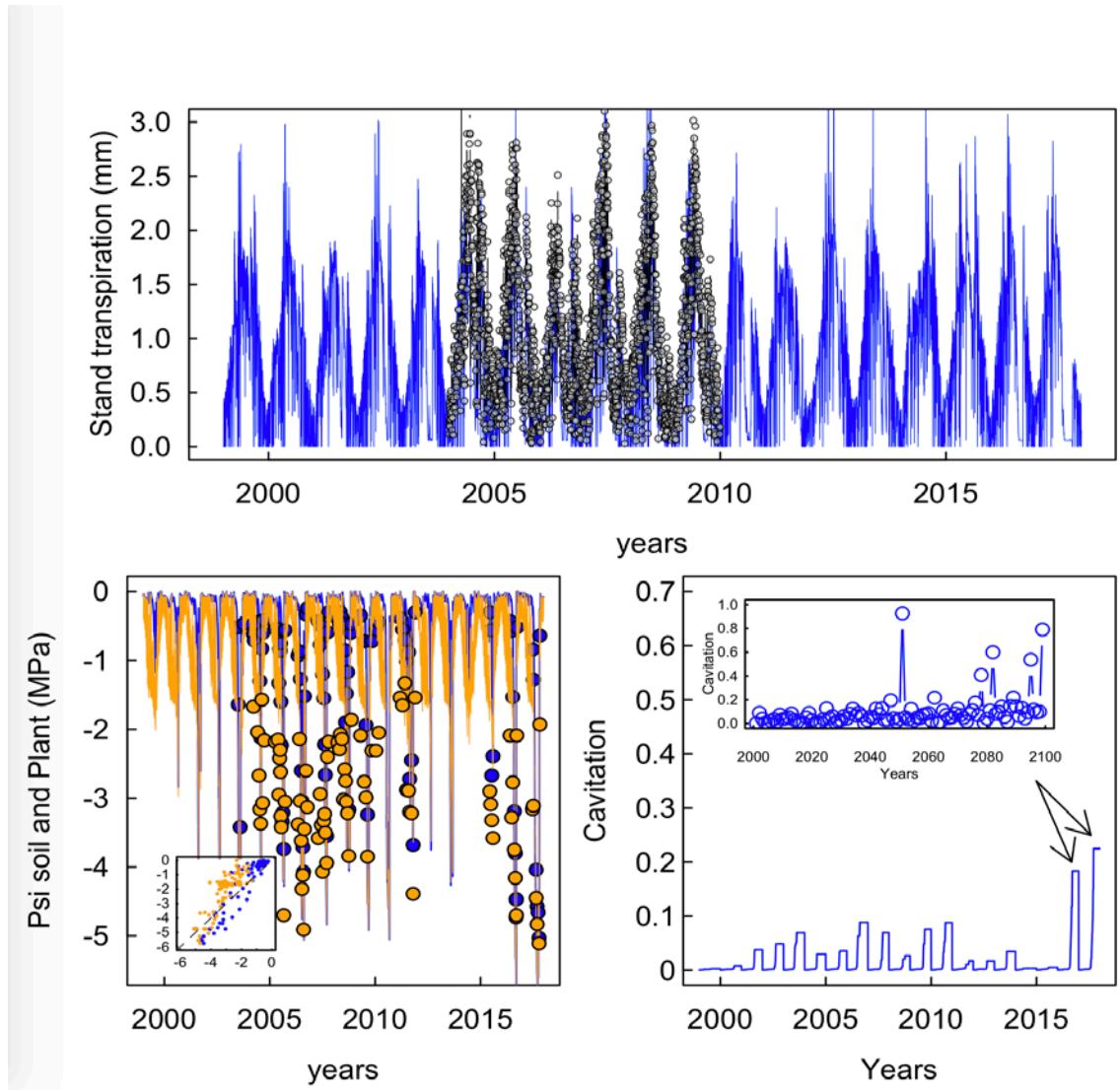
Sensitivity to key mechanistic traits: g_{min} (minimum conductance)



Examples of application: Mortality on the ICOS site Puéchabon

ICOS

INTEGRATED
CARBON
OBSERVATION
SYSTEM



Examples of application: sylviculture *Cedrus atlantica*

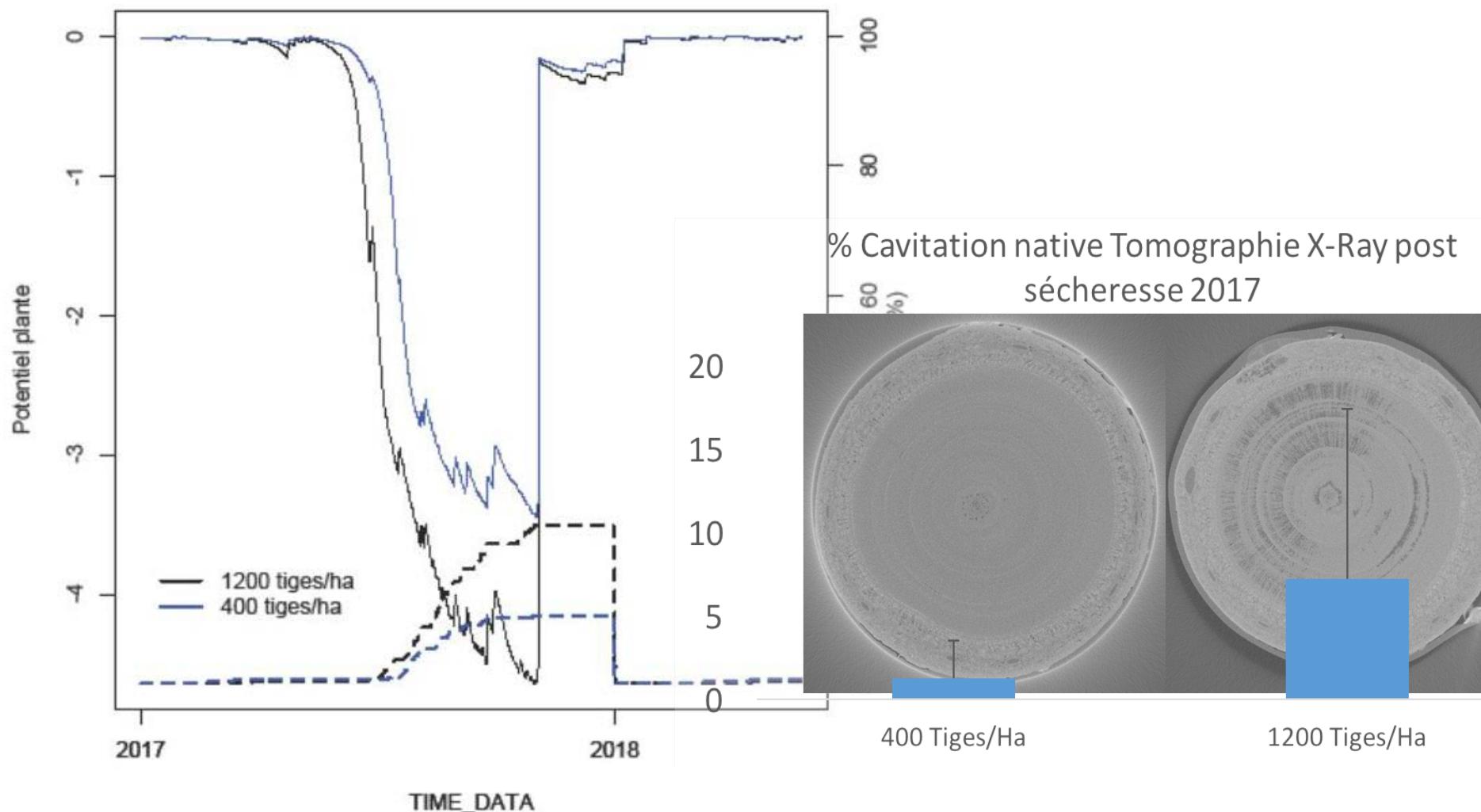
400 tiges/ha

LAI=2.4

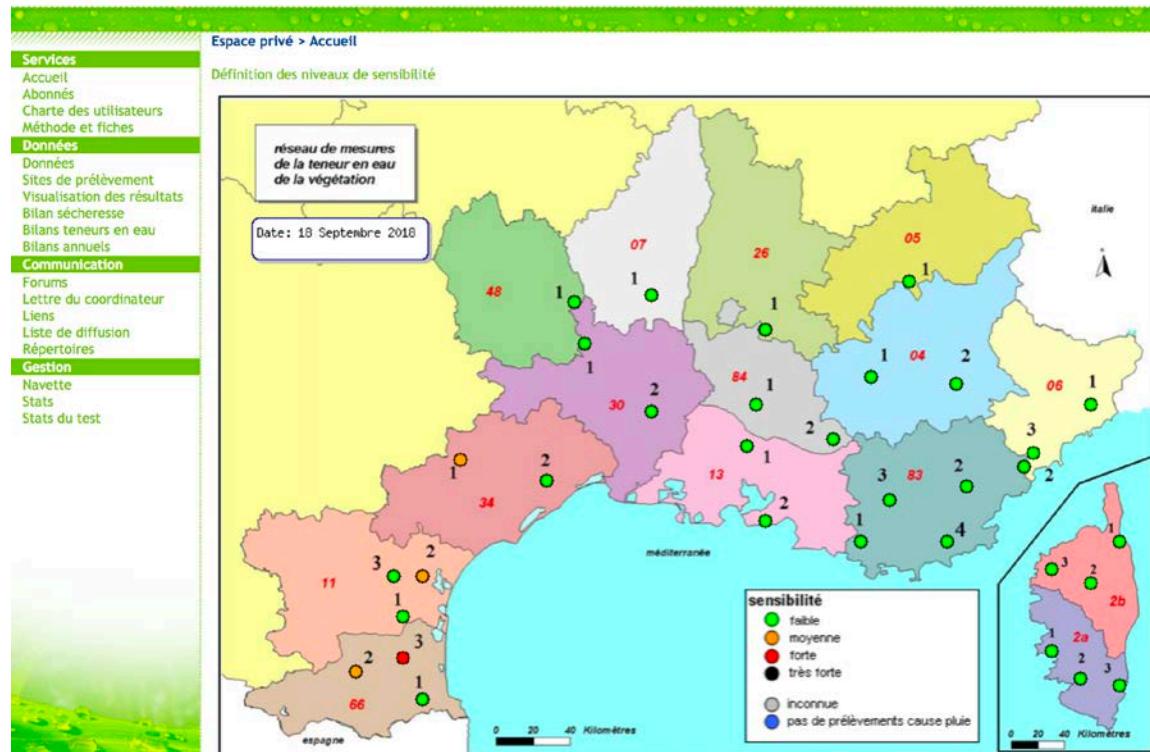


1200 tiges/ha

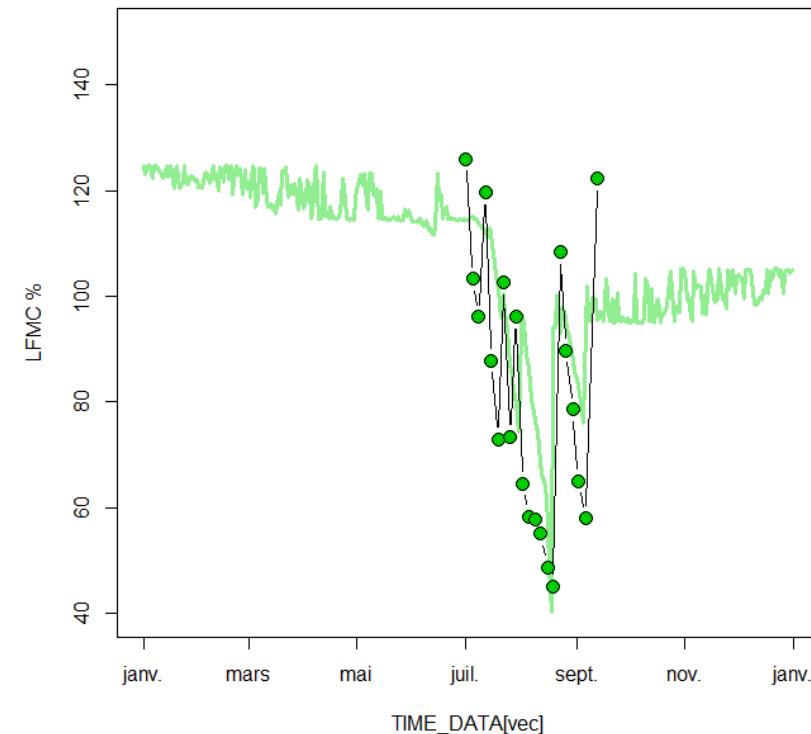
LAI=3



Examples of application: simulating fuel moisture content



rosmarinus 2010 D13S1



Rooting depth = 1 m
P50= -10.5 MPa
Pi0= -3MPa
LDMC= 400 mg/mg

Martin-StPaul N, Pimont F, Ruffault J, Dupuy JL

Examples of application: distribution area at national scale

Quercus ilex

PiTlp = -3.5

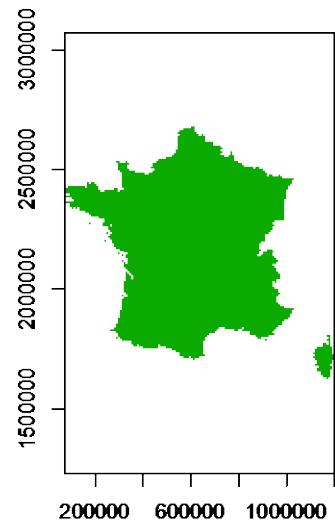
P50=-6

Gmin=4

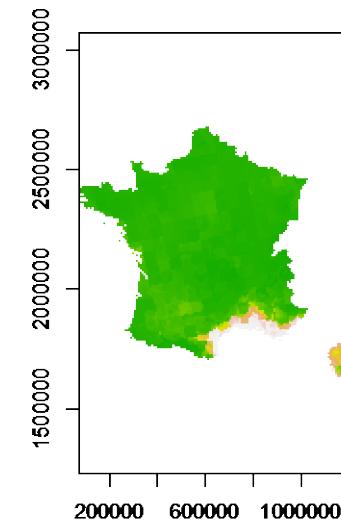
LAI=3

AWC=160

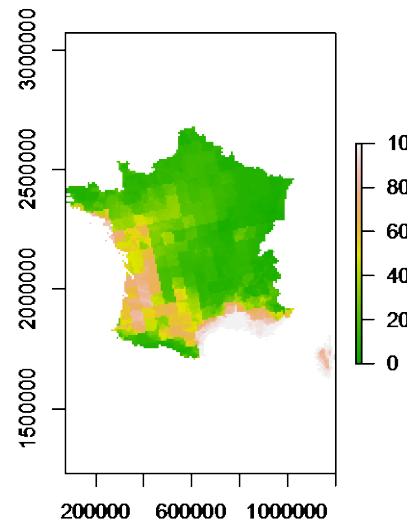
1990 (SAFRAN)



2060 (MPI-RCA4)



2090 (MPI-RCA4)



Fagus sylvatica

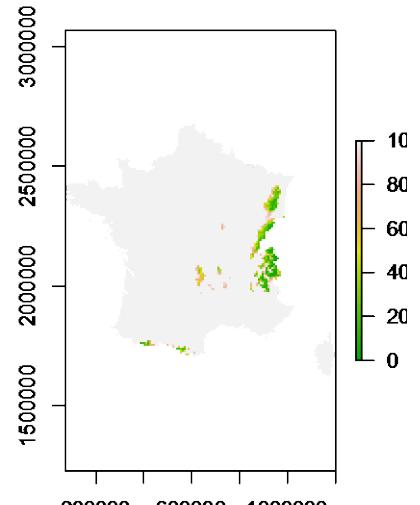
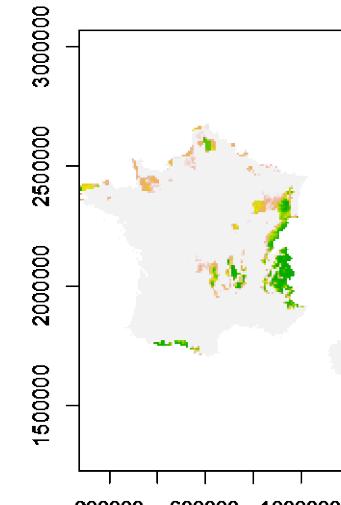
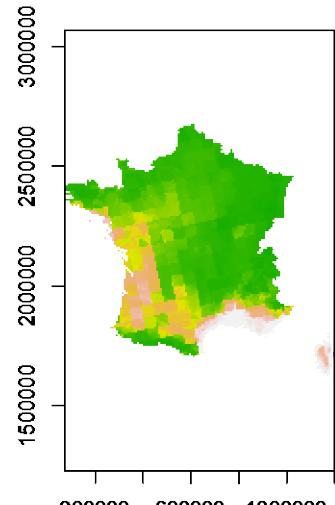
PiTlp = -2 MPa

P50= -3.2 MPa

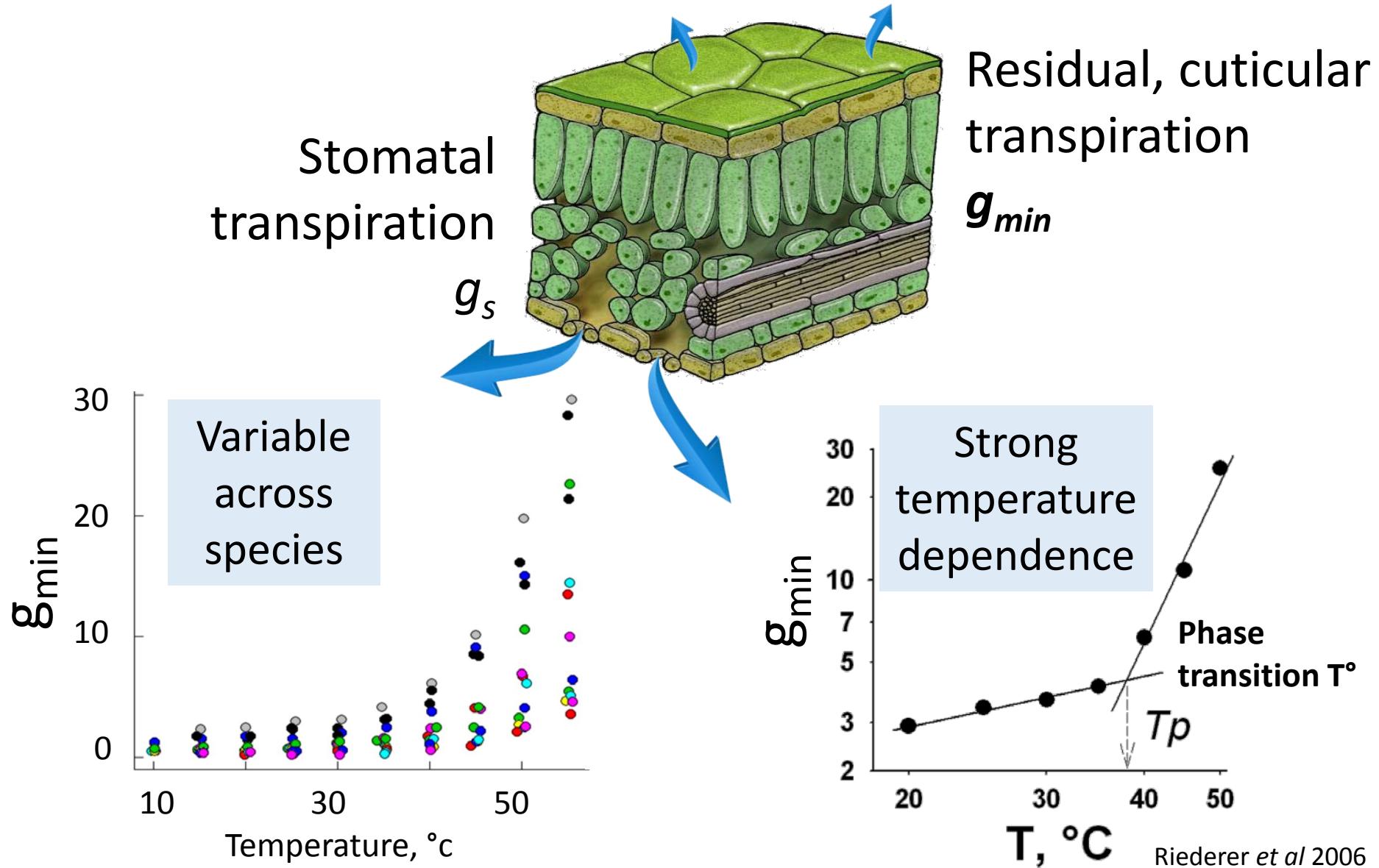
Gmin= 8 mmol/m²/s

LAI= 5 m²/m²

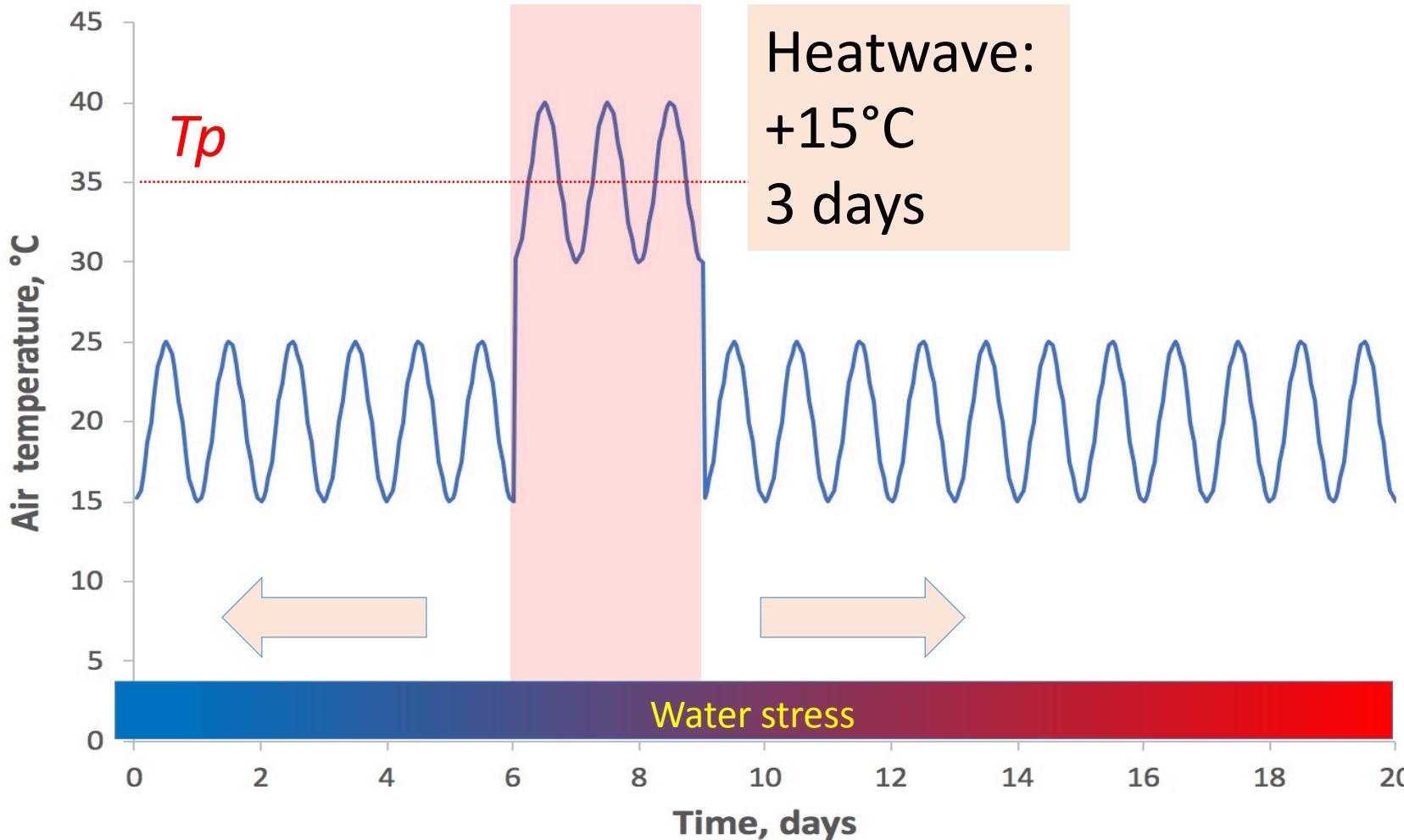
AWC= 160 mm



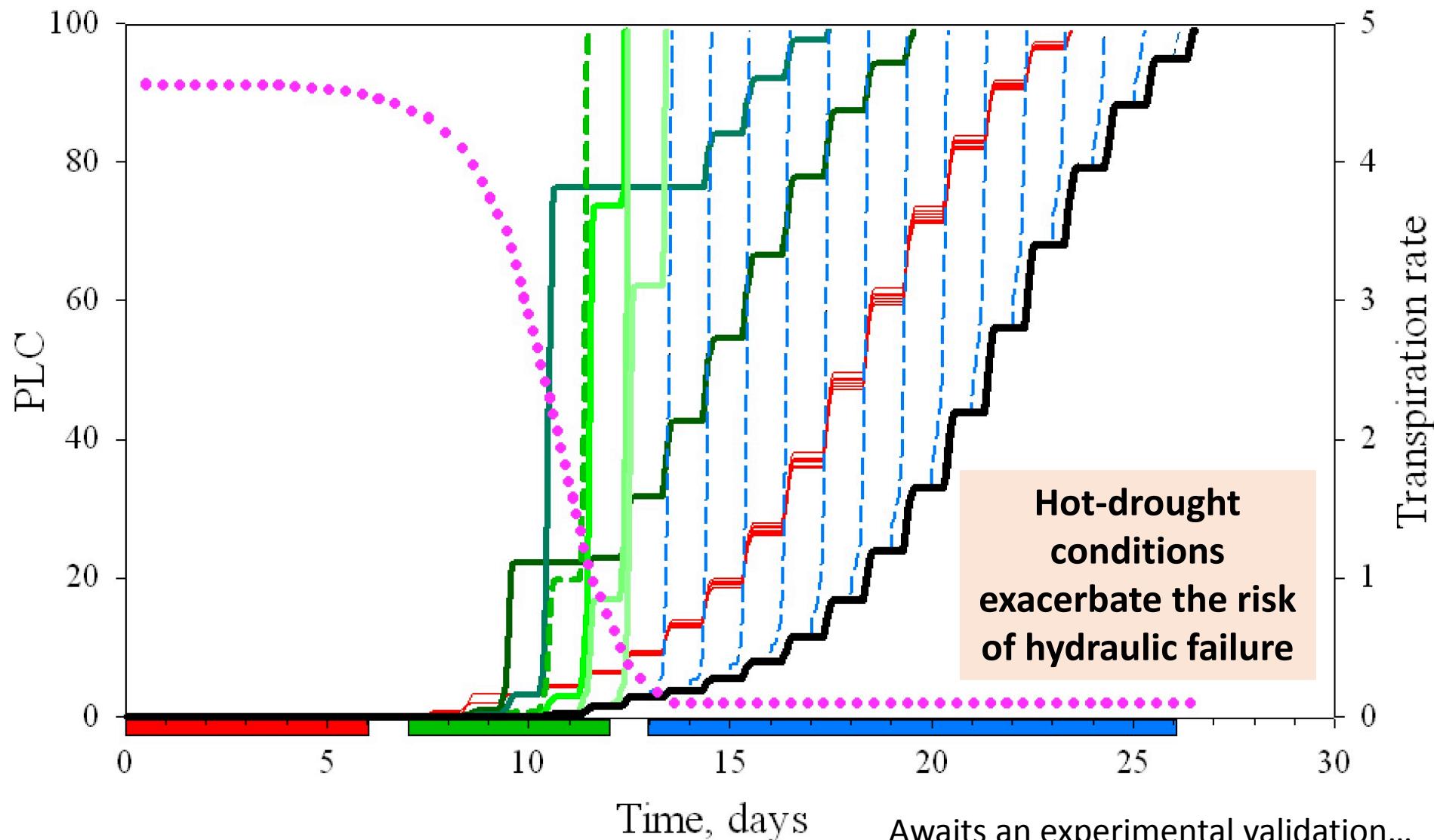
Highlighting the functionnal significance of leaf cuticle conductance (g_{min})



Modelling the effect of heatwaves on hydraulic failure



Modelling the effect of heatwaves on hydraulic failure



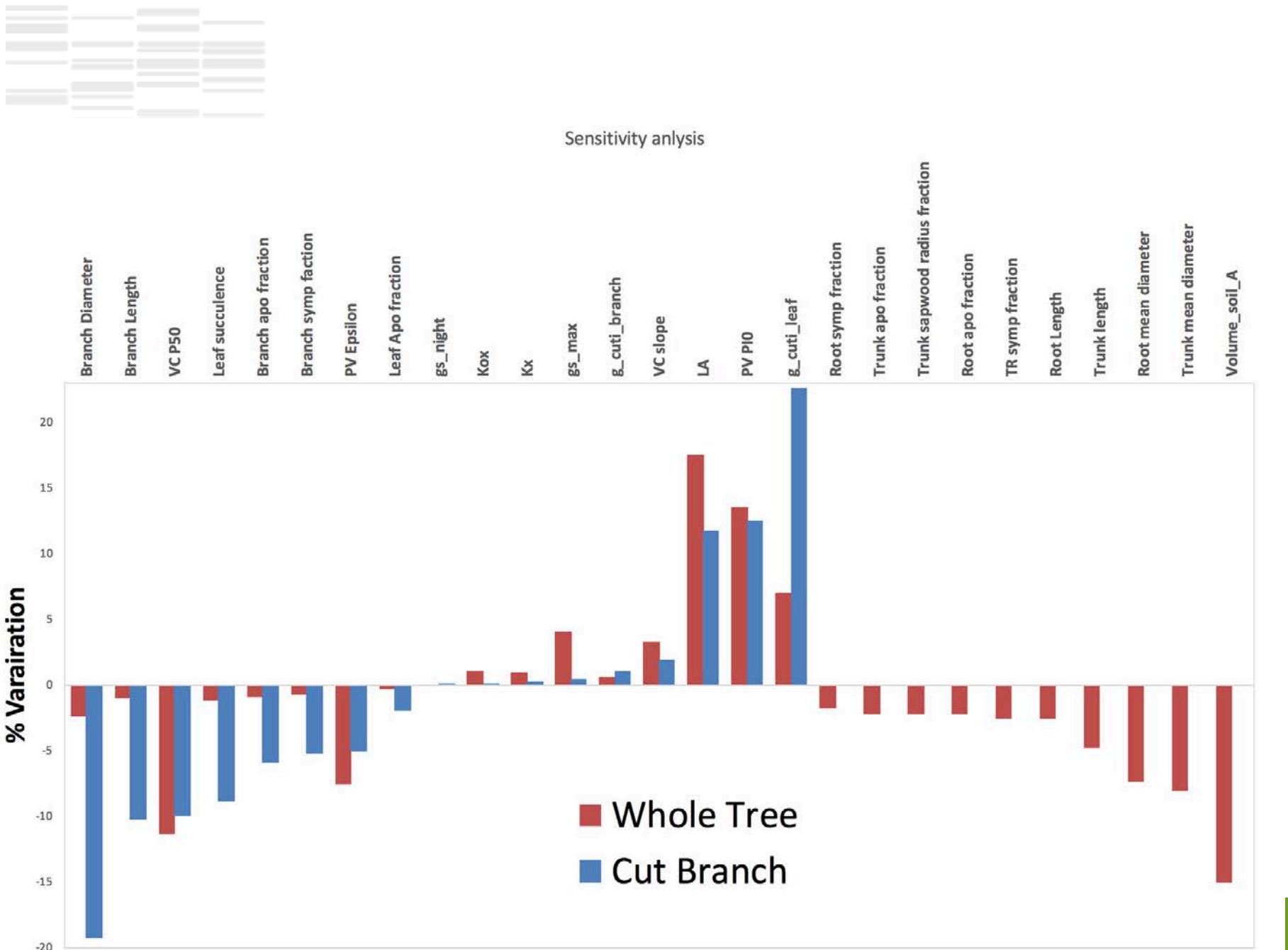
A wide-angle photograph taken from the ground looking up through a dense canopy of tall trees. The sky is visible through the gaps in the leaves. The perspective is from a low angle, looking up at the towering tree trunks and spreading branches.

Thank you

[@NMartin_StPaul](#)

<http://herve.cochard.free.fr/>

[@PlantHydraulics](#)



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