Les risques associés au stress hydrique pour les forêts de l'arc méditerranéen

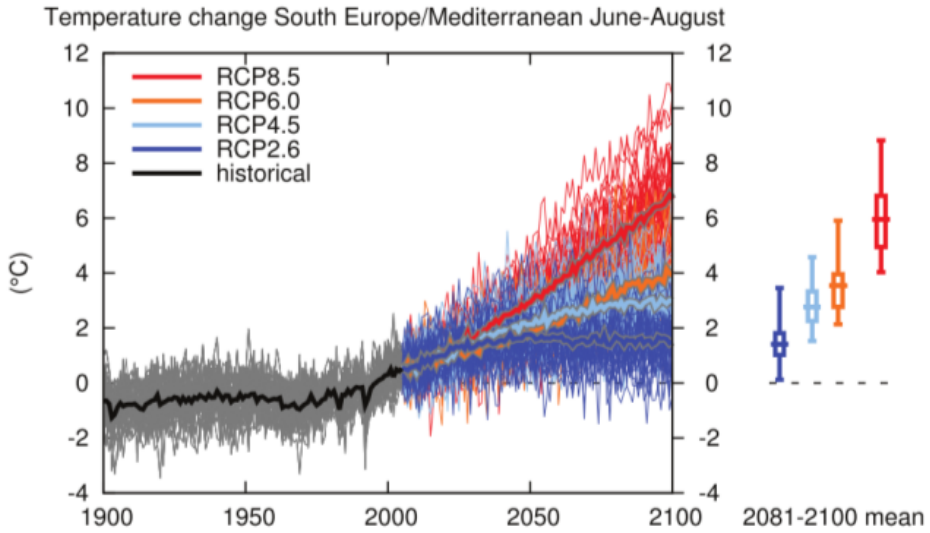
Hendrik Davi

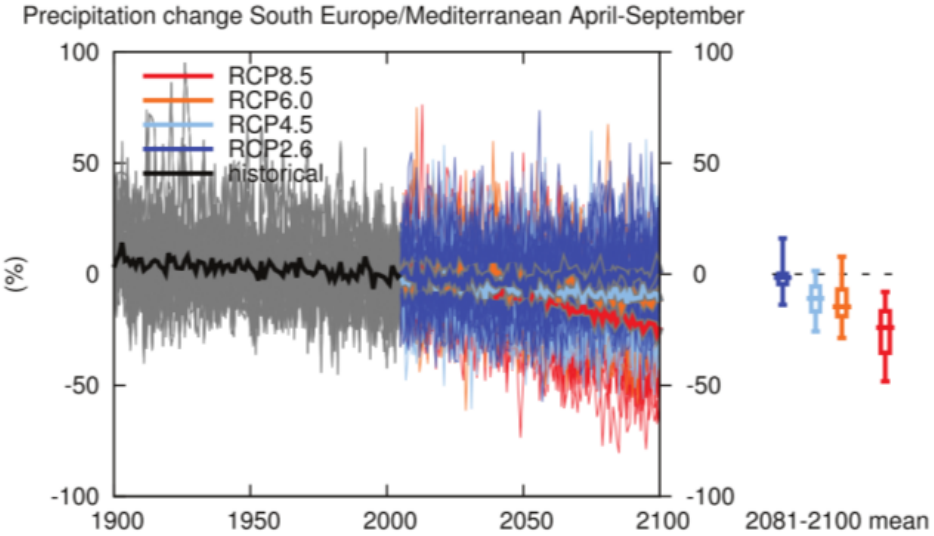
Nicolas Martin

Guillaume Simioni

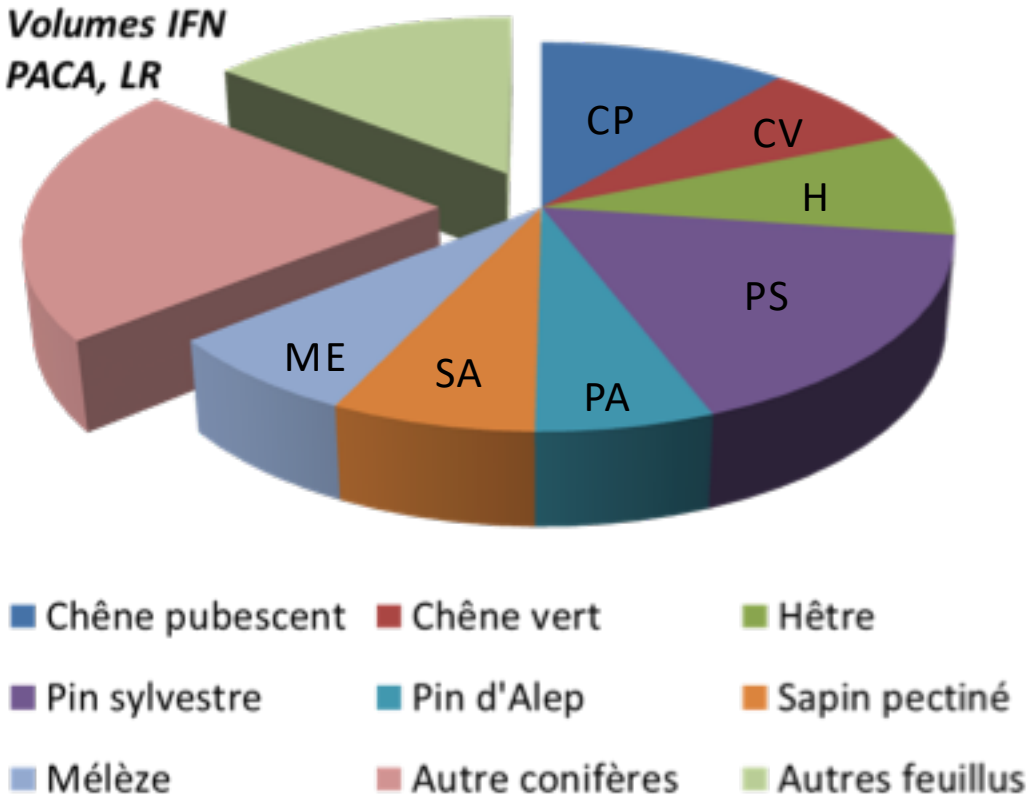
PLAN

1. Introduction
2. Stress hydrique
3. Croissance
4. Mortalité
5. Séquestration de carbone
6. Feux
7. Conclusion





↗ 0.88°C depuis 1860
↘ 23 mm depuis 1902
↗ fortes sécheresses depuis 500 ans



Étage méditerranéen: Pin d'Alep, Chêne vert

Étage supra-méditerranéen: Chêne pubescent, Cèdre

Étage montagnard: Hêtre, Sapin, Pin Sylvestre, Mélèze

Demande évaporative

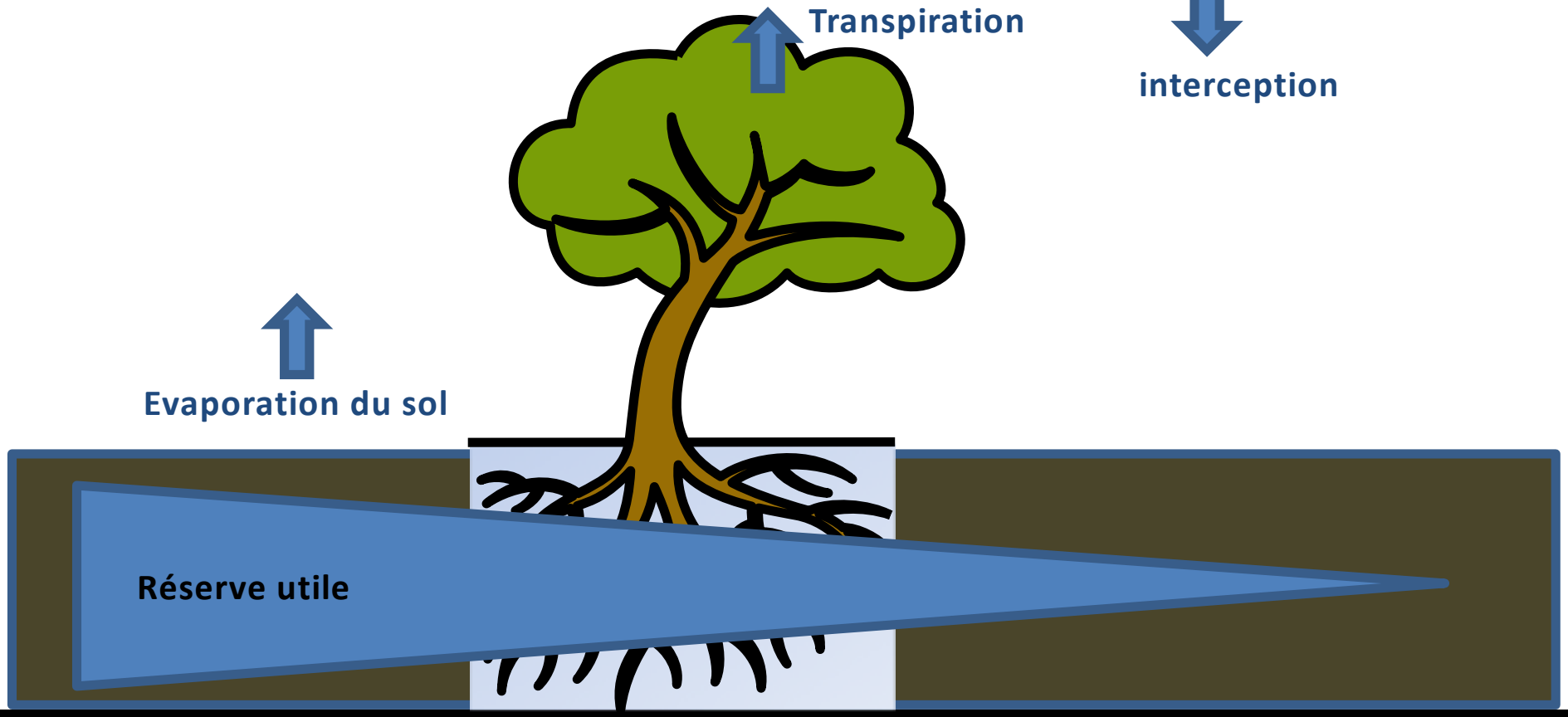
Apport en Eau

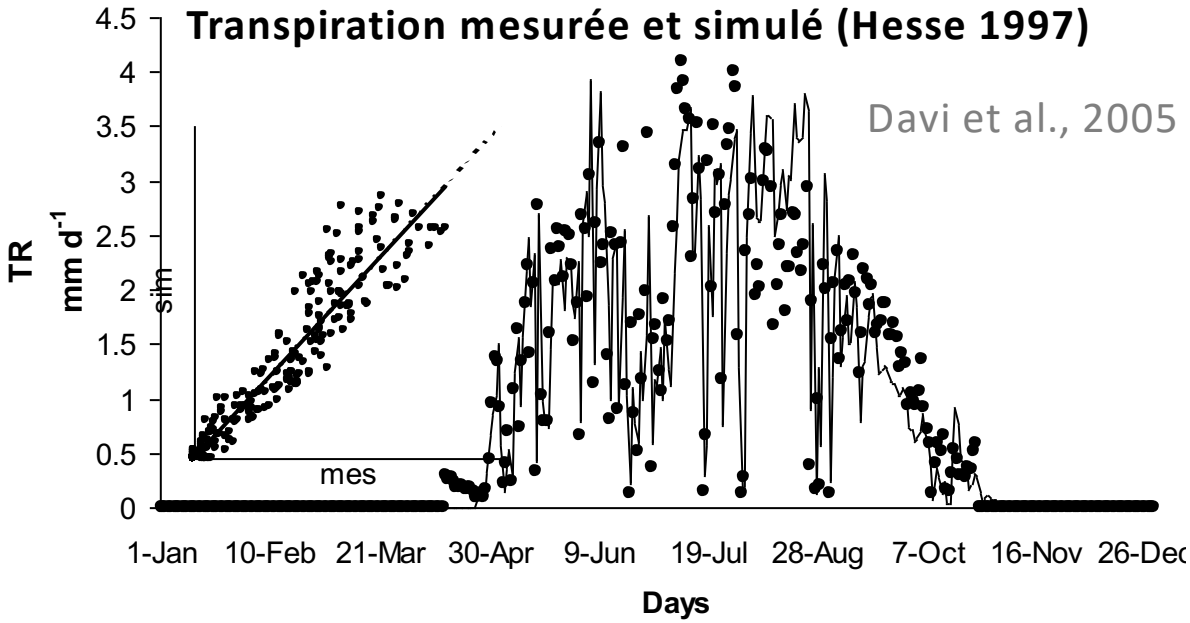
Evaporation du couvert

Transpiration

interception

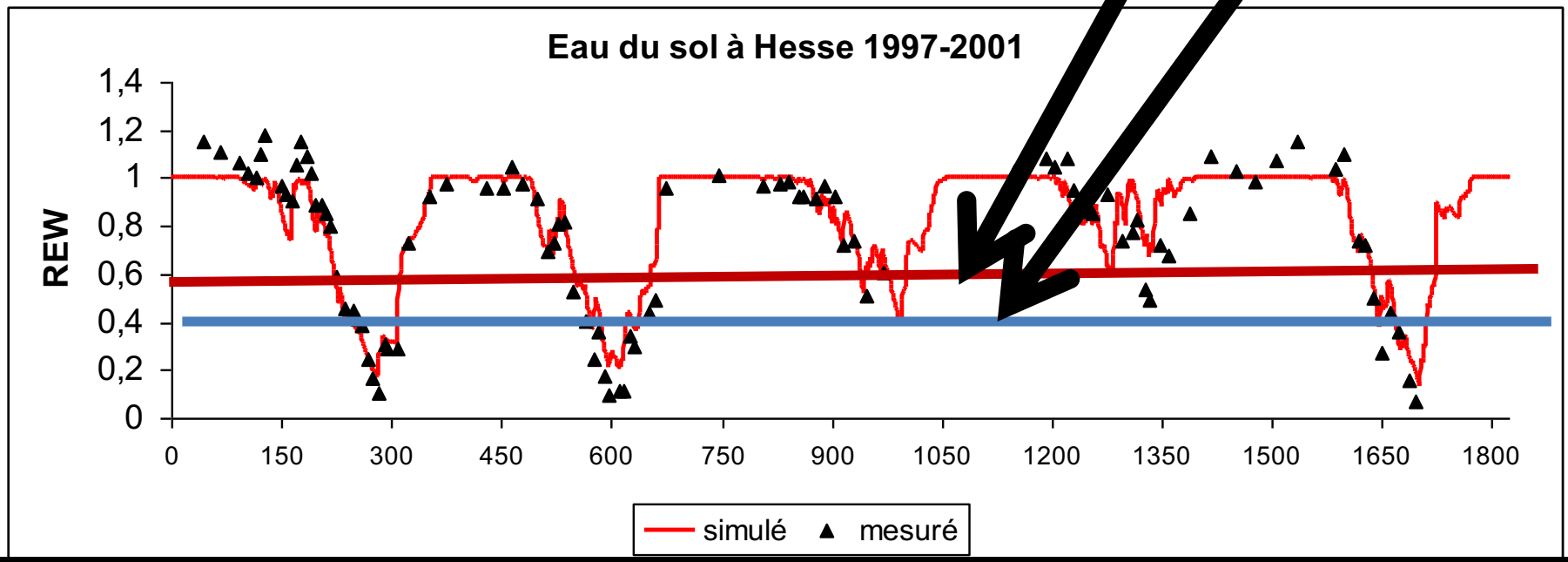
Evaporation du sol

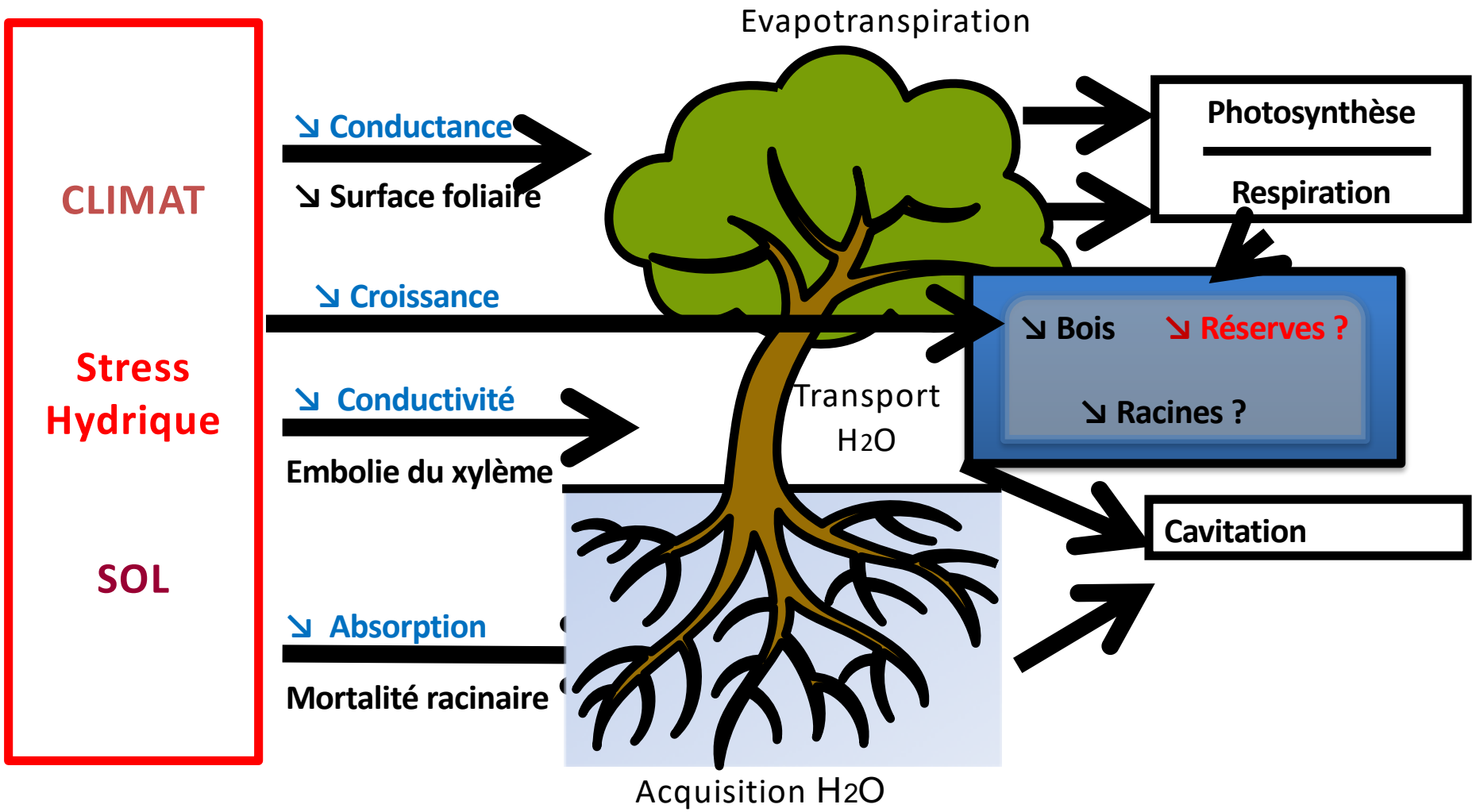


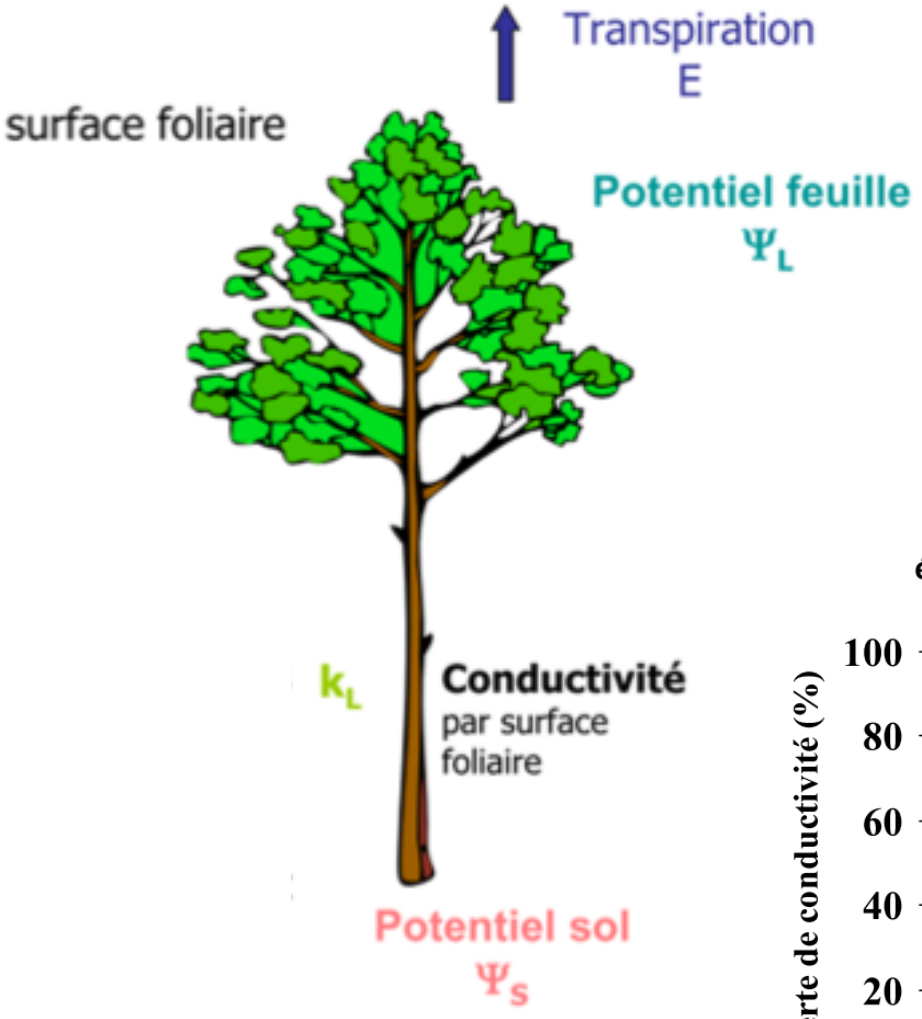


Arrêt croissance

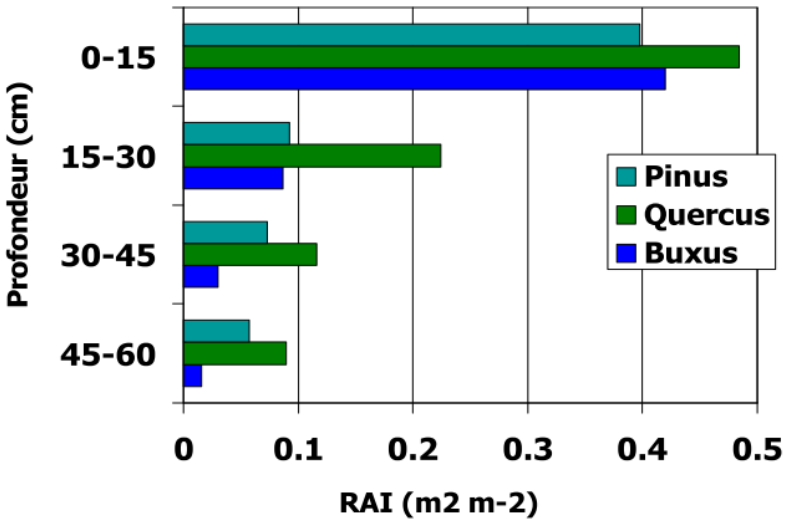
Arrêt photosynthèse



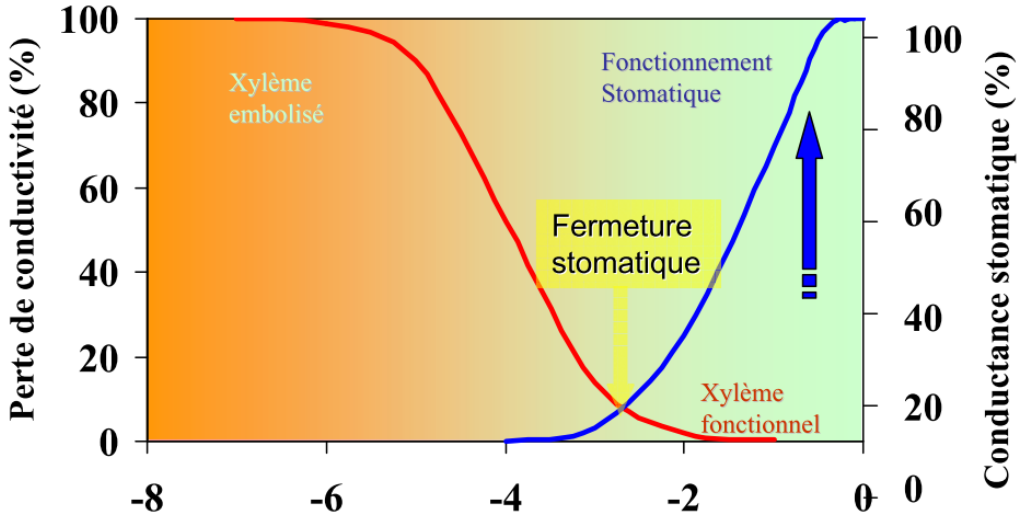

CLIMAT
Stress Hydrique
SOL
Evapotranspiration
↘ Conductance
↘ Surface foliaire
↘ Croissance
↘ Conductivité
Embolie du xylème
↘ Absorption
Mortalité racinaire
Photosynthèse
Respiration
↘ Bois
↘ Réserves ?
↘ Racines ?
Transport H2O
Cavitation
Acquisition H2O

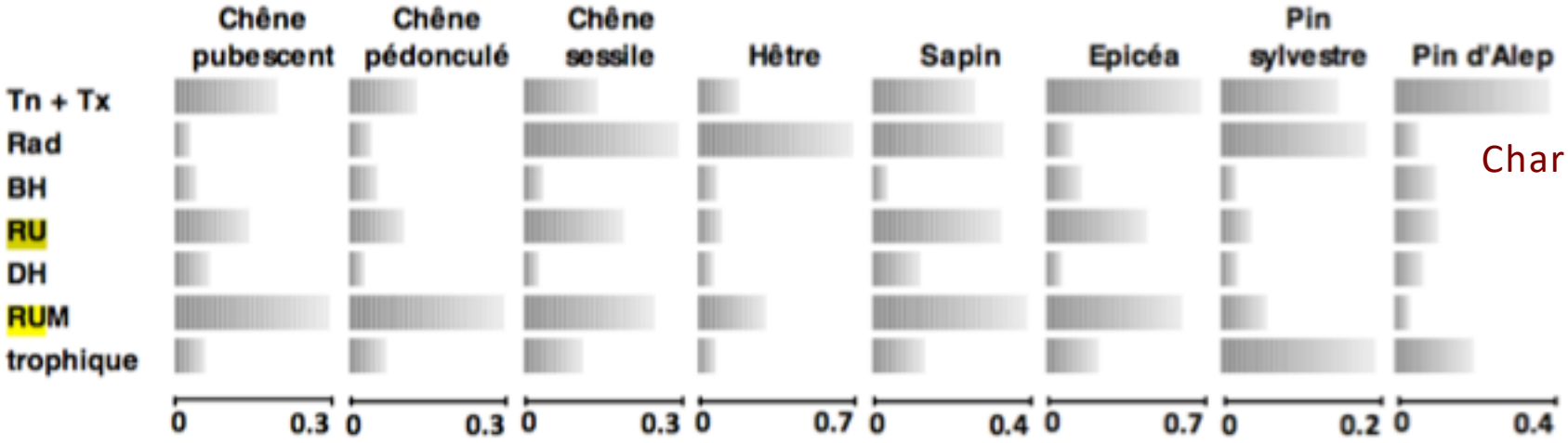


Profils d' Enracinement



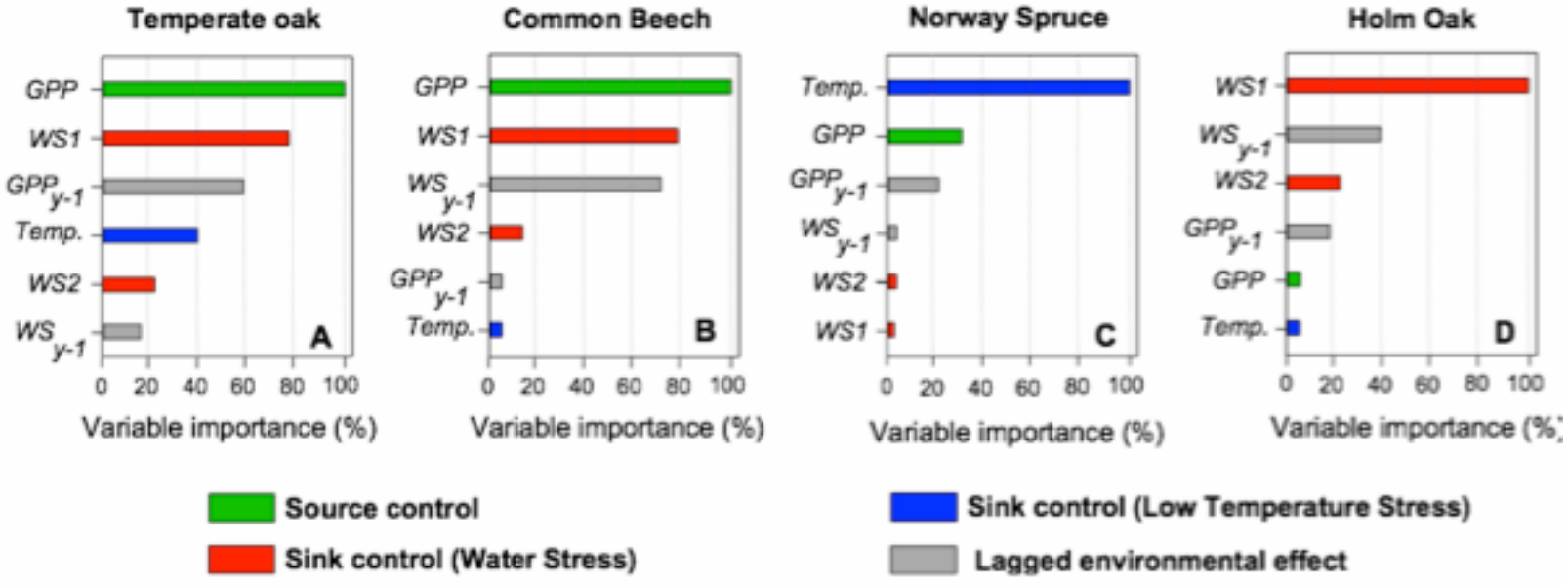
évolution de la conductance stomatique et de la conductivité au cours du déssèchement





Charru 2012

Tableau 3.4 : Contributions relatives des grandes familles de variables à l'explication de la productivité

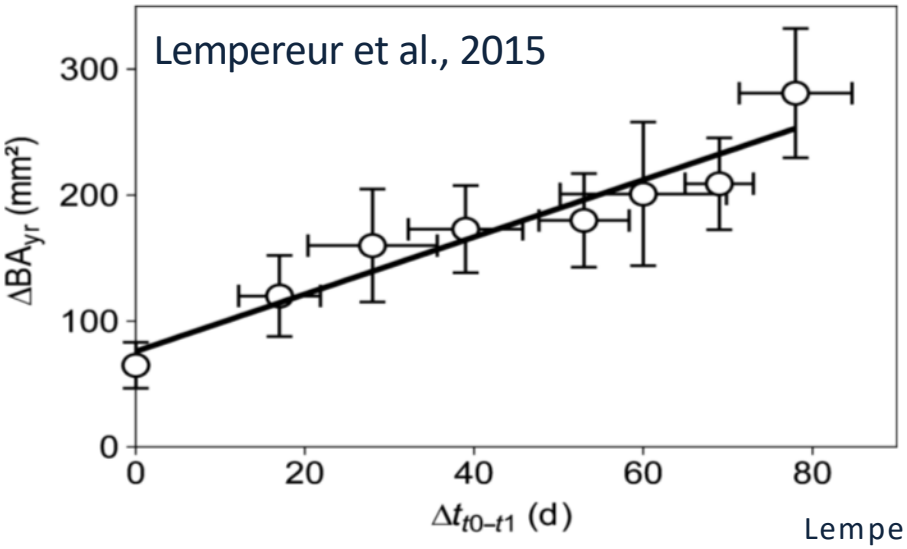


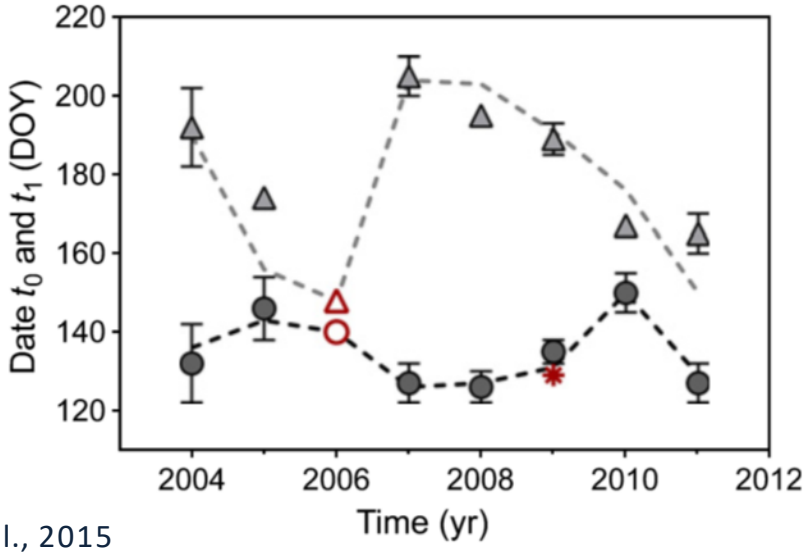
Guillemot 2015 Model CASTANEA

Phénologie de la croissance du Chêne vert

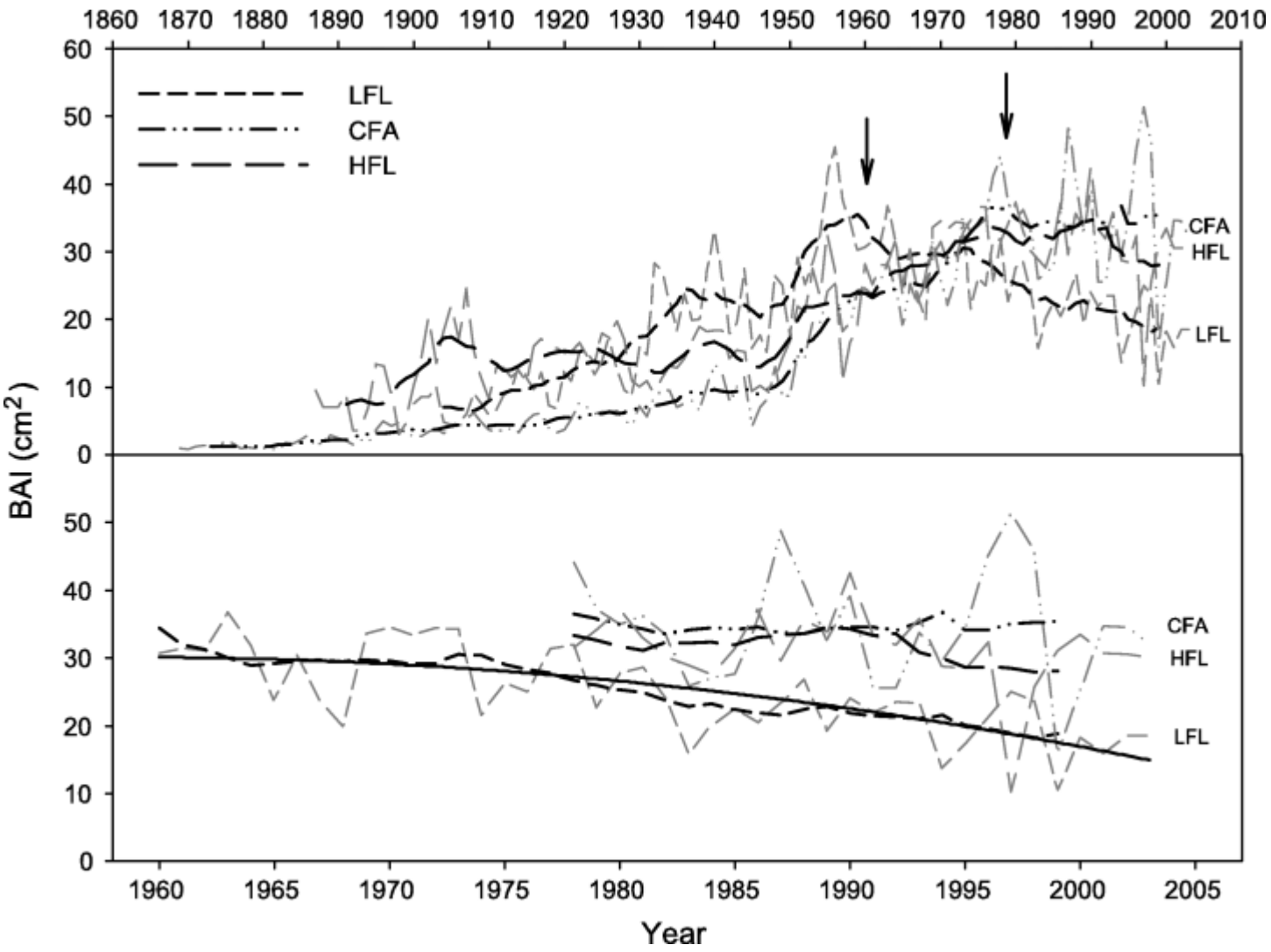
T_0= début de croissance =f(Température printemps)

T_1= fin de croissance = f(sécheresse estivale)

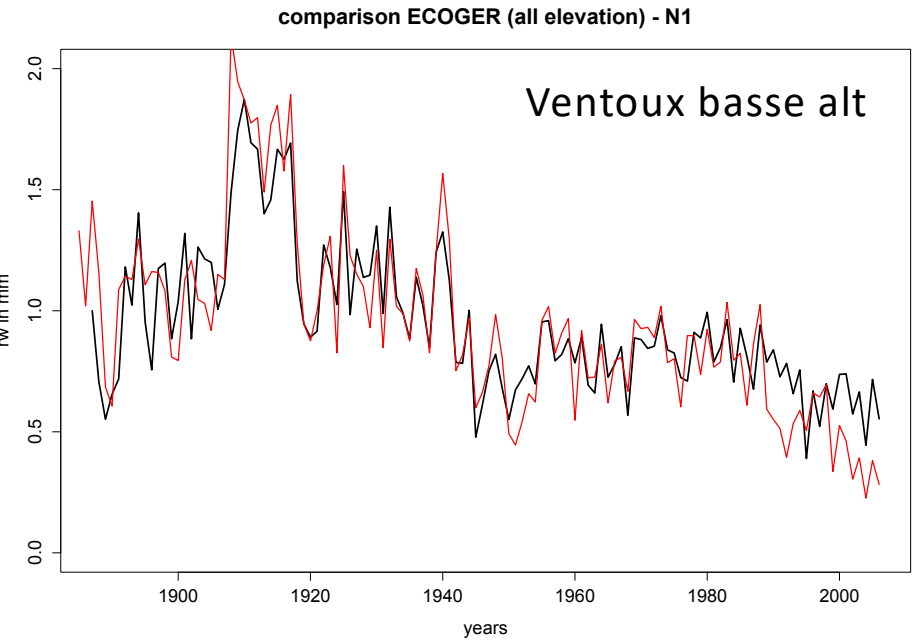


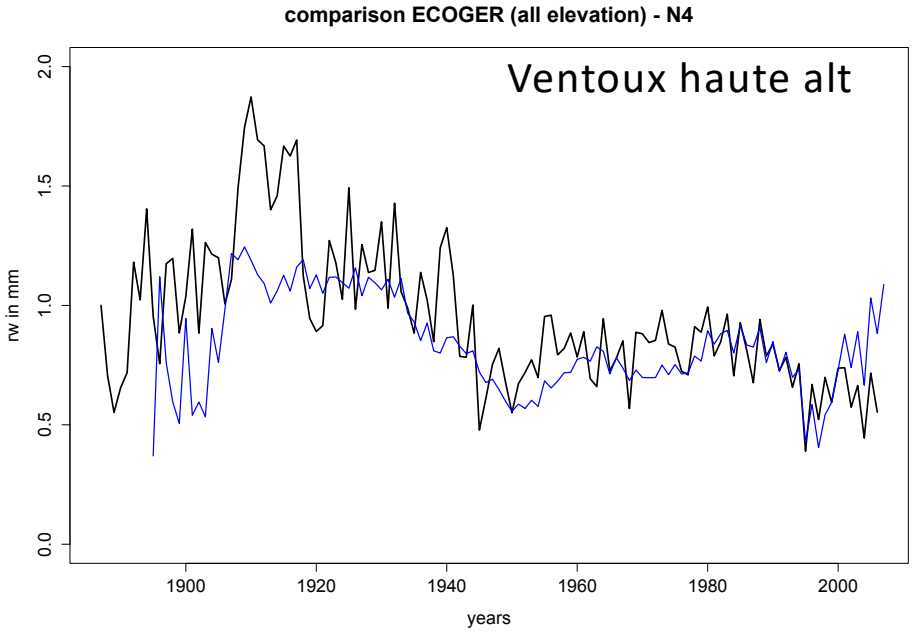


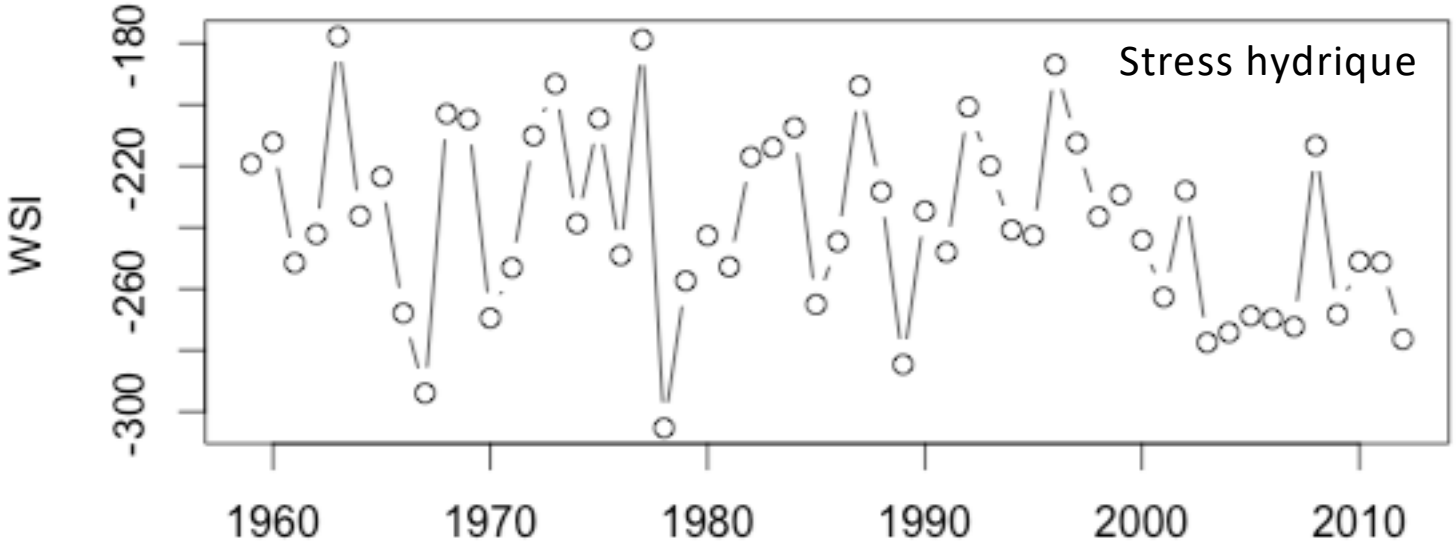
Lempereur et al., 2015

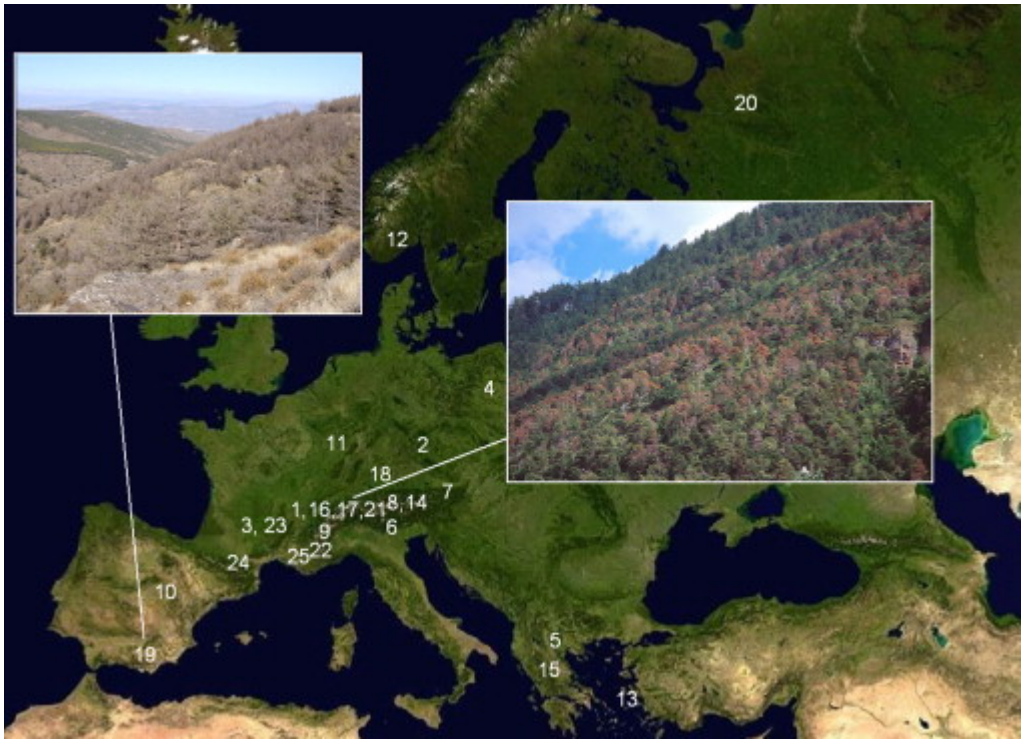


CFA: Intermédiaire, LFL: basse altitude, HFL Haute altitude

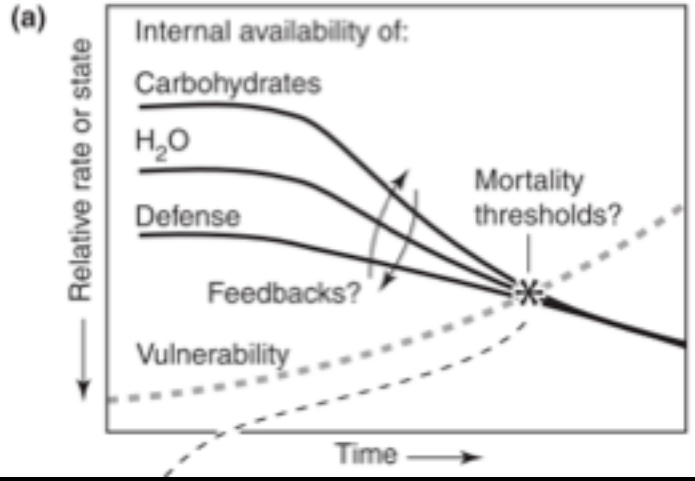

comparison ECOGER (all elevation) - N1
Ventoux basse alt
rw in mm
0.0
0.5
1.0
1.5
2.0
1900
1920
1940
1960
1980
2000
years


comparison ECOGER (all elevation) - N4
Ventoux haute alt
rw in mm
0.0
0.5
1.0
1.5
2.0
1900
1920
1940
1960
1980
2000
years

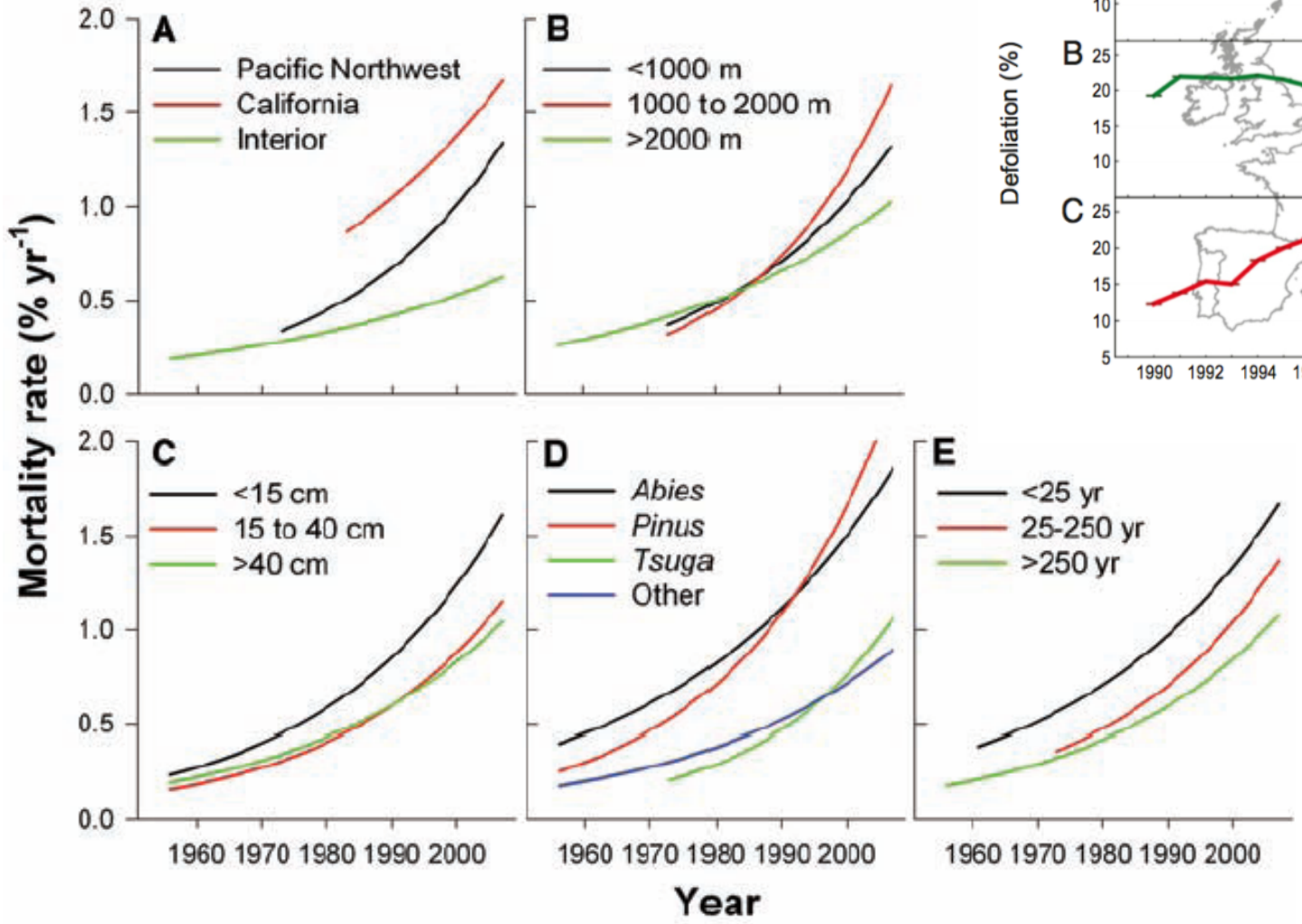

Stress hydrique
WSI
-300
-260
-220
-180
1960
1970
1980
1990
2000
2010

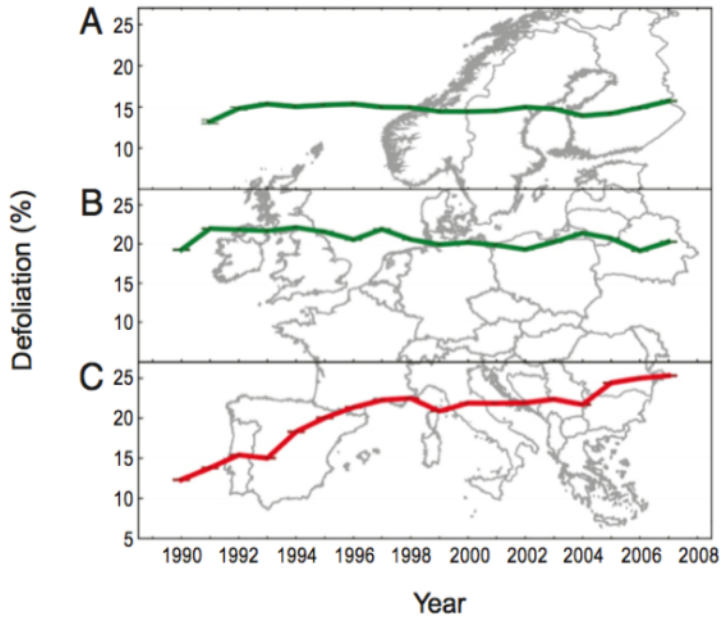


Allen et al., 2008



Evolution des taux de mortalité chez les arbres selon (A) les régions, (B) l'altitude, (C) le diamètre, (D) le genre, (E) le temps depuis le dernier incendie (van Mantgem et al. 2009).

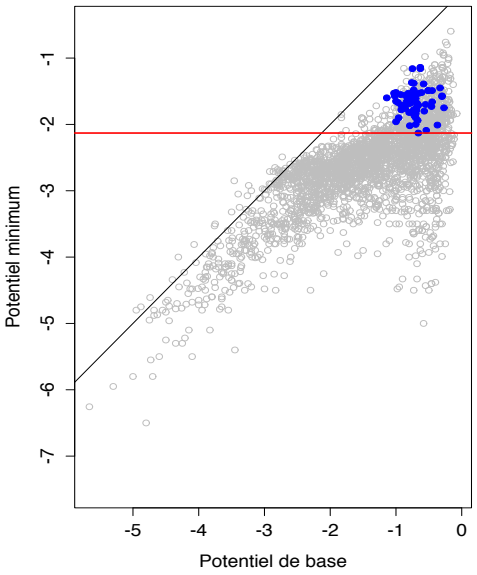


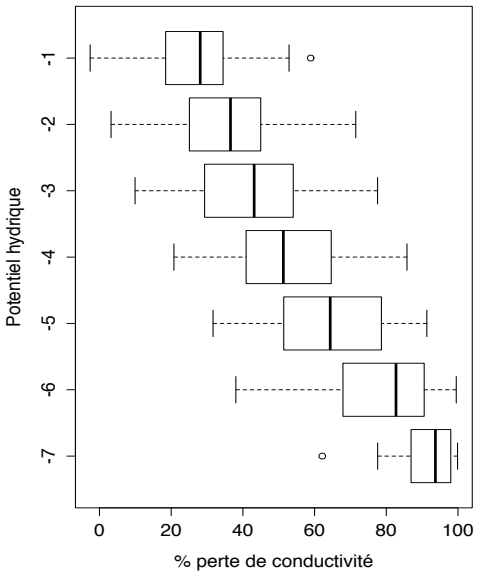


Carnicer et al., 201

Impact du stress hydrique sur la mortalité

Mesures de P50



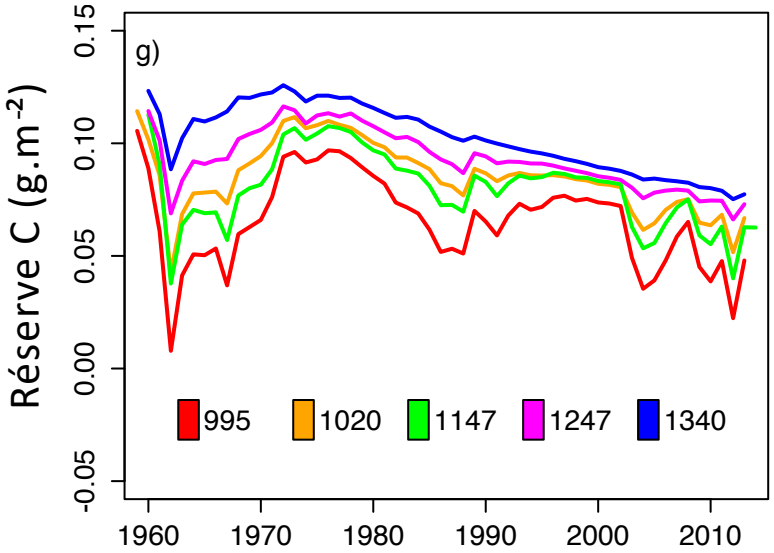


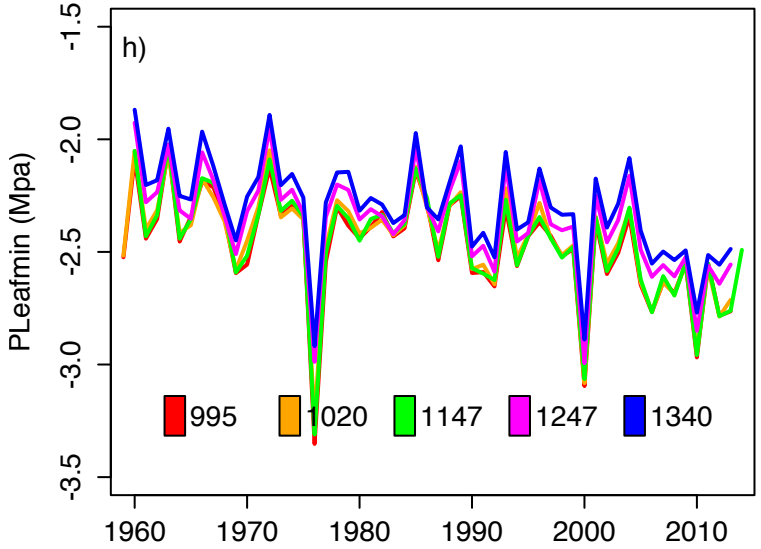
Mesures de mortalité

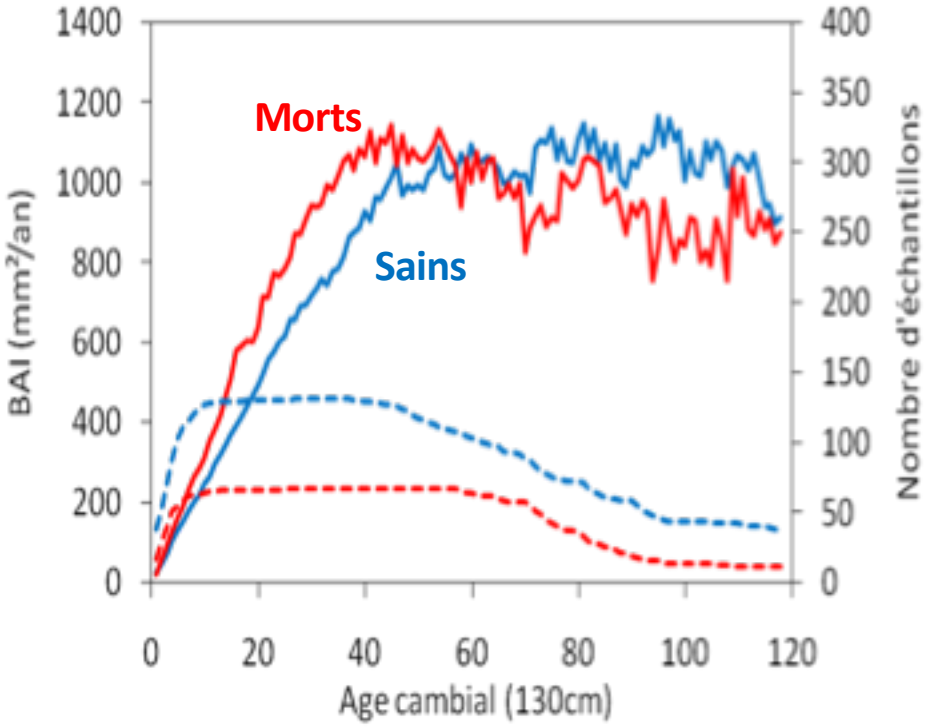
	Inventory 2008	Health survey 2008
DVX1	0.23	0.09
DVX2	0.13	0.23
DVX3	0.02	0.03
CLT	0.25	0.30
DVX4	0.04	0.1
DVX5	0.005	0

Davi & Cailleret, en révision

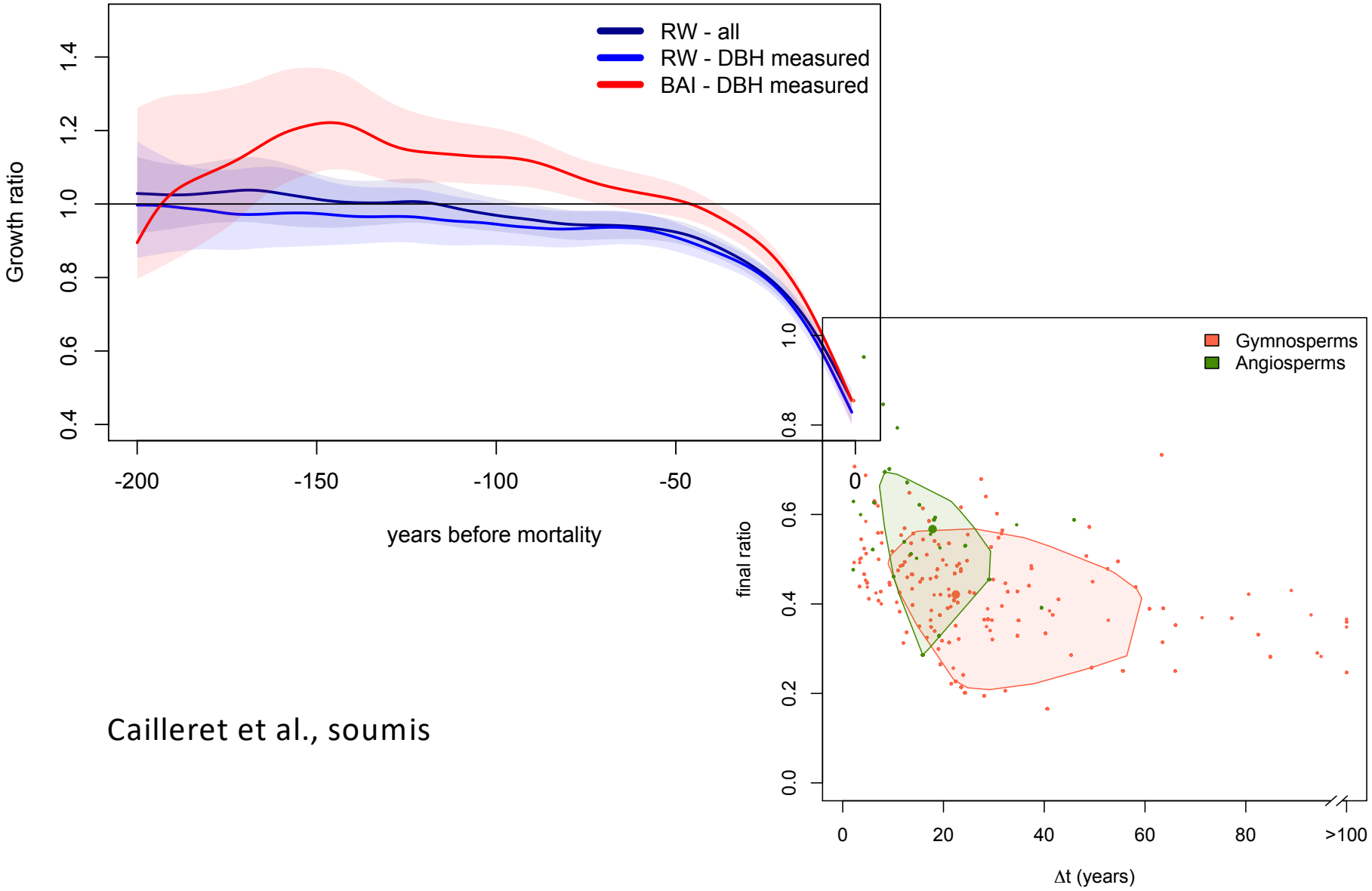
Simulations CASTANEA



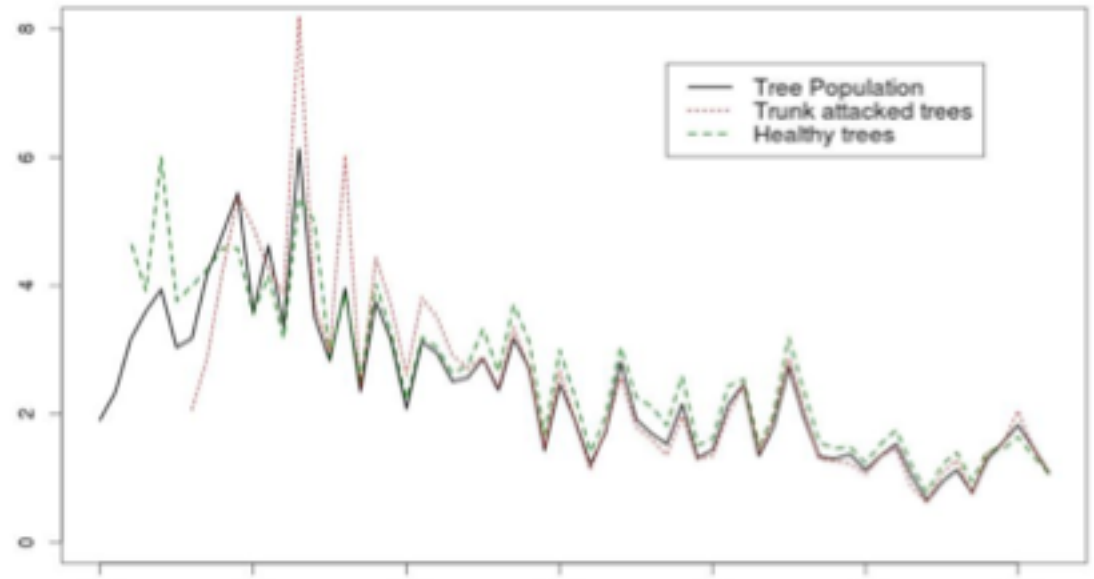




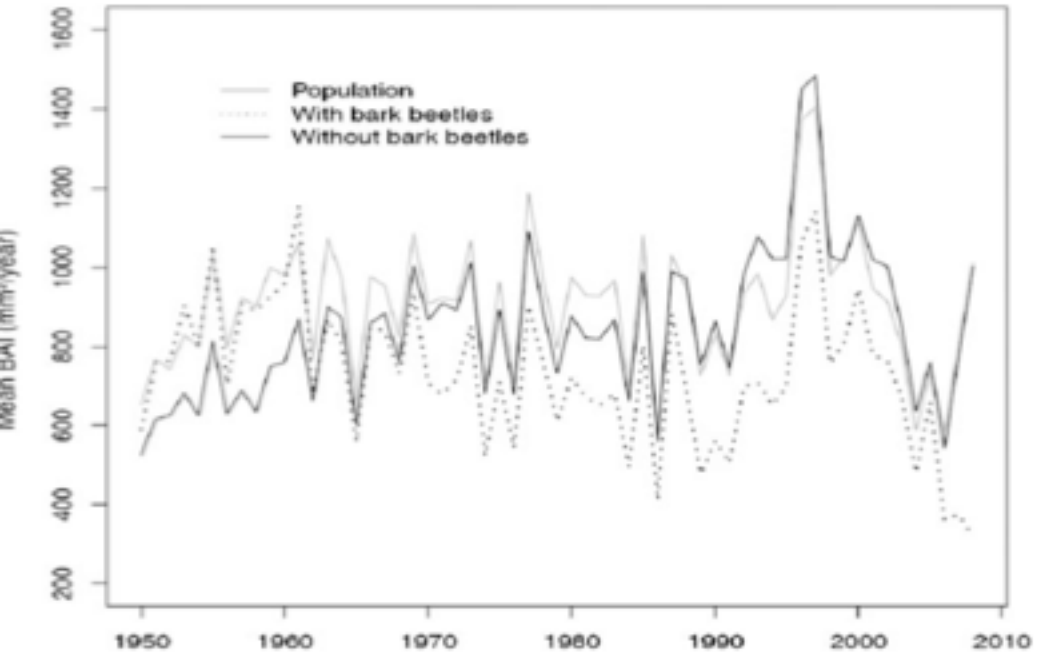
- Sapins morts ont une meilleure croissance que les sains dans les stades juvéniles
- Sensibilité au climat plus forte quand sol « plus favorable »
- Deux hypothèses: (1) plasticité racinaire, (2) croissance rapide => plus grande vulnérabilité



Cailleret et al., soumis



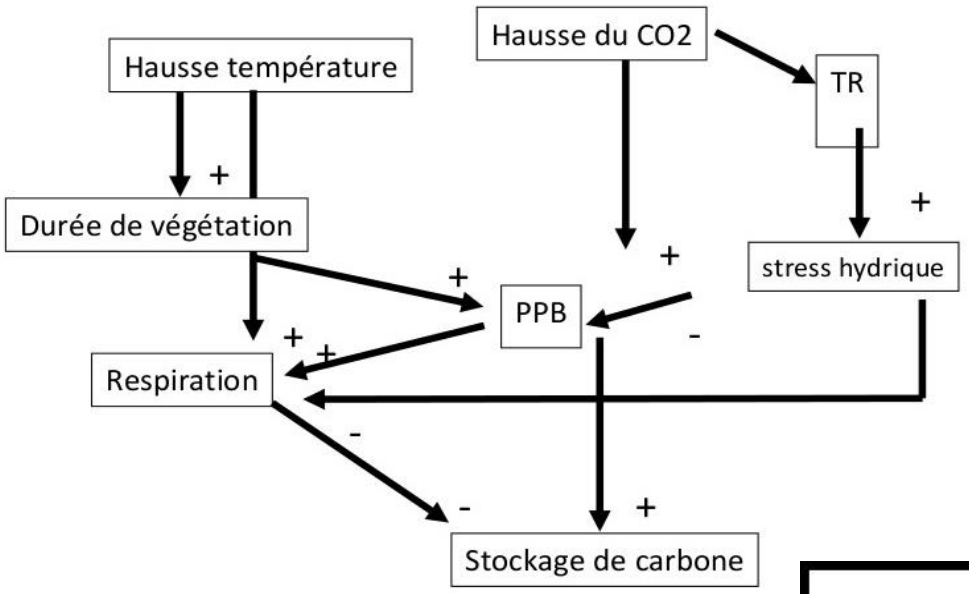
Croissance passée de pin d'Alep attaqués ou non par des scolytes



Croissance passée de sapins attaqués ou non par des scolytes

Gillmann 2014

Davi 2004

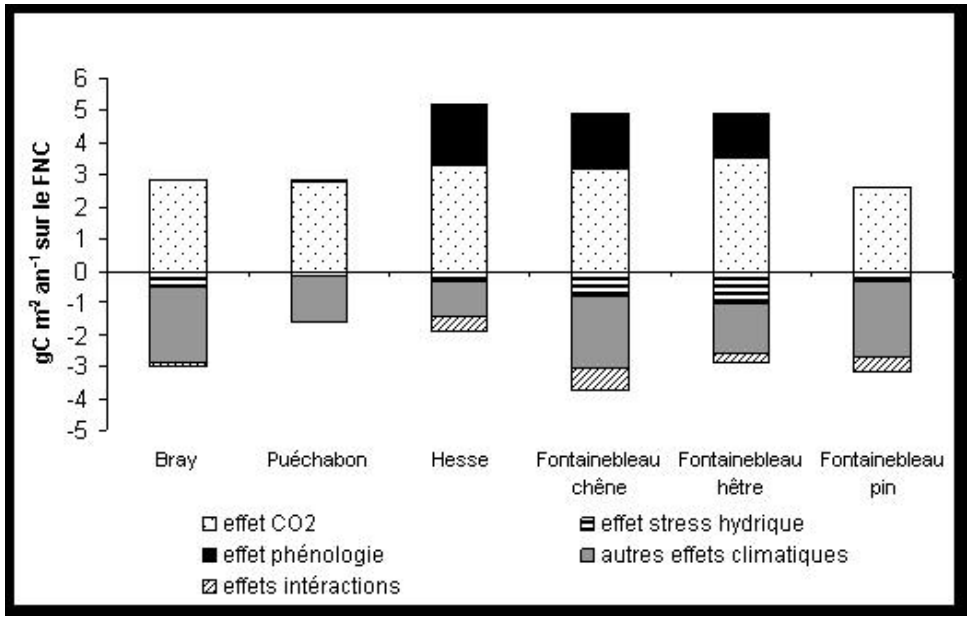


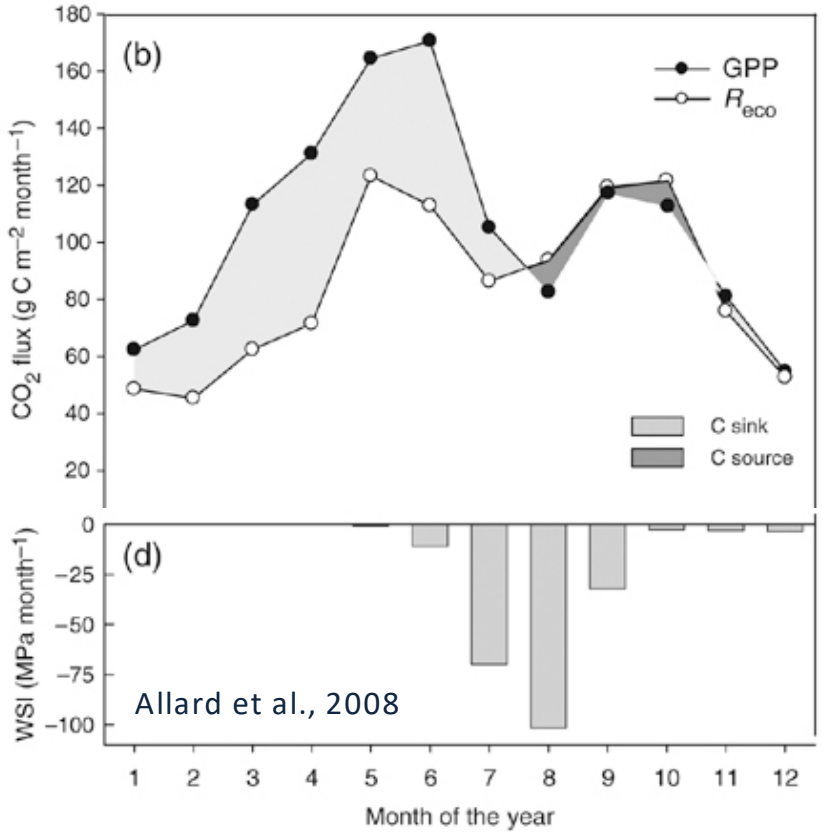
PPB ou GPP= Production Primaire Brute=
∑ photosynthèse

Respiration= $R_{vegetation} + R_{sol}$

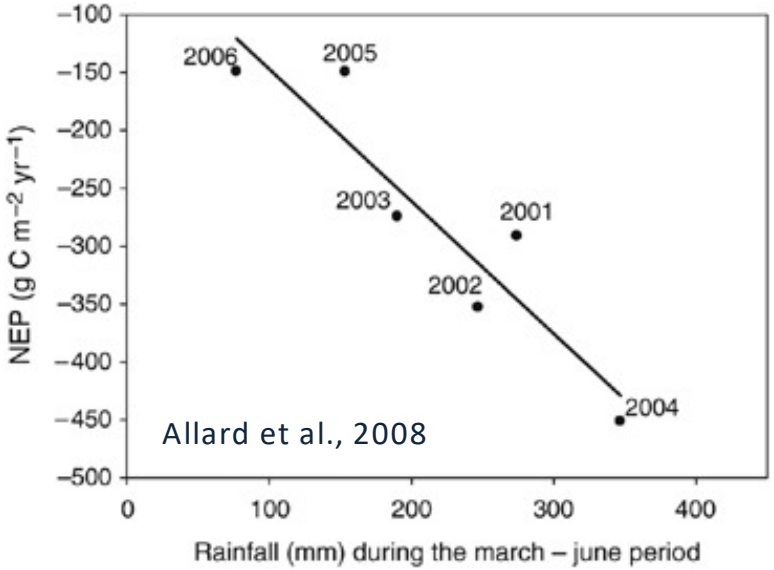
NEP= Stockage de carbone= PPB-Respiration

TR= Transpiration= perte en eau

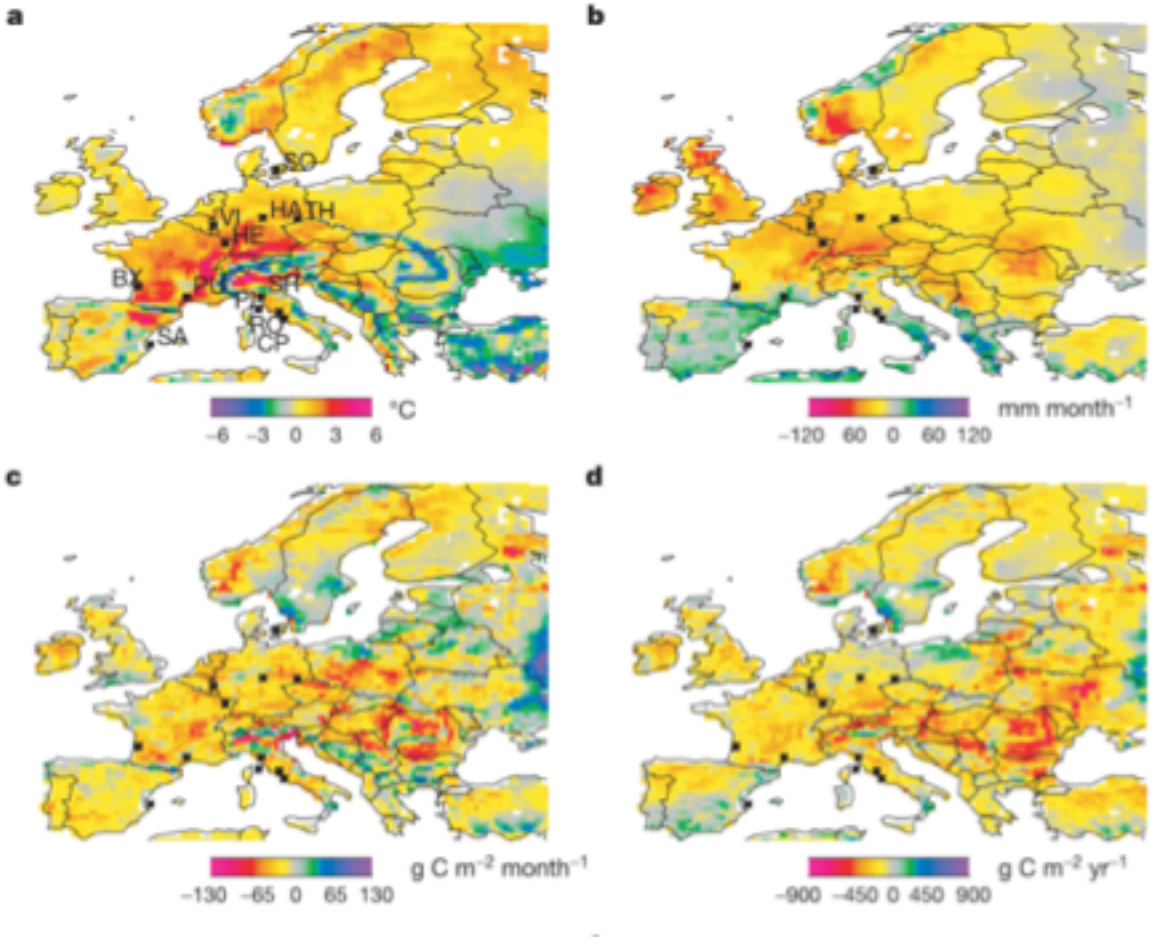




Séquestration de carbone à Puéchabon
Chêne vert

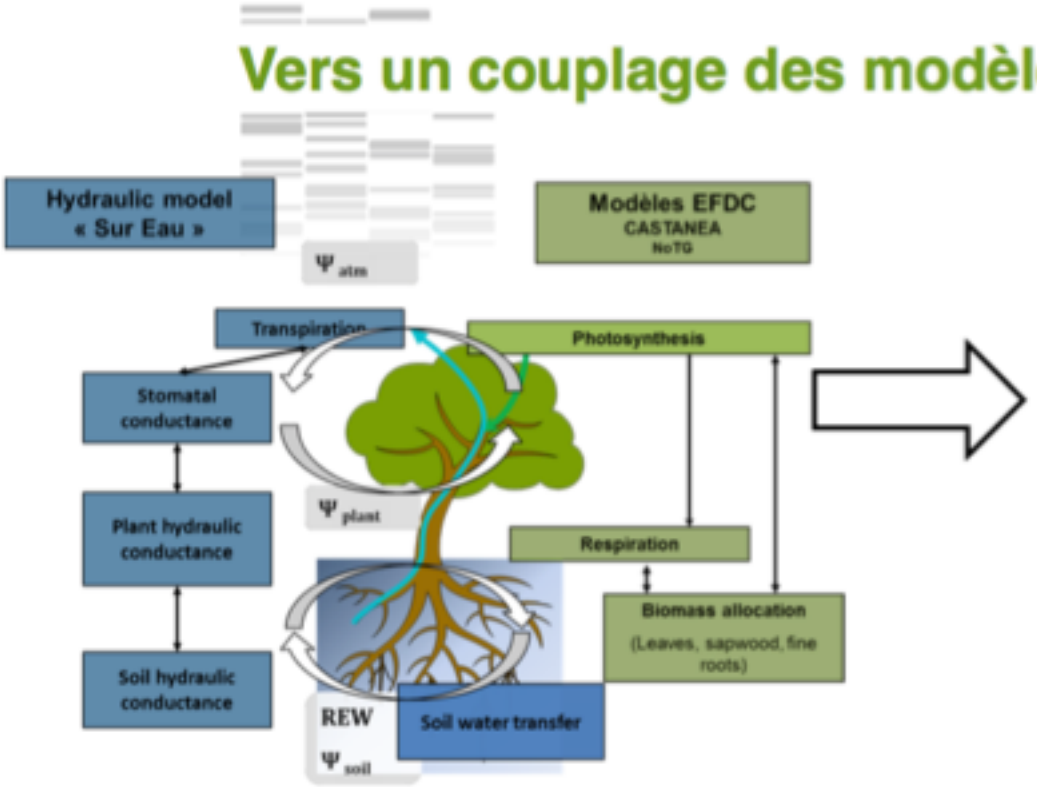


2003: réduction de 12 à 20% de la PPN

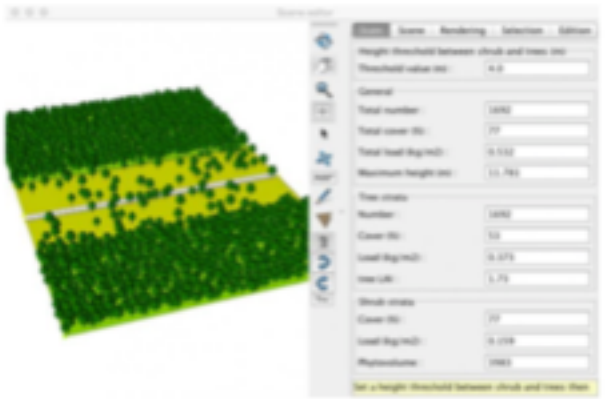


Combustible: Biomasse, teneur en eau, % tissu morts

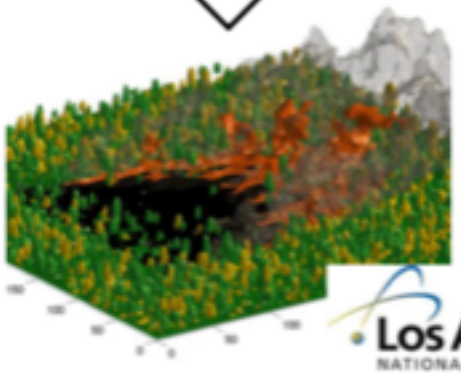
Vers un couplage des modèles



Librairie "Fire" (Capsis)



Modèle physique
FIRETEC (LANL/INRA)



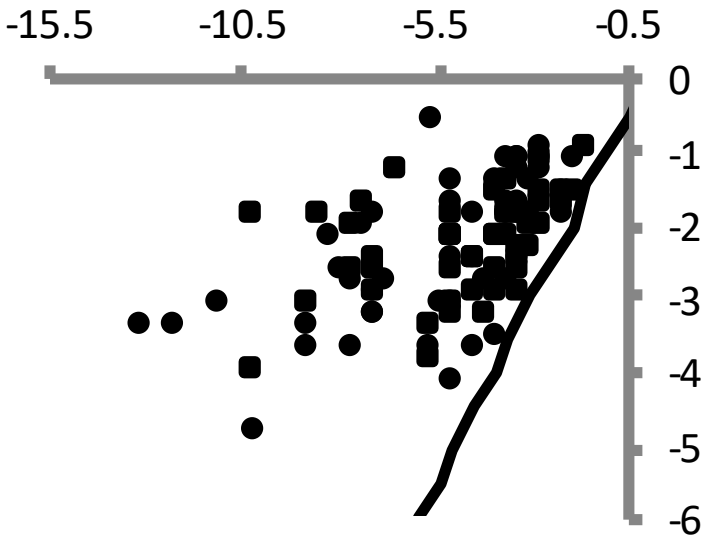
A partir du modèle « Sur Eau » H. Cochard

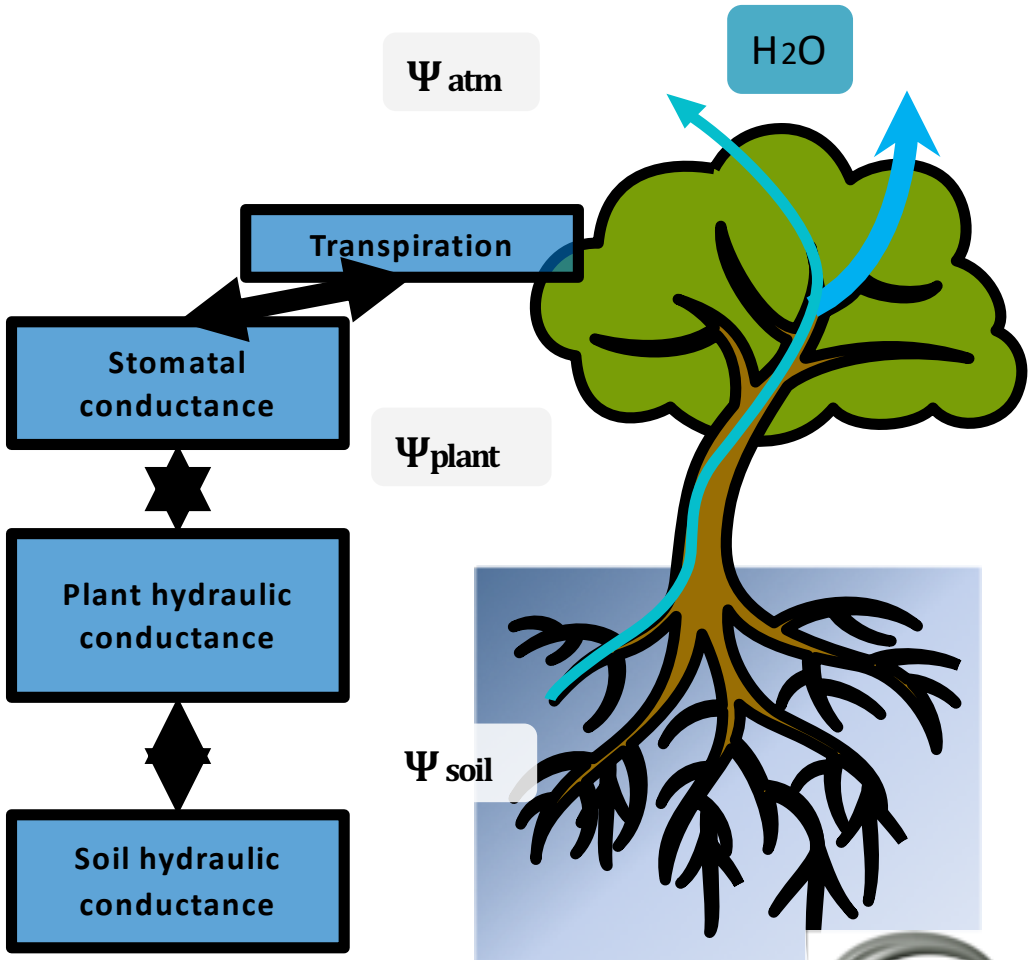
Paramétré à partir de traits :

- P_{12}, Ψ_{tlp}, G, K_{plant}, LA

Prédiction potentielle:

- Mortalité par « hydraulic failure »
- Teneur en H_2O des tissus vivants





Collaboration :
URFM – PIAF -- Biogeco

Martin-StPaul, Delzon, Cochard *en preparation*

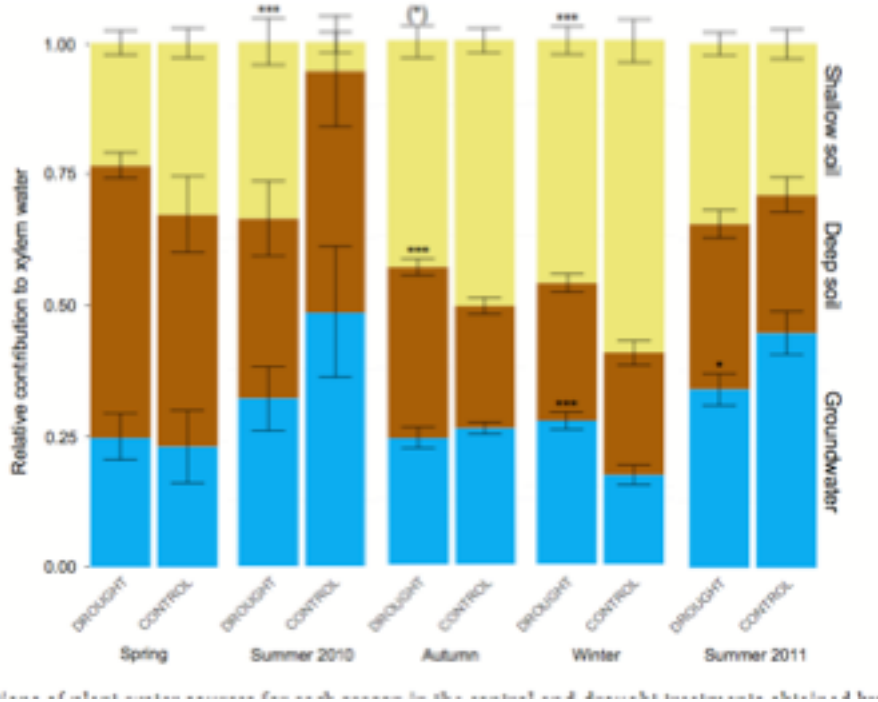
Sol

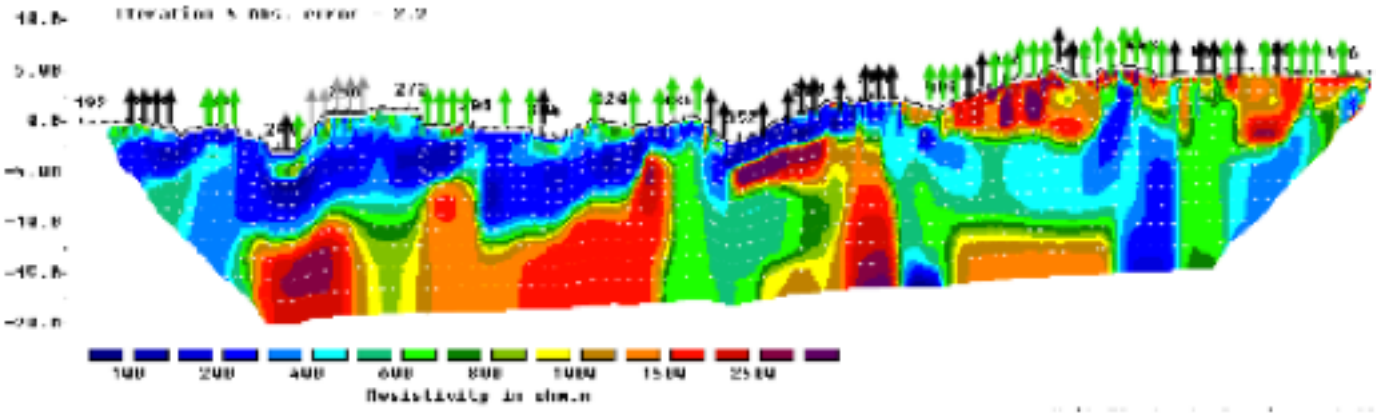
Hétérogénéité des sols forestiers

Ressources hydriques du sous sol

Azote, phosphore

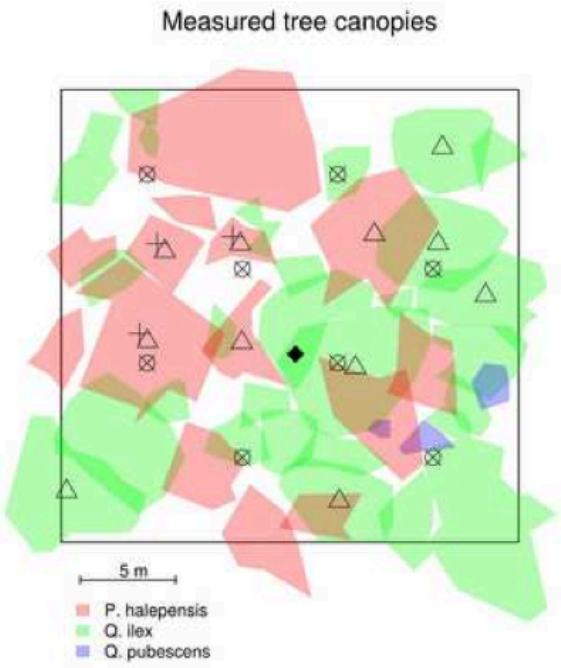
Erosion des sols

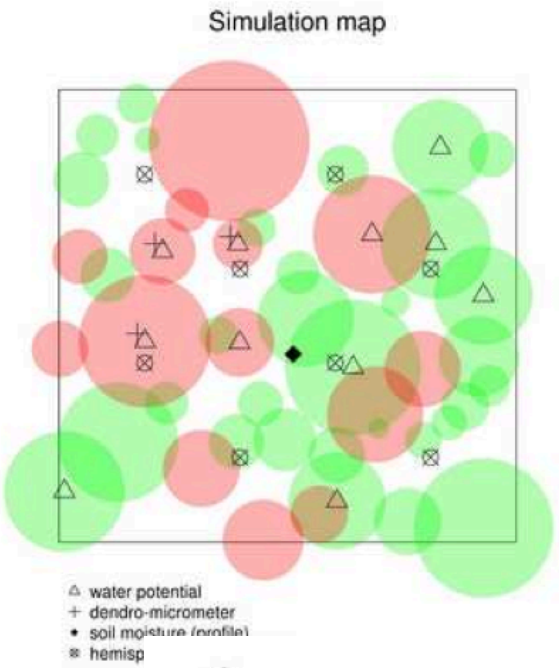


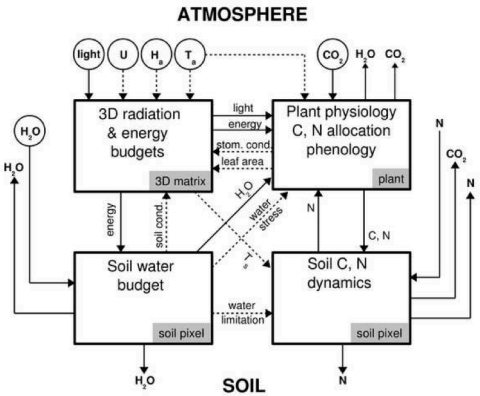


Barbeta et al., 2015

Nourtier et al., 2014



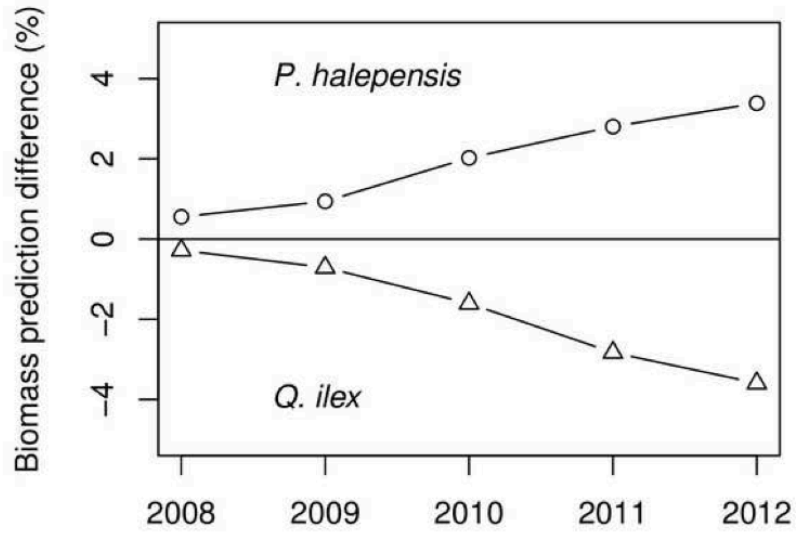




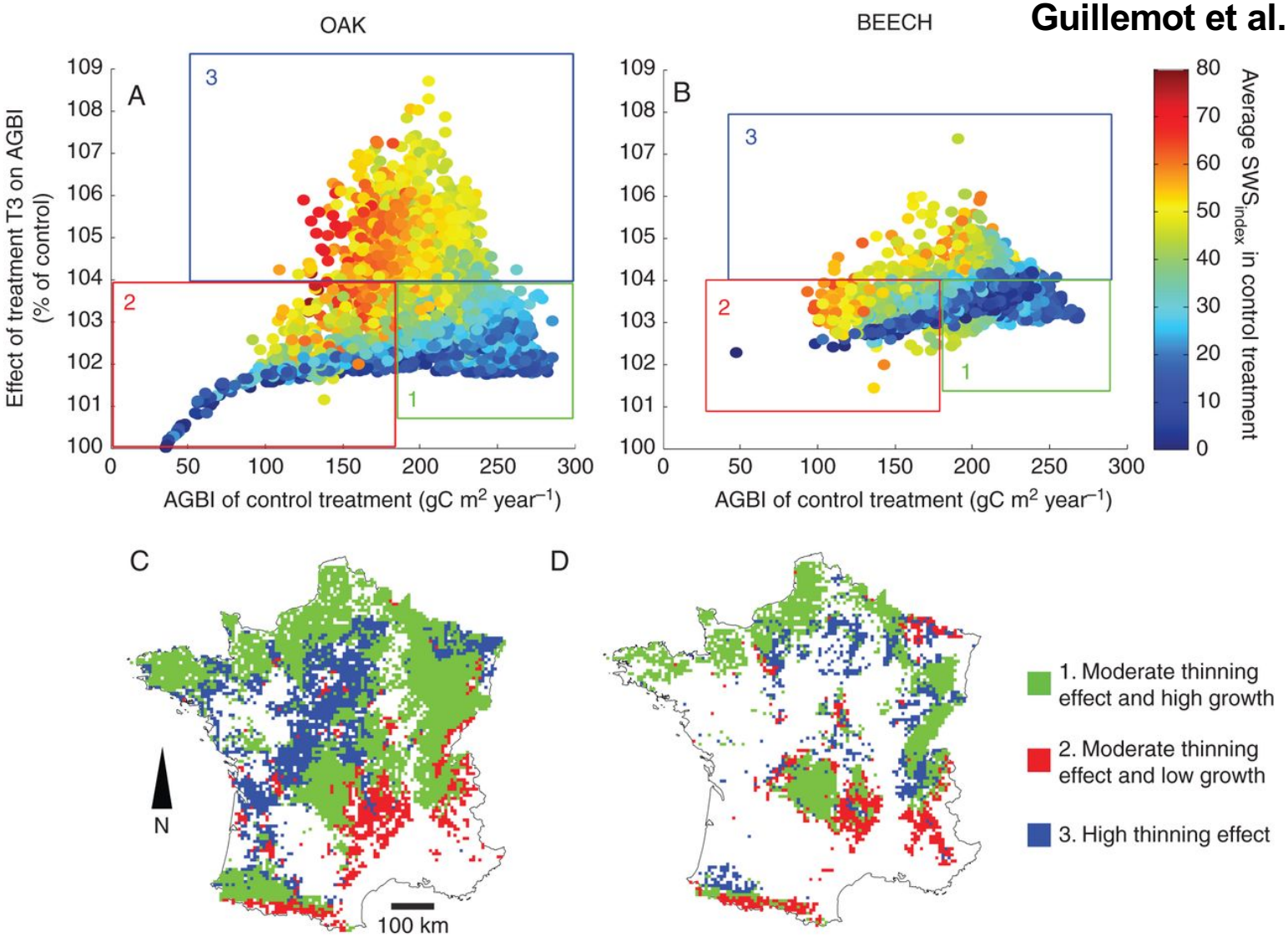
Modèle NoTG

Marie et al., 2014,

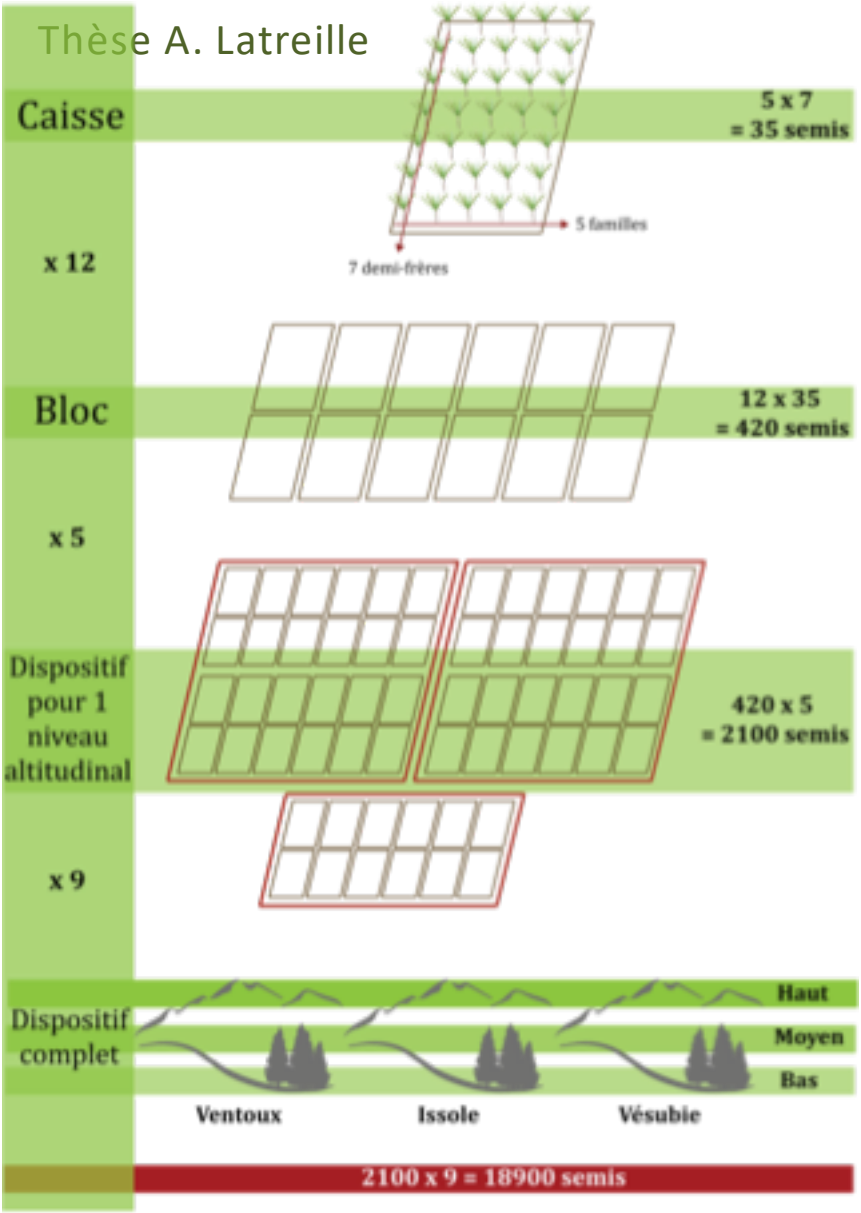
Simioni et al. 2016



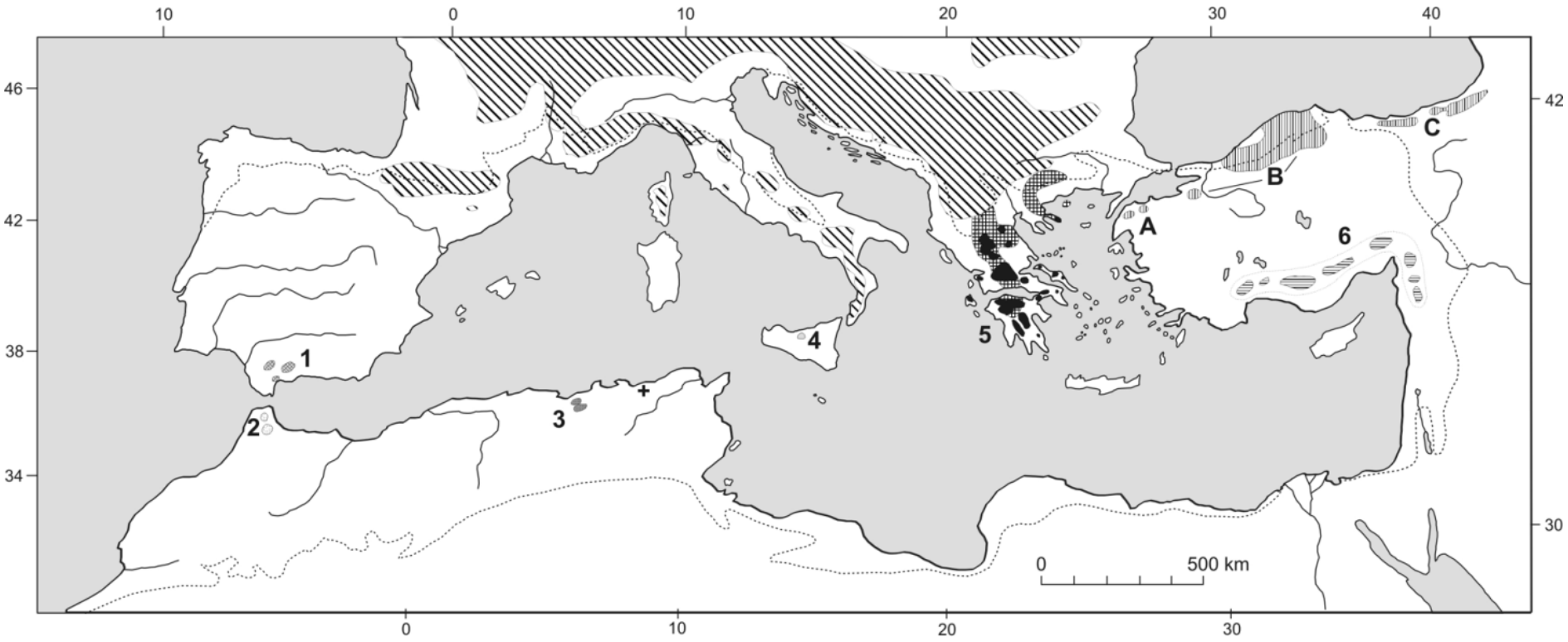
Guillemot et al. 2014

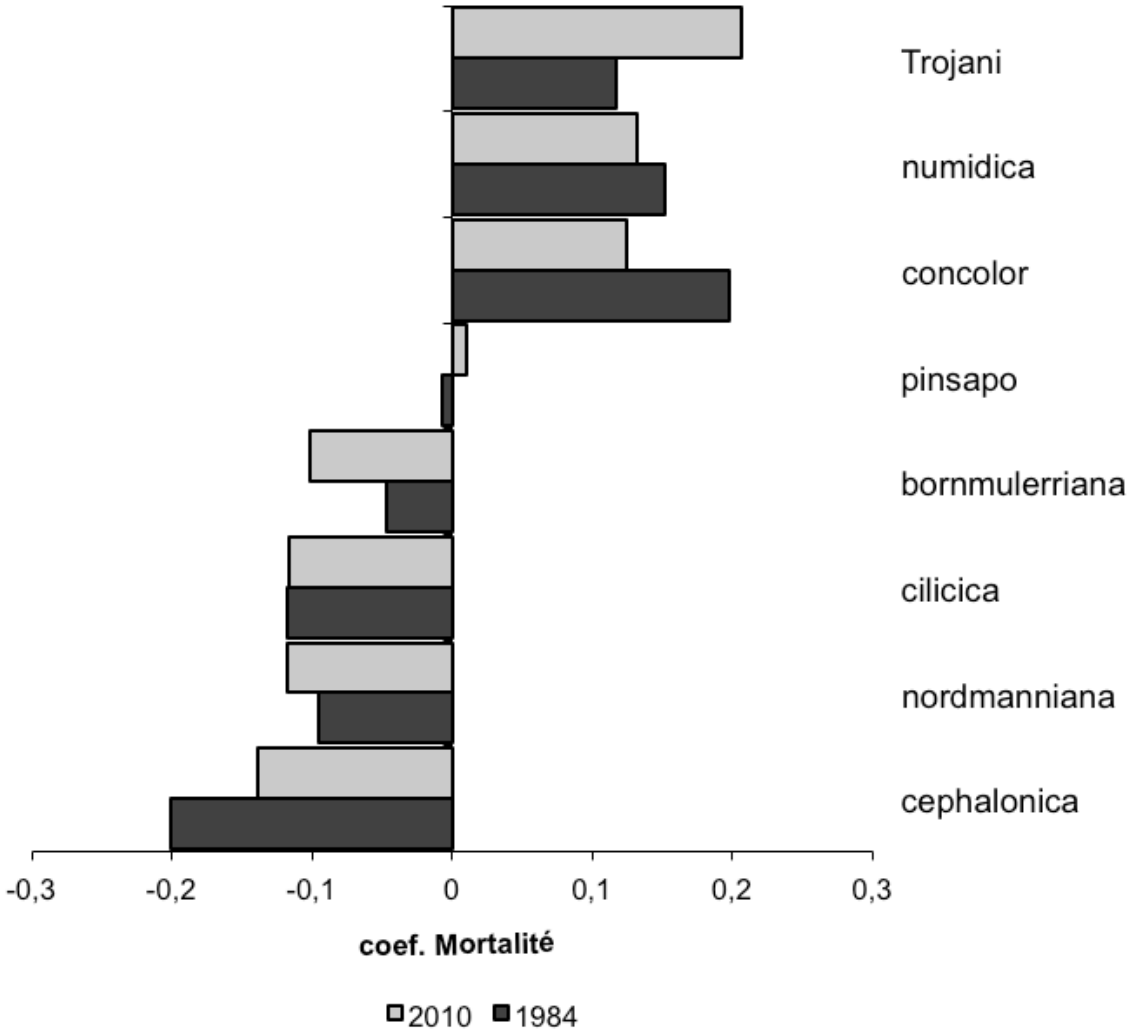


Thèse A. Latreille



ANR MECC, GICC GRAAL


10
0
10
20
30
40
46
42
38
34
30
1
2
3
4
5
6
A
B
C
0
500 km
Abies alba
Abies borisii-regis
1. Abies pinsapo
2. Abies marocana
3. Abies numidica
+ témoignage holocène
4. Abies nebrodensis
5. Abies cephalonica
6. Abies cilicica
A. Abies equi-trojani
B. Abies bornmuelleriana
C. Abies nordmanniana
Sapins pontiques


Trojani
numidica
concolor
pinsapo
bornmulerriana
cilicica
nordmanniana
cephalonica
-0,3
-0,2
-0,1
0
0,1
0,2
0,3
coef. Mortalité
2010
1984