



# Aboveground overyielding in a mixed temperate forest is not explained by belowground processes

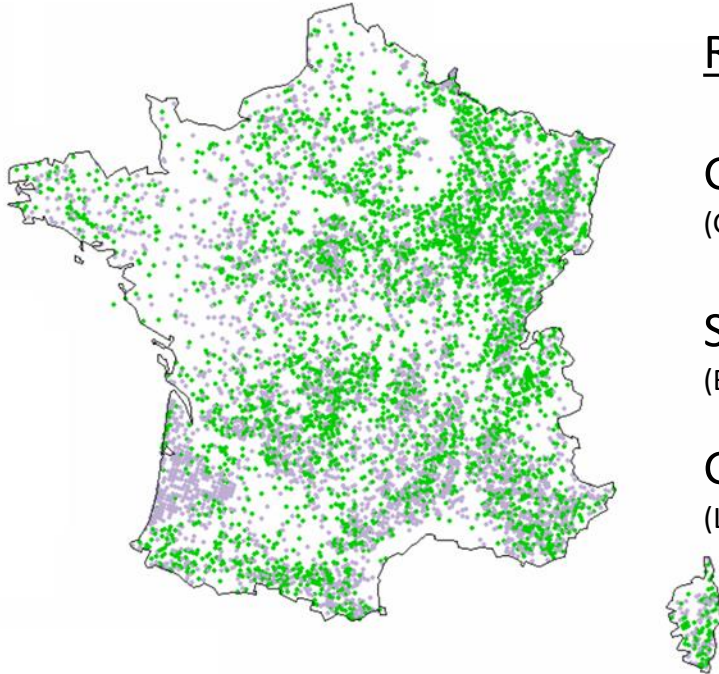
Alexandre FRULEUX, MB BOGEAT-TRIBOULOT, C COLLET, A DEVEAU,  
L SAINT-ANDRE, P SANTENOISE, D BONAL



@alex\_fruleux



# Context : Mixed forests



(Morneau et al., 2008)

## Relative to pure forests :

Generally host greater biodiversity

(Gamfeldt et al. 2013)

Some of them are more resistant to drought and pests

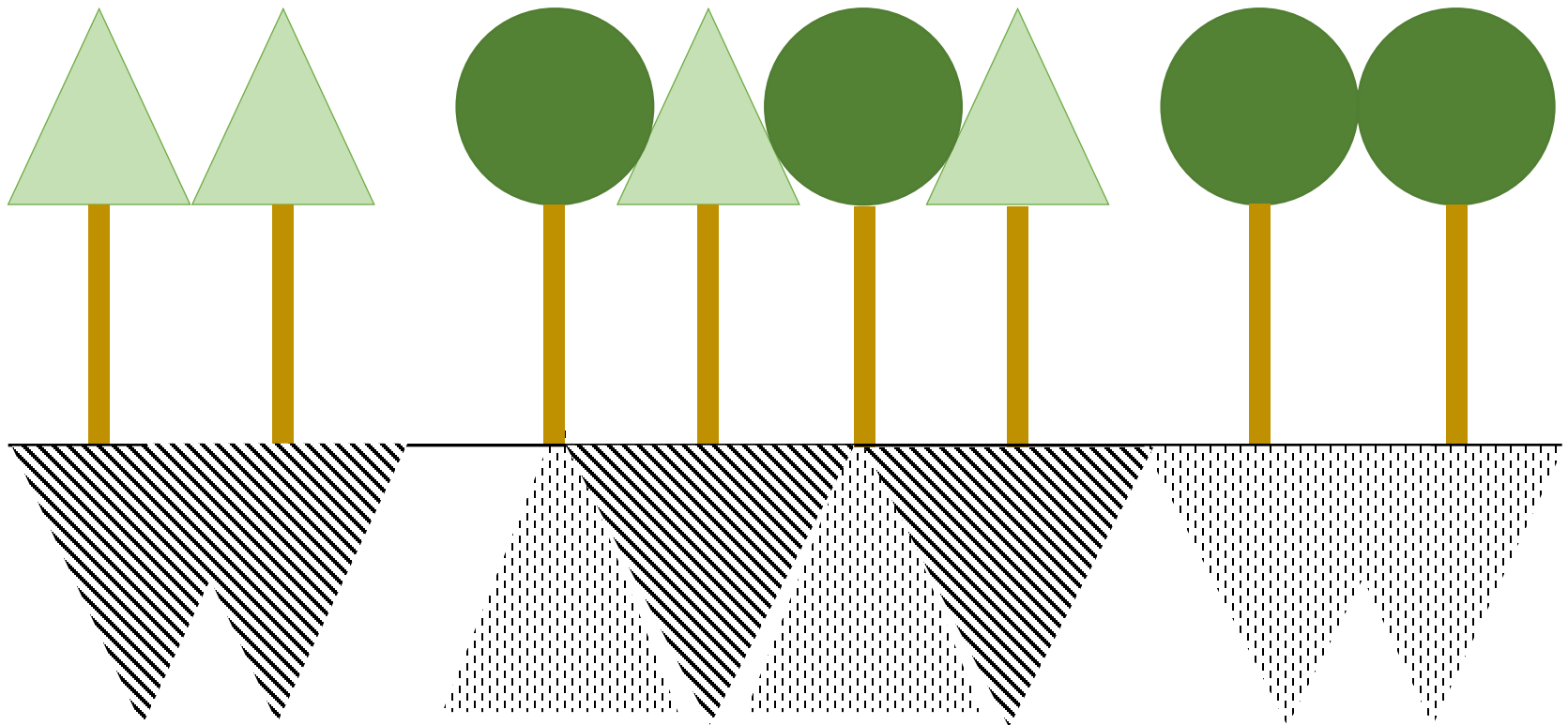
(Bauhus 2017; Jactel et al. 2017)

Generally more productive

(Liang et al. 2016)

Facilitation + competition reduction processes (Loreau and Hector 2001)

# Stratification of organs acquiring resources

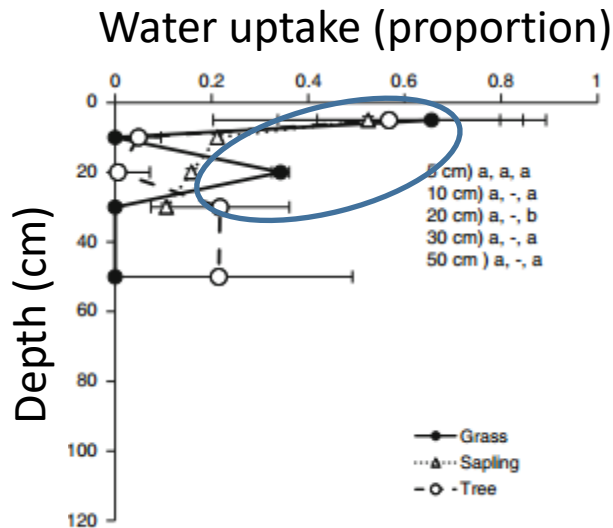


More completed soil volume filling + Canopy packing (Pretzsch et al. 2015, Ma and Chen 2017)

# Spatial niche differentiation for soil water acquisition

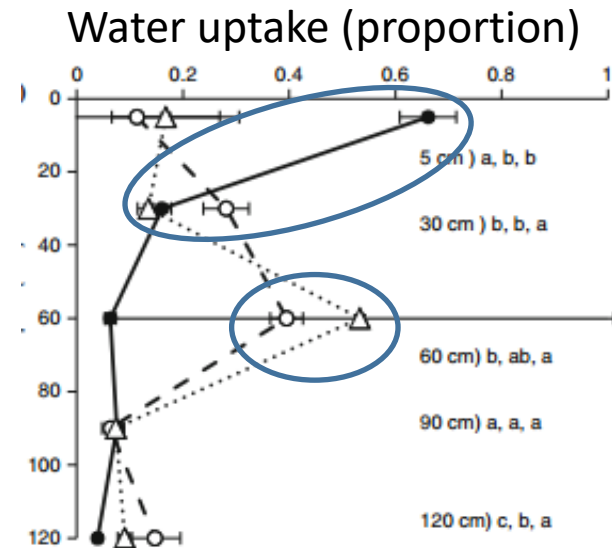
Stress gradient hypothesis (Bertness and Callaway 1994)

Wet season

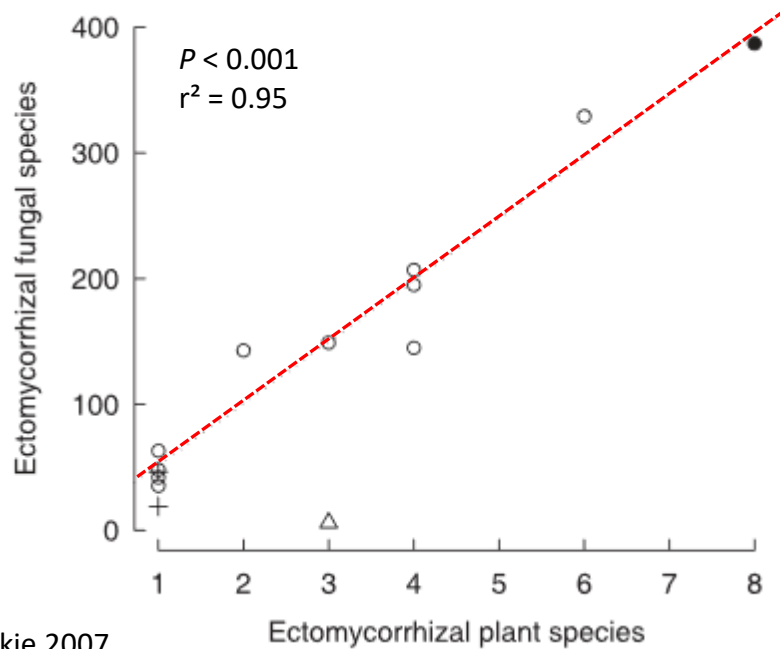


Kulmatiski and Beard, 2013

Dry season



# Higher diversity of ectomycorrhizal fungal species in mixed forests



Dickie 2007

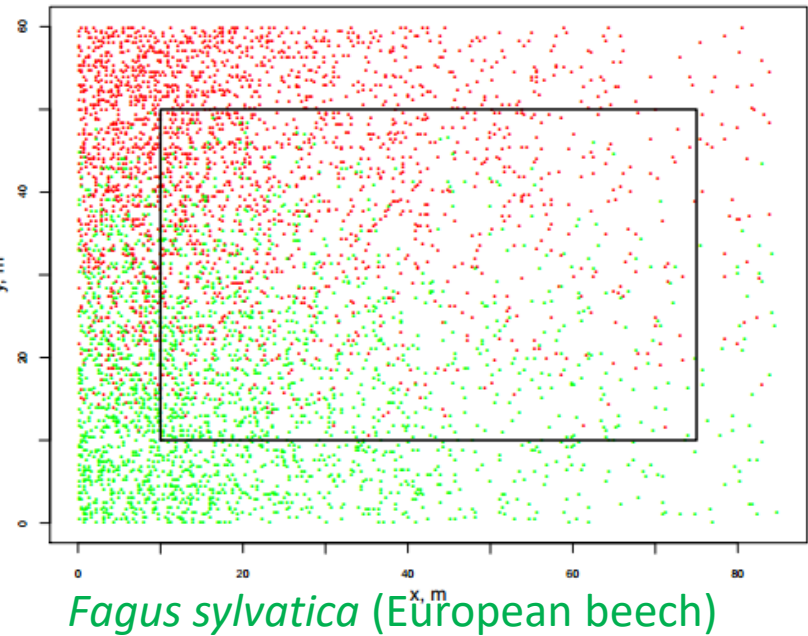


Important functional diversity exists among mycorrhizal fungal species (Johnson et al. 2016)

# Study site : Haye state forest



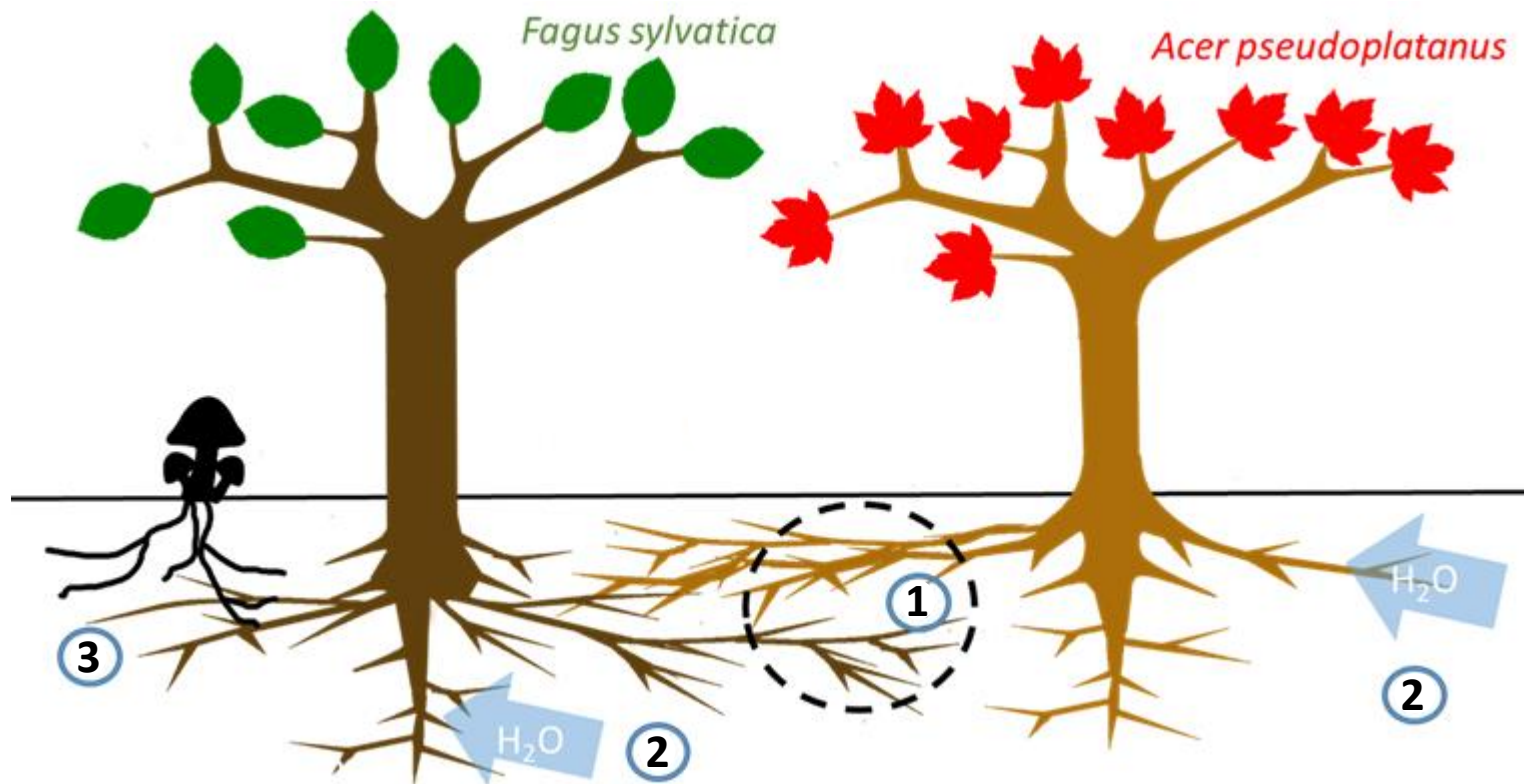
*Acer pseudoplatanus* (sycamore maple)



Radial growth + 13% in mixture (Collet et al. 2014)

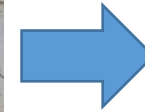
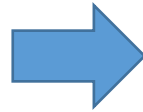
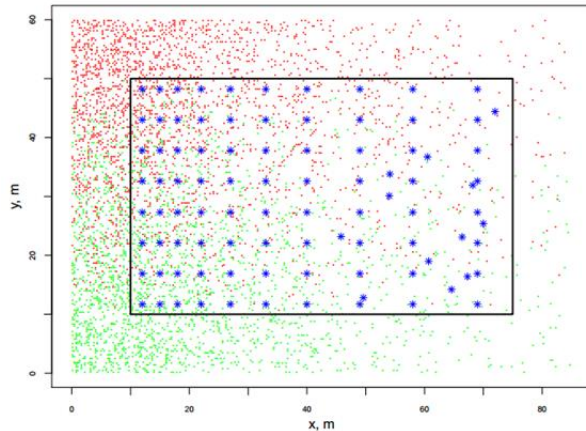


# Our scientific questions

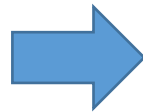


- (1) Are fine root biomass and vertical distribution affected by tree species mixture and density ?
- (2) Do beech and maple trees use different sources of soil water during summer drought ?
- (3) Is the diversity of the ectomycorrhizal fungal community associated with beech trees affected by the proportion of maple trees in their vicinity?

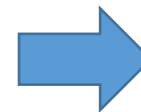
# Materials and methods



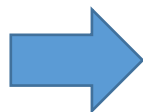
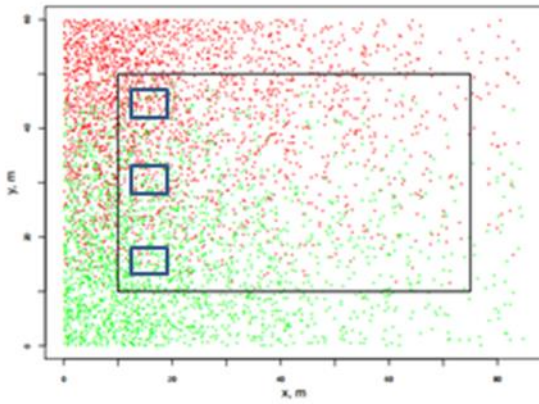
Determination of tree  
Species proportion  
Using Near  
Infrared Spectroscopy (NIRS)



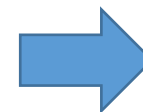
$\delta^2\text{H}$  of soil water  
and xylem water



Depth of soil  
water acquisition  
by trees



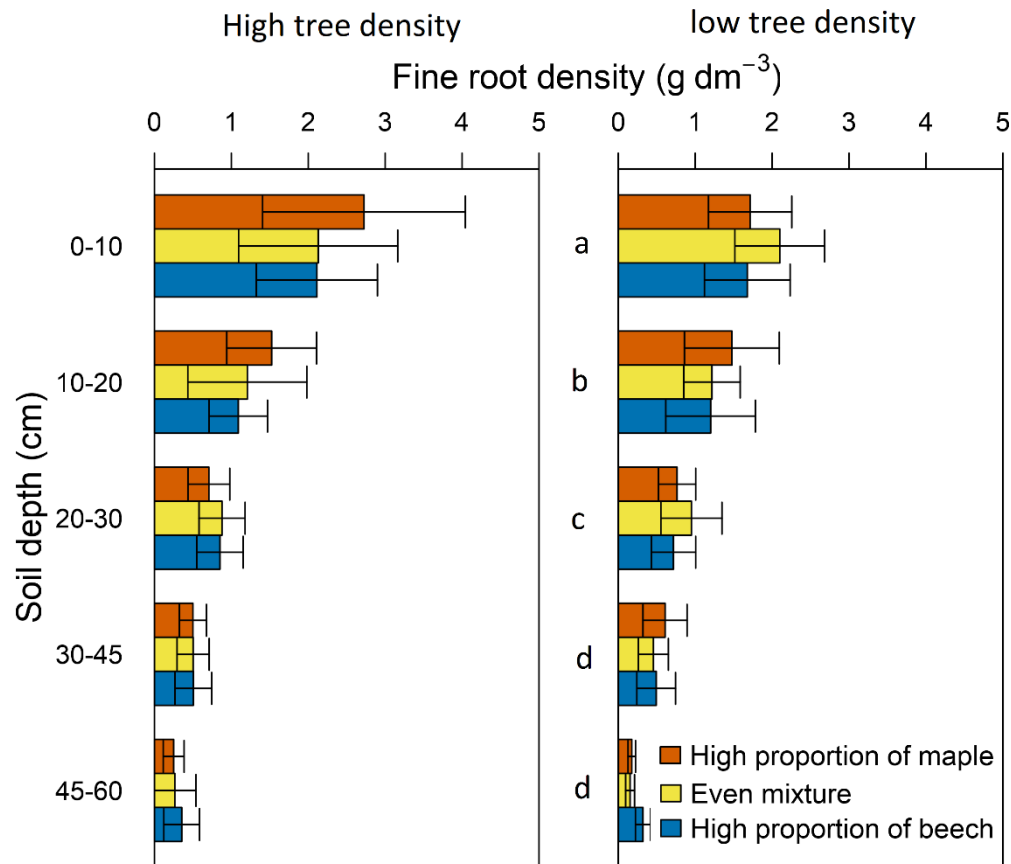
Soil DNA extraction



Ectomycorrhizal  
OTU richness



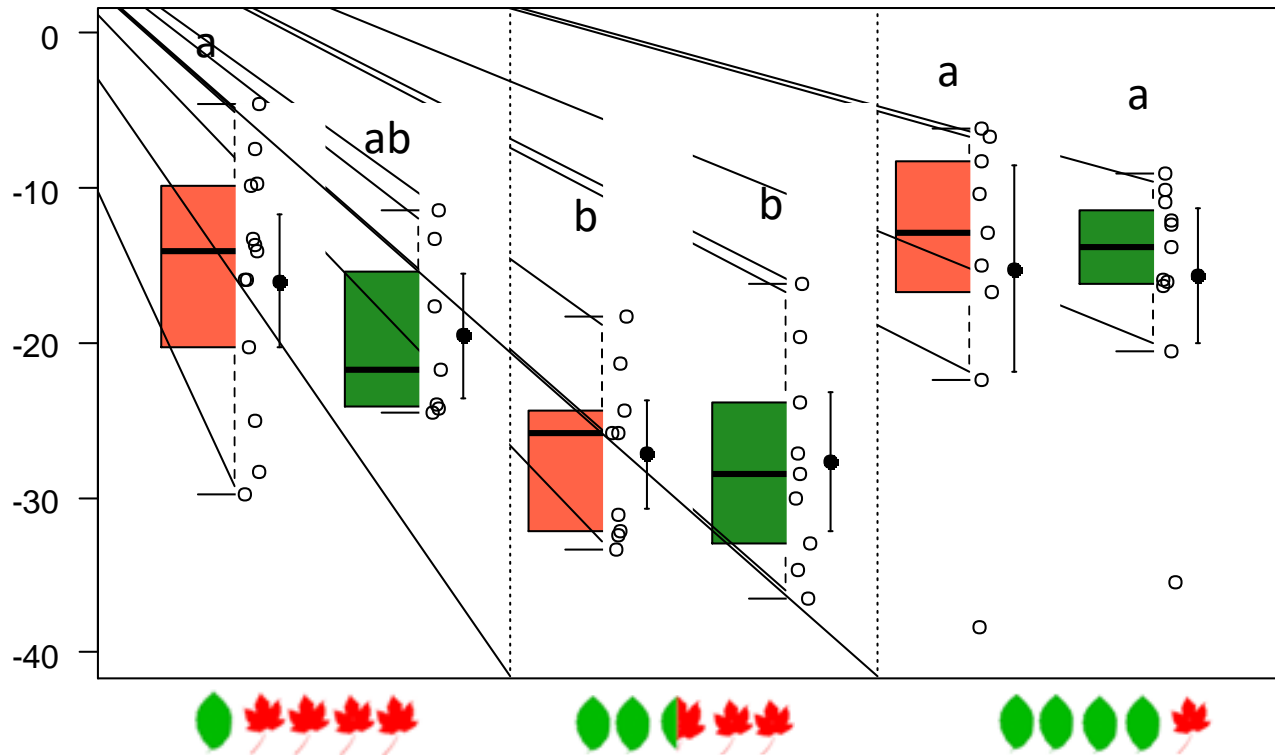
# Results: Vertical distribution of fine root biomass



Fine root density for both species decreased with depth in a similar way

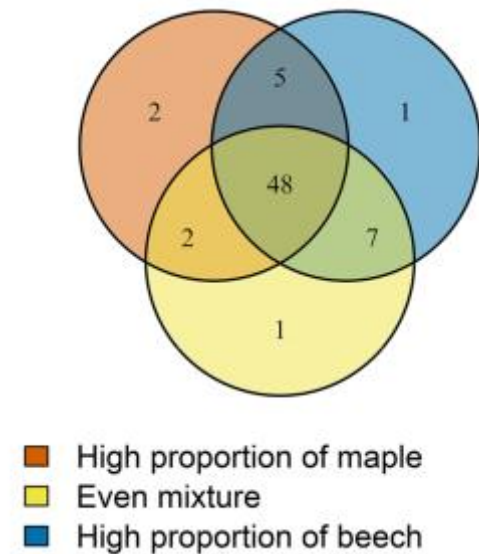
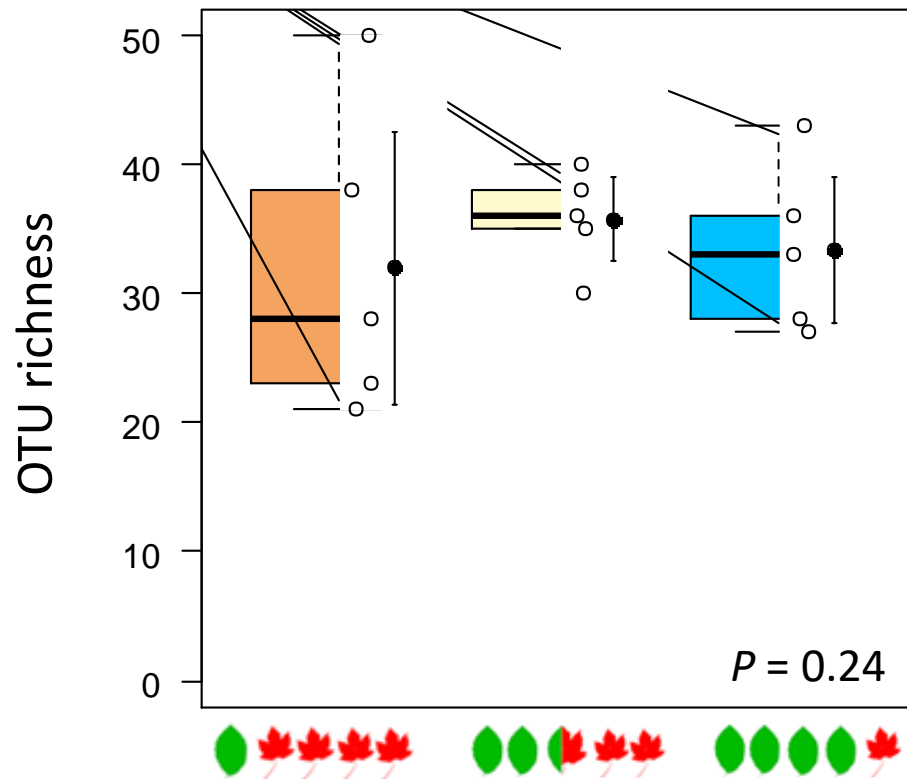
➔ No vertical root segregation

## Results: Soil water acquisition



(Similar results using MixSIAR and the graphical inference method)

# Results: Ectomycorrhizal fungal community structure and composition



# Conclusions

- No belowground overyielding in mixture
- No vertical root segregation between beech and maple
- No niche differentiation for water acquisition between species
- Similar richness of the ectomycorrhizal fungal communities

**Aboveground overyielding in the plantation is probably not the consequence of belowground interactions between tree species**

- Precisely characterize the soil microbiom (bacteria, saprophytic fungi)
- Canopy packing ?

# Aknowledgements

Maud Antoine

Zélie Auvinet

Mathilde Colombat

Bastien Djimbi

Gladys Mernier

Manon Watzky

Pascal Courtois

Erwin Dallé

Bruno Garnier

Jean-Baptiste Lily

Nicolas Marron

Florian Vaast

Christine Gehin

Jonathan Lenoir

Bernard Amiaud

Matthieu Barret

PTEF

ONF



Oecologia  
<https://doi.org/10.1007/s00442-018-4278-0>

ECOSYSTEM ECOLOGY – ORIGINAL RESEARCH

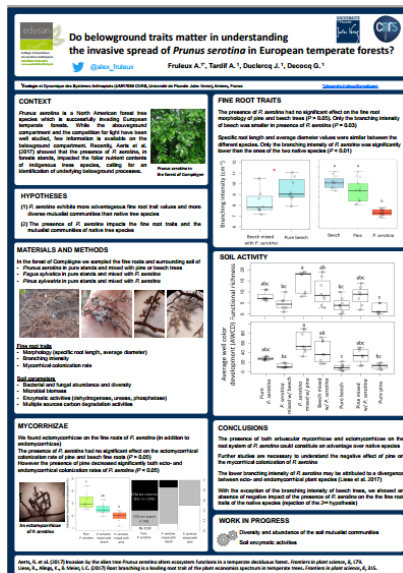


## Aboveground overyielding in a mixed temperate forest is not explained by belowground processes

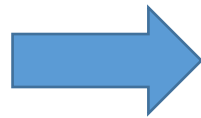
Alexandre Fruleux<sup>1</sup> · Marie-Béatrice Bogeat-Triboulet<sup>1</sup> · Catherine Collet<sup>1</sup> · Aurélie Deveau<sup>2</sup> · Laurent Saint-André<sup>3</sup> · Philippe Santenoise<sup>1,3</sup> · Damien Bonal<sup>1</sup>

Received: 10 May 2018 / Accepted: 13 October 2018  
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Thank you for your attention !



# Determination of water uptake patterns

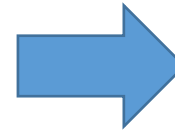


Xylem water deuterium isotope composition

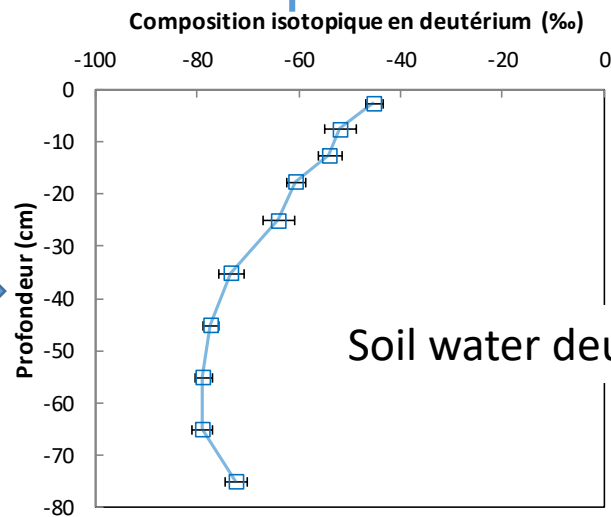
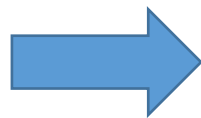


Model

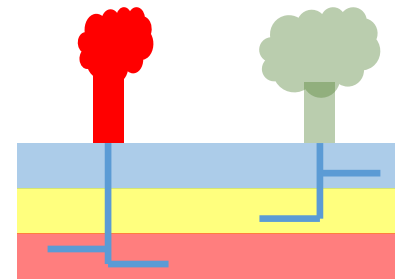
(Romero-Saltos et al. 2005  
Or MixSIAR)



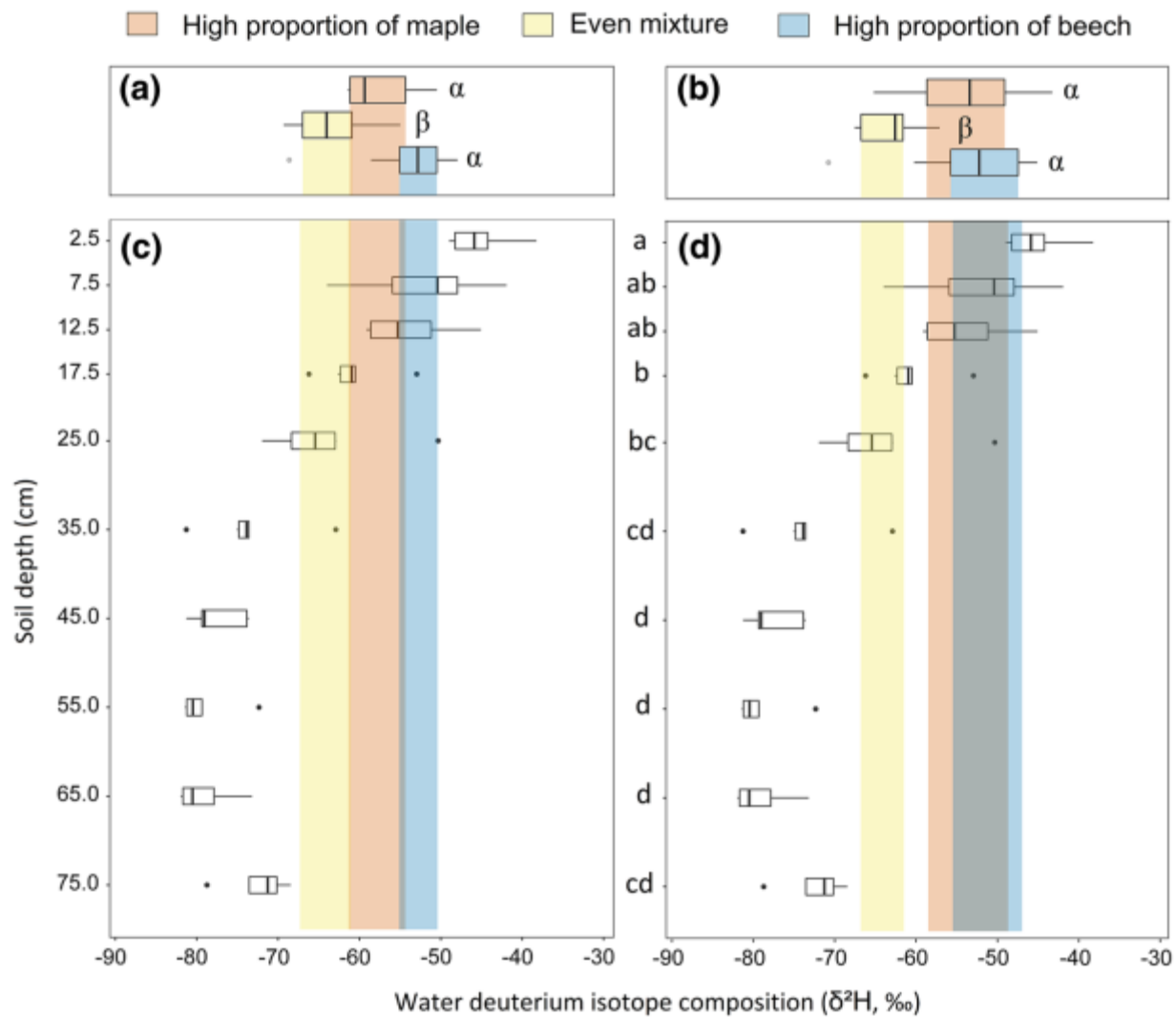
Mean soil water uptake depth or fractions of water sources taken up by trees

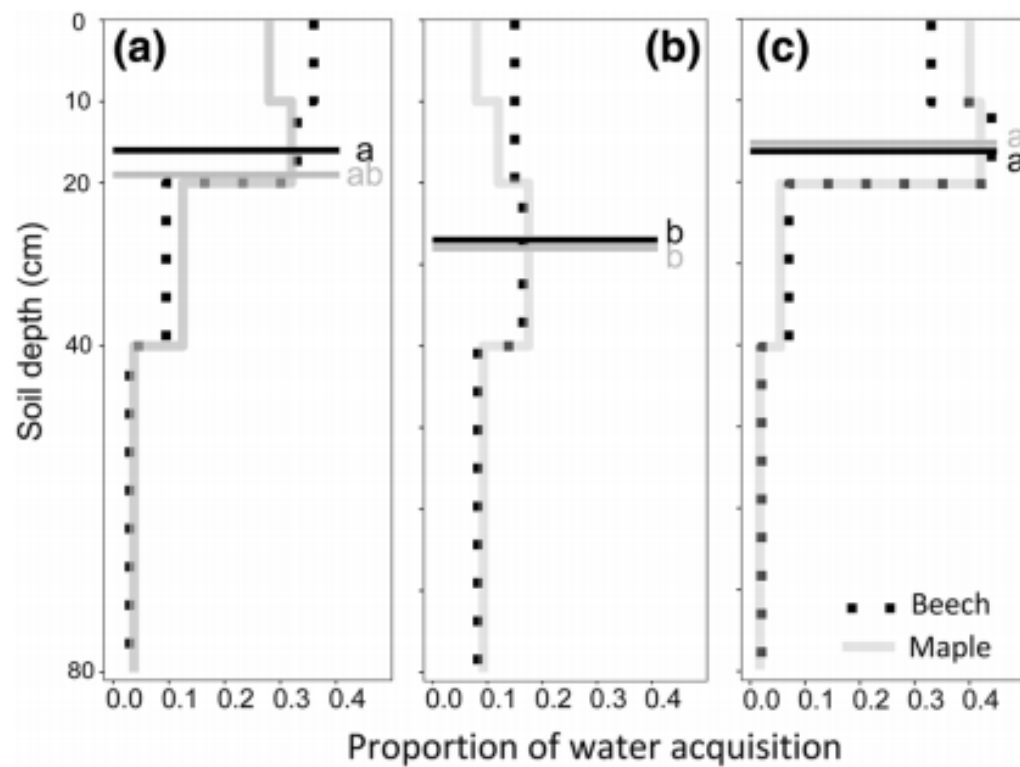


Soil water deuterium isotope composition





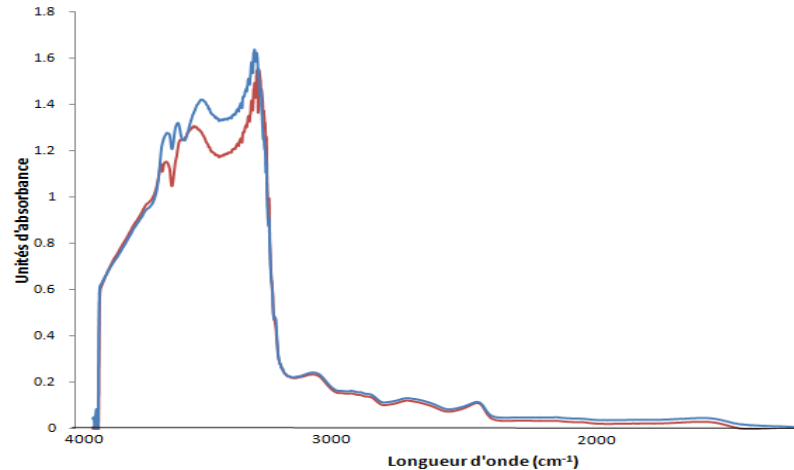




# Near InfraRed reflectance spectroscopy method



Infrared radiations



## Method :

Beech fine roots



Maple fine roots



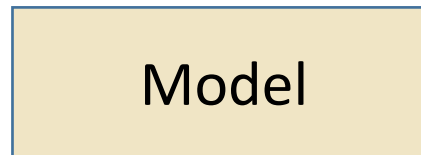
500 artificial mixture spectra  
(the sp proportion is known)



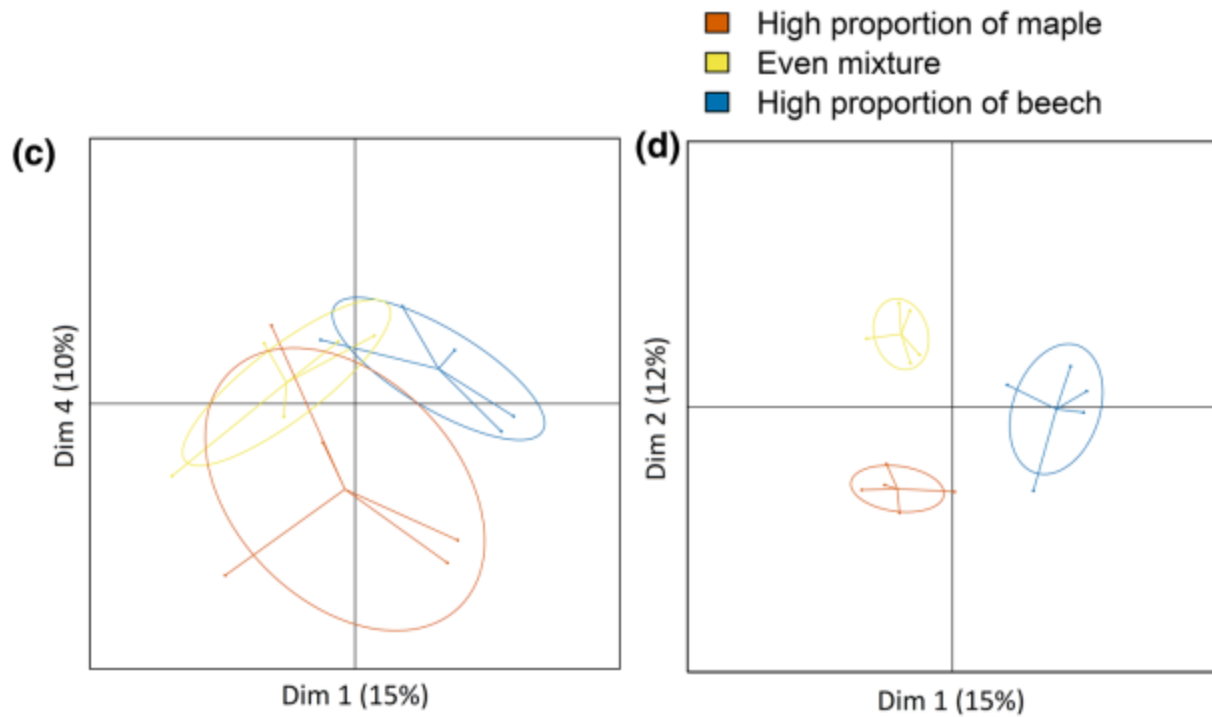
Equation

## Utilisation :

Fine root mixture  
Unknown sp proportion

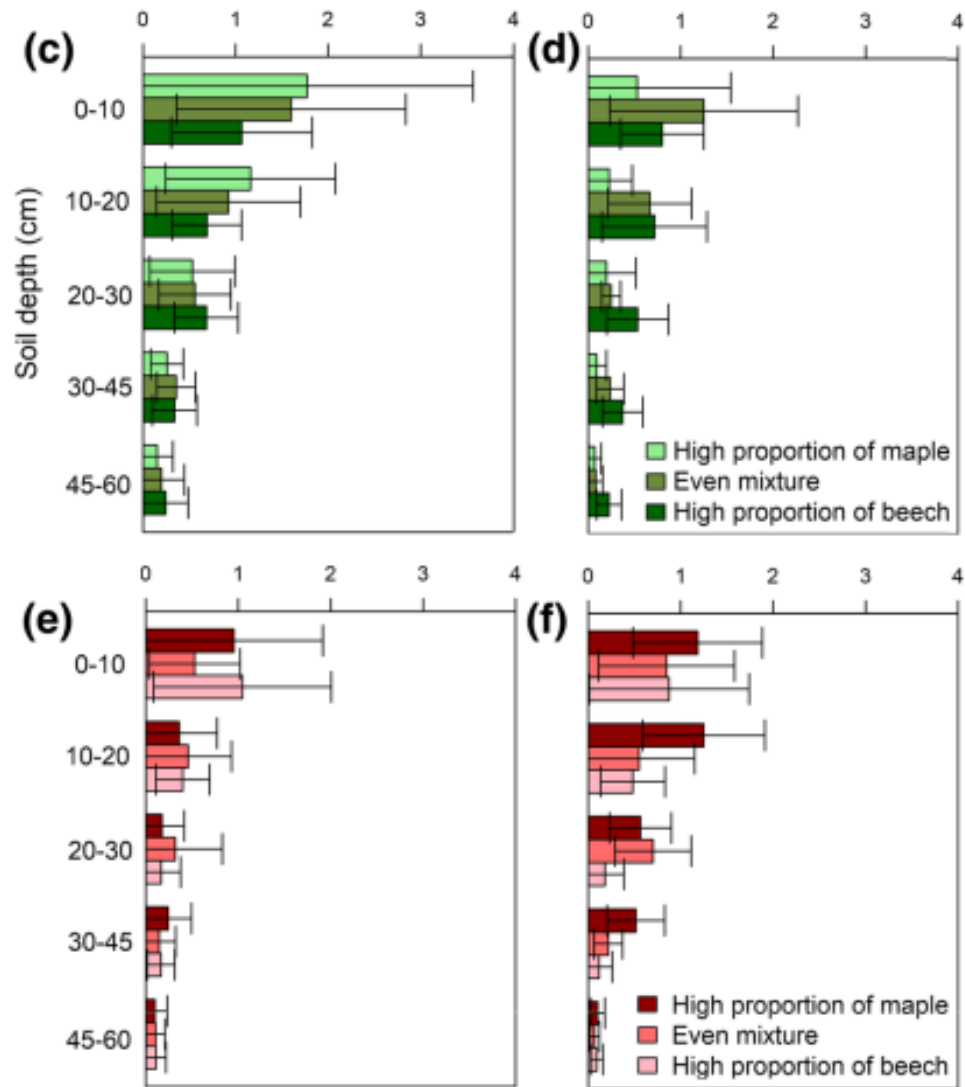


**Beech proportion**



Ectomycorrhizal fungi communities

Non mycorrhizal fungi communities



+ beta of Gale and Grigal (1987)