

# Reversal of the recent growth trend of silver fir (*Abies alba*. Mill) in the context of climate change

Paulina Pinto Gonzalez<sup>12</sup> & Jean-Claude Gégout<sup>1</sup>  
[paulina.pinto@agroparistech.fr](mailto:paulina.pinto@agroparistech.fr)

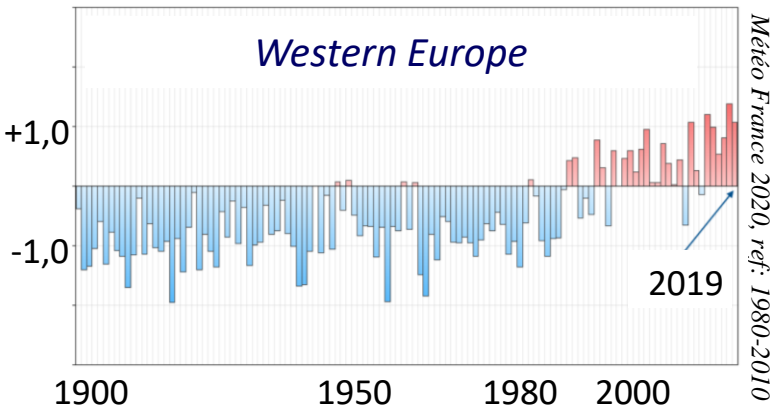


1 - AgroParisTech, INRAE, Silva, 54000, Nancy, France  
2 - Harvard Forest, Harvard University, MA USA

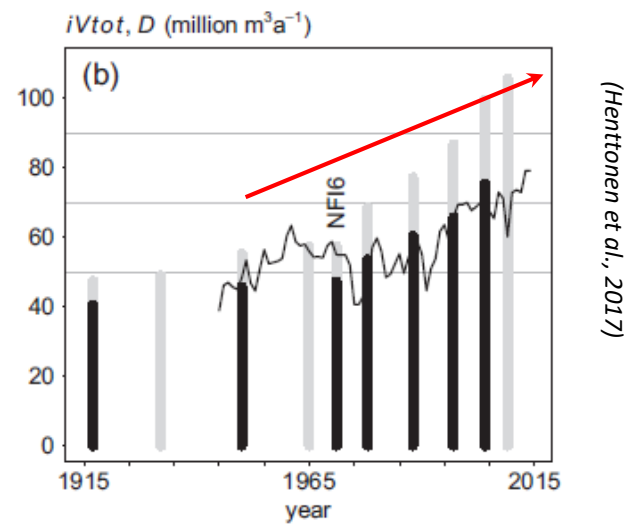


# Introduction

Over the last century, **Western Europe** has experienced a significant warming trend, with the average temperature rising by approximately 2 degrees C.



During the 20th century, a significant increase in forest growth was observed in the Northern Hemisphere



But, recent observations have uncovered instances of dieback events and indications of growth decline in specific coniferous species within the southern extent of their range



# Aims

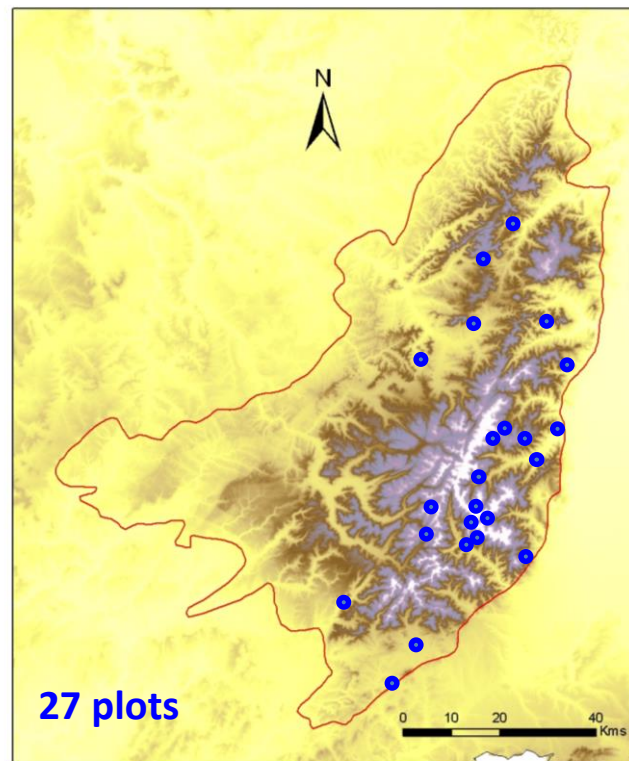
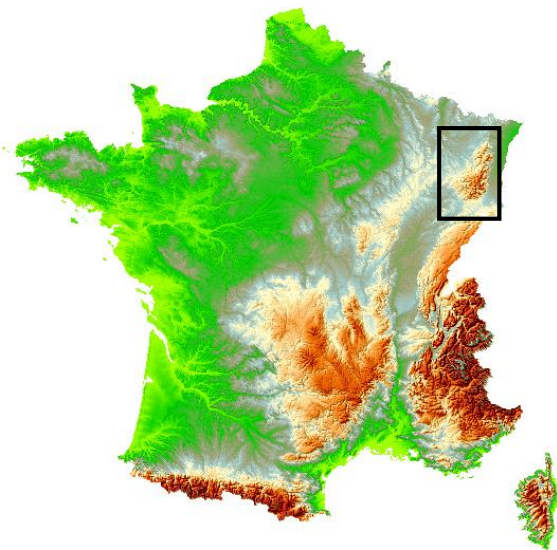
---



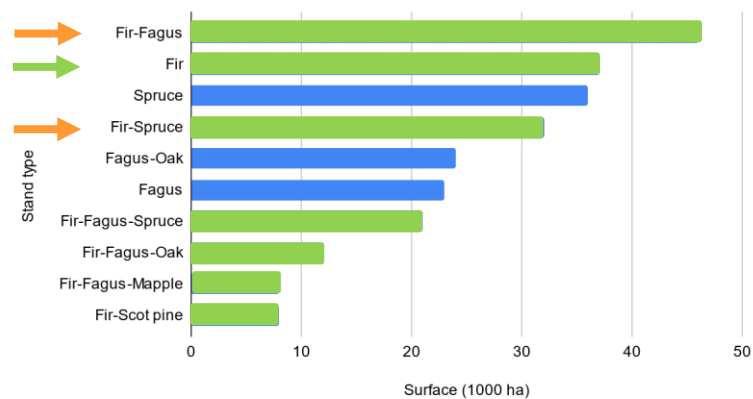
*1. Has the growth trend of coniferous forests in Western European temperate forests changed since the turn of the century?*

*2. In the event of a reversal of the growth trend, what factors might influence or modulate these changes?*

# Species and Study area



Surface of the different stand types in The Vosges Mountains.



# Sampled trees and cores preparation

## Trees inventory



Circumference, azimuth, species, height and dieback.

## Coring trees



3 dominant trees per species from the bark until the pit

## Cores preparation

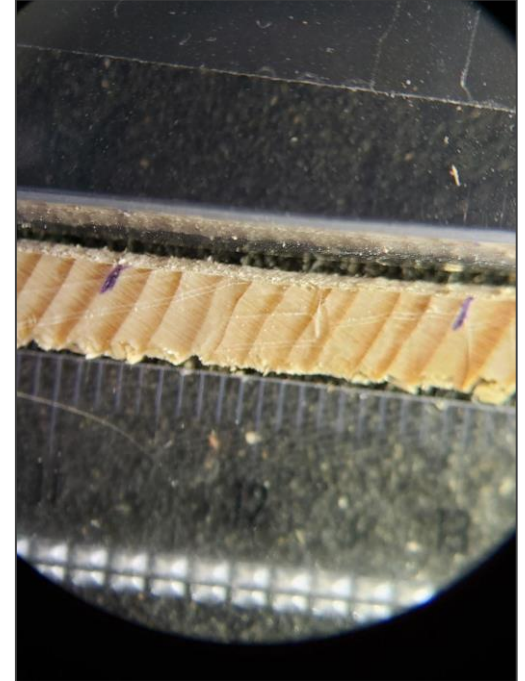


Ring width and age of 3 dominant fir per plot

# Data analysis

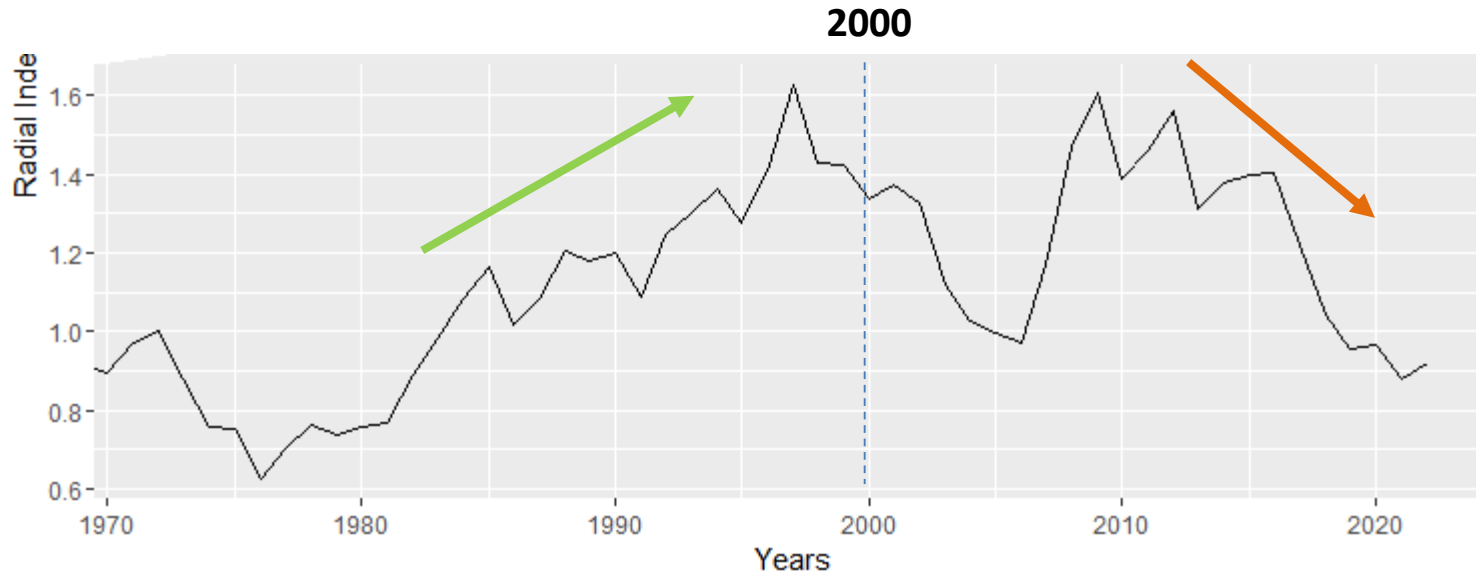
---

- Ring widths were transformed in radial indices by controlling the cambial age effects. We used a method (RCS) allowing to conserve the spatial and temporal variability in the radial growth indices.
- To deal with the long term growth trends, we computed a chronology of the mean radial index since 1975 forward.
- To investigate the factors underlying the growth trends we used a mixed effect model linking Growth index to environmental variables.



*Has the growth trend of silver fir forests changed since the turn of the century?*

## Results – Growth trend



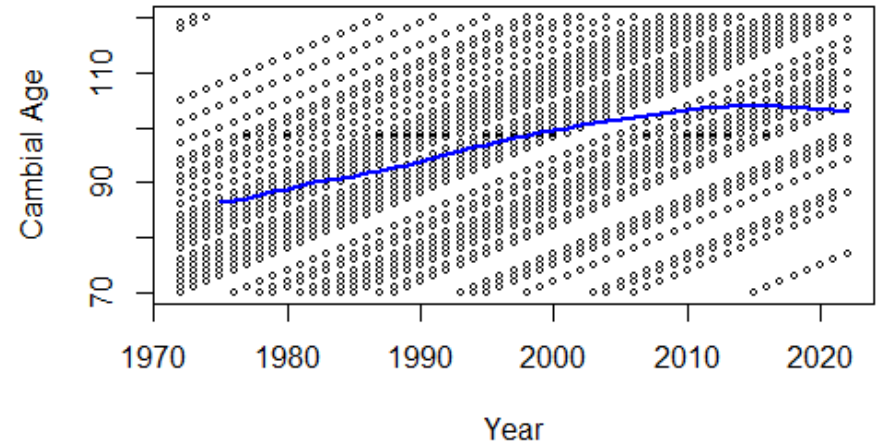
- We observe a positive trend in radial growth during the last decades of the 20th century.
- a turning-point took place between 2000 and 2010. After 2010, results show a significant fir growth decrease

*Has the growth trend of silver fir forests changed since the turn of the century?*

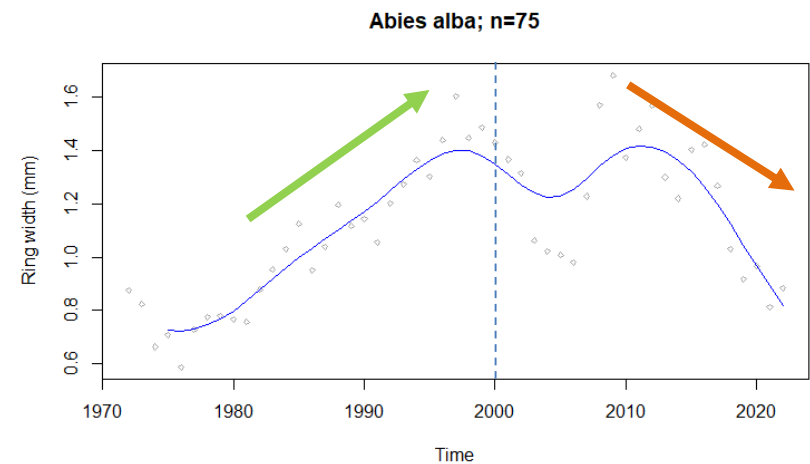
## Results - Growth trend

- **Checking the absence of an age effect:**

Selection of a subset of rings between 70 and 120 years old to maintain the same average age of rings over time.



- Increasing and decreasing trends are confirmed with the same turning point between 2000 and 2010
- A strong growth decrease of ~30% occurred since 2017.

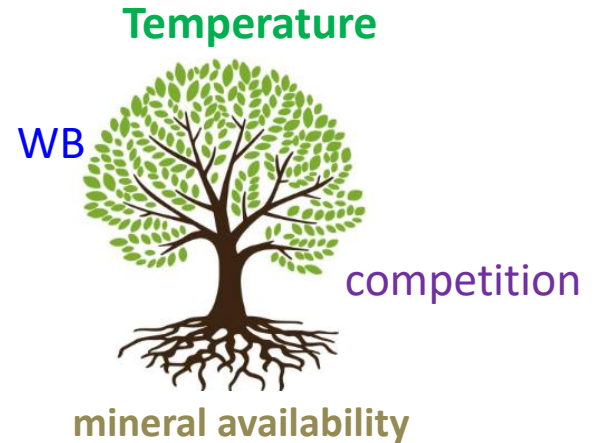




What factors might influence or modulate the reversal of the growth trend?

# Results – modelling framework

G f((SoilNut, Spring T, Spring P, Summer P, Summer T)  
 | tree random effect)



Pinto, et al 2008

## – Final fitted models

1975 – 1996 (lme~Rli) = ( **SoilNut**, **Spring T** + **Summer T** + (random=~1 | **Tree**))  
 +        +        +

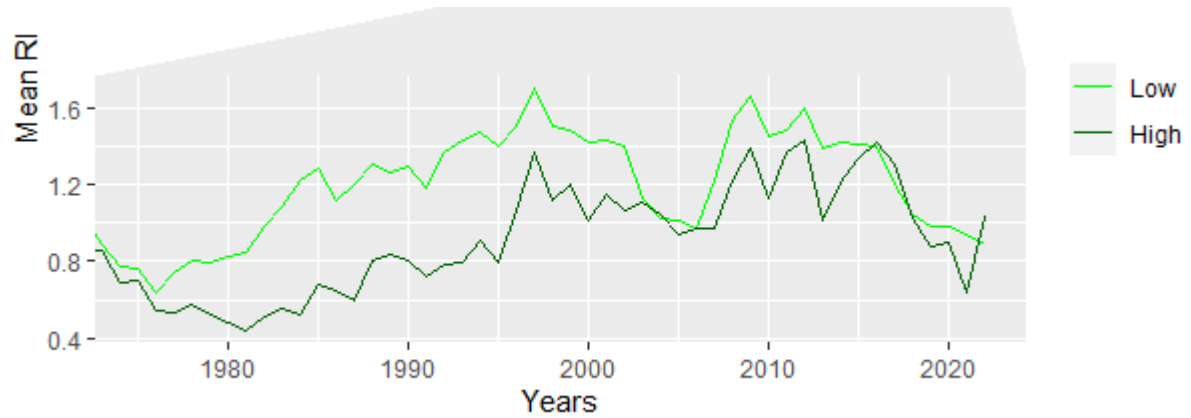
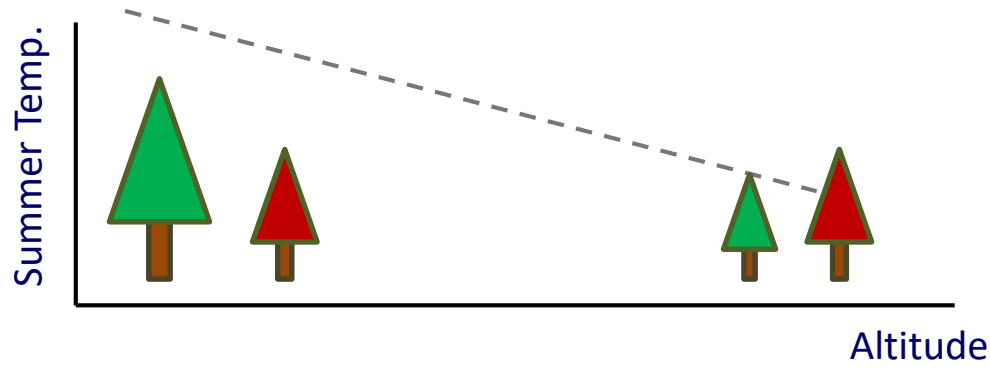
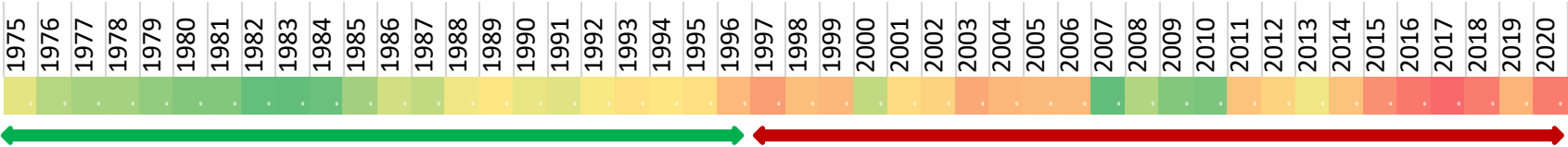
1997-2020 : (lme~Rli) = ( **Summer T** + (random=~1 | **Tree**))  
 —

2009-2020 : (lme~Rli) = ( **Summer T** + (random=~1 | **Tree**))  
 —

Temperature

Water availability

# Results – Growth and altitudinal gradient



The altitudinal gradient of growth disappears with time according to the increasing water stress at low altitude.



## Conclusions

- We have noted a significant growth trend reversal, transitioning from a robust increase during the last decades of the 20th century to a subsequent decline since the beginning of the 21st century
- The decreasing trends were predominantly observed at lower altitudes, which aligns with the increasing drought stress at these elevations.
- During the XXth century, growth was higher at low elevations and lower at high elevations, but now it appears consistent throughout the entire elevation range
- The changes in radial growth could potentially serve as early indicators of future range shifts.



Thanks to people that contribute with :  
**Students of the MSc FEN (Forest and their Environment)**  
field work : E. Thirion; Lucas Putigny, Sophie Lorenz;  
Climatic data set : Christian Piedallu

