Evidence of long-term climate-change impacts on growth response of beech (*Fagus sylvatica*) since the late 1970s in southern Belgium

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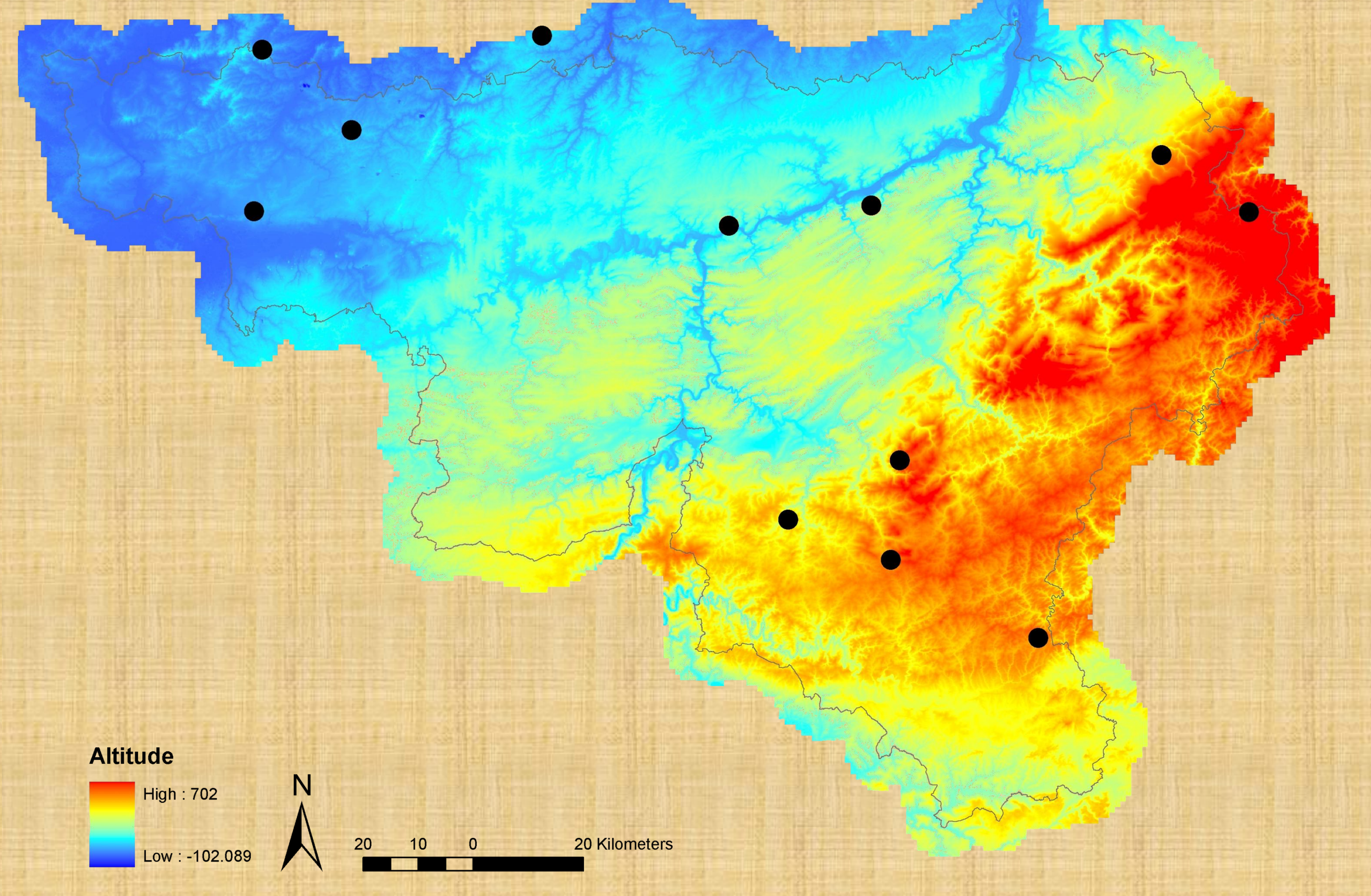
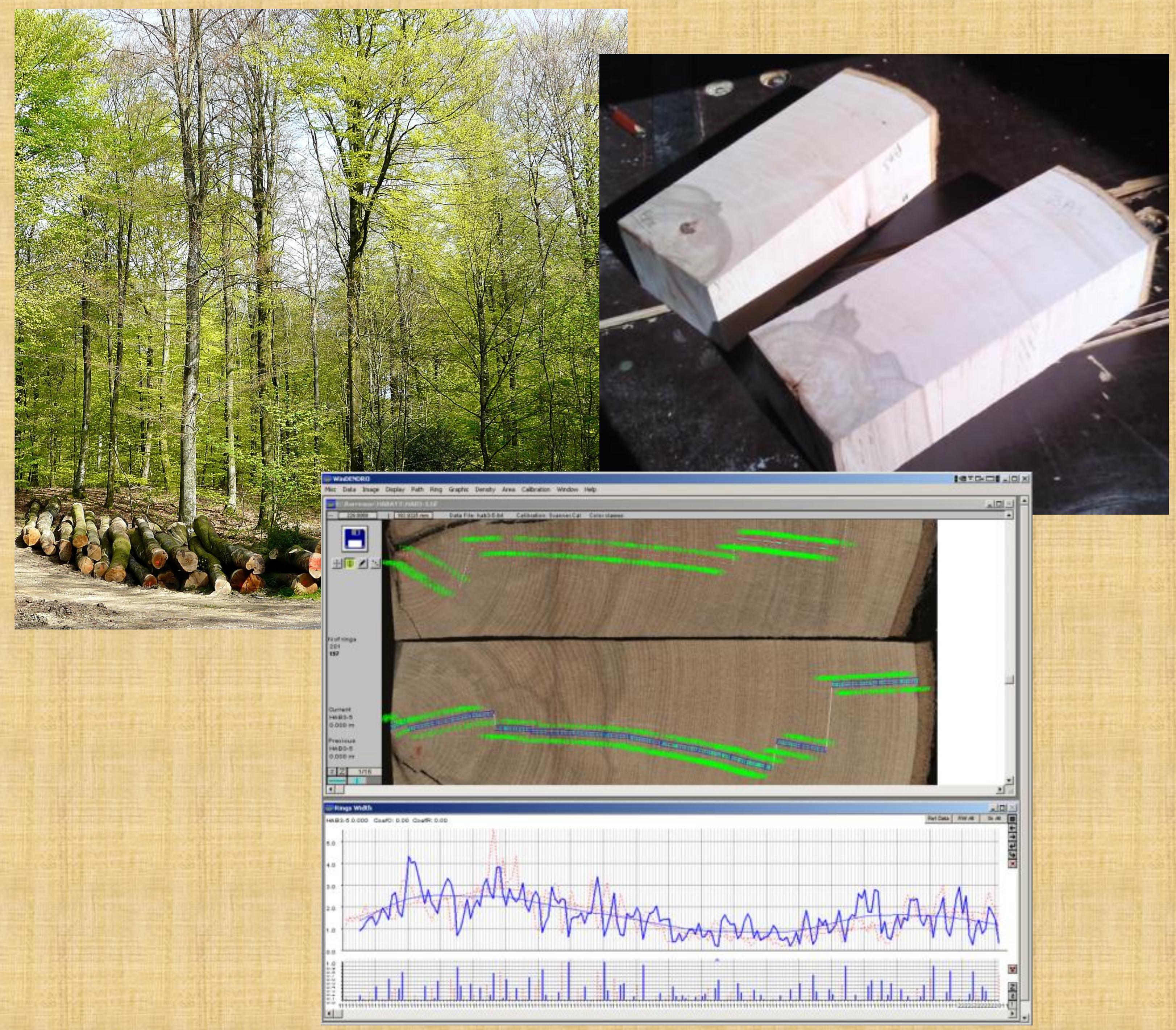


INTRODUCTION

Changes in growth is one of the primary responses of trees to environmental and climatic variation. Climate change: temperature increase, precipitation modification in time and space, and higher intensity and frequency of extreme events are expected to have strong influence on forest. Intense droughts as in 1976 and 2003 may particularly be harmful for soil moisture dependent species like common beech (*Fagus sylvatica*). These last decades beech declines (crown condition) were observed throughout Western Europe. This study aimed to better understand how beech reacted to climate change since the 1950s. The influence of climate on the radial growth was investigated using chronologies of 12 mature beech stands.

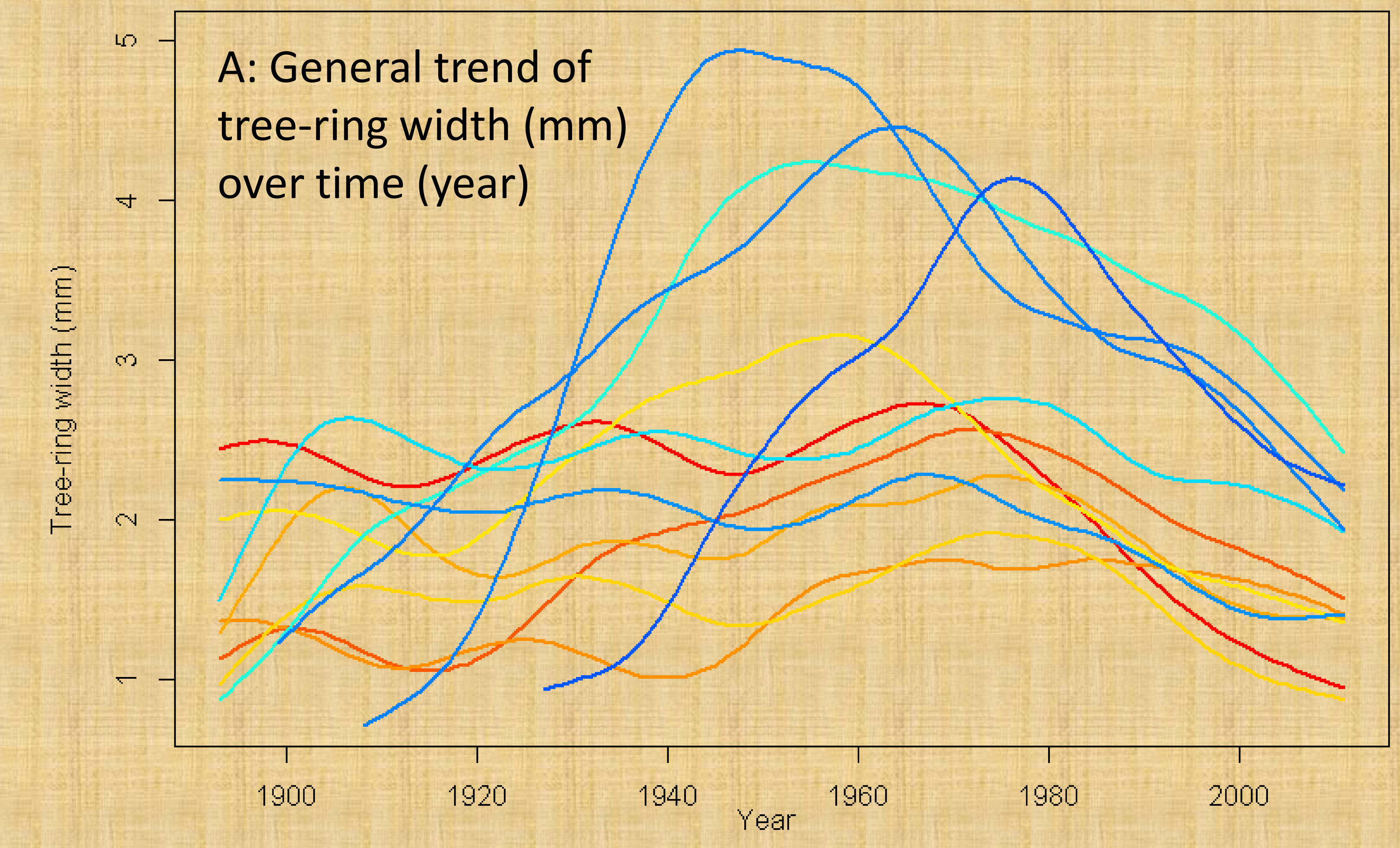


MATERIAL AND METHODS

Twelve beech stands were selected along a NE-SW climatic gradient of altitude (67-590m) in Wallonia (southern Belgium). In each stand 13 dominant or co-dominant beech trees were cut down and 1 disk per tree was collected. To improve handlings and increase ring measurement quality 2 'bars' 12 cm wide were extracted from each disk. Air-dried bars were planed, sanded (sandpaper 150) and scanned at high resolution (minimum 1200 dpi).

Tree-ring widths were measured using WINDENDRO. Individual ring-width series were cross-dated and site-specific chronologies were built using R dplR package. Site chronologies were detrended using a cubic smoothing splines (frequency response of 0.5 at a wavelength of 24 years) .

Long-term variations of tree-rings were analyzed using moving intra-site mean sensitivity and moving inter-sites correlation coefficient. Responses to climate were analyzed using moving bootstrapped correlation coefficients. These moving analysis were performed on 30-years periods from 1952 to 2011. Daily climate data of the European Climate Assessment & Dataset were used for correlation analysis.

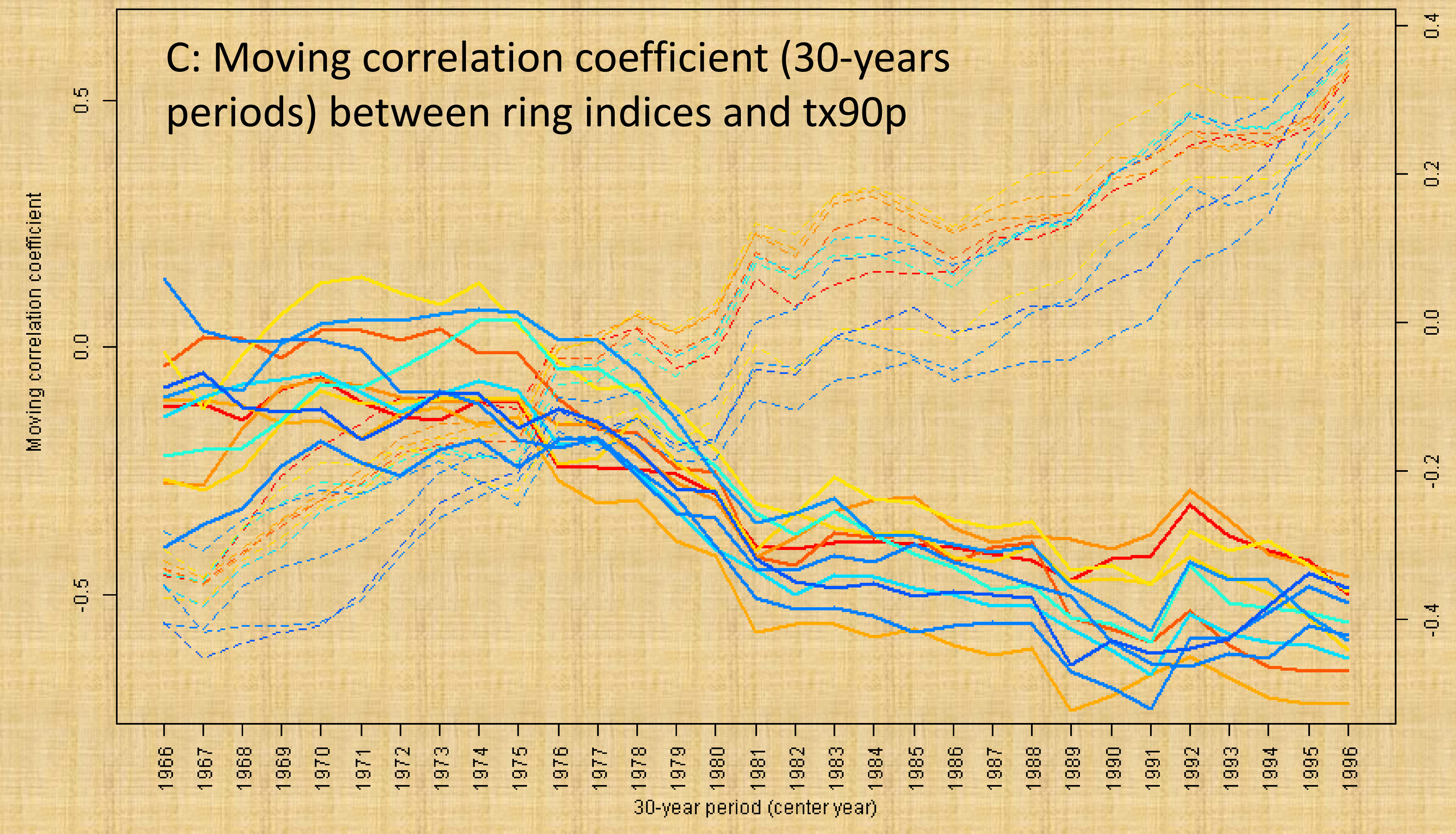


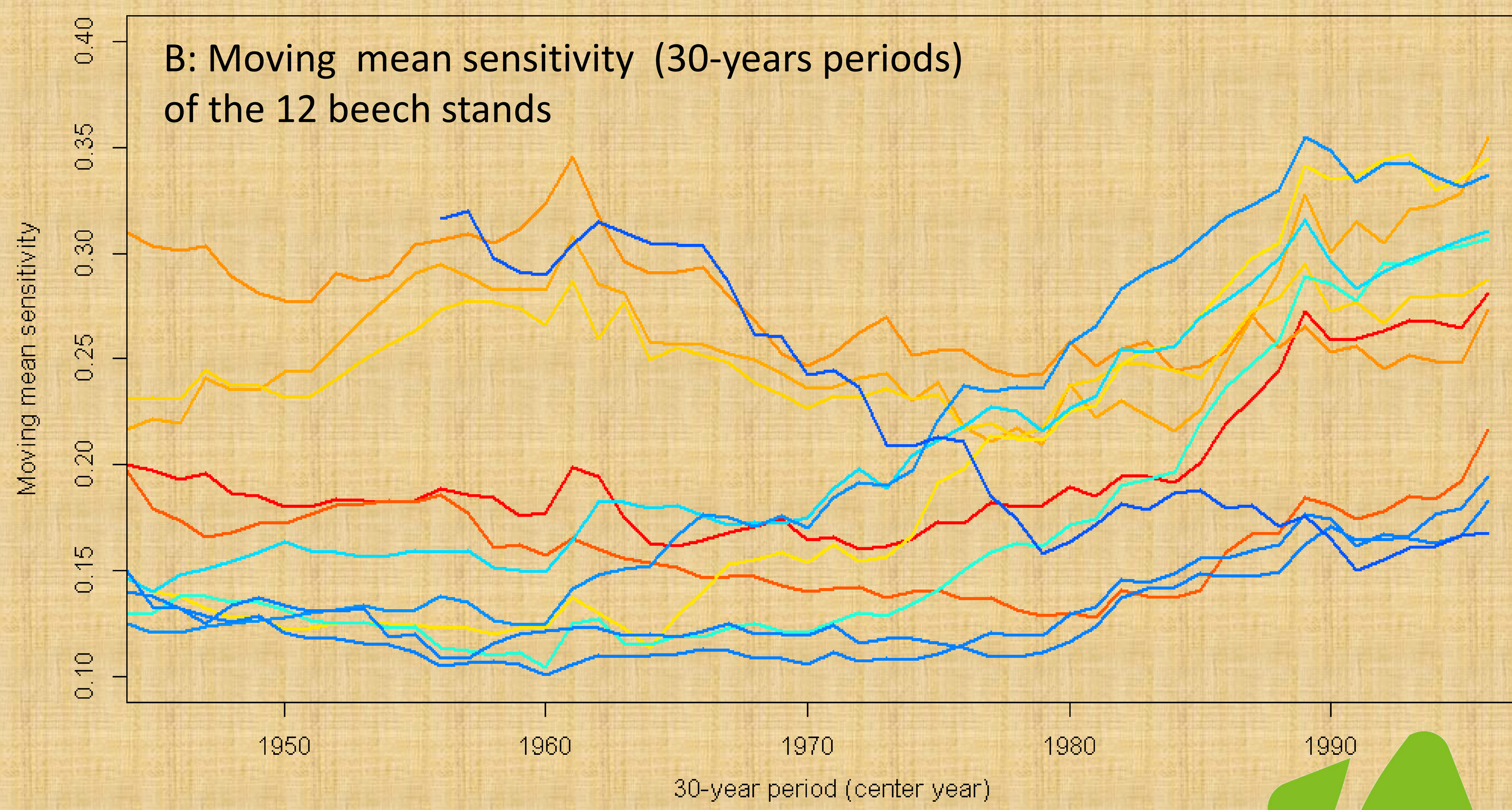
FIRST RESULTS

During the 20th century ring width first increase and then decrease strongly for all site. The switch occurred during the late 1970s (A). At the same period the correlation (synchronism) between site indices chronologies increases quickly. The mean sensitivity of most beech stands increases also to reach a unprecedented level (B).

Moving correlation analyses suggested that the observed growth decrease and sensitivity increase is consequent to constant warming temperature.

The correlation between ring indices and the frequency of hot temperatures is increasing quickly in the late 1970s (C): higher the number of days with a maximal temperature > 90-percentile during the previous summer (tx90p) is, lesser is the beech growth. The increase of temperature generate more frequent and intense heatwaves and droughts in such a way that beech growth is becoming more and more dependant on water availability.





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