INTRA-ANNUAL DYNAMICS OF CARBON ASSIMILATION, STEM RADIAL GROWTH AND WOODY CARBON SEQUESTRATION IN A MATURE BEECH FOREST

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1. INTRODUCTION

Forest ecosystem constitute a major carbon sink, mainly in wood, but seasonal dynamics of production of this woody biomass remains poorly quantified.

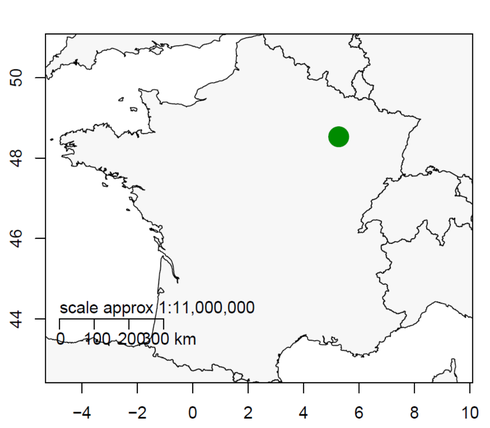
- **Our goal:**

To investigate how the intra-annual dynamics of the carbon allocated to the wood is related to the carbon captured by the leaves and the environmental conditions.

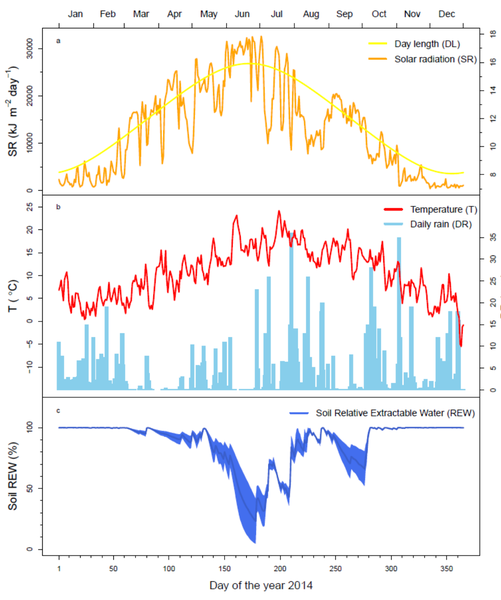
We combined various approaches to accurately assess the intra-annual dynamics of forest stand gross primary productivity (GPP), tree stem girth increase (SGI), and woody biomass production (WBP).

- **Our hypothesis:**

(H1) in beech (as in conifers) the inner coordination of wood formation mechanisms results in WBP lagging behind SGI;
(H2) GPP seasonal course would be principally driven by solar radiation variations (H2a) whereas SGI would mainly depend on photoperiod (H2b) and WBP would be rather limited by temperature (H2c);
(H3) As a result, WBP should spread over a shorter period than GPP.



Study site: Montiers-sur-Saulx
Climat: attenuated semi-continental



2. MATERIALS and METHODS

- During the 2014 growing season, wood samples (microcores) containing phloem, cambial zone, and developing xylem were collected monthly on 14 dominant beech trees (Fagus sylvatica L.) grown in a flux tower site (Montiers, France) to monitor wood formation.
- The variation of stem circumferences were monitored monthly with manual dendrometers.
- The microcores were prepared in the laboratory to allow the observation of the developing xylem and phloem under light microscope, and to measure their radial increment.
- Image analysis were performed to measure optical density and to estimate biomass production in developing xylem.
- Flux tower measurements were used to estimate the daily GPP of the stand, and record the climatic conditions of the site.

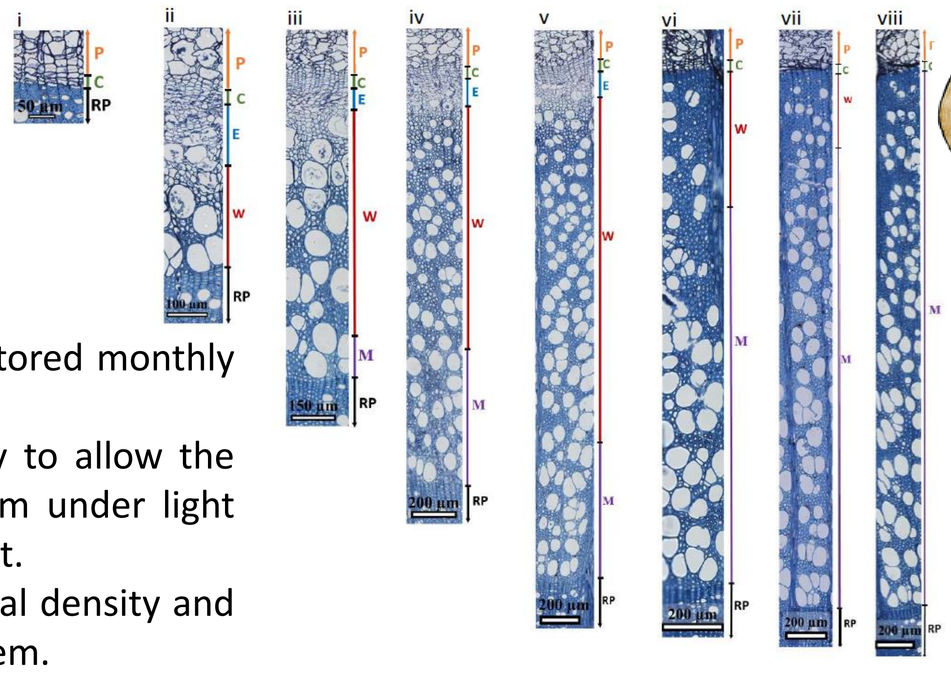
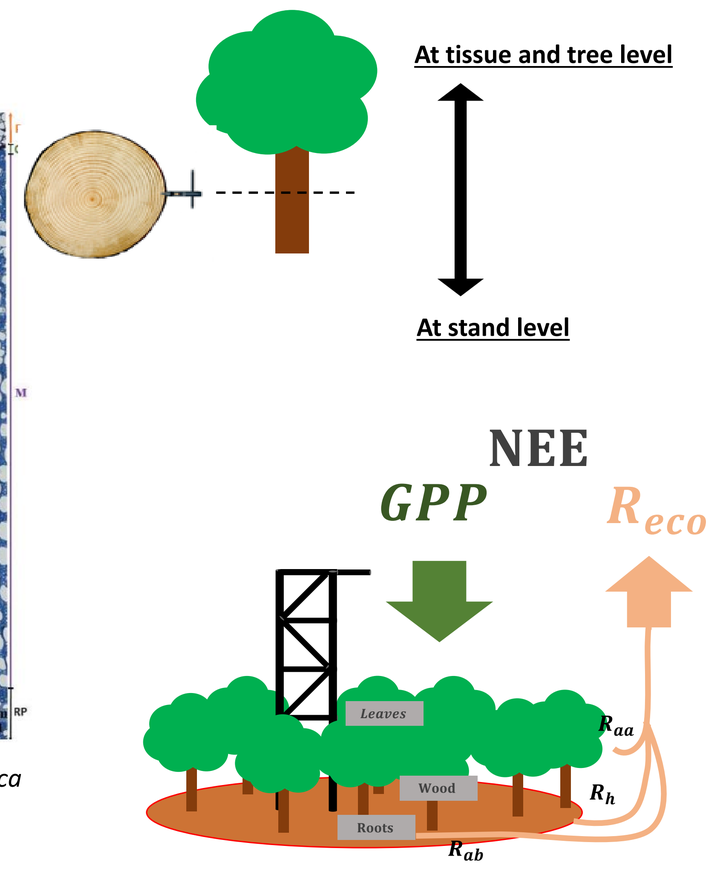


Fig 1: Phenology of wood formation for *Fagus sylvatica* during the 2014 growing season in Montiers forest



3. RESULTS

3.1 Temporal coordination between intra-annual dynamics of GPP, SGI and WBP

All along the growing season, the WBP lagged a few days behind SGI

From April to June, GPP quickly increased, preceding WBP, while from June until mid-November, carbon uptake slowly declined, lagging behind stem biomass production.

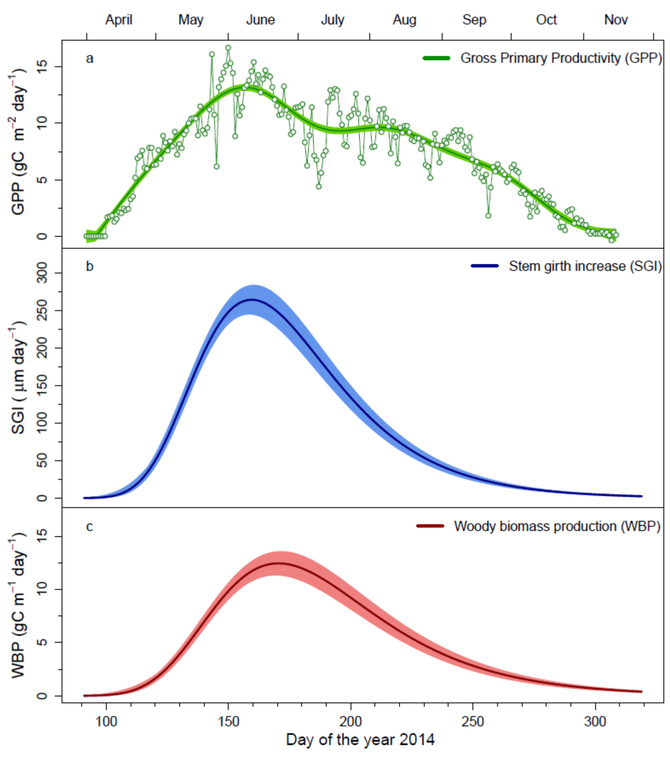


Fig 2: Temporal coordination between intra-annual dynamics of GPP, stem girth increase and woody biomass production

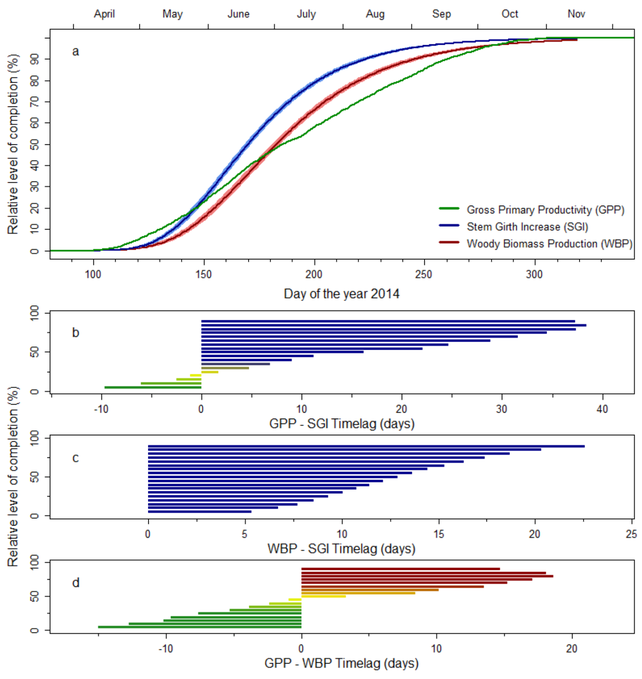


Fig 3: Timelag between intra-annual dynamics of GPP, stem girth increase and woody biomass production

3.2 Synchronization between intra-annual dynamics of GPP, SGI and WBP, and seasonal courses of environmental factors

Both GPP and SGI were tightly synchronized with the course of photoperiod and solar radiation, while WBP showed a higher synchronization with the course of temperature.

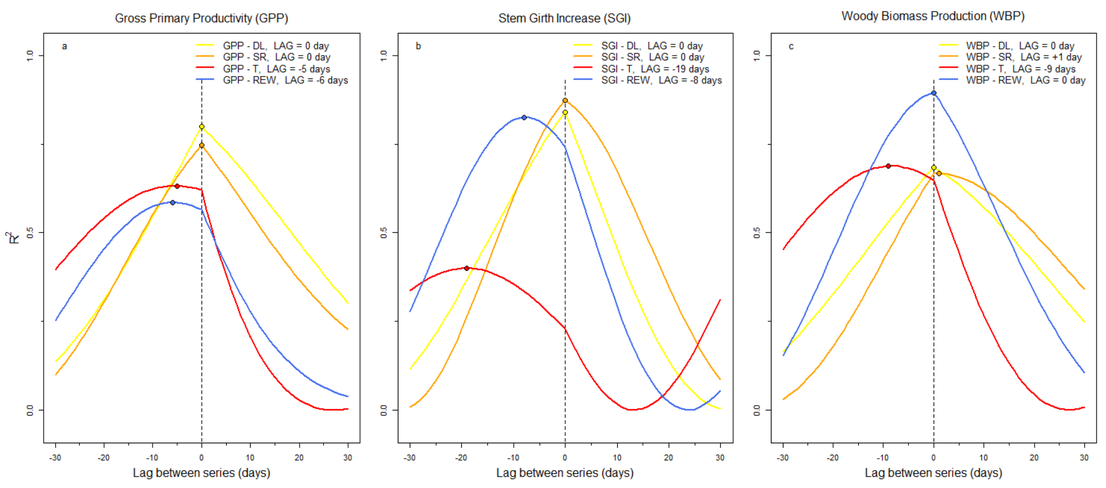


Fig 4: Synchronization between intra-annual dynamics of GPP, SGI and WBP, and the environmental factors (Daily solar radiation, photoperiod, temperature and soil REW)

4. CONCLUSIONS

- Our work demonstrated that all along the growing season the intra-annual dynamics of GPP, SGI, and WBP were shifted in a mature beech forest.
- These results allow a better understanding of the interplay between forests carbon uptake, tree growth, and woody biomass production, in a changing environment.

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