

DÉCORTIQUER LA FORMATION DU BOIS
POUR COMPRENDRE L'EFFET DES
PERTURBATIONS NATURELLES ET
ANTHROPIQUES SUR LA CROISSANCE DES
CONIFÈRES BORÉAUX

Annie Deslauriers

Le 2 mai 2016

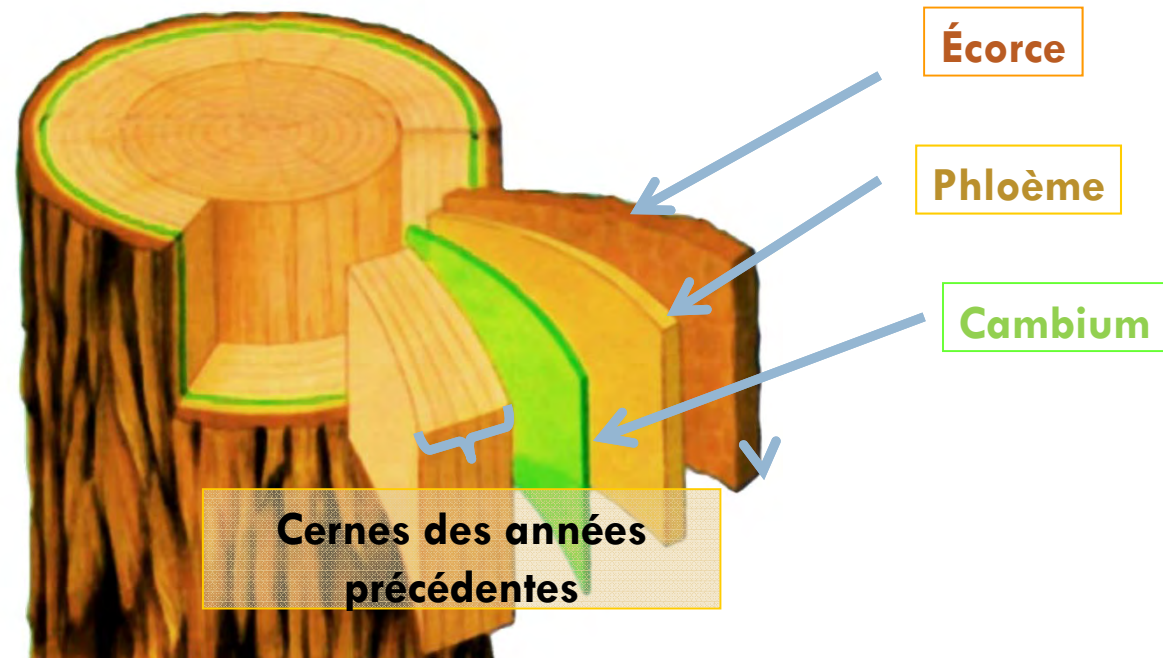
Colloque du CEF, Montréal



La formation du bois décortiquée

□ Le cambium

- Base de la croissance radiale des arbres
- Sensible aux facteurs environnementaux

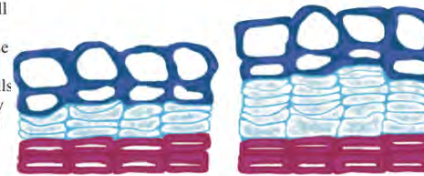


La formation du bois décortiquée

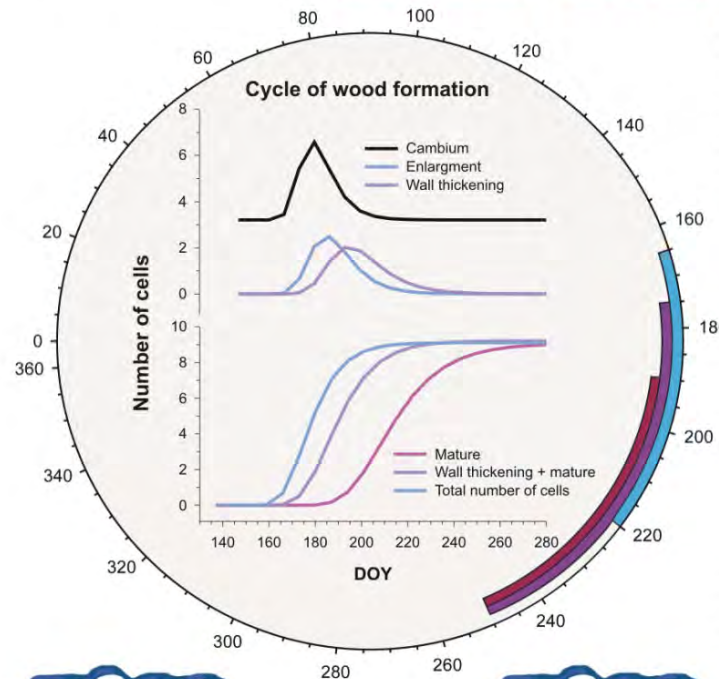
Notre approche

- Suivre le développement du bois (xylogénèse)
 - Cette approche permet d'étudier:
 - Quand (phénologie)
 - Comment (physiologie)
 - Résultat final (cerne de croissance)

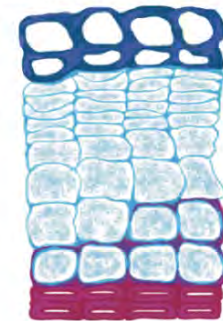
DOY 140: Dormant cambium has minimum number of cells with thicker cell walls. Radial walls of cambial cells are narrow and of similar dimensions (because no division occur). On the contrary, when the cambium is **active**, the numbers of cells increases, cell walls are thinner and newly forming cell with very thin tangential cell walls can be observed.



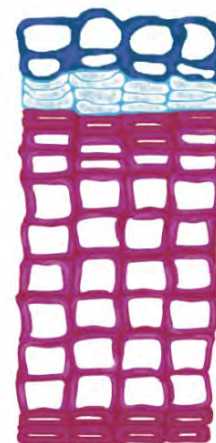
DOY 165: The onset of wood formation can be observed when at least one full row of enlarging cell are observed. The size of the enlarging cell must be at least two time the width of cambium and consist only of primary cell wall. Enlargement occurs despite compression being the forming cells enclosed between xylem and phloem tissues.



DOY 180: Once their final size had been reached, the phase of **cell wall thickening and lignification** begin. Lignification is shown by a colour change from **blue** (unlignified secondary cell walls) to **red** (lignified cell walls). At first, lignin deposition is observed at the cell corners on the primary wall, then extending along the middle lamella, primary walls and, finally, on the secondary wall.

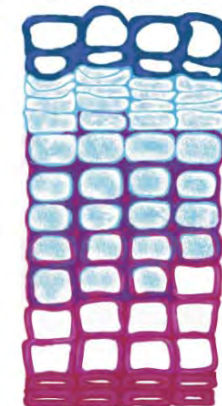
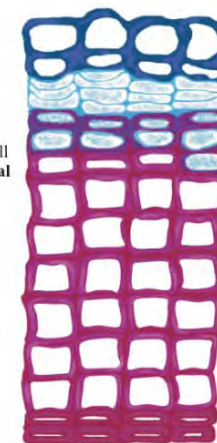


DOY 200: Several **mature tracheids** are observed. The final stages of maturation involve autolysis of the protoplast. The **red** color over the whole cell wall, and the **empty lumen** indicates the end of lignification and the attainment of the mature stage for the tracheid.



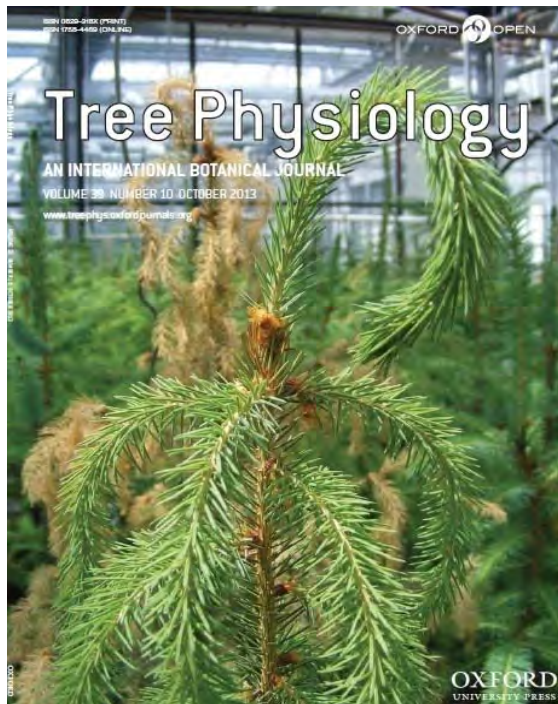
DOY 220: No more cell are observed in cell enlargement phase setting the end of ring width increase. As no more cell are found in this stage, **cambial activity** can be considered as finished.

DOY 250: The period of **wood formation** can be considered as finish when all cells have reach maturity.



La formation du bois décortiquée

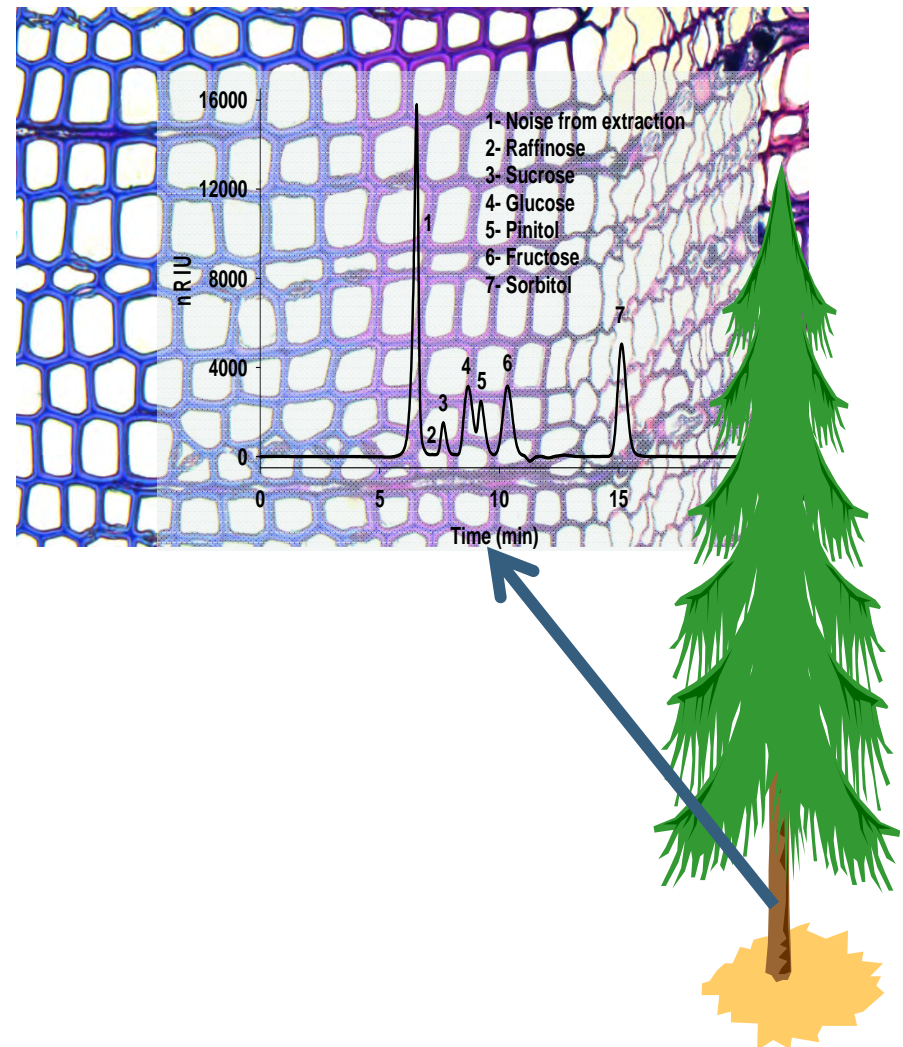
- L'étude de la formation du bois permet de connaître la variabilité dans le timing et la dynamique de croissance
- **Indicateur biologique:** réponse au climat actuel, aux changements climatiques et aux perturbations naturelles



La formation du bois décortiquée

□ Les approches **multidisciplinaires** sont gagnantes

- Anatomie
- **Physiologie**
- Chimie
- Génomique et protéomique



Dispositifs expérimentaux

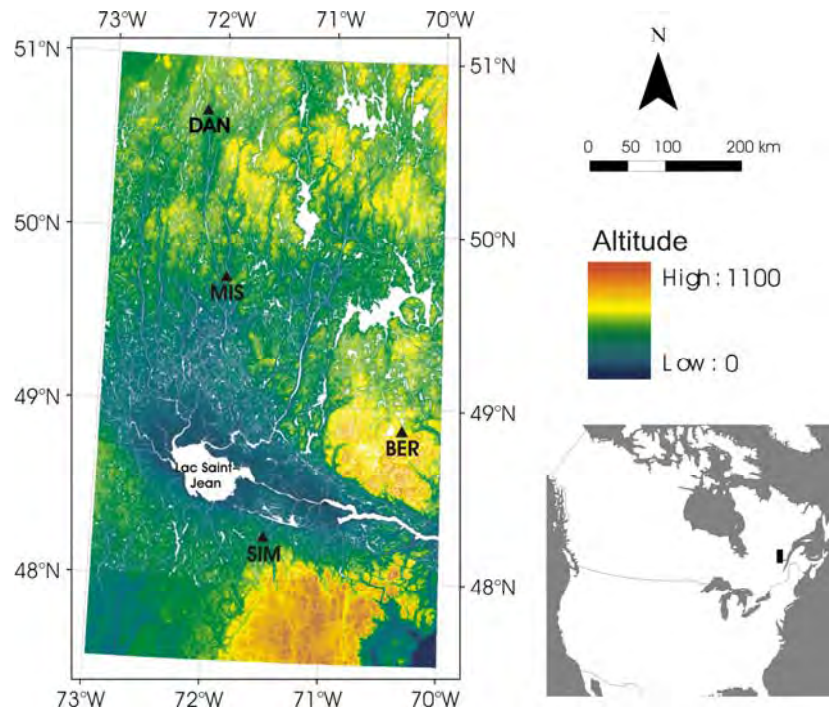


Photo Evelyn Belien



Photo Lorena Balducci

Quelques thèmes de recherche actuelles



- Phénologie de la formation du bois et phénologie foliaire – lien entre les deux
- **Physiologie de la croissance** – caractériser rôle de l'eau et du carbone dans la formation du bois
- Réponse physiologique de l'arbre en réactions aux **perturbations naturelles** (la tordeuse des bourgeons de l'épinette)

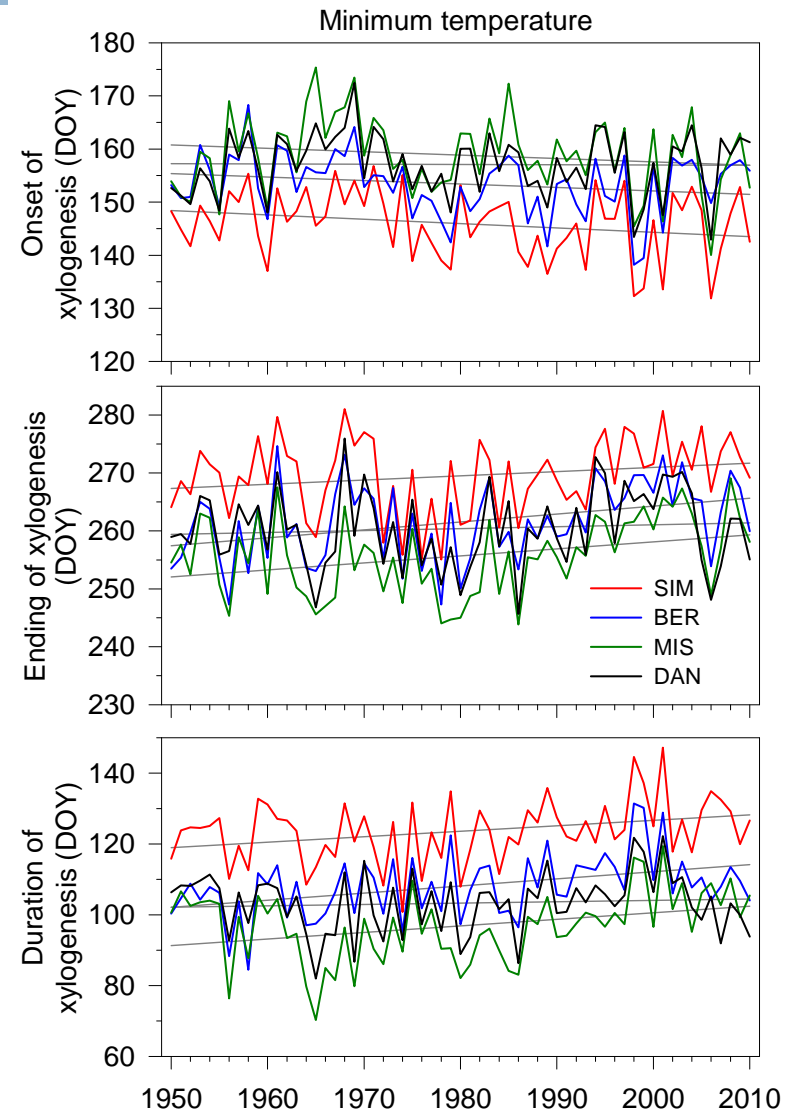
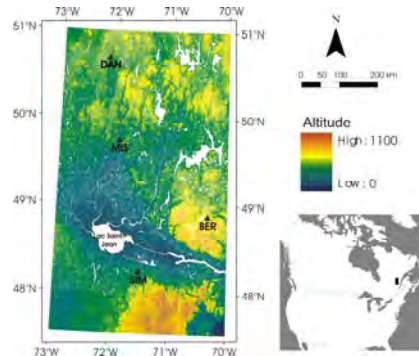
Phénologie et température – reconstruction de la variabilité passée et future

□ Phénologie 1950 -2010

▣ **Début:** précoce entre -0.8 et -0.5 jour/10 ans

▣ **Fin:** + 0.7 jour / 10 ans

▣ **Durée:** prolongement + 1.5 jour/10 ans



Xylem formation can be modeled statistically as a function of primary growth and cambium activity

Jian-Guo Huang^{1,2}, Annie Deslauriers² and Sergio Rossi²

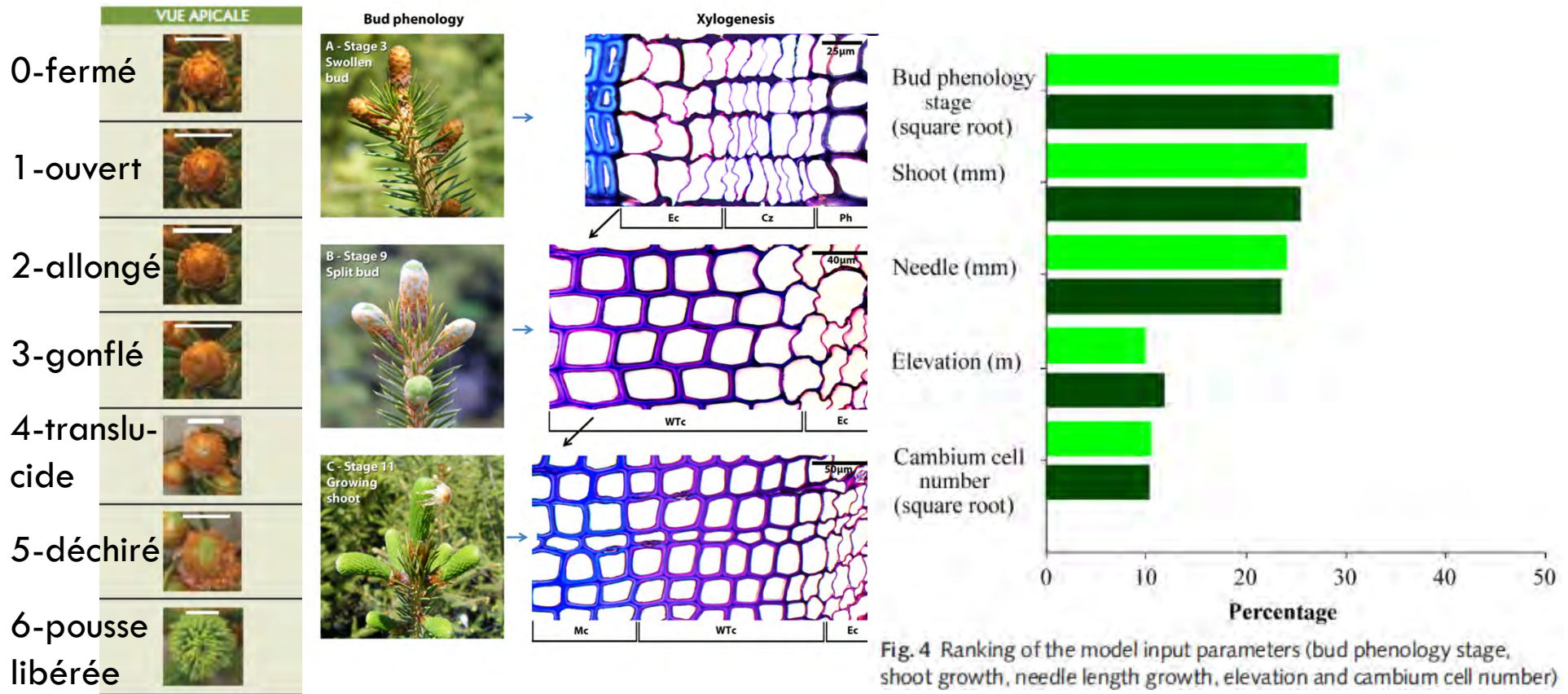


Fig. 4 Ranking of the model input parameters (bud phenology stage, shoot growth, needle length growth, elevation and cambium cell number)

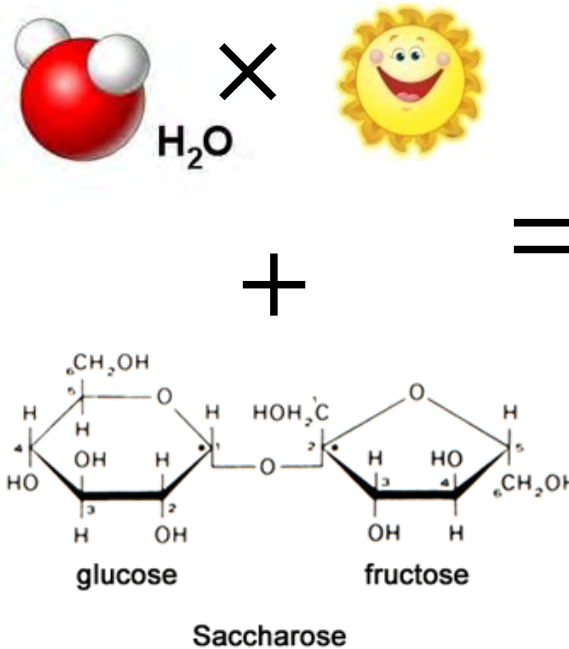
Physiologie de la croissance: effet de l'eau et du carbone

□ Facteurs de l'environnement

- Température
- Eau

□ Carbone

- Pool des glucides
- Reserves (amidon)



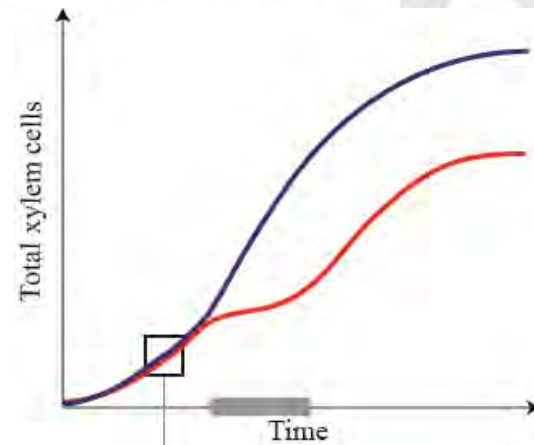
The Contribution of Carbon and Water in Modulating Wood Formation in Black Spruce Saplings¹

Annie Deslauriers, Jian-Guo Huang*, Lorena Balducci, Marilène Beaulieu, and Sergio Rossi

Plant Physiology[®], April 2016, Vol. 170, pp. 1–13,

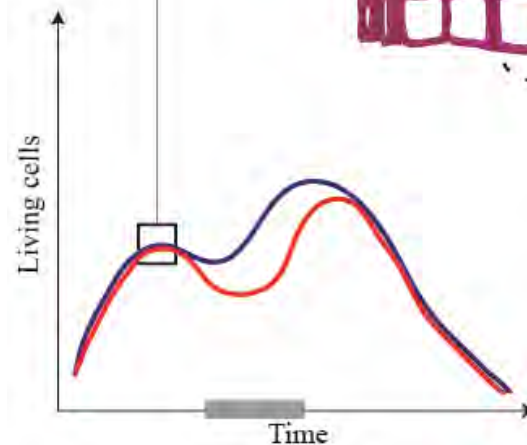
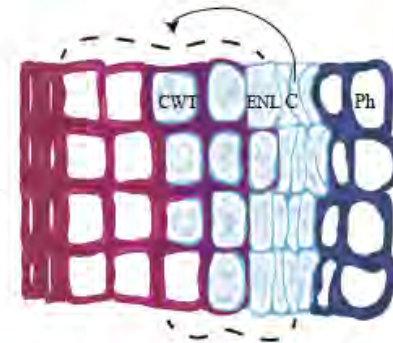


Photo Lorena Balducci



Meristematic activity

Water (73%) considered as first constrain in modulating the production of xylem from the cambial cells (C) during the growing season. Cambium (C) stop dividing in case of water deficit to limit the number of cell locked in differentiation without enough water. **Carbon** (18% in total) come as a second constrain with a negative effect of pinitol and a positive effect of sucrose.



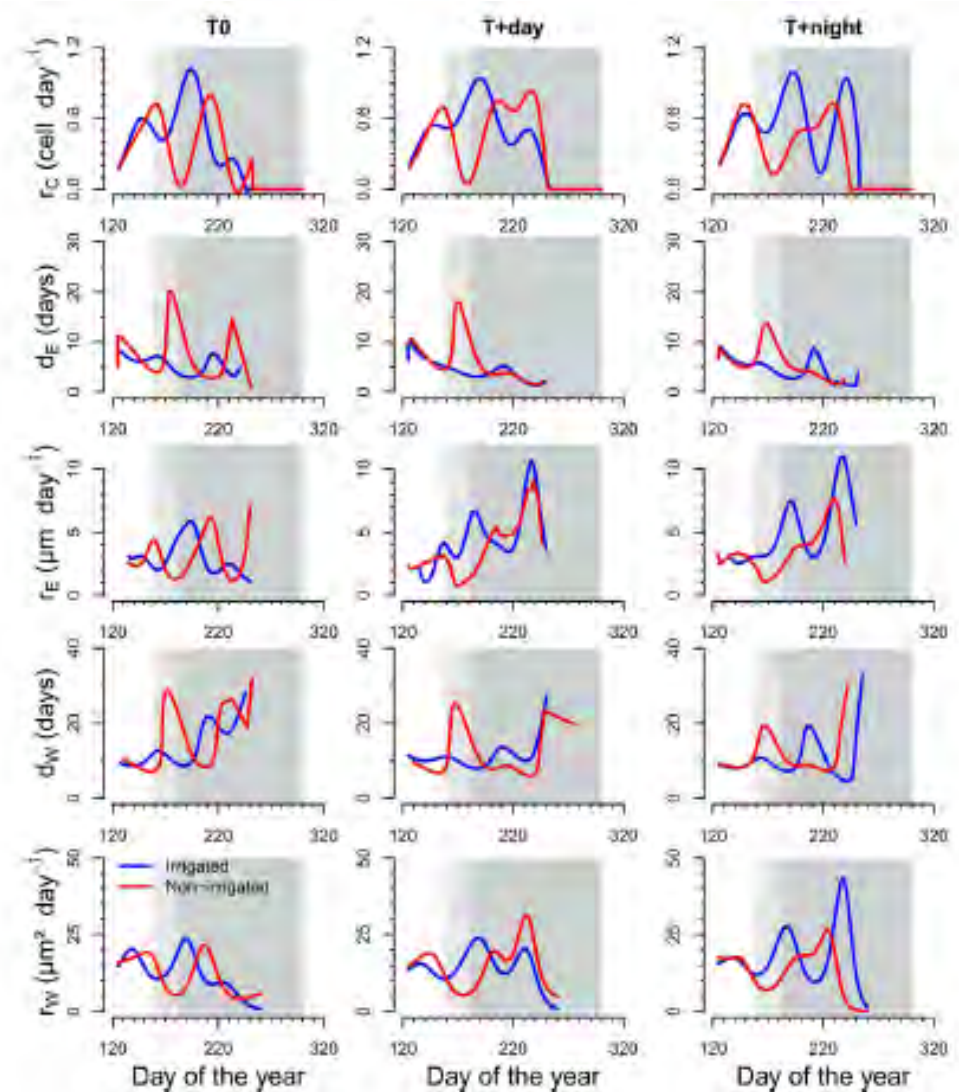
Building stage

Carbon (59% in total) was the main factor modulating the number of living cell. The forms of sucrose and fructose were the most important, acting either indirectly to attract water molecules for building the required turgor pressure for cell enlargement (ENL) or directly, for building the cell wall (CWT). The carbon is preferentially coming from the **nearby cambium** (23%). **Water** (15%) operate as a subsequent limiting factor in building turgor pressure.

Original Article

Compensatory mechanisms mitigate the effect of warming and drought on wood formation

- **Stress hydrique:** Forte ↓ du nombre de cellule
- **Réchauffement:** ↑ du nombre de cellule
- **Peu d'effet sur l'anatomie des cellules** (↓ densité)
 - ▣ Compensation entre les sous-mécanismes de la formation du bois

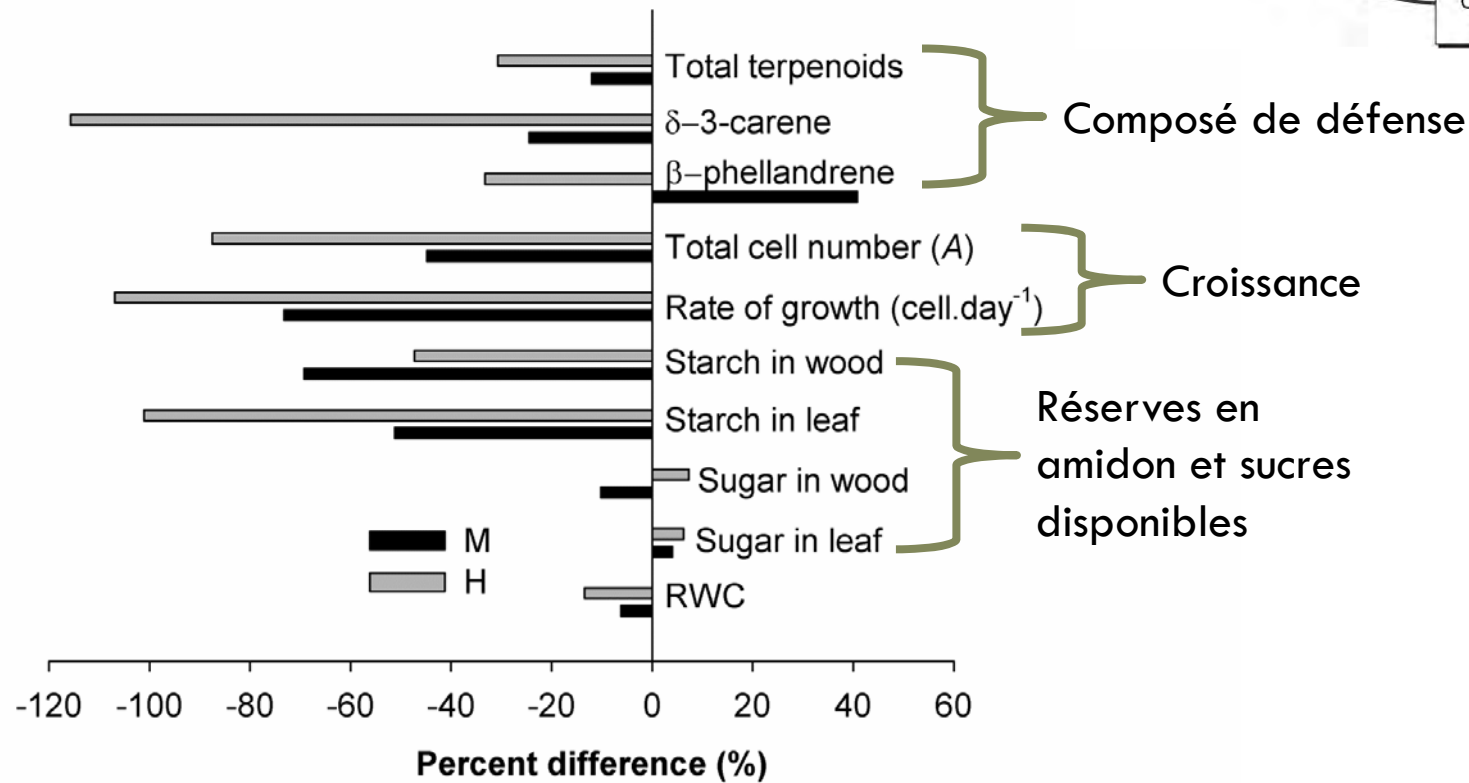
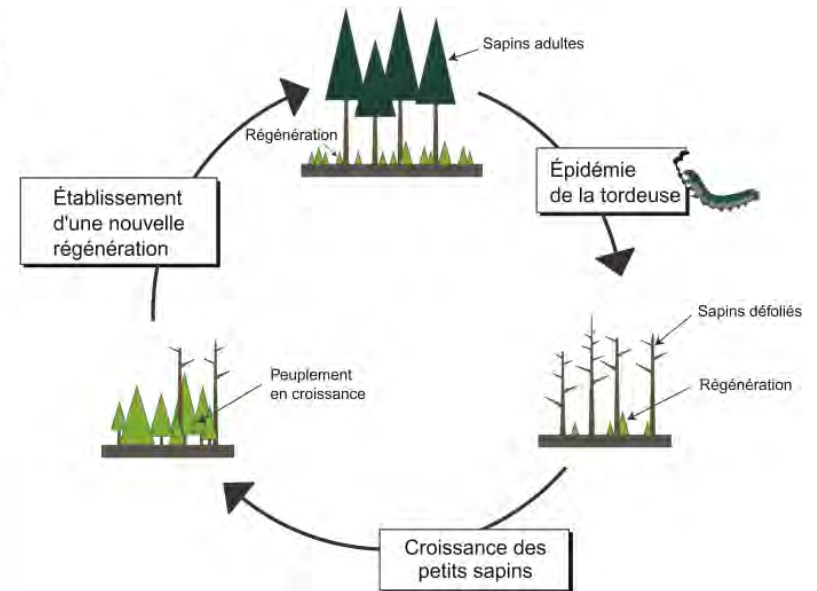




Carbon allocation during defoliation: testing a defense-growth trade-off in balsam fir

Annie Deslauriers[†], Laurie Caron[†] and Sergio Rossi

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Ma vision pour le CEF

Merci pour votre attention !



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