



Vingt ans d'expérience en modélisation de l'architecture des plantes

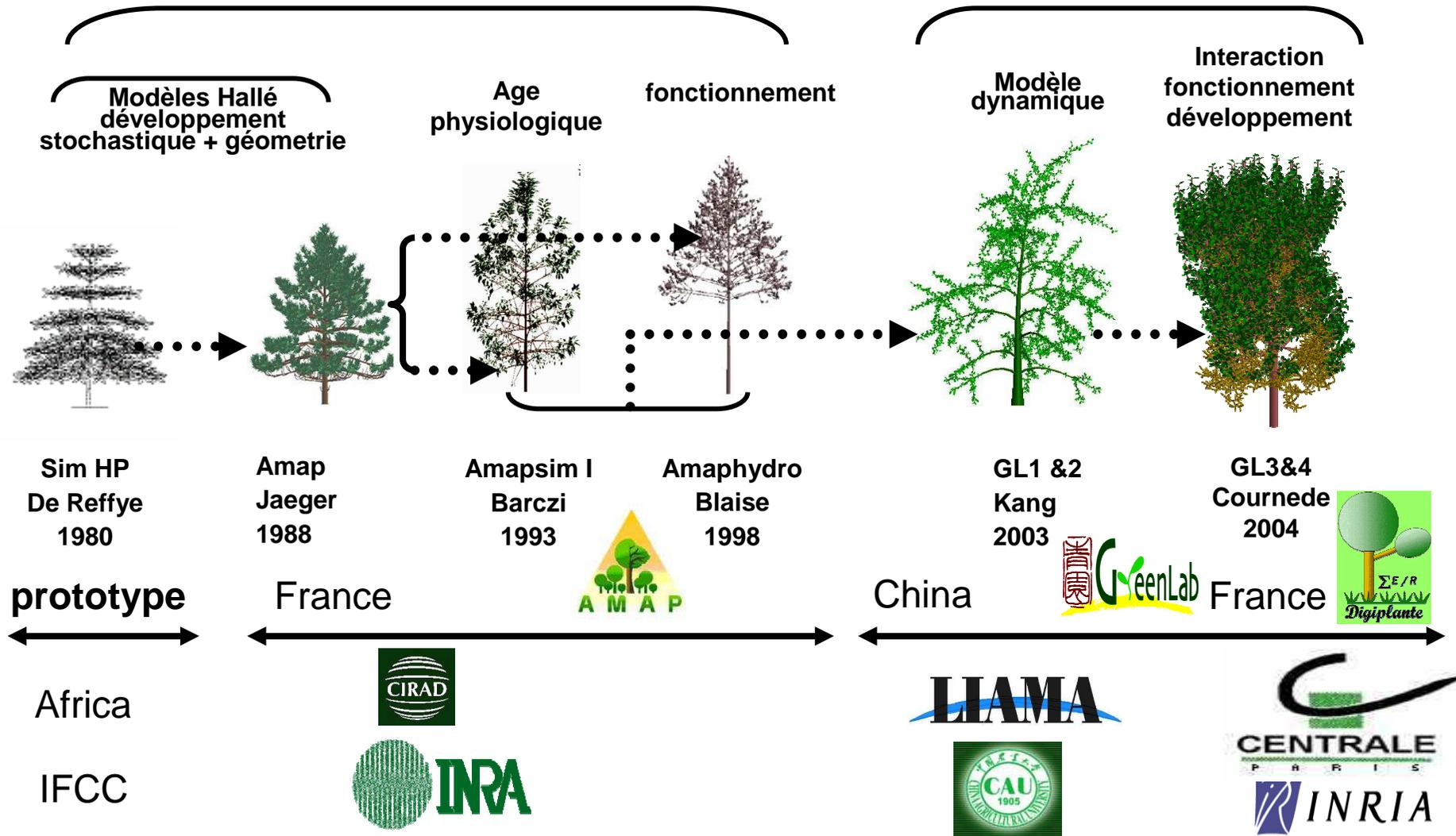
Synthèse des recherches et
développements menés à l'UMR
AMAP

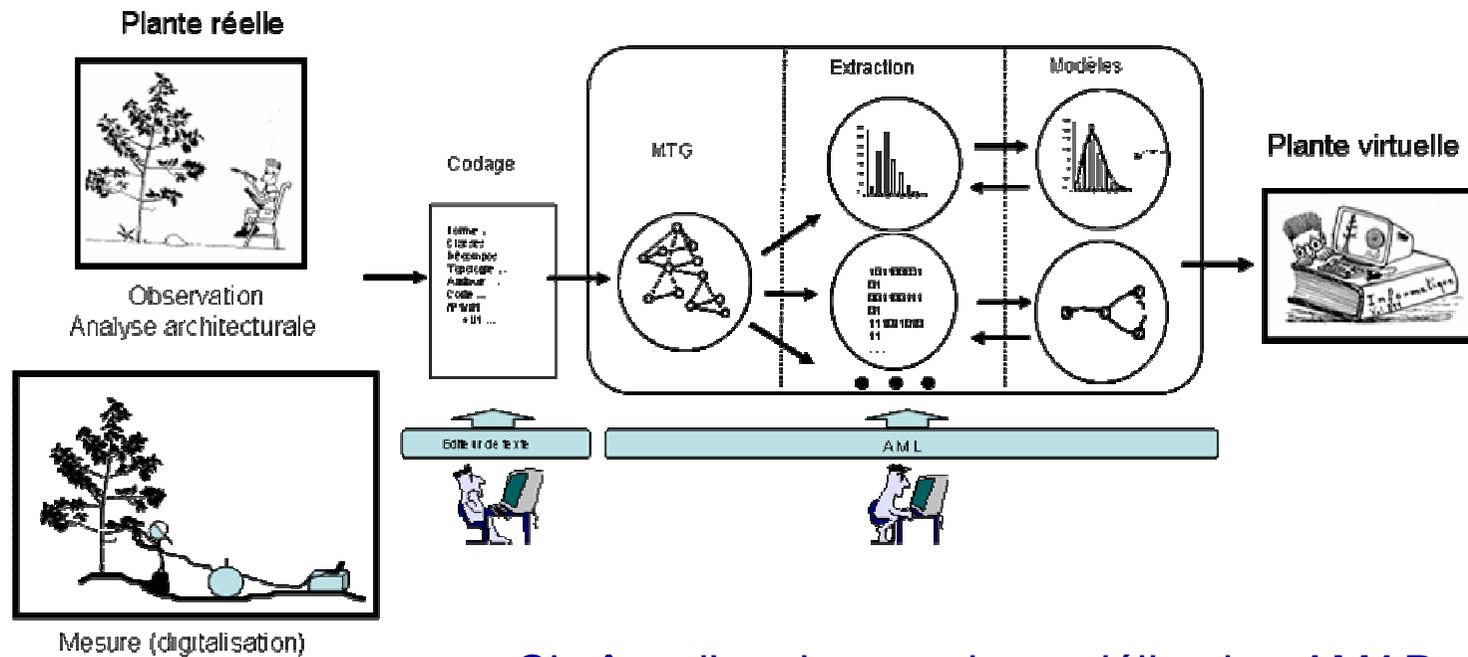
Thierry FOURCAUD et al.



Simulations de croissance

Modèles mathématiques





Chaîne d'analyse et de modélisation AMAP

pluridisciplinarité

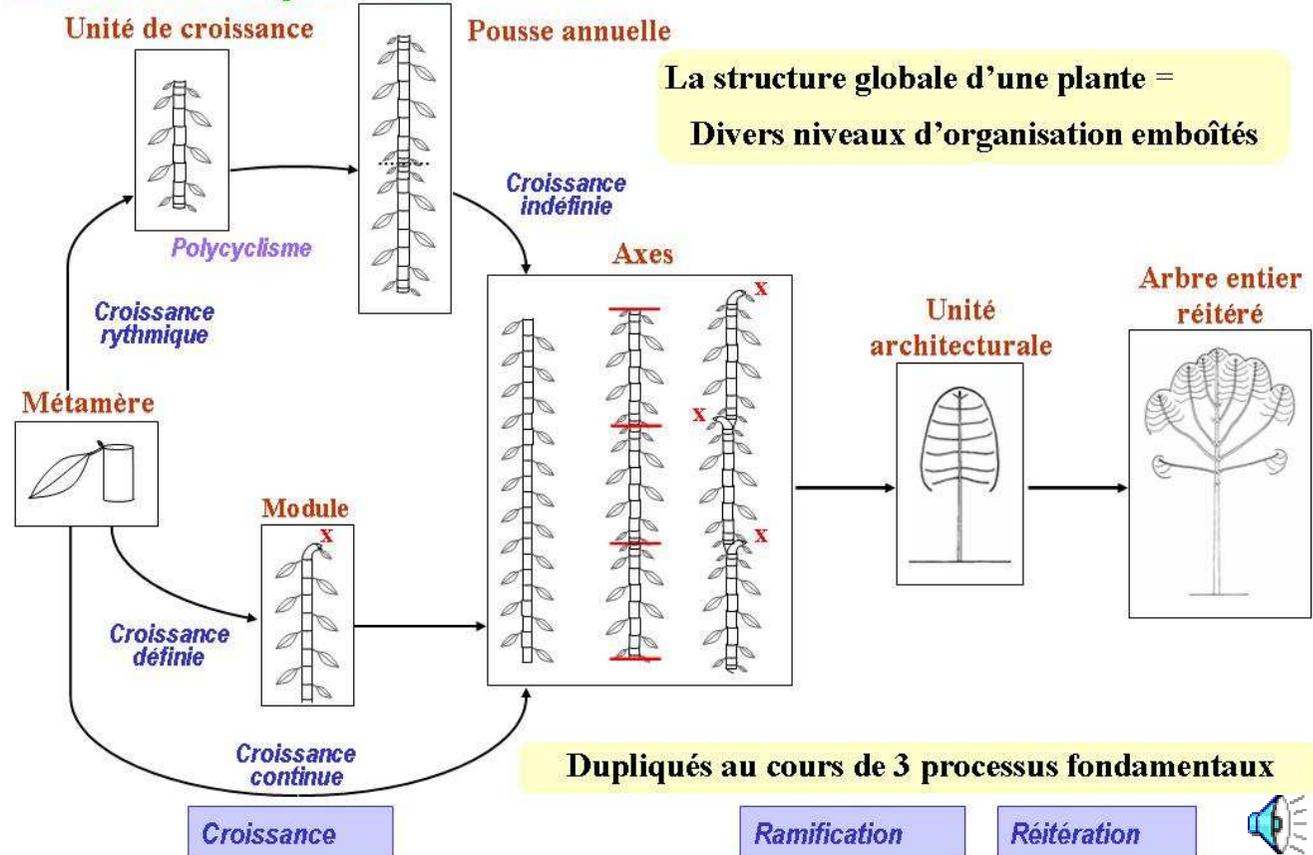
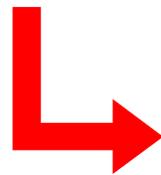
Plante réelle

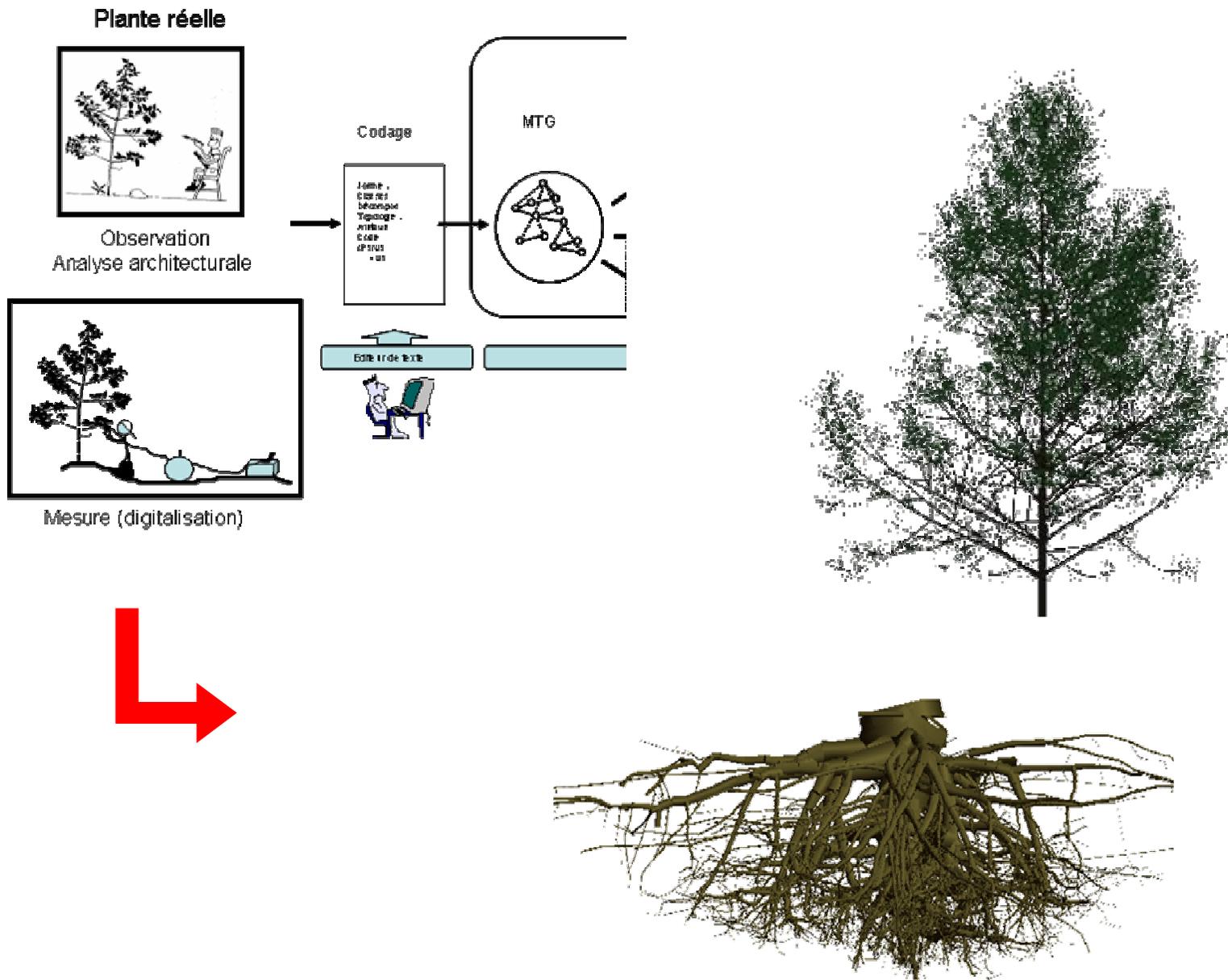


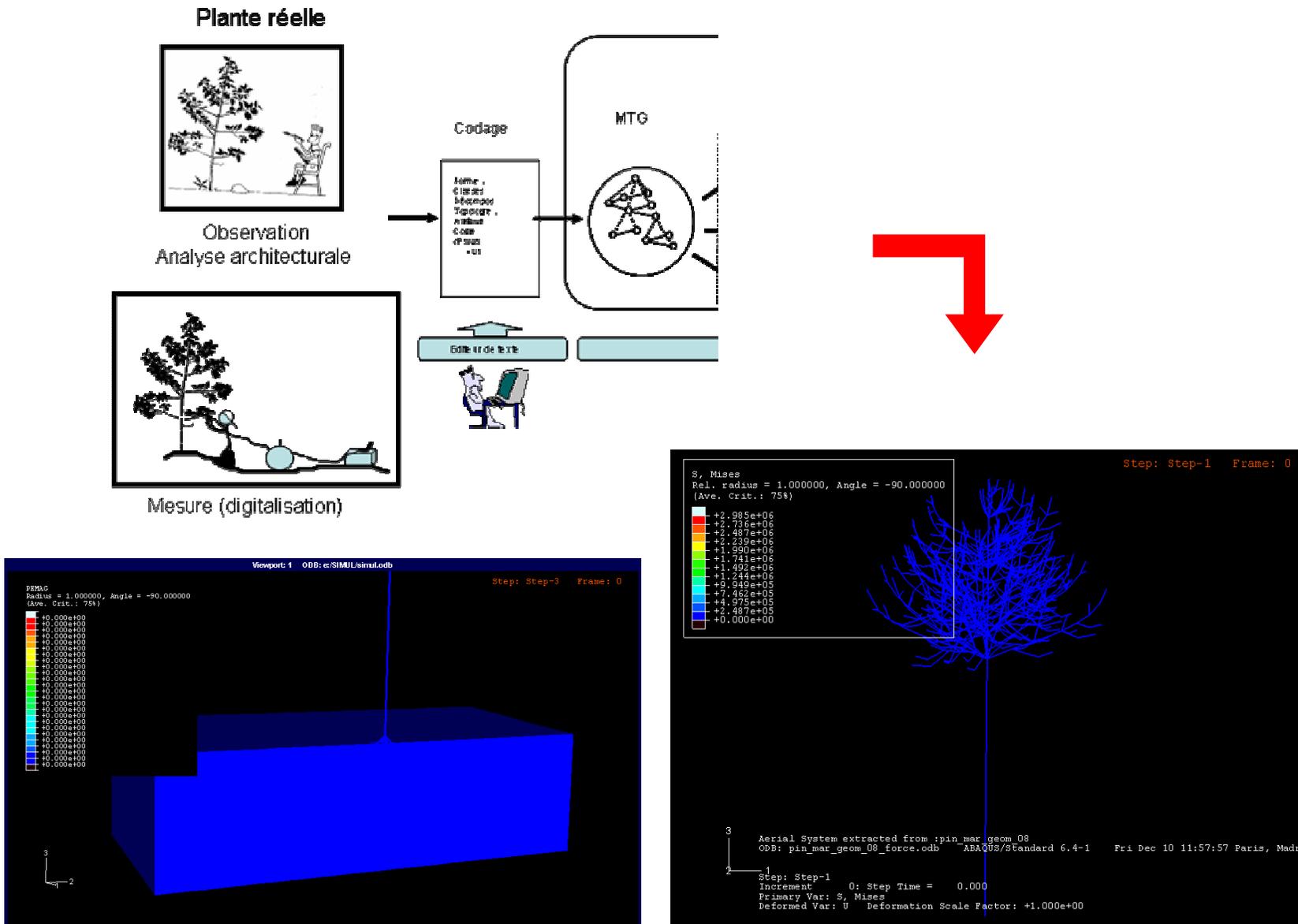
Observation
Analyse architecturale

Barthélémy & Caraglio, 2007

Les niveaux d'organisation







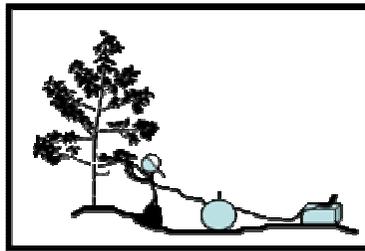
Dupuy et al., 2008

Sellier et al., 2008

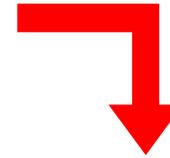
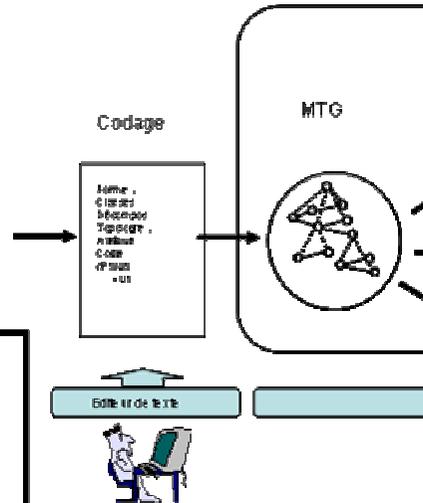
Plante réelle



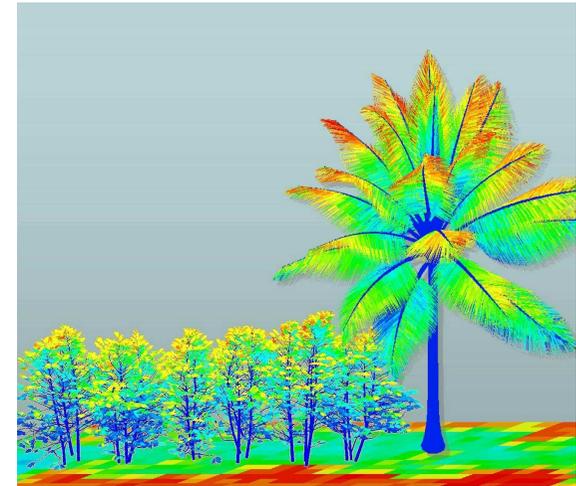
Observation
Analyse architecturale



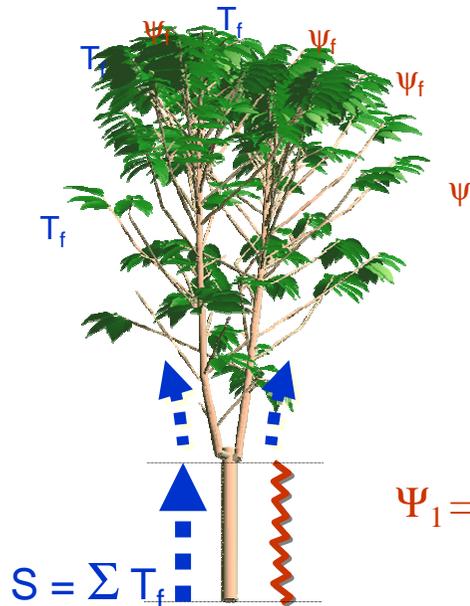
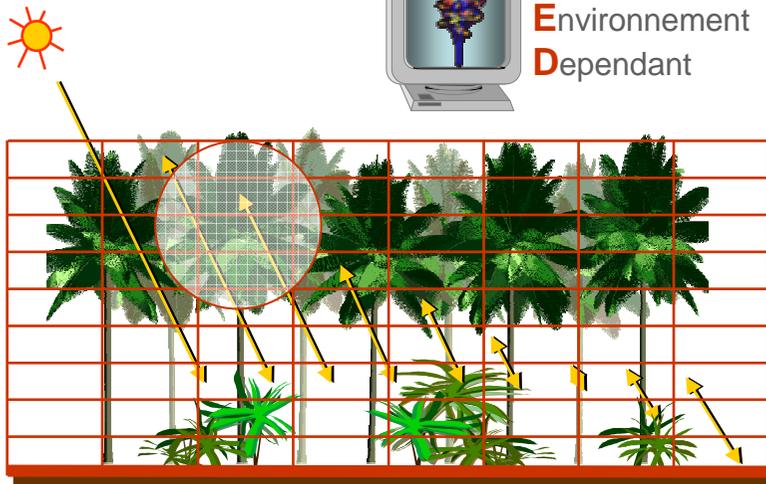
Mesure (digitalisation)



Dauzat et al., 2008



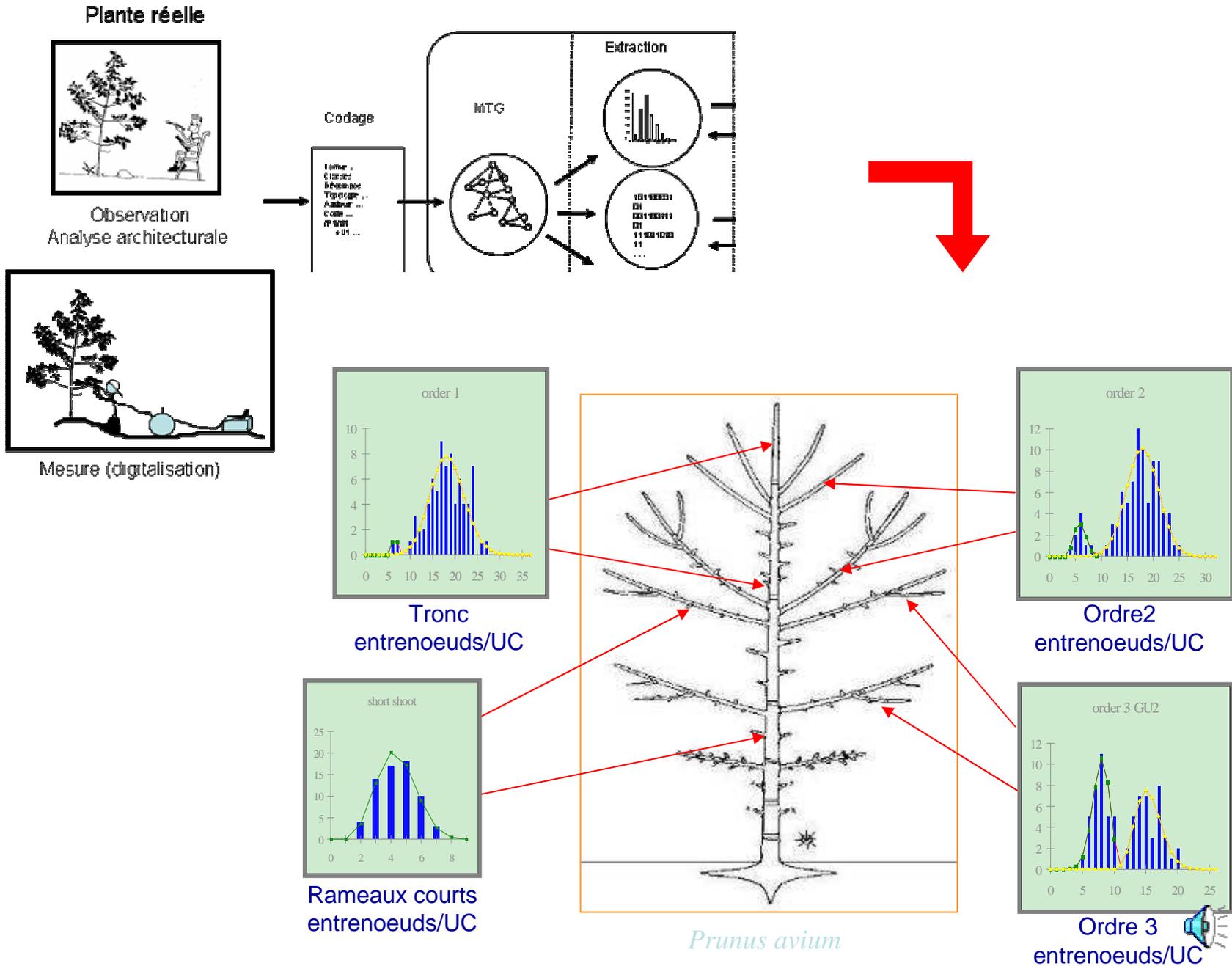
A R C H I tectural
Modelling
Environnement
Dependant

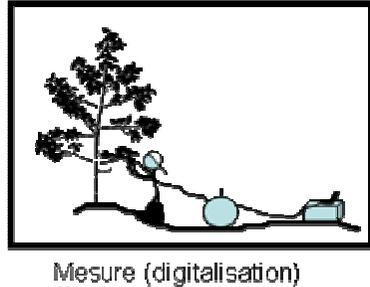
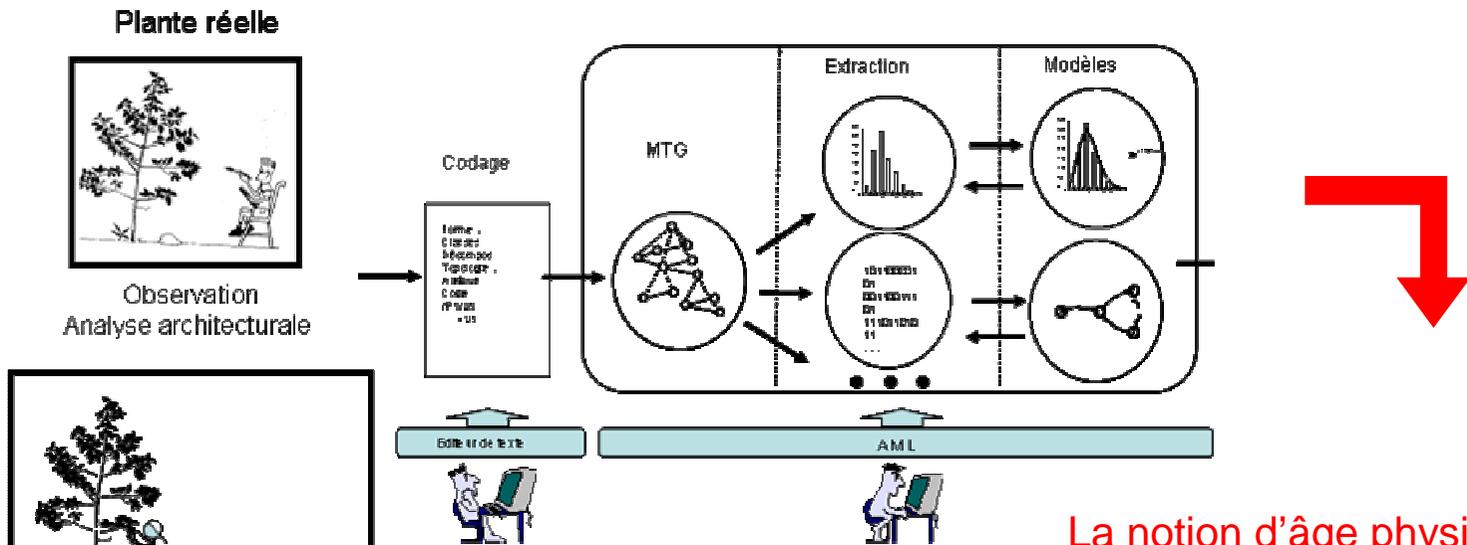


$$S = \sum T_f$$

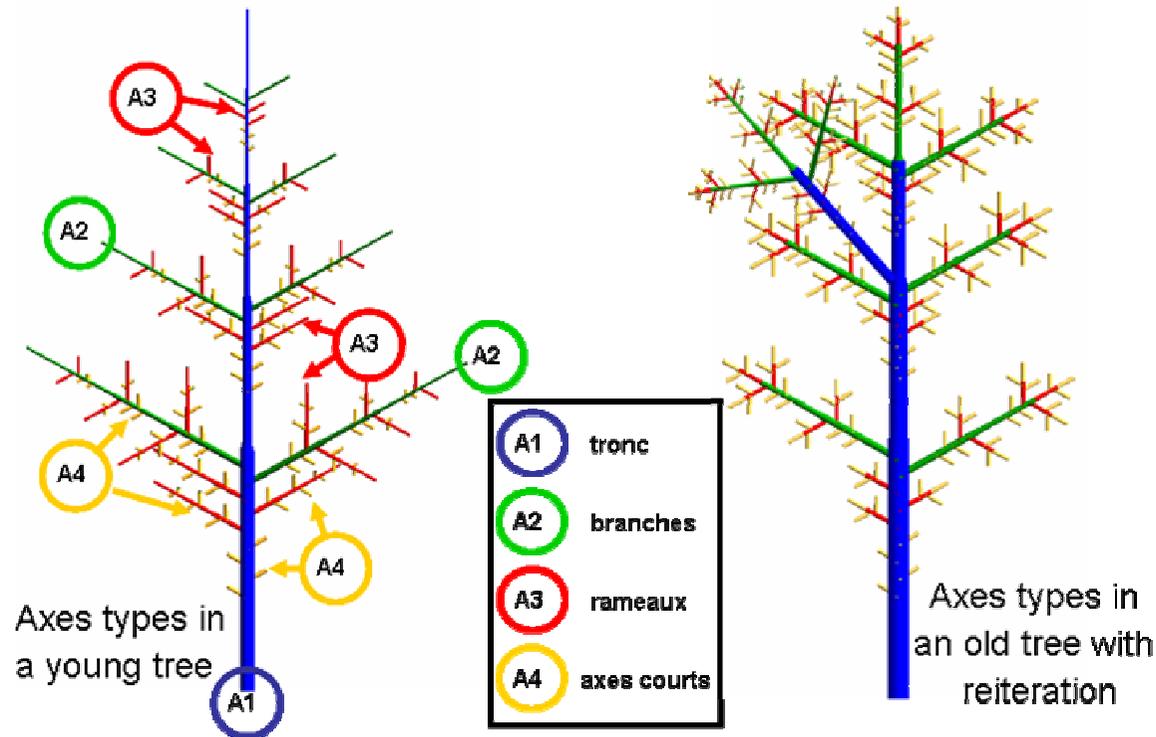
$$\Psi_1 = \Psi_0 - R.S$$

$$\Psi_0$$





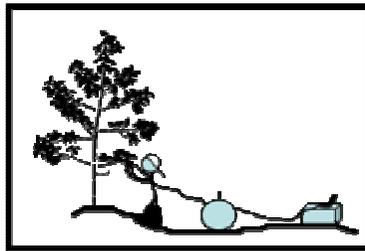
La notion d'âge physiologique



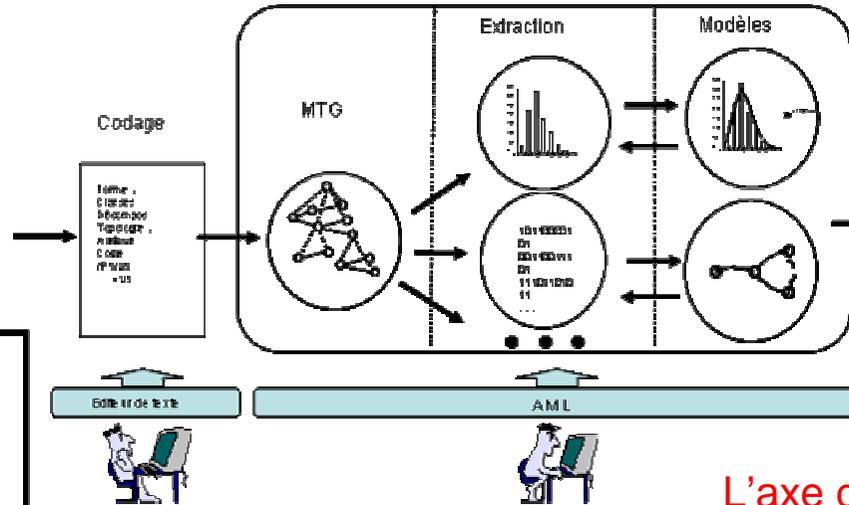
Plante réelle



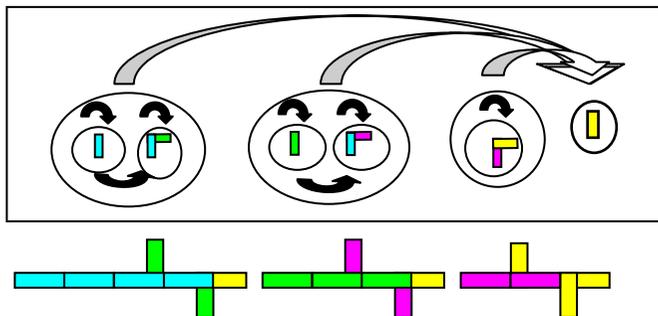
Observation
Analyse architecturale



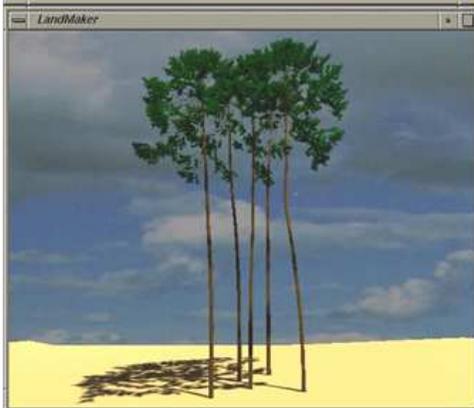
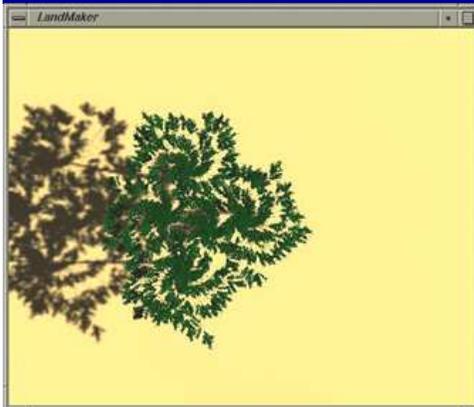
Mesure (digitalisation)



L'axe de référence



Automate



$S_L(7)$

$S_L(6)$

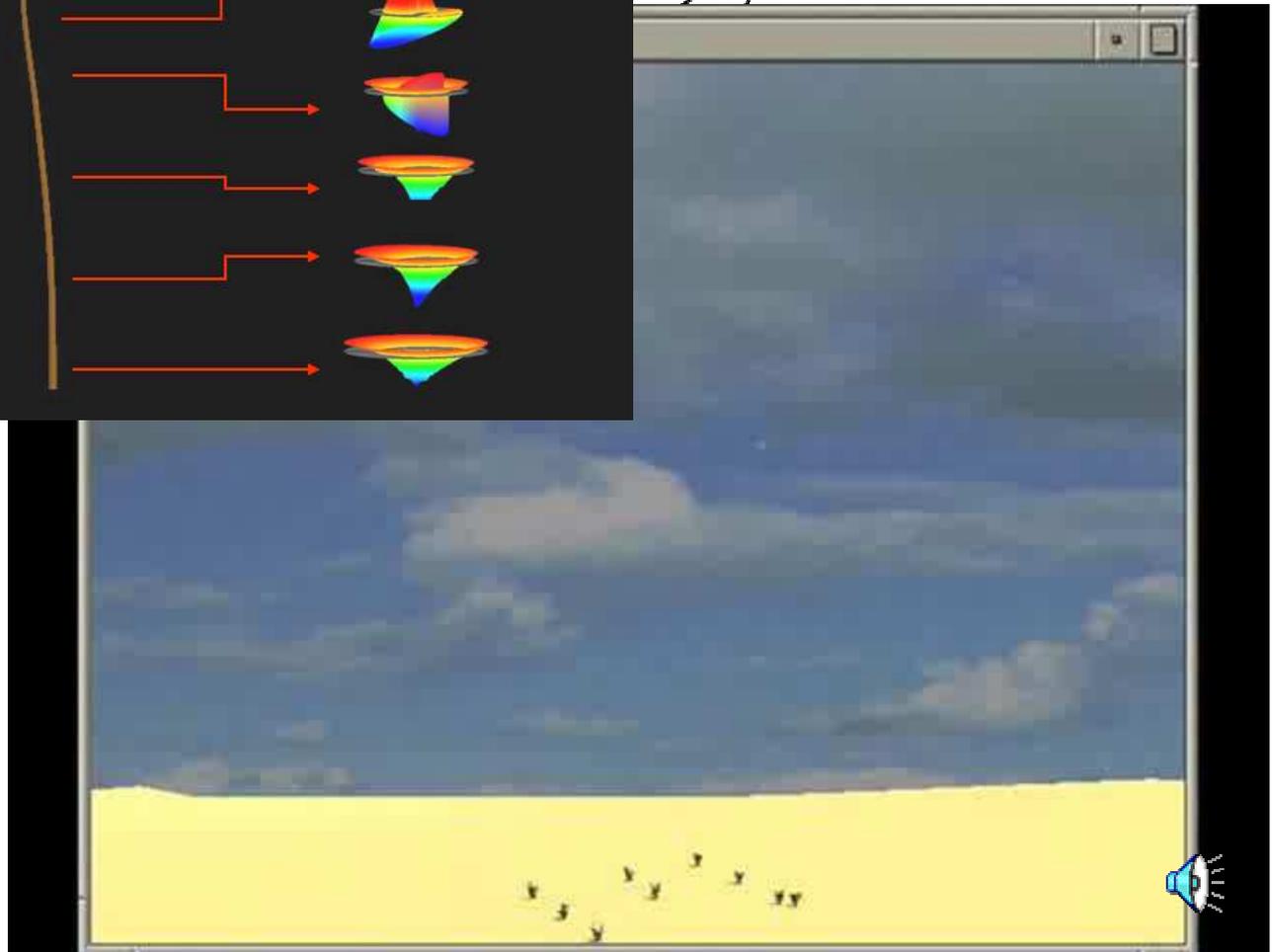
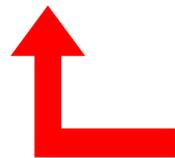
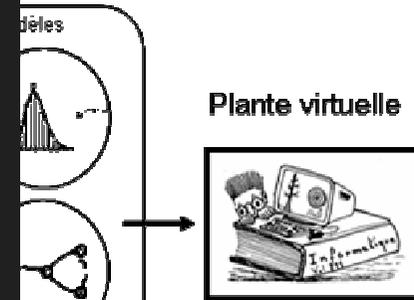
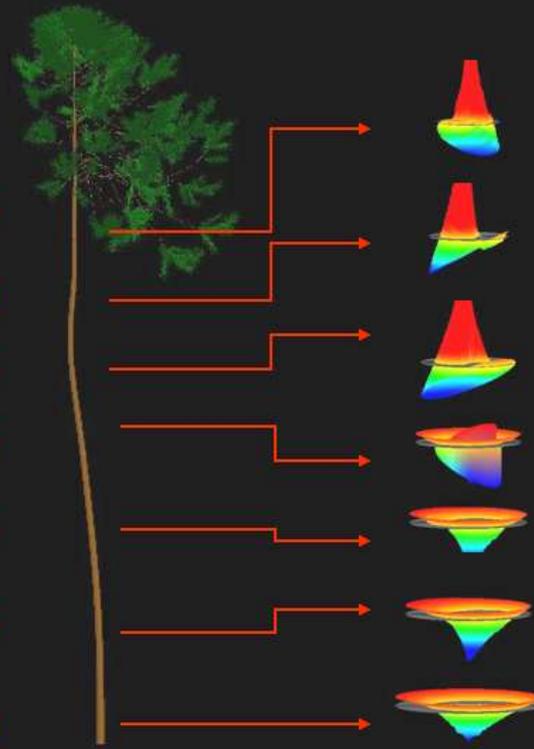
$S_L(5)$

$S_L(4)$

$S_L(3)$

$S_L(2)$

$S_L(1)$





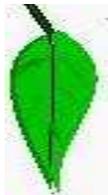
Efficience climatique

Quantité de matière végétale (étape n)

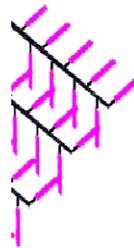
Quantité de matière végétale (étape n-1)

$$Q_n = \frac{E_n \Delta t}{\sum_{j=1}^2 \left[r_j A_j + r'_j B_j \left(\frac{Q_{n-1}}{f_{jn}} \right)^{1+\alpha} + \rho_j C_j \left(\sum_{i=1}^{n-1} \left(\frac{Q_{i-1}}{f_{ji}} \right)^{\frac{1}{1+\alpha}} \right)^2 \right]} * Q_{n-1}$$

feuille



racine



fruit

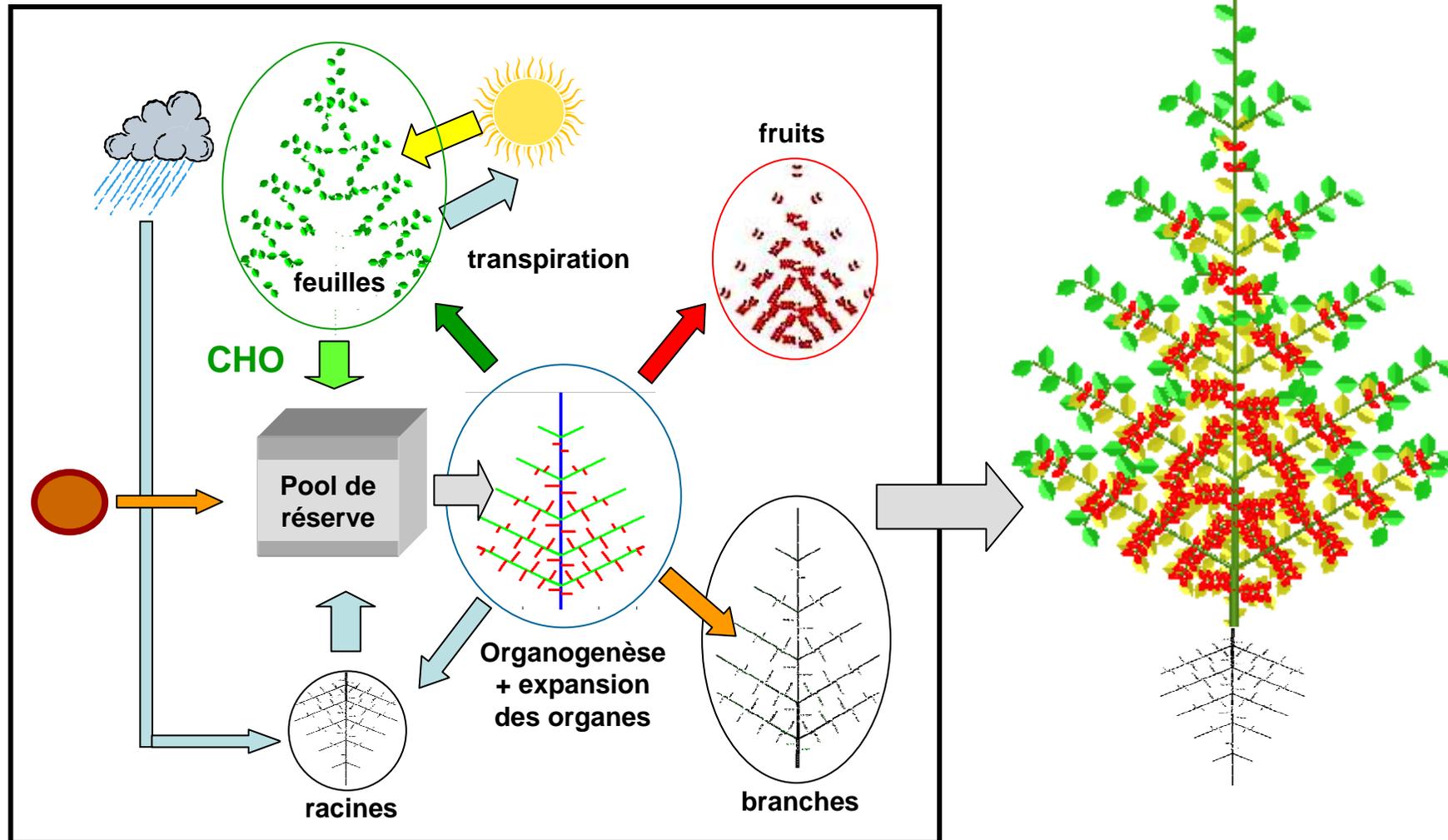


entre-noeud



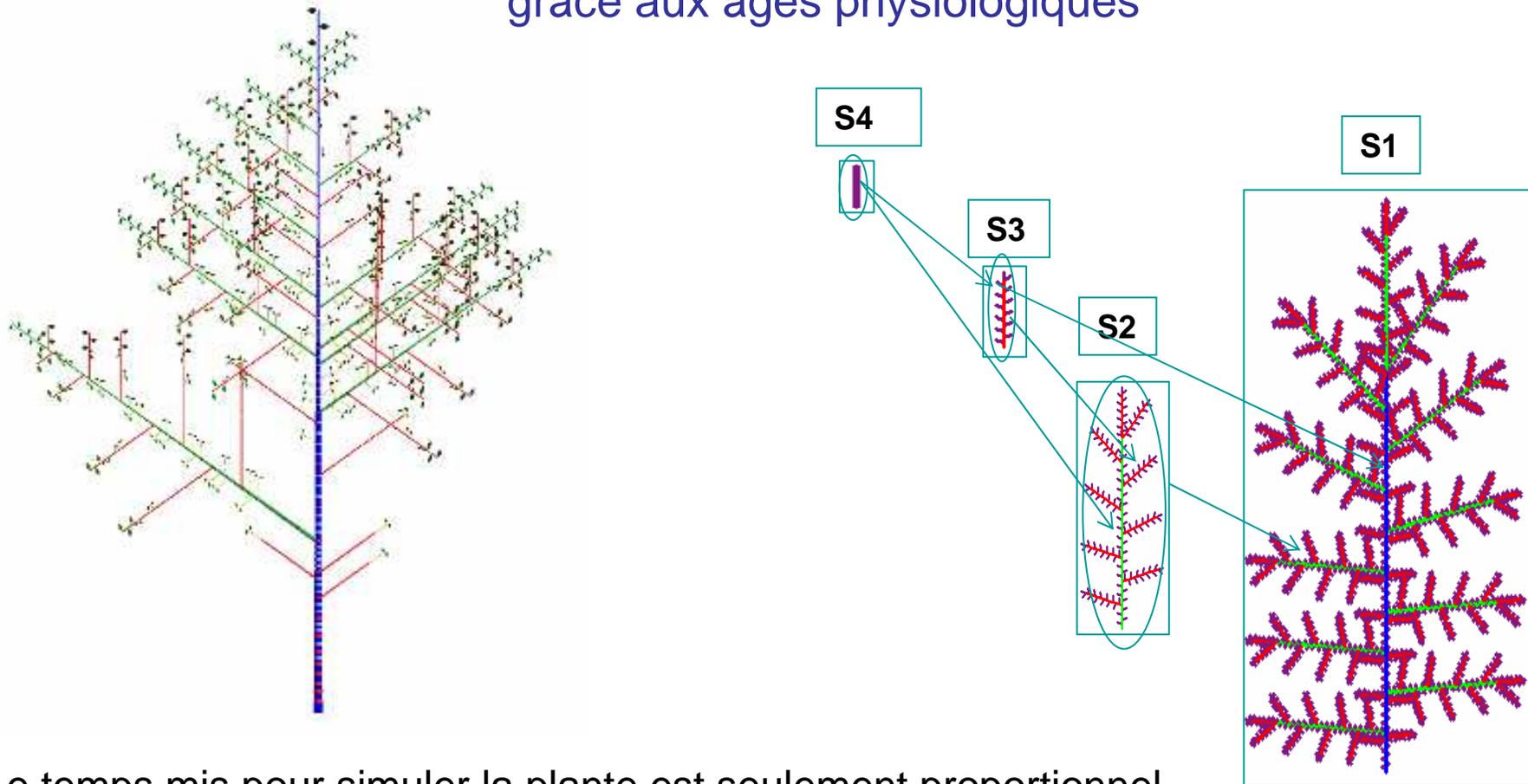
cerne





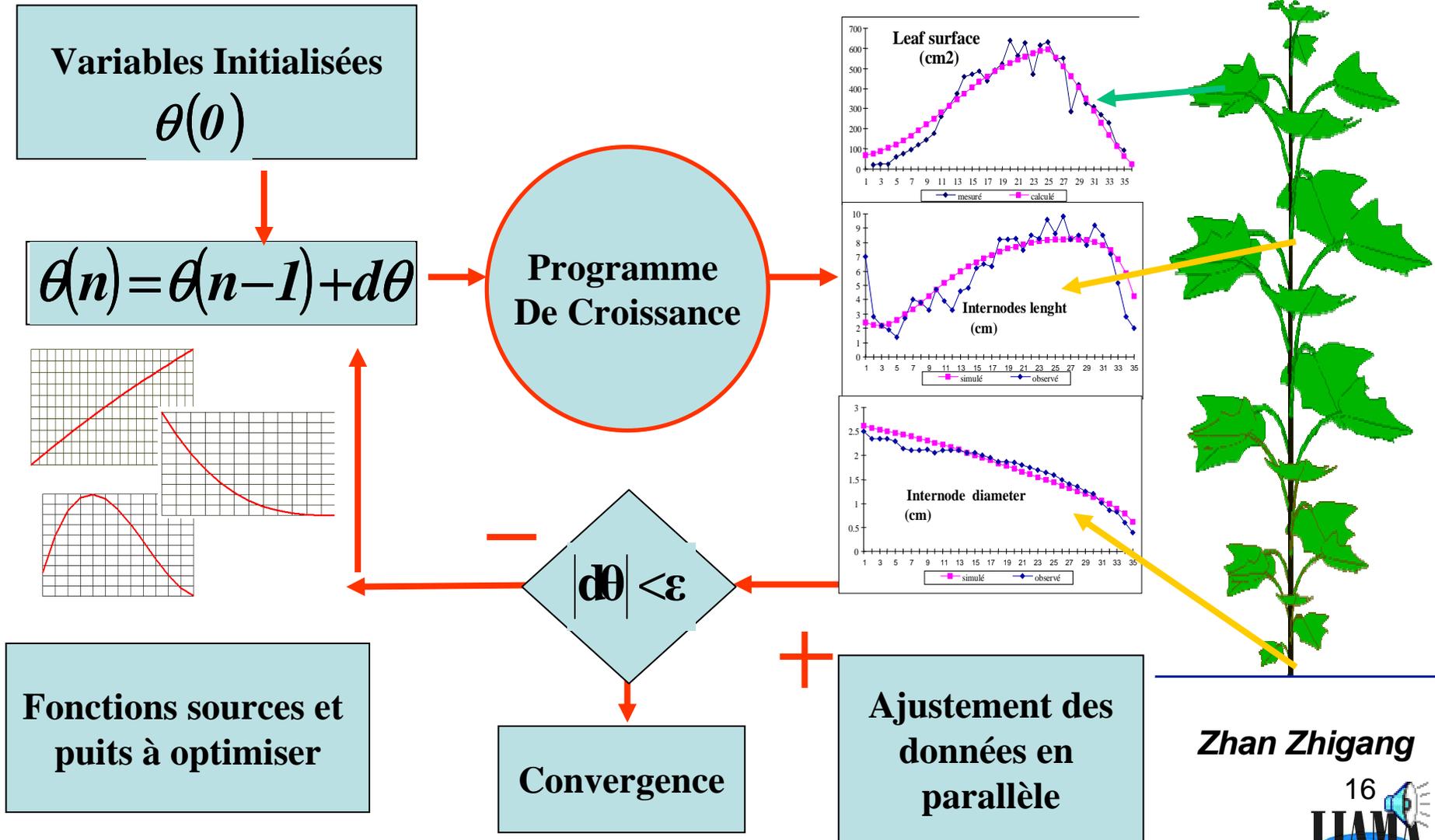


Organogénèse : factorisation par sous-structures grâce aux âges physiologiques



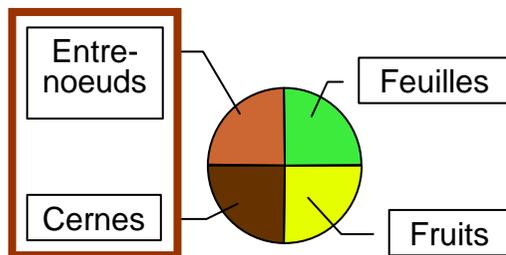
Le temps mis pour simuler la plante est seulement proportionnel aux âges chronologiques et physiologiques.

➤ Identification paramétrique



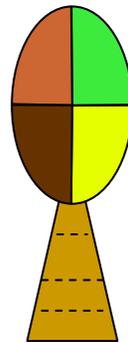
Zhan Zhigang

- Différentes échelles d'analyse et de représentation de la plante : biomasses agrégées par compartiments à différents niveaux.



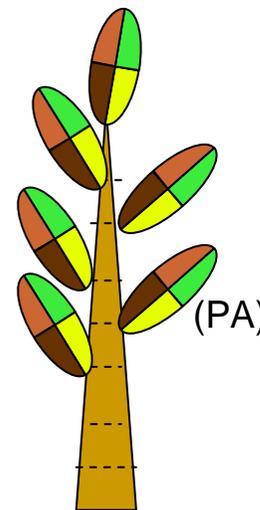
0: Plante "Cumulée"

- Masse du compartiment feuille
- Masse du compartiment entre-noeud
- Masse du compartiment fruit (ou fleur)
- Masse du compartiment cernes (éventuellement)



1: Plante "Sucette"

- Le tronc est détaillé par UC
- Les axes sont tous regroupés



2: Plante "Hochet"

- Le tronc est détaillé par UC
- Les axes sont regroupés par zone branchée (PA)



3: Plante Complète

- Les compartiments de biomasse sont détaillés au niveau de l'organe.

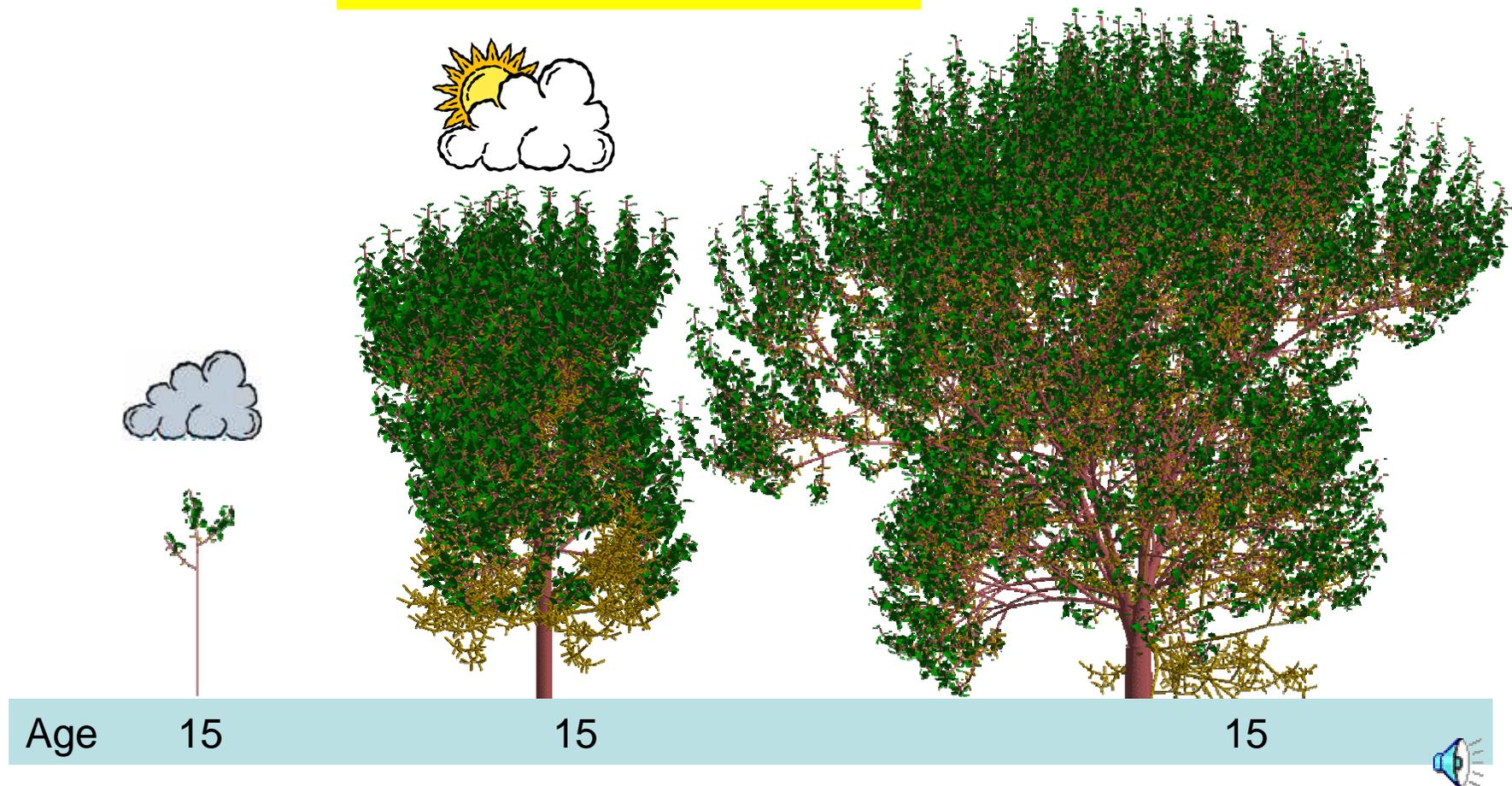
➤ Exemples de simulations de plantes

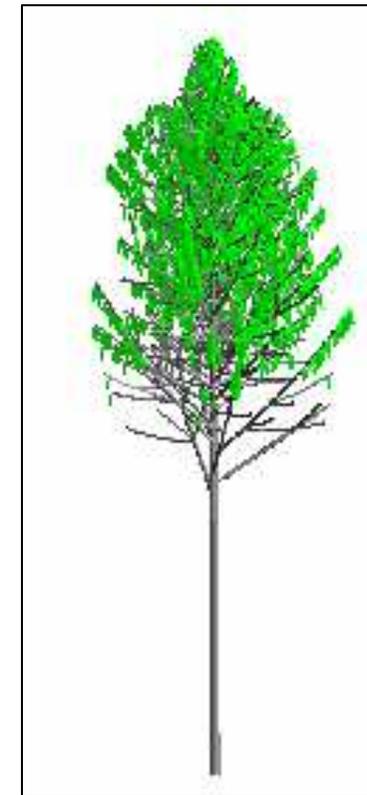
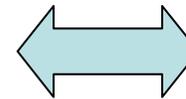
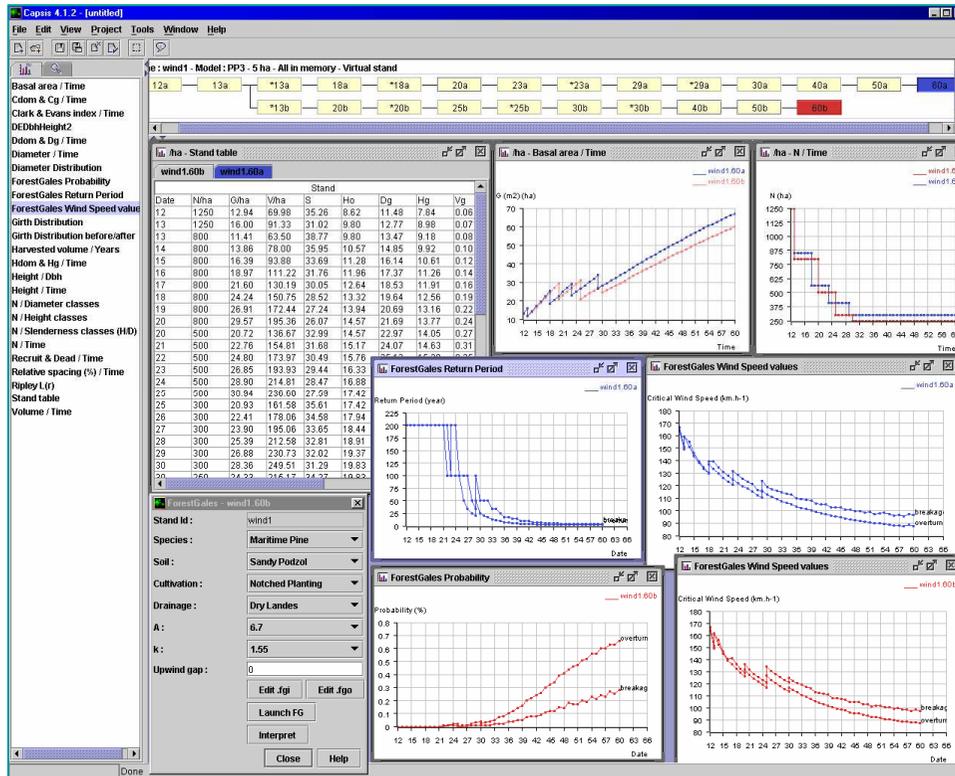


- Plasticité de l'architecture d'un arbre d'un âge donné en fonction de son environnement (*A. Mathieu, P.H. Cournède 2004*)



Conditions de lumière





Pp3 sous Capsis

AMAPsim

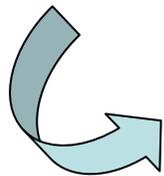


4 F. Boudon et G. Le Moguédec / Déformation asymétrique de houppiers pour la génération de représentations paysagères réalistes

REFIG 2007

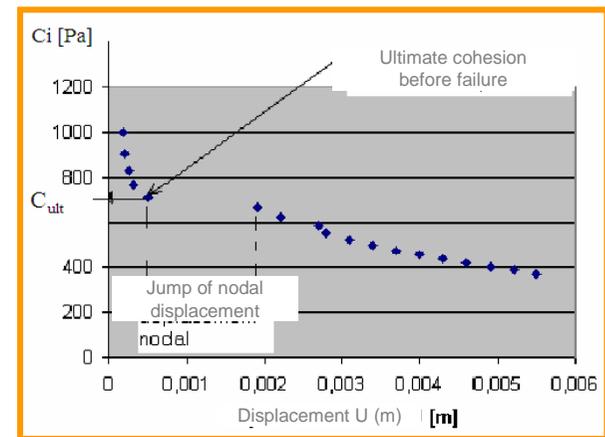
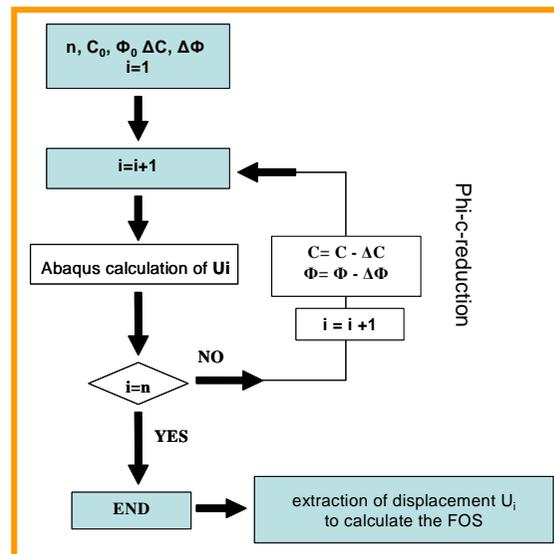
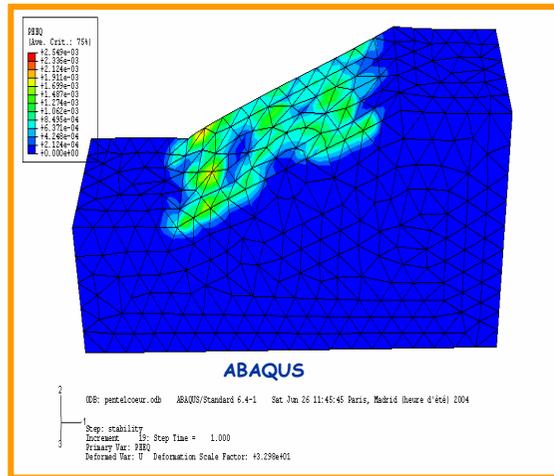
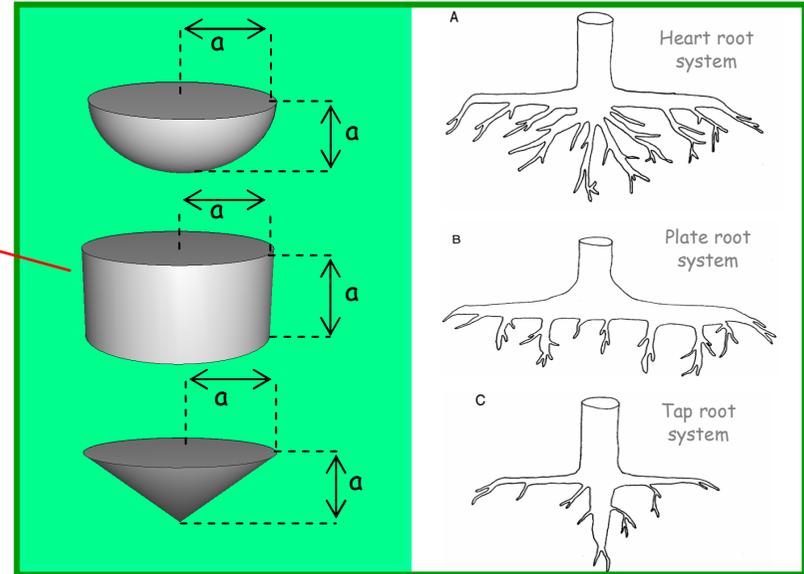
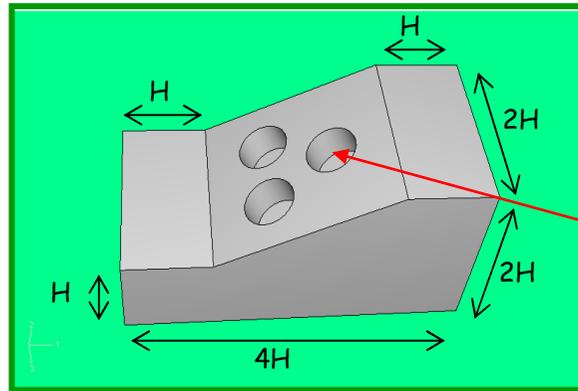


Figure 2: Exemples d'enveloppes asymétriques montrant la plasticité du modèle pour représenter les couronnes d'arbres (inspiré de Cescatti [Ces97]).

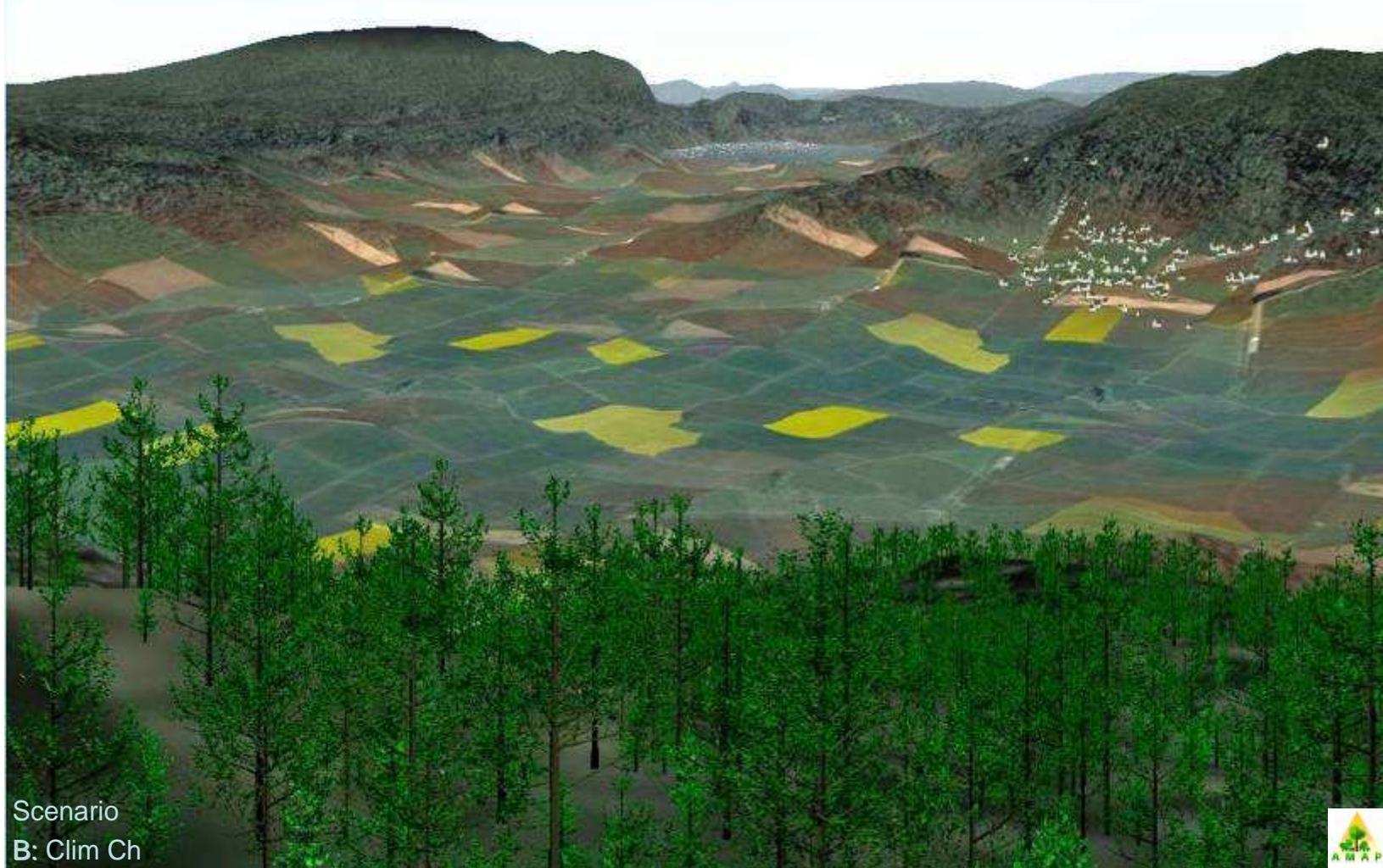


SeXi FS

Vincent & Harja, 2008



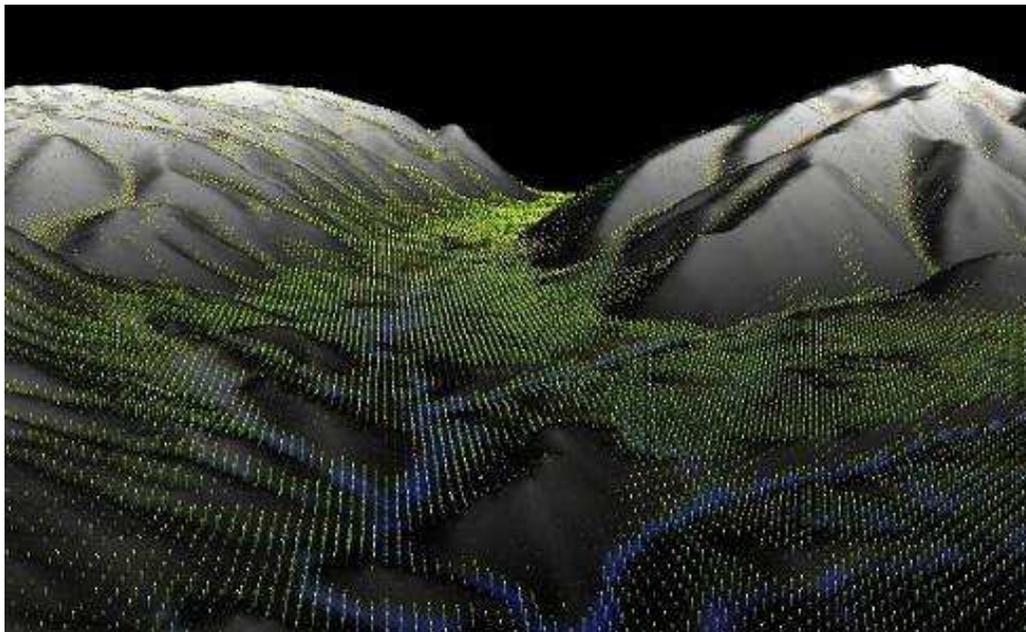
Visualisation - landscape change



Scenario
B: Clim Ch



Basé sur les équations du modèle Greenlab
(cycle de l'eau, temps thermique)



Lechevalier & Jaeger, 2008

$$dQ = E dt \alpha S_p \left(1 - \exp \left(-\beta \frac{S}{S_p} \right) \right) \quad (1)$$

$$E = E_0 E_T E_w, \quad (2)$$

$$dW = \frac{dQ}{wue} \quad (3)$$

$$c = \int_{t_0}^t \frac{\max(0, T(\tau) - T_b)}{T_g} d\tau \quad (4)$$

Merci de votre attention!!!

