



“TOP-VINE”, a topiary approach based architectural model to simulate vine canopy structure

Gaëtan LOUARN, Éric LEBON, Jérémie LECOEUR

*UMR LEPSE, Agro M - INRA, Montpellier FRANCE



- Vine canopy structure mainly depends on
 - the Genotype x Training System pair retained
 - environmental effects





■ Vine canopy structure mainly depends on

➤ the Genotype x Training System pair retained

➤ **environmental effects**



Irrigated



Non irrigated



■ Vine canopy structure characterization



➤ Direct measurement of structural indices

- SFE_p (CARBONNEAU, 1980)
- LLN (SMART, 1988)

➤ Architectural models :

- RIOU et al., 1989 ; SCHULTZ 1995 : Restricted to a limited range of training systems
- MABROUK et al., 1997 : no dynamical description



Objectives:

■ Propose and validate an architectural model of vine :

- **Able to describe spatial leaf area distribution for contrasted Genotype x Training System pairs**
- **Able to take into account the canopy structure variability inherent to each Genotype x Training System pair**
- **Allowing a low-cost dynamical description of the canopy structure**

Model description

- The model is based on the topiary concept :

- Canopy structure = Volume + Leaf area density
- No topological description



- It operates at the shoot level, assuming that each shoot carries the same leaf area (\approx true for balanced load spur pruned vines)
- Leaf area is an input of the model

Model description

■ What's a vine shoot topiary?

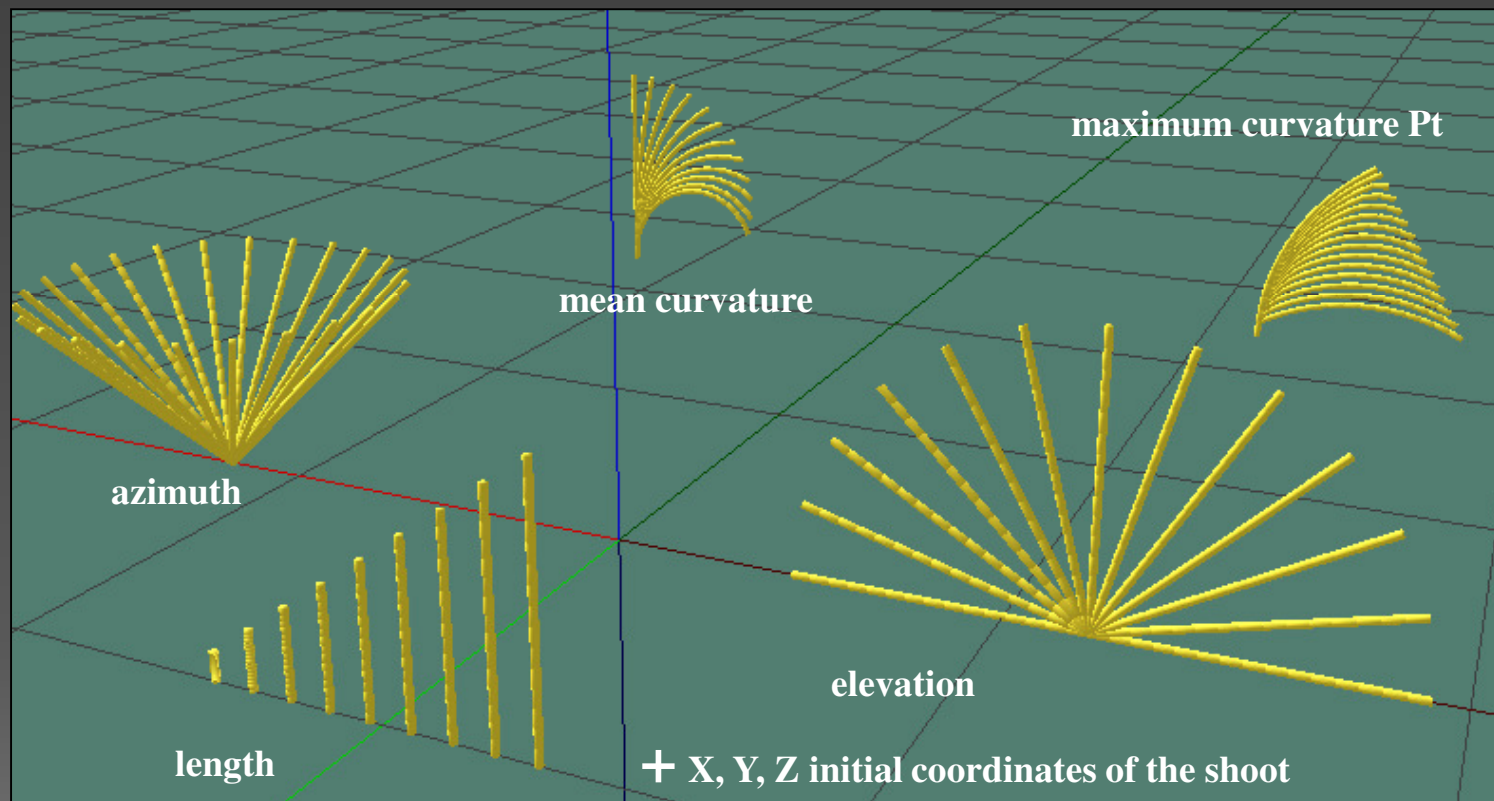
■ STEP 1 :

Description of the 3D
main shoot path



Model description

- Simplified description of the path using 8 parameters :



Model description

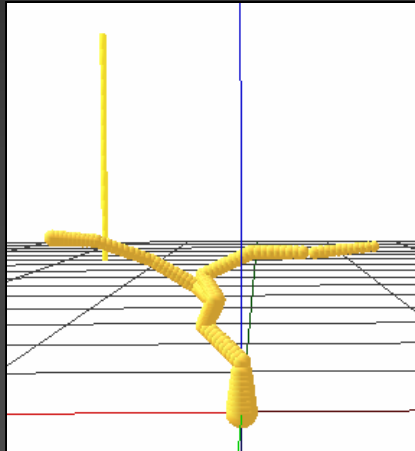
■ What's a vine shoot topiary?

■ STEP 2 :

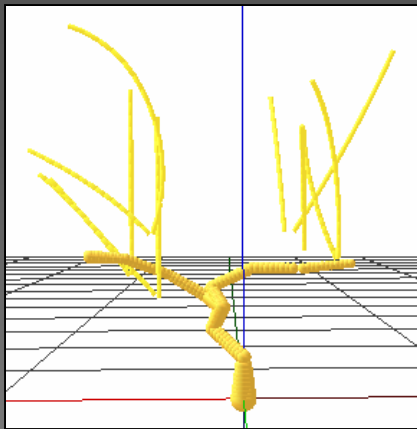
Description of the volume
prospected by the
secondary axes



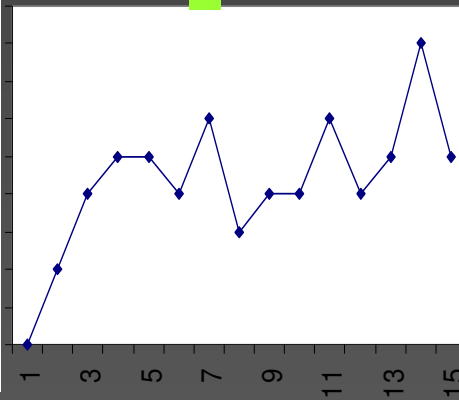
Model description



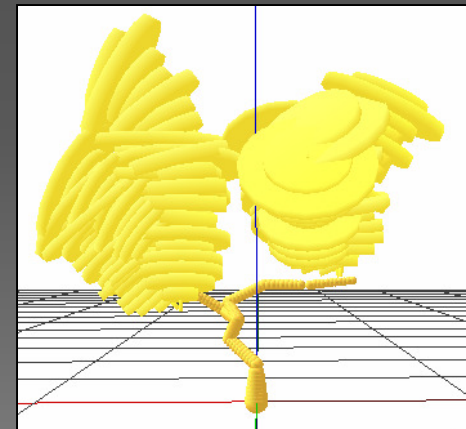
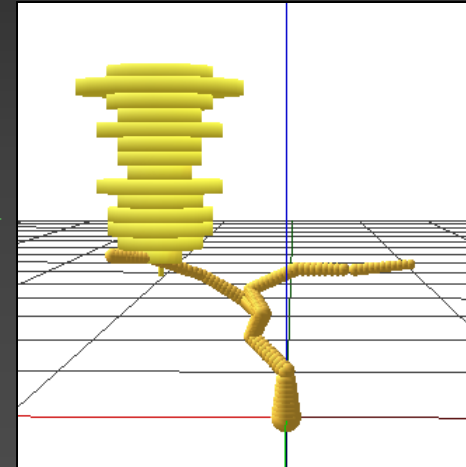
Measurements /
Model



Secondary shoot length



Position on the main shoot

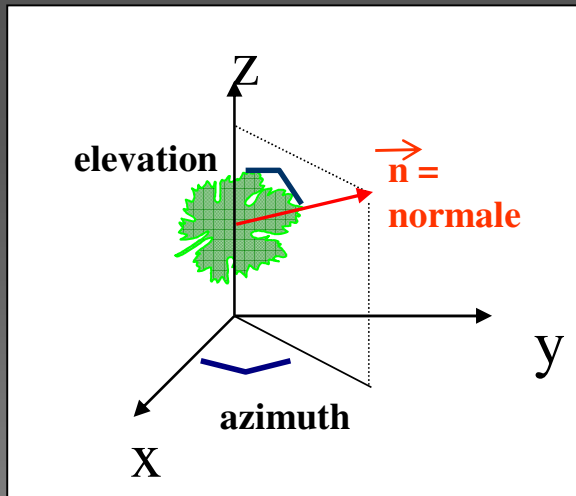


Model description

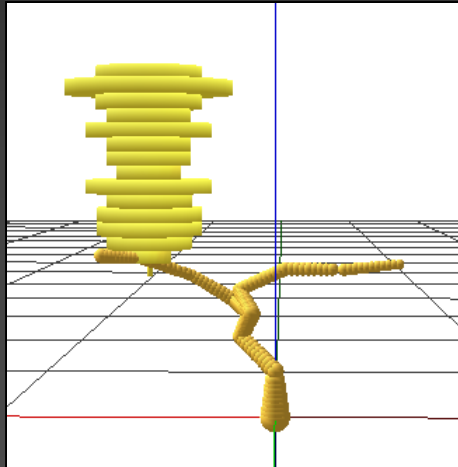
■ What's a vine shoot topiary?

■ STEP 3 :

Leaf positioning into the
prospected volume

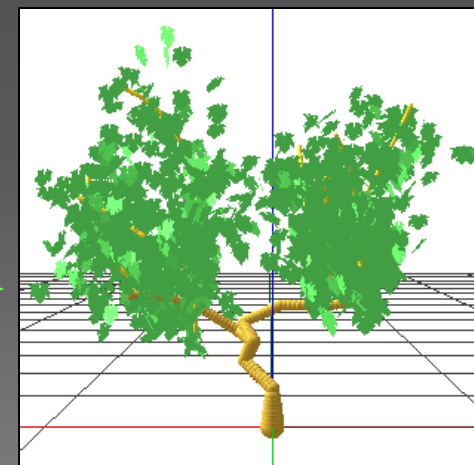
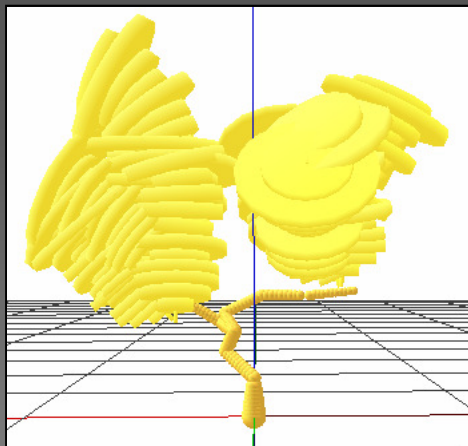
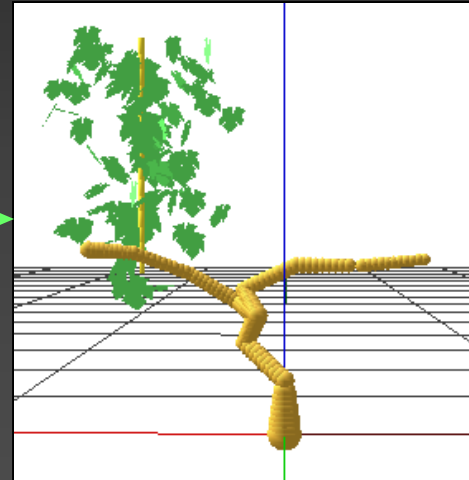


Model description



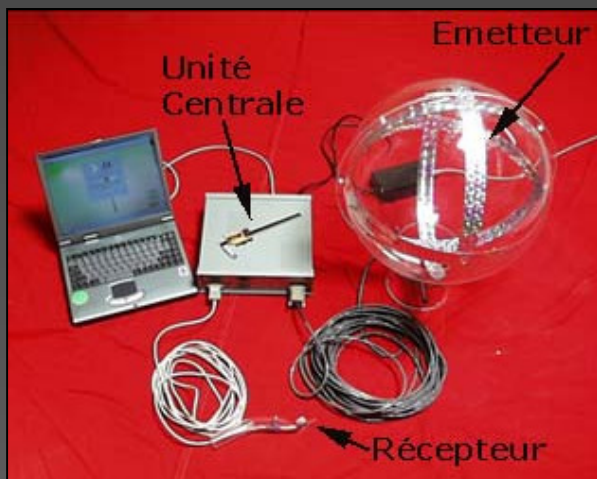
Measurements /
Model

- Primary and secondary leaf number
- Mean leaf area



Model parameterization

- The model was parameterized for two architecturally contrasted genotypes (Syrah, Grenache N.) and for 2 training systems (VSP, SW)

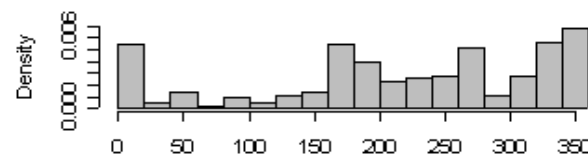


Model parameterization

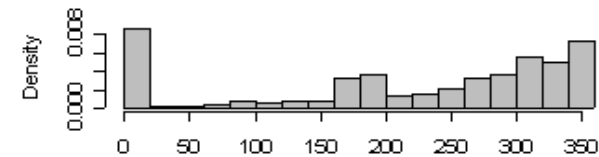
■ Distributions examples of the shoot parameters

Azimuth

VSP Grenache

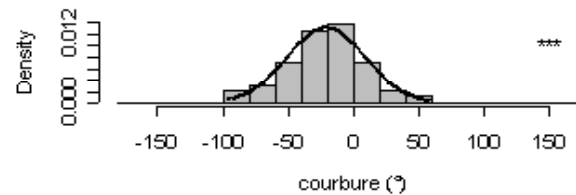


VSP Syrah

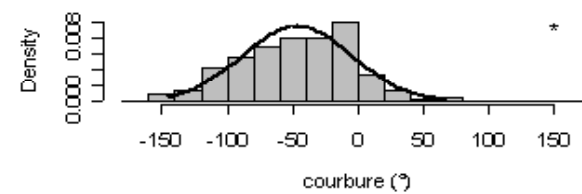


Curvature

grenache 3FG

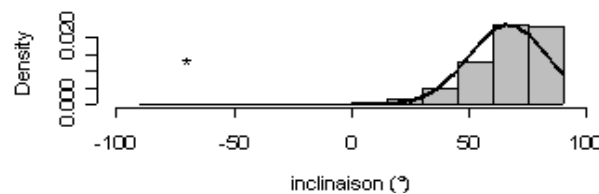


syrah 3FS

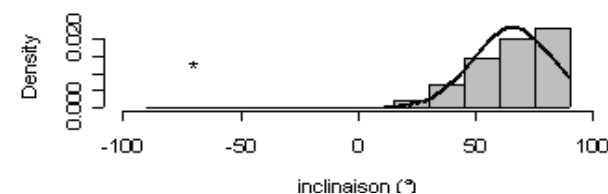


Elevation

grenache 3FG

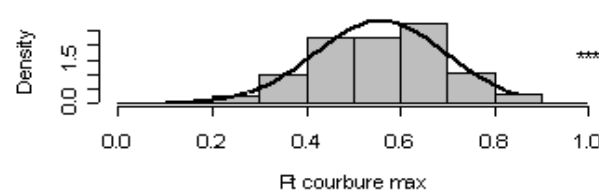


syrah 3FS

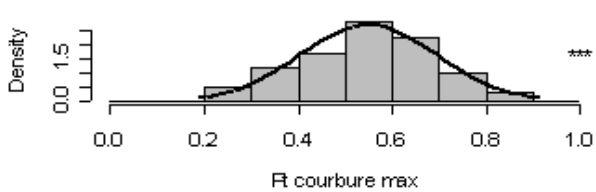


Curvature Pt

grenache 3FG



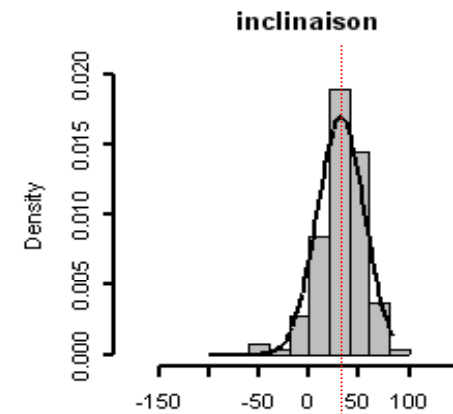
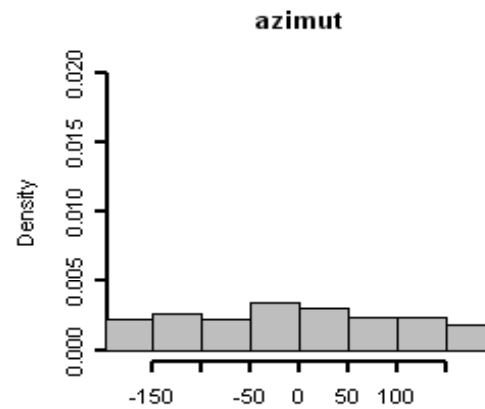
syrah 3FS



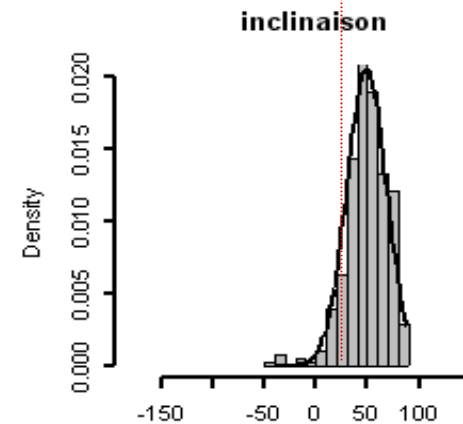
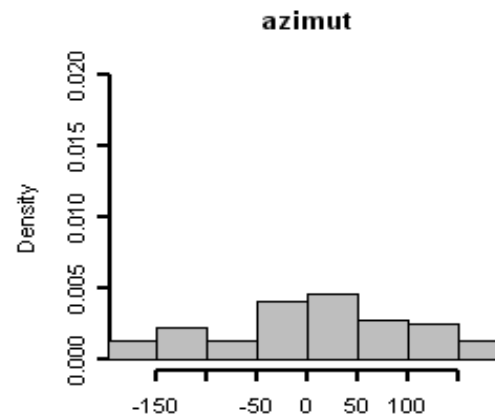
Model parameterization

■ Distribution examples of the leaf parameters

VSP
Grenache

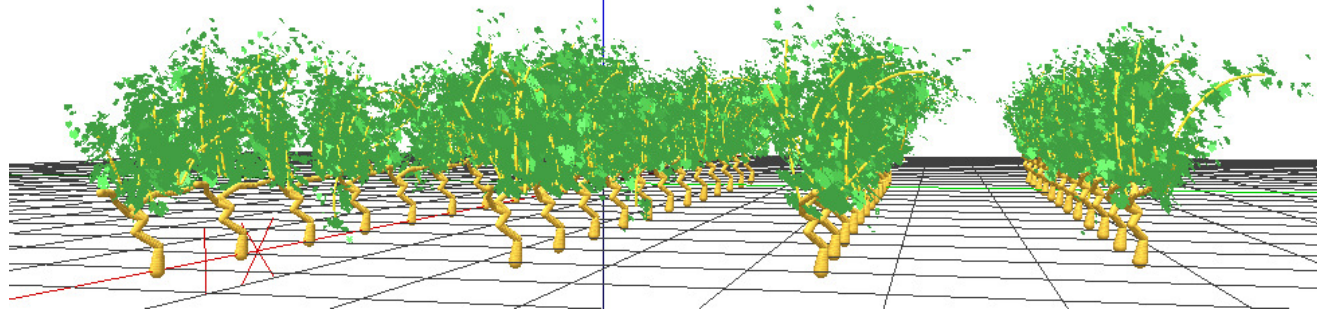


SW
Syrah

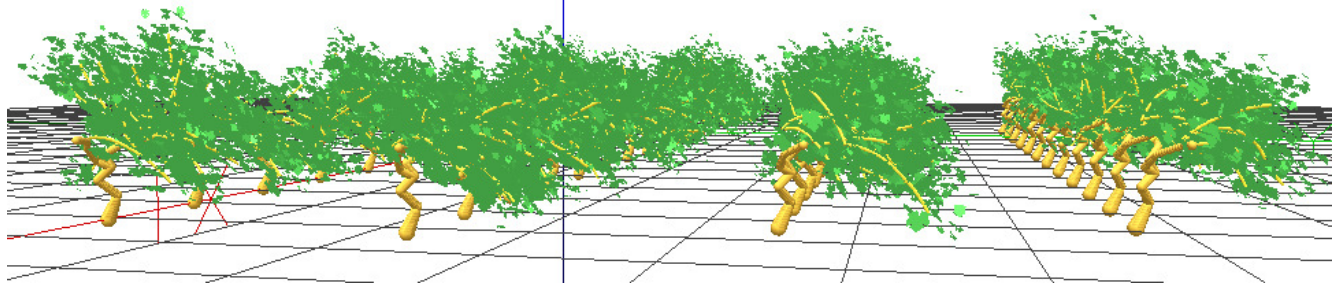


Model parameterization

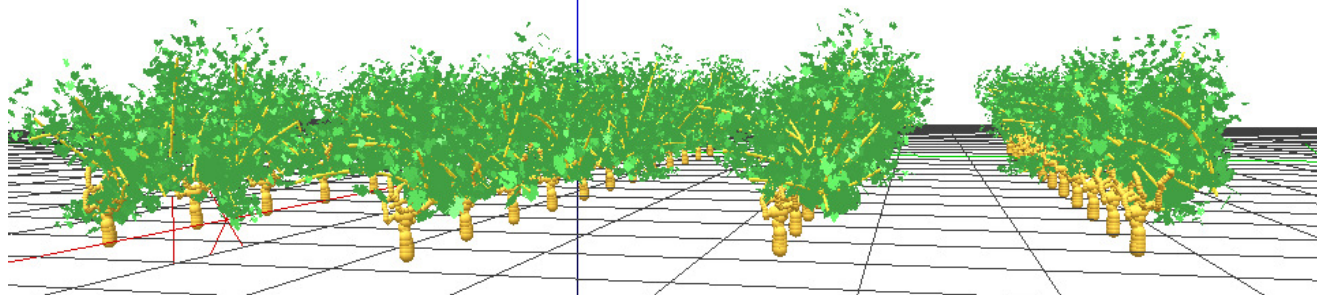
VSP
Syrah



SW
syrah

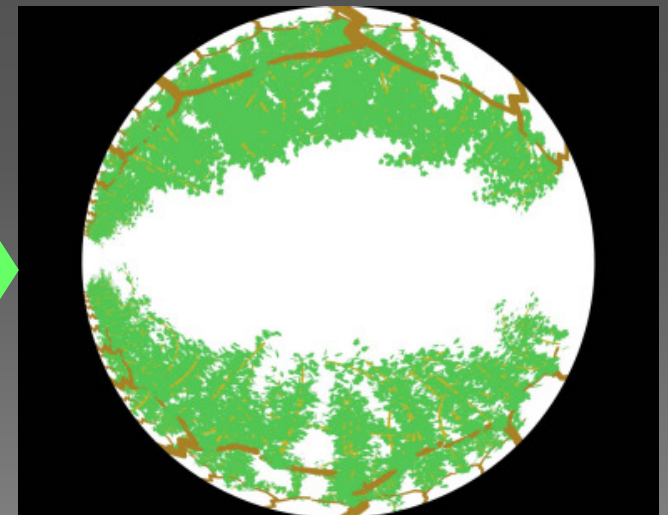
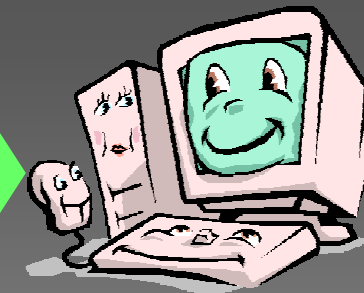
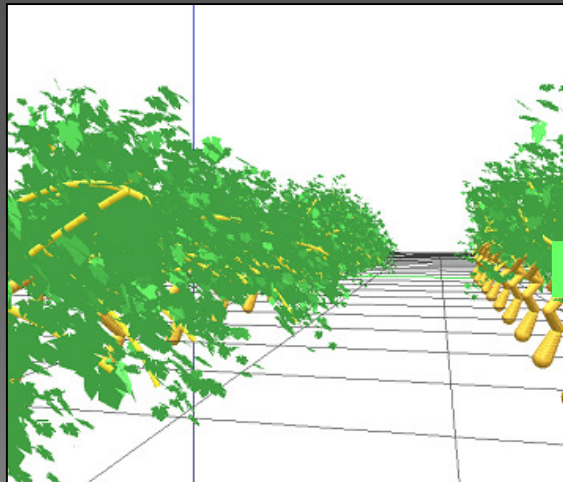


Gobelet
Grenache



Model validation

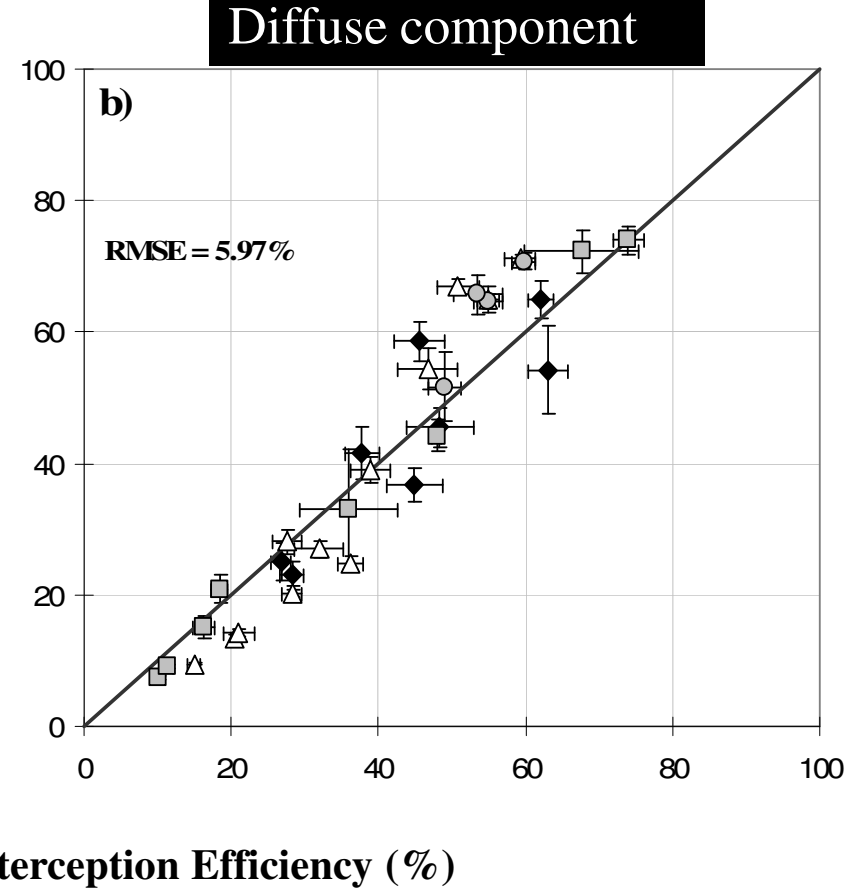
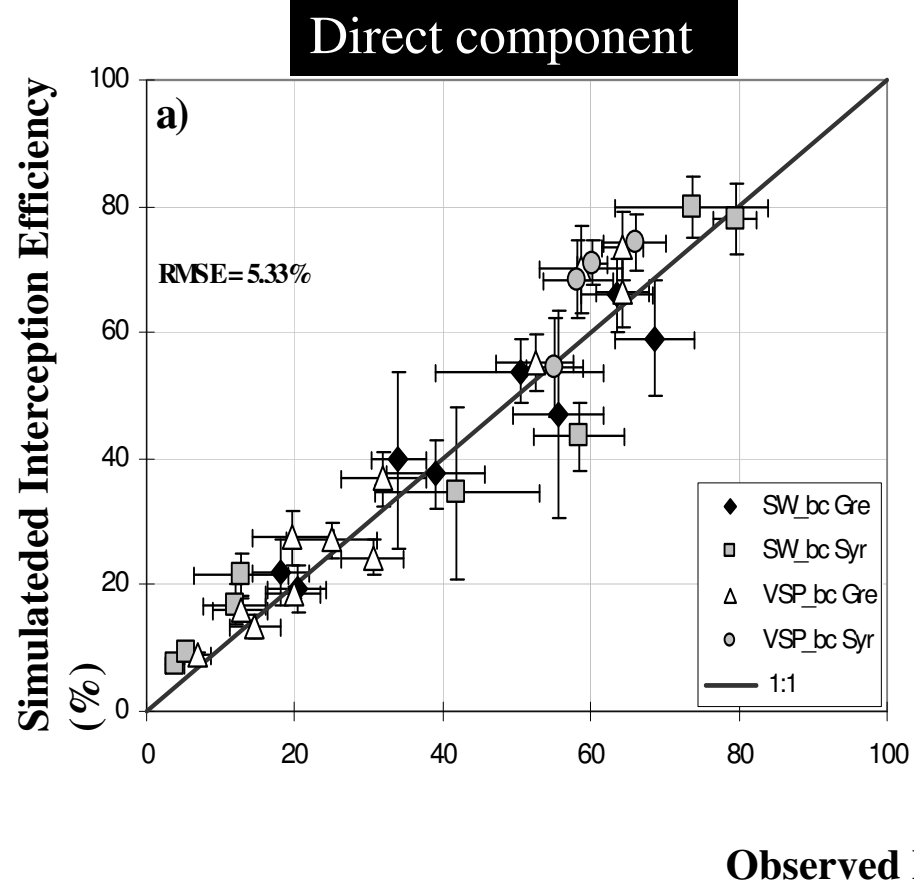
■ Validation at the canopy scale : Hemispherical photographs



Model validation

■ Validation at the canopy scale : Hemispherical photographs

➡ 4 sampling dates * 2 Training systems * 2 genotypes * 24 pictures (4 positions)

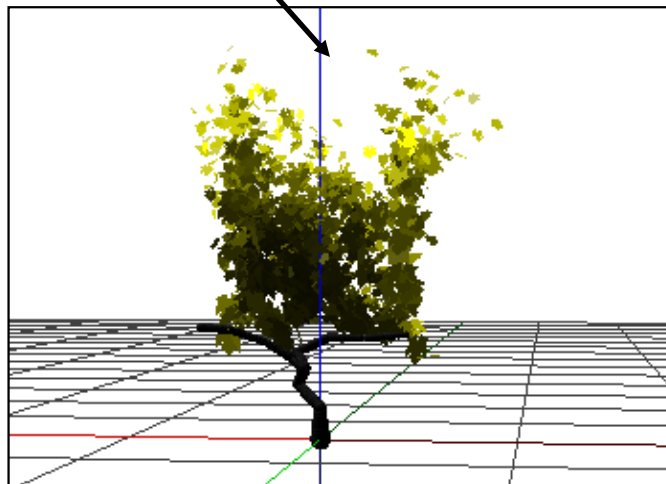
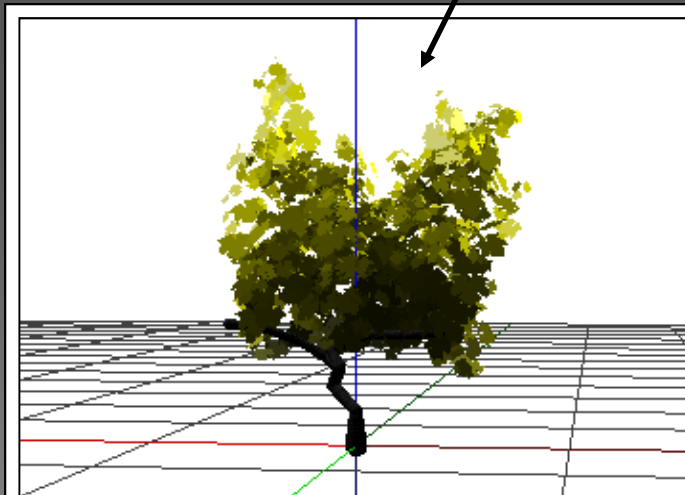
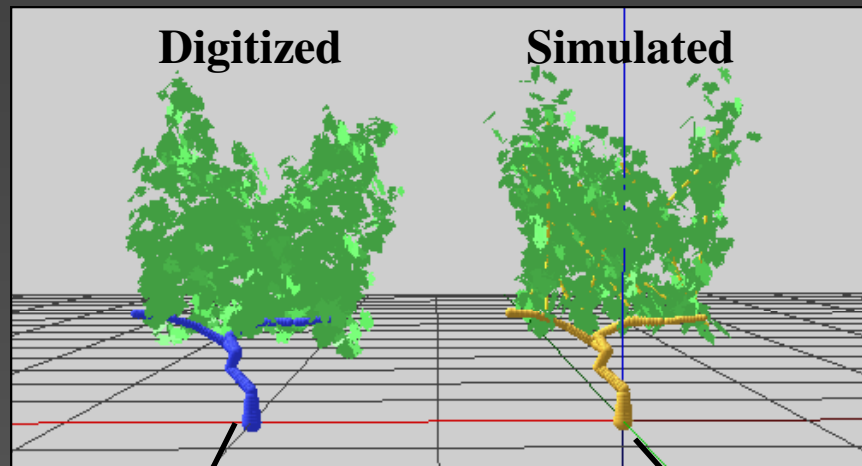


Model validation

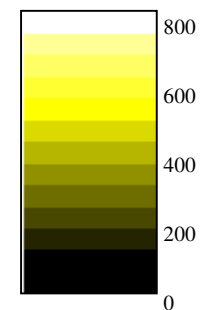
■ Validation at the organ level :

➡ Comparison of digitized and simulated vines using leaves radiative balance simulation

VSP
Grenache

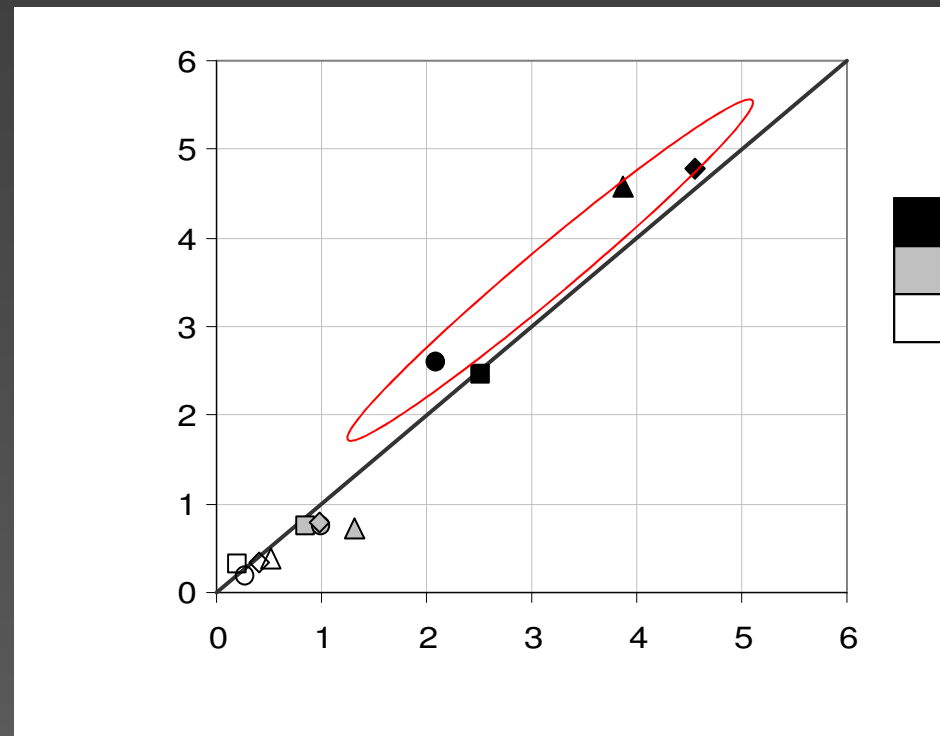


Mean PAR irradiance
($\mu\text{mol m}^{-2} \text{s}^{-1}$)



Model validation

■ Validation at the organ level :



Louarn et al., 2008 aob



Correctly rank the different training systems

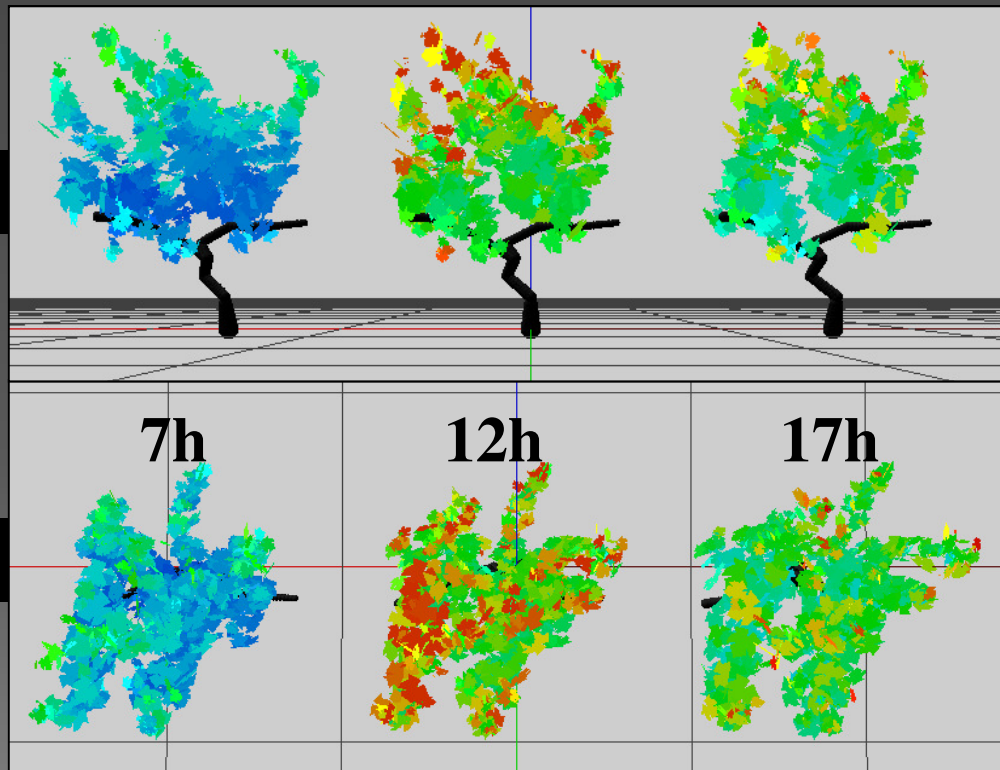


Tend to slightly overestimate self-shading into the canopy

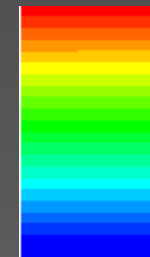
Conclusion

- Good agreement of model outputs with field data at both canopy and organ level
- Discriminate and correctly rank a relatively narrow range of training systems
- Connection in progress with an ecophysiological model of shoot growth (dynamic) and a photosynthesis model (farquhar)

Front view



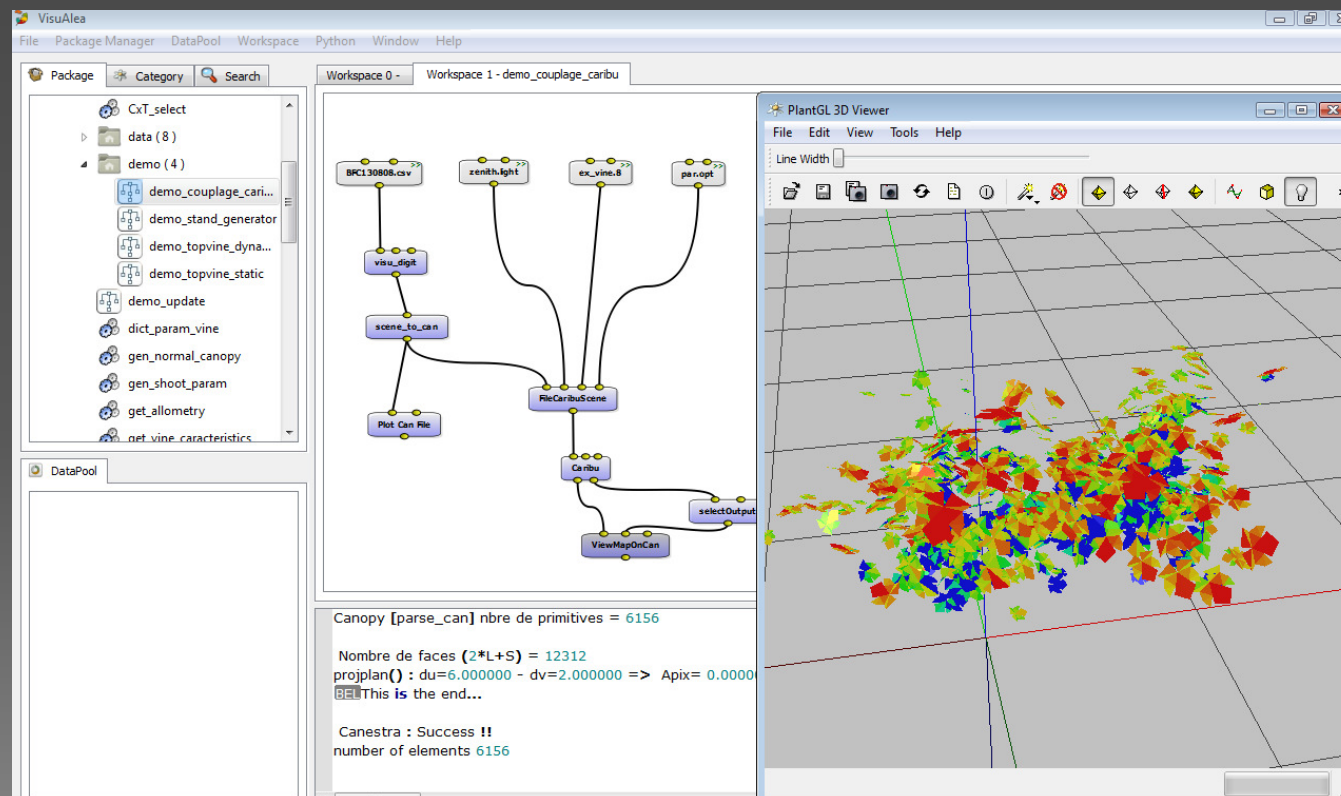
Top view



Photosynthetic activity

Conclusion

- Good agreement of model outputs with field data at both canopy and organ level
- Discriminate and correctly rank a relatively narrow range of training systems
- Connection in progress with an ecophysiological model of shoot growth
- Integrated into the ALEA ecophysiological platform
(<http://openalea.gforge.inria.fr/dokuwiki/doku.php>)





Thank you for your attention

