



The Capsis project

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Objectives of Capsis

Meaning

Computer-Aided Projection for Strategies In Silviculture

Objectives

Simulate the consequences of the forest management by using the scientific knowledge

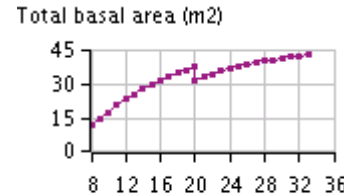
Build a software platform to integrate many forest growth, yield and dynamics models

For who

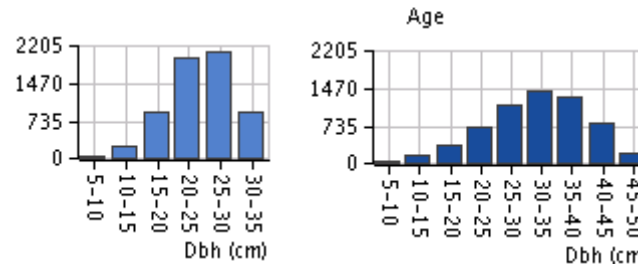
Forestry modellers, forestry managers and education

Forestry models

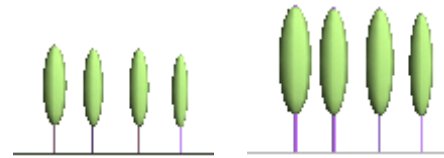
Stand level models:



Distribution models:

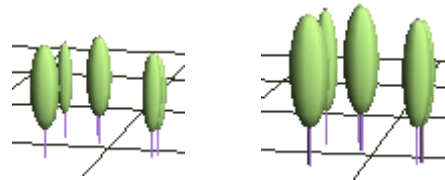


Individual based models:



Various types of stand growth and yield models

Spatialized models:



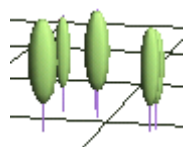
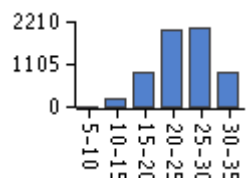
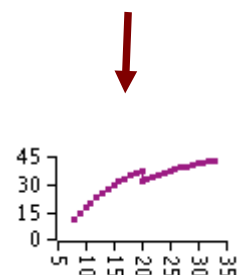
... and also Mixt models:

- Process-based + growth and yield
- Distribution + spatial structure
- Individual based + genetics ...



Various representations in memory

Kind of model



Other...

Example

Lemoine model (stand-level, plantation):

- Age
- Number of trees
- Girth (dominant, mean tree) (cm)
- Basal area (m²)
- Height (dominant, mean tree) (m)
- Volume (mean tree) (m³)

PP3 model (distribution, plantation):

A collection of bars

- Age
- Diameter (cm), Height (m), Tree volume (m³)
- Number of trees in the bar
- Crown (base height, diameter) (m)
- Other (biomass, carbon mass, leaf area, etc.)

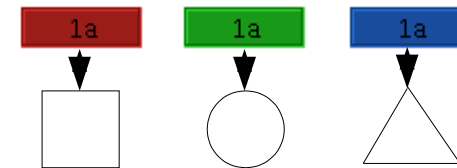
Samsara model (individual-based, spatialized):

A collection of trees

- Age
- Diameter (cm) , Height (m)
- Location x, y, z (m)
- Species
- Crown (base height, radius) (m), Light (MJ)

Capsis specificities

The **data structure can be different** for different models

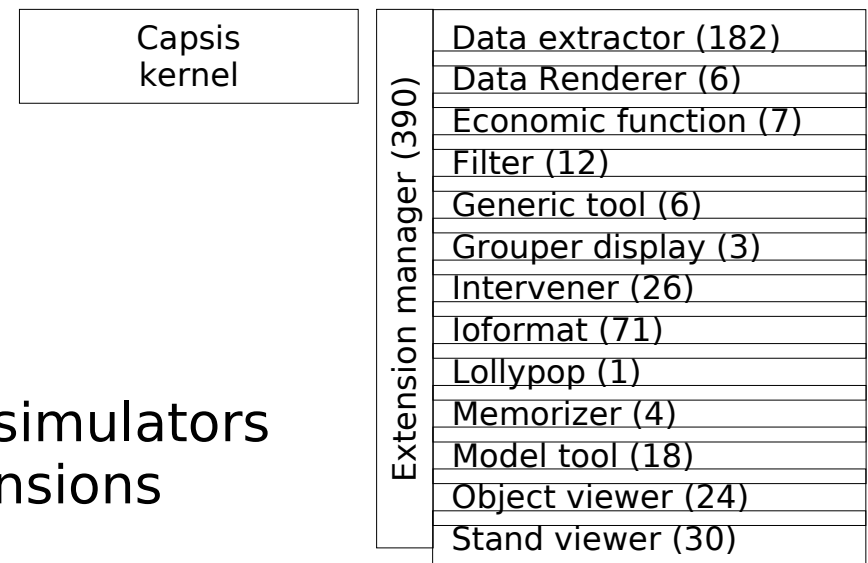


-> several thematics are possible

At present time: (1) **forestry** and (2) **fish dynamics** (experimental)

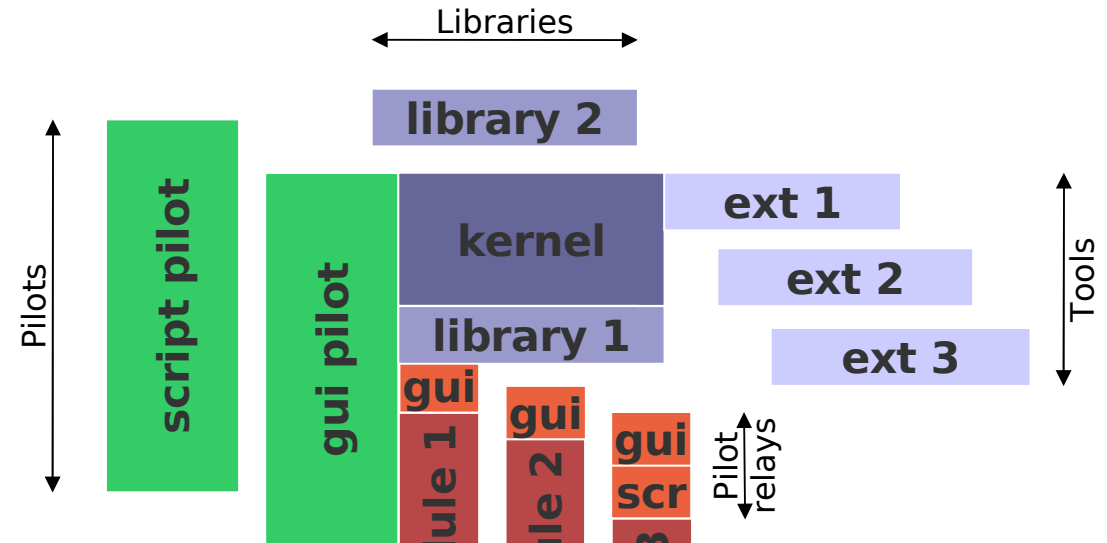
Stability: the kernel not often changes

Evolutions: extensions everywhere



- Interactive / script modes
- French / English user interface (english only in the code)
- Possible connections with other simulators
- Grouping system with filter extensions

Capsis Software Architecture



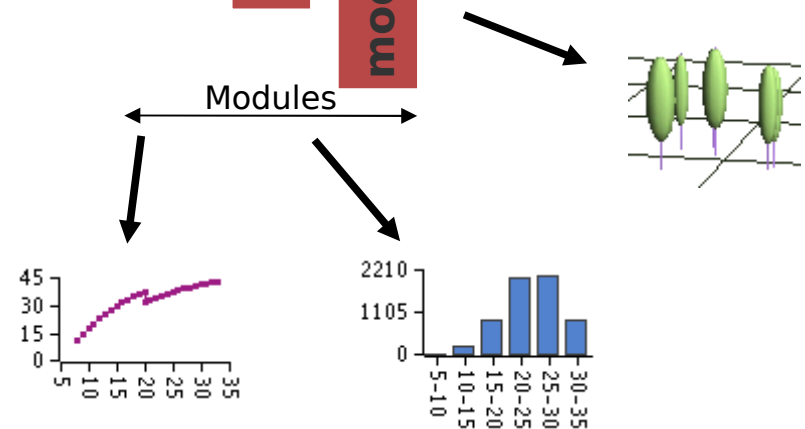
Kernel: stability

Libraries: additional tools

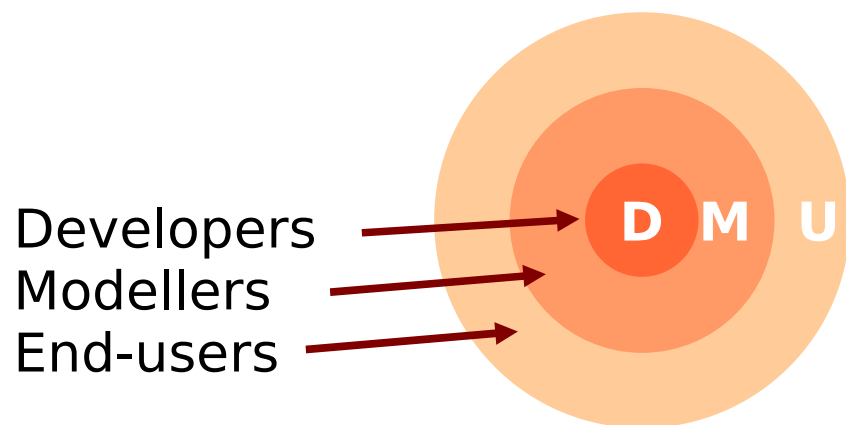
Modules: Stand growth models

Extensions: evolutive part

Pilots: interactive or not



The Capsis project organisation



Actors roles:

Developers: computer developers, design, training courses, assistance

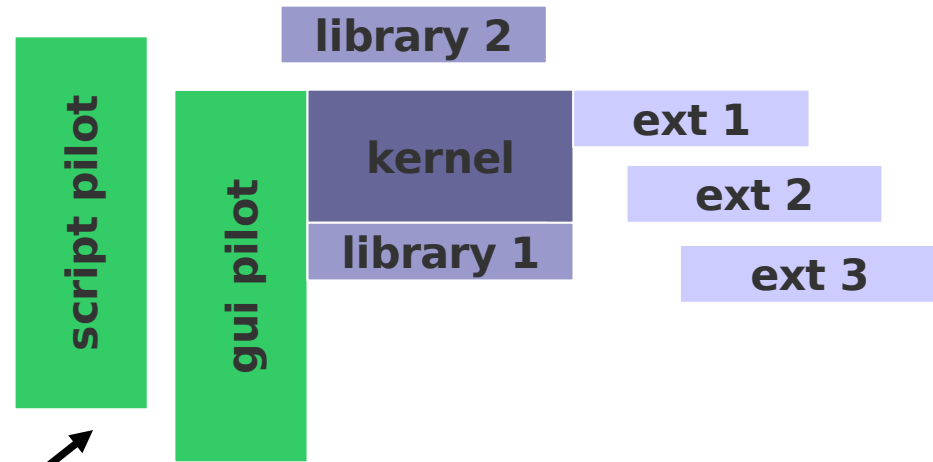
Modellers: scientists, build their models inside Capsis

End-users: interested by using the models

The Capsis Community:

Developers + Modellers are co-developing together

Clear participation rules

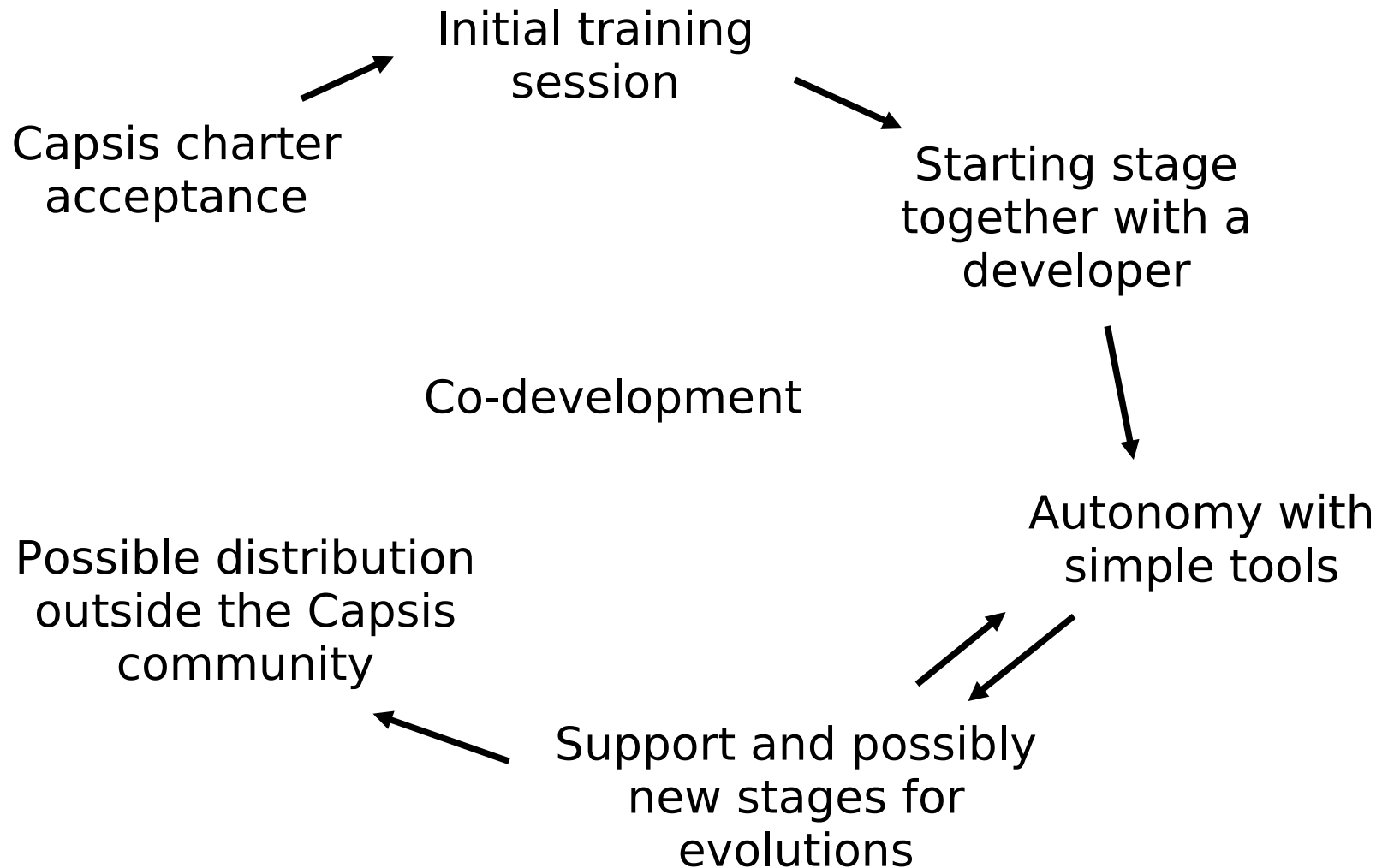


The Capsis charter:

- 1. Free kernel:** the Capsis kernel is a free software (LGPL licence)
- 2. Development:** the modelers are in charge of the development of their models
- 3. Support:** They can have support from the developers
- 4. Free access in the community:** All the source codes are freely accessible by all members in the Capsis community
- 5. Respect of intellectual property:** all members respect the intellectual property of the other members
- 6. Validations:** developers deal with technical validation, modelers deal with functional validation
- 7. Distribution:** the stabilized / validated modules may be distributed when the author decides and chooses a licence
- 8. Decentralization:** modelers manage directly the relations with their end-users



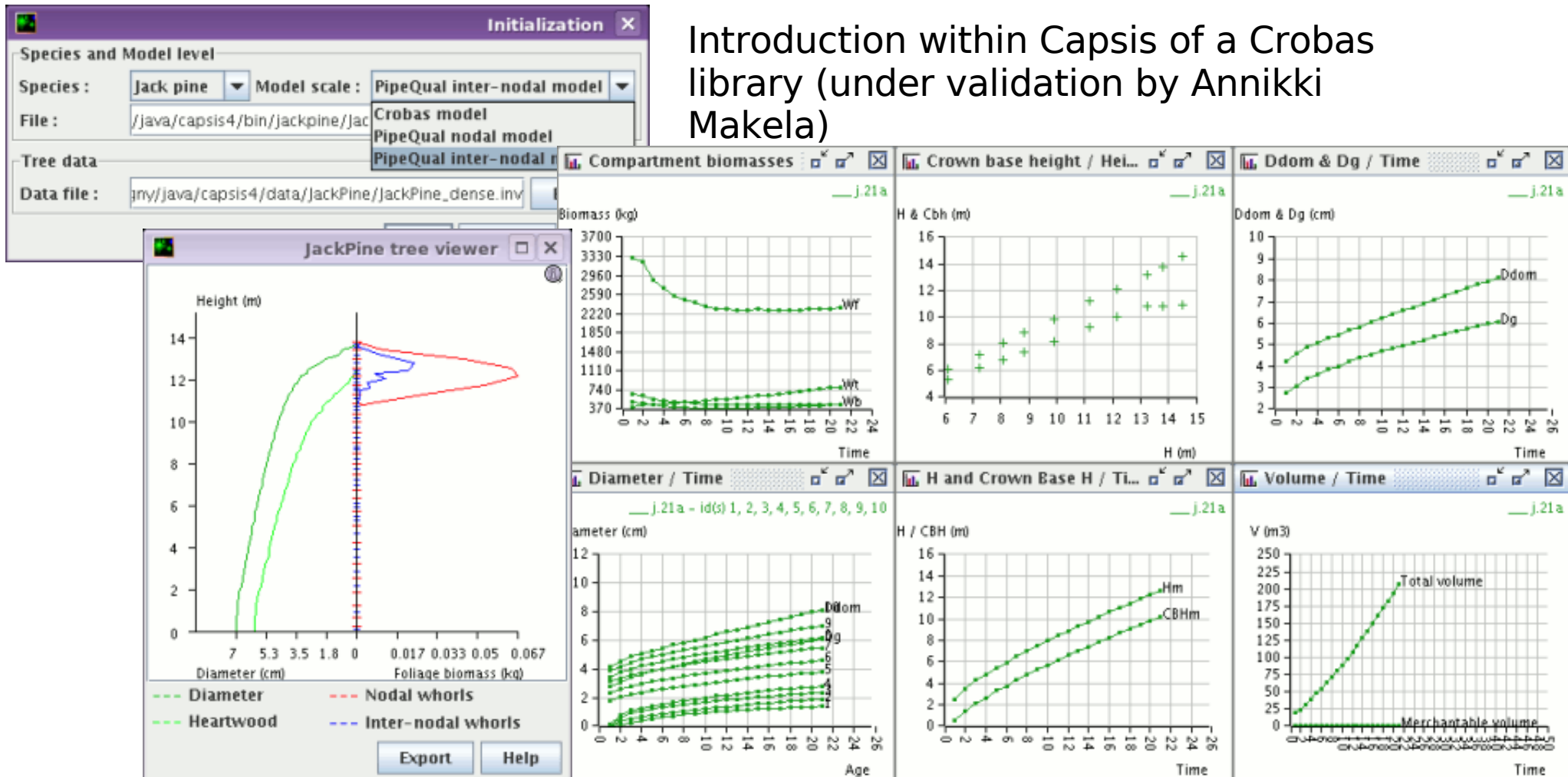
The Capsis methodology



Recent projects 1/6...

JackPine

Growth of Jack pine in Canada using the Crobas - PipeQual model by Annikki Makela (University of Helsinki, Finland).



Introduction within Capsis of a Crobas library (under validation by Annikki Makela)

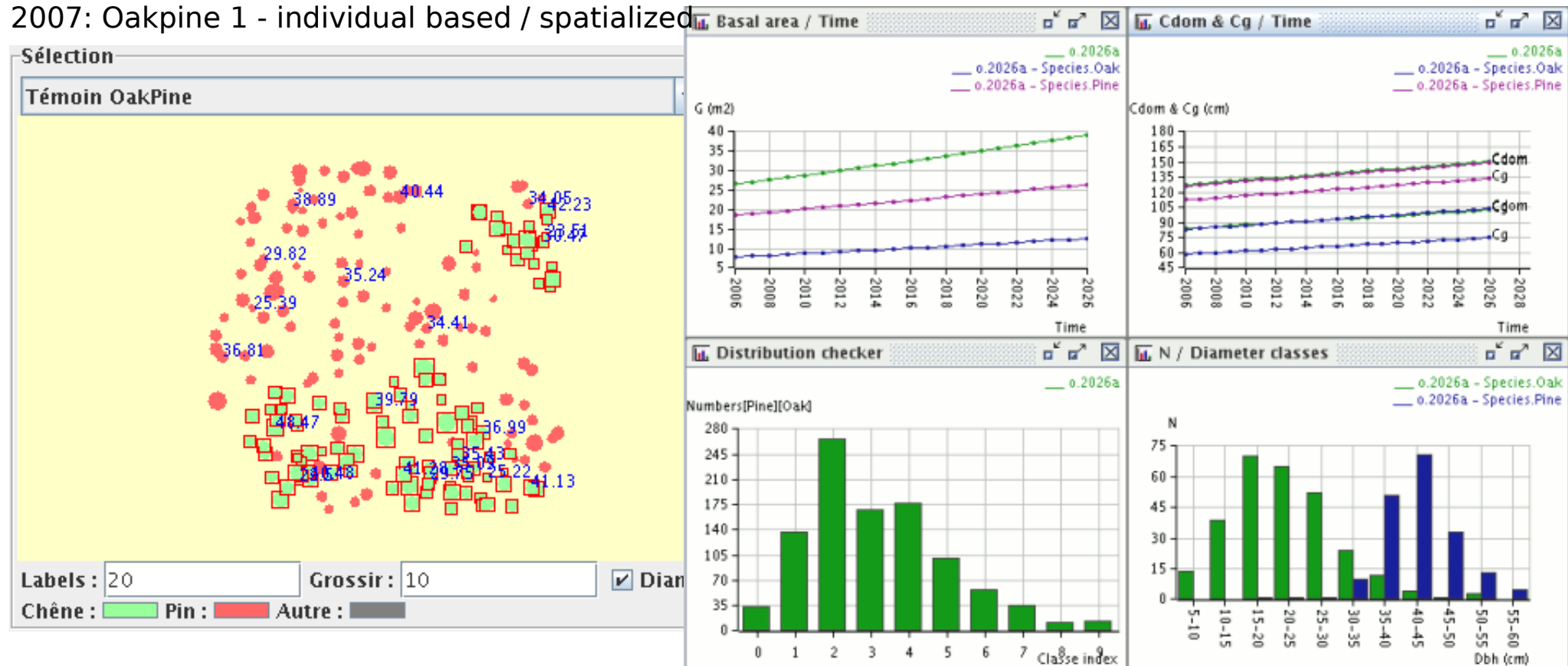
Recent projects 2/6...

OakPine2

A dynamics model for heterogeneous forests : Oak + Pine

2008: Oakpine 2 - distance-independent tree model

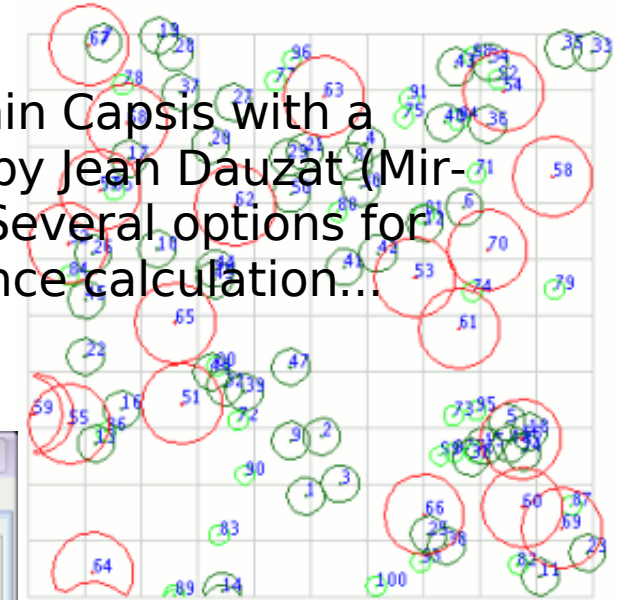
2007: Oakpine 1 - individual based / spatialized



Recent projects 3/6...

Stretch

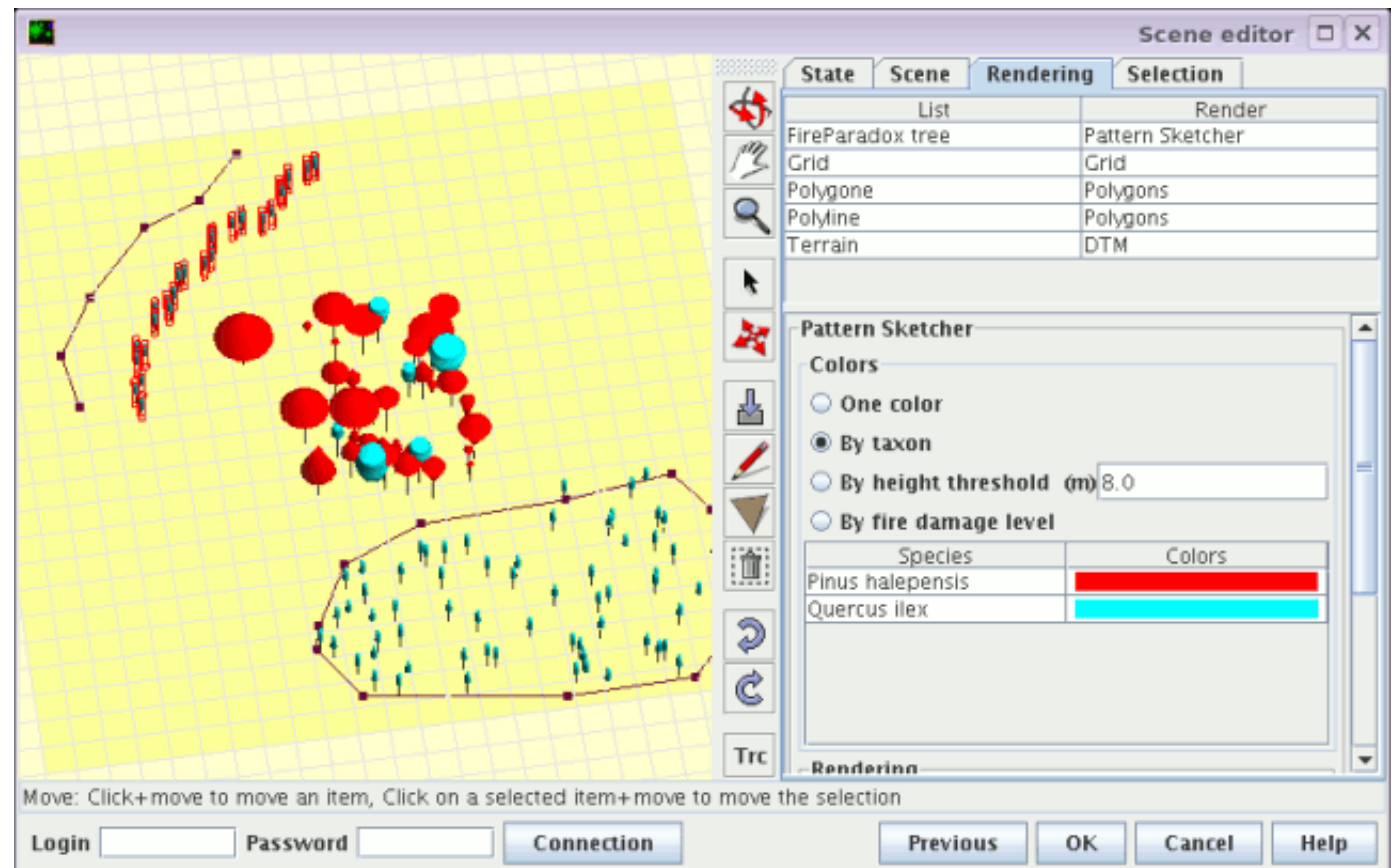
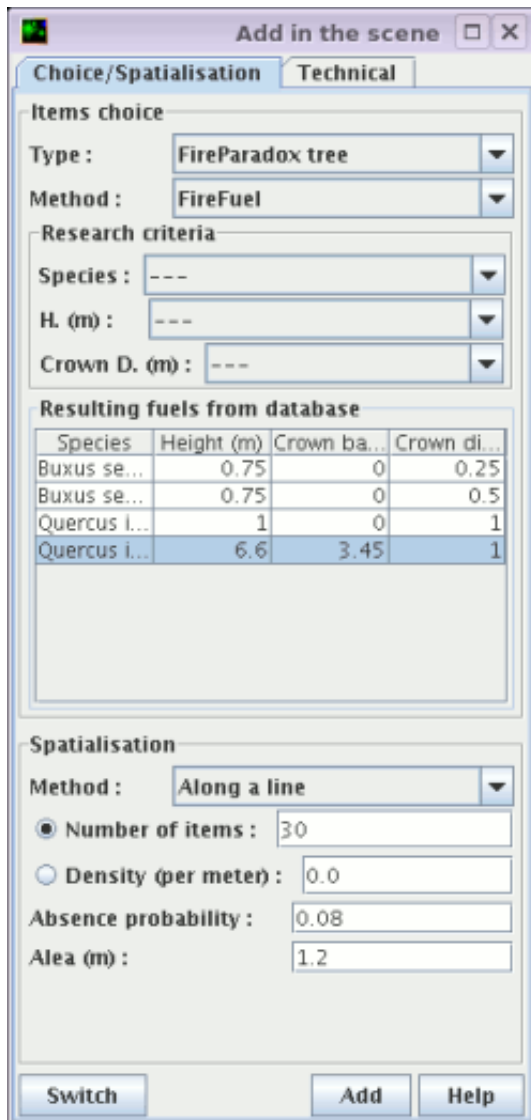
A rewriting of the Sexi-FS model within Capsis with a connection to the AMAP light model by Jean Dauzat (Mir-Musc-Radbal) and other evolutions. Several options for growth equations and radiative balance calculation...



Recent projects 4/6...

FireParadox

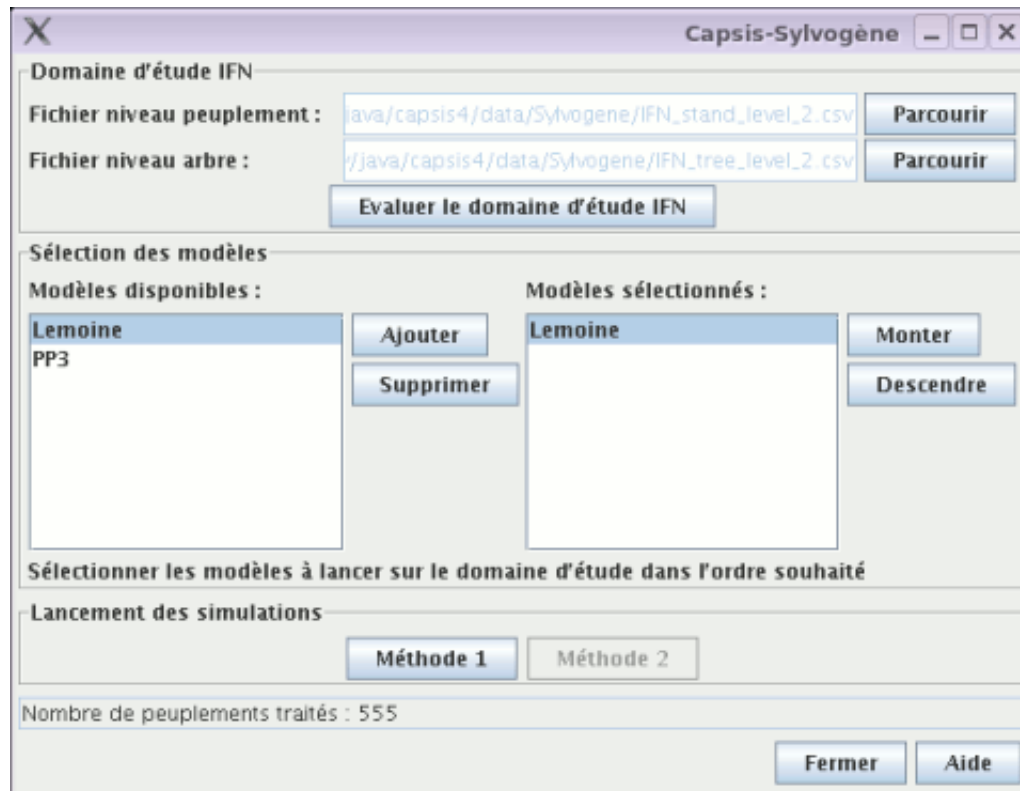
- European project : An Innovative Approach of Integrated Wildland Fire Management Regulating the Wildfire Problem by the Wise Use of Fire: Solving the Fire Paradox.
- Needs a software to place in 3D the plants / trees (considered as fuel) and export a file to a fire calculation program. Will consider the growing again of the trees after fire.



Recent projects 5/6...

Sylvogene

- Pole of competitiveness : "Industrie et Pin maritime du Futur"
- The Sylvogene project involves INRA, FCBA (AFOCEL + CTBA), IFN, CRPF, ONF, CAFSA, FORELITE, VILMORIN...
- Action « Build a permanent analysis system for the resource » for the Massif des Landes de Gascogne



- INRA, IFN et FCBA share their data and models

- FCBA decided to integrate its models within Capsis to ease their connection with the IFN data bases.

Recent projects 6/6...

Regix

Stand level model for short rotation coppice of poplar and eucalypt.
Economics oriented

Regix X

Culture existante Terrain nu

Culture

Nom : Surface (ha) :

Espèce : populus

Fertilité : Mauvaise

Choix d'un échancier

Culture

populus 1000/ha 10 ans 10 ts 1ere rotation detail
populus 2000/ha 7 ans 10 ts 1ere rotation detail

Echancier de la culture

Année	Opération	Détail	Type	Quantité
0	Nettoyage...	Grobroye...	Mécanisati	1.0
0	Herbicide...	Roundup c...	Intrant	3.0
0	Herbicide...	Application	Mécanisati	1.0
0	Fertilisatio...	Engrais 1...	Intrant	222.0
0	Fertilisatio...	Application	Mécanisati	1.0
0	Labour pr...	Labour 35...	Mécanisati	1.0
1	Reprise la...	Disques o...	Mécanisati	1.0
1	Boutures	1000 tige...	Autre	1000.0
1	Plantation...	1000 bou...	Autre	1.0
1	Herbicide...	Gardenet...	Intrant	3.5
1	Applicatio...	Tracteur...	Mécanisati	1.0
1	Entretien...	Herse rot...	Mécanisati	2.0
2	Herbicide...	Gardenet...	Intrant	3.5
2	Applicatio...	Tracteur...	Mécanisati	1.0

Regix X

Culture existante Terrain nu

Parcelle

Nom : Surface (ha) :

Peuplement

Espèce (cloné) : populus

Age de la culture (année) :

Densité initiale (tiges/ha) :

Densité vivante (tiges/ha) :

Fertilité : Mauvaise

Prévision du modèle

Age final :

Densité finale (tiges/ha) :

Diamètre moyen (cm) :

Hauteur moyenne (m) :

Biomasse : tv

Mettre à jour les graphiques

Choix d'un échancier

Ok Cancel Help

n.2a - Bilan Economique

Inclure les frais fixes et variables

Rot.	An	Opération	Détail	Type	Qua.	Unité	Prix	Gaz.	Total par...	
1	0	Nettoyage parcelle / Broyage végét	Grobroyeur ou disques	Méc.	1 ha	75...	0	-75,00...		
1	0	Herbicide en plein préparation	Roundup (3l/ha)	Intr.	3 l	10...	0	-30,00...		
1	0	Herbicide en plein préparation	Application	Méc.	1 ha	60...	6	-60,00...		
1	0	Fertilisation avant labour	Engrais 100 U P205 (sup)	Intr.	222 kg	0,2	0	-48,84...		
1	0	Fertilisation avant labour	Application	Méc.	1 ha	30...	12,6	-30,00...		
1	0	Labour profond	Labour 35-40 cm	Méc.	1 ha	16	30,7	-160,00...		
1	1	Reprise labour	Disques ou Herse rotative	Méc.	1 ha	10	3,75	-100,00...		
1	1	Boutures	1000 tiges/ha	Autre	1 0	Sans	0,3	0	-300,00...	
1	1	Plantation manuelle	1000 boutures / h / jour	Autre	1 ha	15	0	-150,00...		
1	1	Herbicide de prélevée sur ligne an.	Gardenet paysage 3,5 l/ha	Intr.	3,5 l	85...	0	-297,50...		
1	1	Application année 1	Tracteur + rampe	Méc.	1 ha	60...	6	-60,00...		
1	1	Entretien entre lignes année 1	Herse rotative	Méc.	2 ha	10	16,6	-200,00...		
1	2	Herbicide de prélevée sur ligne an.	Gardenet paysage 3,5 l/ha	Intr.	3,5 l	85...	0	-297,50...		
1	2	Application année 2	Tracteur + lance	Méc.	1 ha	10	6	-100,00...		
1	2	Entretien entre lignes année 2	Herse rotative	Méc.	1 ha	10	16,6	-100,00...		
1	10	Abattage mécanisé	arbre sur pied - perche s.	Méc.	12	lv	5,0	113	-610,39...	
1	10	Débardage	perche sur coupe - perch	Méc.	12	lv	16	113	-2 017...	
1	10	Déchetage bord de route	perche bord de route - pl	Méc.	12	lv	10	126	-1 260...	
1	10	Vente plaquettes bord de route			12	lv	37...	0	4 727,9...	
1	11	Entretien entre lignes année 1	Herse rotative	Méc.	2 ha	10	16,6	-200,00...		
2	45	Abattage mécanisé	arbre sur pied - perche s.	Méc.	37	lv	11	413	-2 034...	
2	45	Débardage	arbre							
2	45	Vente bâlon bord de route								
2	45	Abattage mécanisé	arbre							
2	45	Déchetage sur coupe	réma							
2	45	Vente plaquettes bord de route								

n.2a - Synthèse financière

Taux d'actualisation (% [0,100]) : 4.0

Unité des quantités : MWh

Synthèse globale projet : Inclure les frais annuels et variables

Rotation		Scénario d'exploitation							
		Scenario A : Plaquettes bord de route							
		Scenario C : Bâlon sur coupe et plaquettes sur coupe							
Quantité	Quantité g.	Coût culture	Coût explo.	Revenu	TIR (00)	Bâo	BASq	Annuité co.	
1	1 123	1 252,407	2 208,84	9 485,22	4 727,91	0,008	-2 459,7...	-2 967,8	-118,71

Synthèse projet : détail par produit :

Produit	Quantité	Quantité gazole	Coût exploitation	Revenu	Solde
bâlon bord de r...	695,914	660,156	4 676,10 EUR	0,00 EUR	-4 676,10 EUR
plaquettes bord...	427,491	477,402	4 809,12 EUR	4 727,91 EUR	-81,21 EUR

Synthèse projet : détail par produit et rotation :

Rotation	Produit	Quantité	Quantité gazole	Coût exploitat.	Revenu	Solde
1	plaquettes bo...	318,976	353,017	3 908,40 EUR	4 727,91 EUR	819,50 EUR
2	bâlon bord d...	695,914	660,156	4 676,10 EUR	0,00 EUR	-4 676,10 EUR
2	plaquettes bo...	108,515	124,385	900,72 EUR	0,00 EUR	-900,72 EUR

Synthèse projet : détail par processus d'exploitation :

Exploitation	Quantité	Quantité gazole	Coût exploitation
Abattage mécanisé	1 123,405	590,404	4 127,91 EUR
Déchetage sur coupe	108,515	60,048	428,91 EUR
Déchetage bord de ro...	318,976	126,077	1 260,77 EUR
Débardage	1 014,89	361,028	3 667,63 EUR

Integrated modules: various types

IBM

Fagacées
Fasy
OakPine1
Jackpine...

IBM + Spatialized

Cytisus
Fiesta / NRG
Mountain
Paletuviers
Presage
Quercus
Regelight
Samsara
Selva
Sexi - Stretch
Simsys
TranspopRege...

Diameter class

CA1, Luberon
Eucalypt
IfnCa
Laricio
NZ1
PNN
PP3
QS1
Sylvestris
Transpop
Oakpine2...

Diameter class + Spatialized

Alisier
Dynaclim
Ventoux, Ventoug...

Fish

Bidasoa
Dynet
Guppy

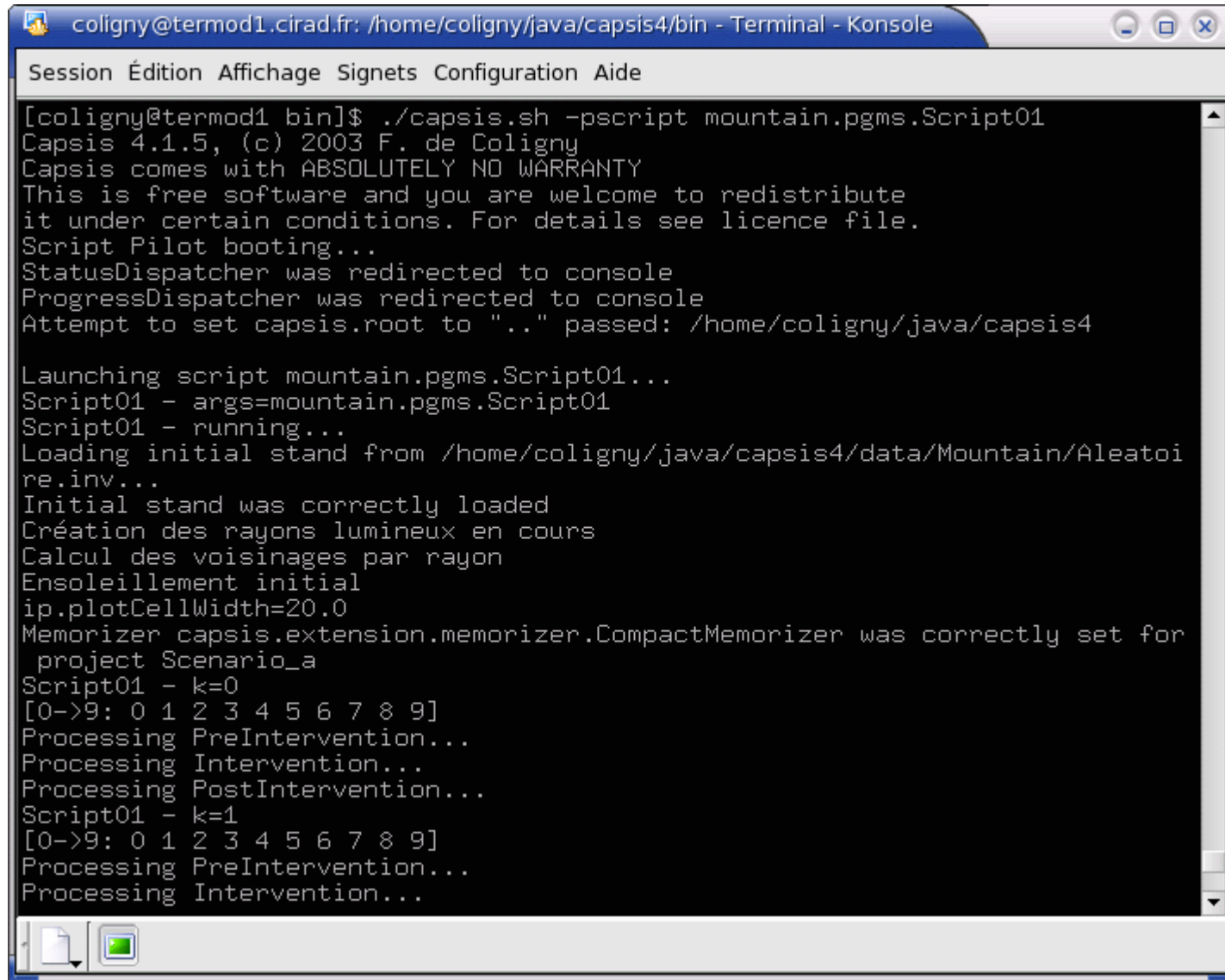
Stand level

ISGM
Lemoine

AgroForestry

HiSafe

Script mode for repetitive simulations



```
coligny@termod1.cirad.fr: /home/coligny/java/capsis4/bin - Terminal - Konsole
Session Édition Affichage Signets Configuration Aide
[coligny@termod1 bin]$ ./capsis.sh -pscript mountain.pgms.Script01
Capsis 4.1.5, (c) 2003 F. de Coligny
Capsis comes with ABSOLUTELY NO WARRANTY
This is free software and you are welcome to redistribute
it under certain conditions. For details see licence file.
Script Pilot booting...
StatusDispatcher was redirected to console
ProgressDispatcher was redirected to console
Attempt to set capsis.root to ".." passed: /home/coligny/java/capsis4

Launching script mountain.pgms.Script01...
Script01 - args=mountain.pgms.Script01
Script01 - running...
Loading initial stand from /home/coligny/java/capsis4/data/Mountain/Aleatoir
e.inv...
Initial stand was correctly loaded
Création des rayons lumineux en cours
Calcul des voisinages par rayon
Ensoleillement initial
ip.plotCellWidth=20.0
Memorizer capsis.extension.memorizer.CompactMemorizer was correctly set for
project Scenario_a
Script01 - k=0
[0->9: 0 1 2 3 4 5 6 7 8 9]
Processing PreIntervention...
Processing Intervention...
Processing PostIntervention...
Script01 - k=1
[0->9: 0 1 2 3 4 5 6 7 8 9]
Processing PreIntervention...
Processing Intervention...
```

Transfert actions (2006 - 2008)

22 oct 2007 : **Mathieu Fortin** and **Sylvain Turbis** organised a training session on Capsis and the SaMARE model for 13 people outside the Department of Natural Resources and Wildlife on September 12 in Quebec City. The trainees were from **timber companies, consulting firms** and **forest cooperatives** from several regions of Quebec where Maple is present.

20 août 2007 : On June 7th 2007, **Céline Meredieu** and **Thierry Labbé** (INRA Bordeaux) presented Capsis and the PP3 module to foresters. Thirty three participants came from **CASFA, CPFA, CRPF, GFOGARGPF Sud-Landes, Groupama, ONF, SODEF**. This session was jointly **organised by INRA, CRPF Aquitaine and ONF**. The presentation began by the context of the Sylvogène project (Pôle de compétitivité Industrie et Pin du futur) with Sebastien Drouineau (CRPF). Then Céline Meredieu presented Capsis and theoretical and conceptual information about the PP3 project. Dominique Merzeau (CPFA), Sebastien Drouineau (CRPF) and Didier Canteloup (ONF) showed how to use Capsis/PP3 for various applications. (...)

15 jan 2007 : On January 10th, **Mathieu Fortin** and **Sylvain Turbis** (Ministère des Ressources Naturelles et de la Faune (MRNF), Québec, Canada) presented Capsis and the Samare module to **foresters from MRNF region 06 and 07**. Four of the seven participants came from the region 06 (BR06, UG61, UG62, UG64), and the three others were from the region 07 (BR07, UG71, UG72) (BR ? regional office, UG ? management unit). (...)

28 nov 2006 : On October 17th, **Thomas Pérot** and **Sandrine Perret** (Cemagref Nogent sur Vernisson) organized a second session to transfer to the French Forestry Office (ONF) the Laricio and Sylvestris modules. Two of the three participants came from the **ONF DT Centre Ouest**, and the third was from the **ONF DT RD based at Fontainebleau**. (...)

29 juin 2006 : In Orleans, training session by **Patrick Vallet** to the Fagacees model and how to use it in the Capsis platform for the colleagues of the **French Forestry Office (ONF)**. The session was **organized by Sandrine Verger (ONF-DT Centre-Ouest)** and welcomed 12 participants (12.6.2006).

Recent publications

Labonne, J., Ravigné, V., Parisi, B., and Gaucherel, C. **2008**. *Linking dendritic networks structure to population demogenetics : the downside of connectivity*. *Oikos* : 1479-1490.

Hong L.X., Tang S.Z., Li H.K., Li Y.C., de Coligny F., **2008**. *Integrated Stand Growth model (ISGM) and its Application*. In: Fourcaud T, Zhang XP, eds. *Plant Growth Modeling and Applications*. Proceedings of PMA06. Los Alamitos, California: IEEE Computer Society, pp. 223-230.

de Coligny F., **2008**. *Efficient Building of Forestry Modelling Software with the Capsis Methodology*. In: Fourcaud T, Zhang XP, eds. *Plant Growth Modeling and Applications*. Proceedings of PMA06. Los Alamitos, California: IEEE Computer Society, pp. 216-222.

Perot T., S. Perret, C. Meredieu et C. Ginisty, **2007**. *Prévoir la croissance et la production du Pin sylvestre : le module Sylvestris sous Capsis 4*. *Revue Forestiere Francaise* 59(1): 57-84.

Goreaud F., Alvarez I., Courbaud B., and de Coligny F., **2006**. *Long-Term Influence of the Spatial Structure of an Initial State on the Dynamics of a Forest Growth Model: A Simulation Study Using the Capsis Platform*. *Simulation* 2006 82: 475-495.

Goreaud F., de Coligny F., Courbaud B., Dhôte J.-F., Dreyfus P., Pérot T., **2005**. *La modélisation : un outil pour la gestion et l'aménagement en forêt*. *Vertigo* 6(2).

de Coligny F., Meredieu C., Labbé T., Vallet P., Dreyfus P., **2005**. *Using Capsis for connection with wood quality*. In Proceedings of the fifth Workshop "Connection between Forest Resources and Wood Quality : Modelling Approaches and Simulation Software", Waiheke Island, New Zealand, 20-27 November 2005.

Capsis User Interface (Linux, english)

The screenshot displays the Capsis 4.1.5 software interface. At the top, the menu bar includes File, Edit, View, Project, Tools, Window, and Help. Below the menu is a toolbar with various icons. The main workspace is divided into several sections:

- Project Overview:** Shows the current project name "pp3 - Model : PP3 - 5 ha - All in memory - Virtual stand" and a diagram of tree growth stages (12a, 20a, 30a, 40a, 50a, 60a) and a second row (*20b, 30b, 40b, 50b, 60b).
- Tree Growth Diagram:** Shows the current tree "laricio - Model : Pin laricio - 5 ha - All in memory - virtual stand" with growth stages (15a, 20a, 30a, 40a, 50a, 60a, 70a, 80a) and a second row (*15b, 20b, 30b, 40b, 50b, 60b, 70b, 80b).
- Girth / Time Plot:** A line graph showing Girth (cm) vs Time for three trees: pp3.60a - Tree 78 (orange), pp3.60b - Tree 78 (blue), and laricio.80a - Tree 79 (green). The x-axis ranges from 7 to 98, and the y-axis ranges from 15 to 135.
- laricio.80b - MAID Viewer:** A window displaying a bar chart of Diameter (cm) vs N (Number of trees) and a table of variables and values.

The MAID Viewer table contains the following data:

Variable	Value
N	3709
G (m2)	271.52
V (m3)	3447.28
Dg (cm)	30.53
Ddom (cm)	35.78
Hg (m)	26.94
Hdom (m)	27.83
SHB (%)	14.18

At the bottom of the interface, a status bar indicates "Updating selector for model pp3..."

