Capsis : a Software Platform for Forestry Dynamics

Coupling Risk to Growth models

Ecole Chercheur Multirisques - Chantilly 2022

Francois de Coligny

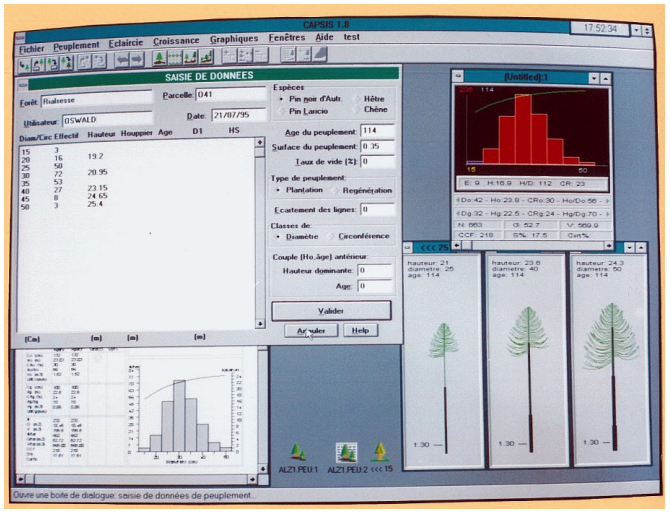
INRAE - AMAP (France)
Botany and Modelling of Plant Architecture and vegetation

Objectives

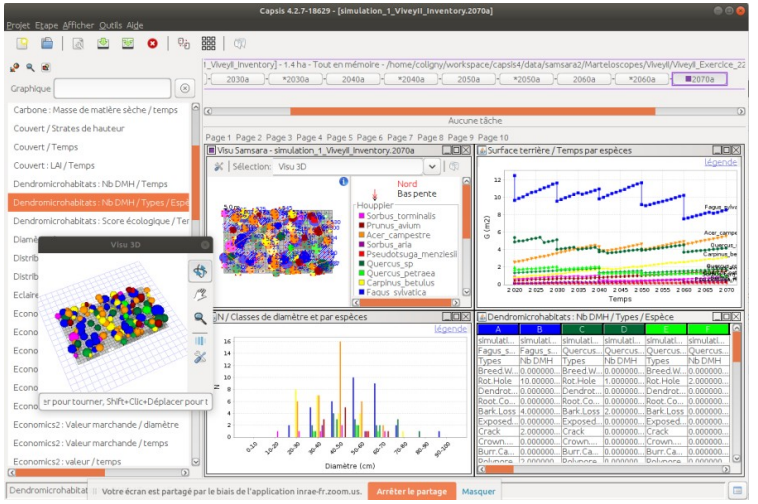
Build **a software platform** to host **forest growth and dynamics models**, for **modellers, forestry managers** and **education**

Original idea of a scientist at **INRA URFM Avignon** in 1994

- a first version with 12 models inside
- with support of several partners including french ministry in charge of forests



Capsis 1.8 (1994)

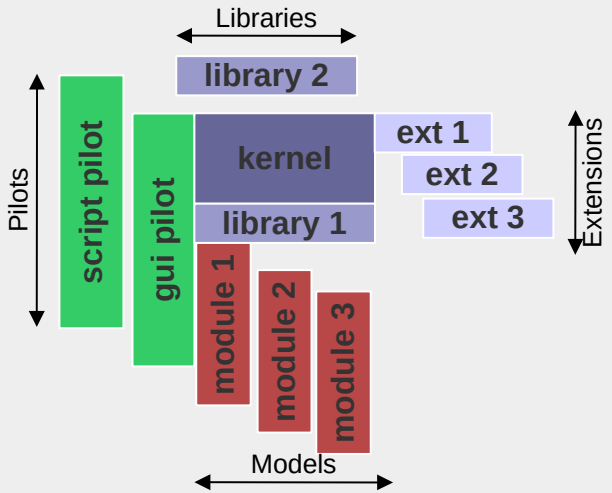


Capsis 4.2.7 (2022)

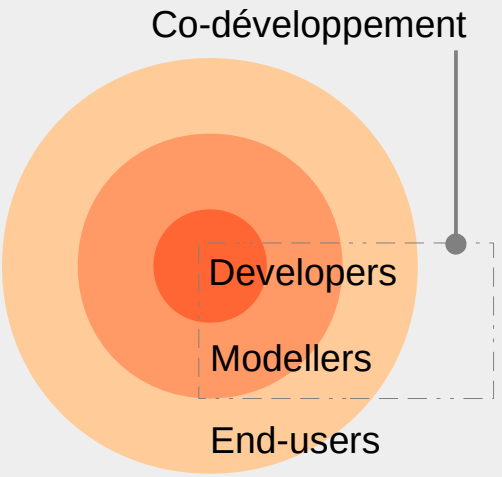
Project moved to **INRA AMAP Montpellier** in 1999

- more scalable version : several types of models, Windows, Linux & Mac...
- new models integrated every year with new partners

A co-development oriented organisation



Software architecture



Actors and roles

Free software (LGPL)

Capsis charter :
- property
- sharing with other co-developers

Clear property rules

Capsis charter

Accepted by all members

- aims at sharing and intellectual property respect
- compatible with academic and private field partners

http://www.inra.fr/capsis/charter

Capsis Charter

Main points

1. **Free kernel**: the Capsis4 kernel is a free software (LGPL licence) : kernel + generic pilots + extensions + libraries (all the capsis.* packages)
2. **Development**: the modellers are in charge of the development of their models into Capsis
3. **Support**: They can have support from the developers : training sessions, design, starting help, further assistance
4. **Free access in the community**: All the source codes are freely accessible by all members in the Capsis community, modules may become the base for new modules, code can be shared…
5. **Respect of intellectual property**: all members respect the intellectual property of the other members.
6. **Validations**: developers deal with technical validation, modellers deal with functionnal validation.
7. **Distribution**: the stabilized / validated modules may be distributed when the author decides and chooses a licence (LGPL free license suggested), possible download from a ftp site.
8. **Decentralization**: modellers manage directly the relations with their end-users: financing, training, assistance, models documentation, contracts…

To comply with the charter, the modellers may **distribute** the Capsis platform with their own modules but **NOT with the modules of the other modellers**. The modules (i.e. the growth models) are indeed not free and belong to their authors who may decide to distribute them with the license they choose. The section 4 of the charter grants access on all the modules to the modellers of the Capsis community but only to them, resulting in this distribution restriction.

Method: take care of the modellers

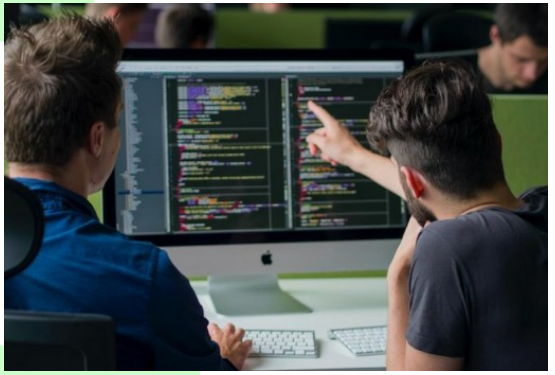
Targeted public: a modeller has designed a forestry growth model and wishes to integrate it in Capsis to get a simulator for his own objectives

- discussion
- accept the charter
- training
- immediate working session to start together
  (never start alone)

Or in video conference...

Goal: get quickly a running prototype
-> often in few days / during few weeks

Start in 'pair programming' on the same machine
-> the developer masters the technique
-> the modeller masters his model
-> the simulator is valid technically and fonctionally



The modeller can then continue by himself with simple tools...

... and a Long term support

Capsis Training Sessions

8-9 March 2022 : 9 people
Online supports and exercices
Video conference mode

Capsis
Computer-aided projection of strategies in silviculture

Sitemap Login

- Home
- Presentation
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- Charter
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- Documentation
- Projects
- Transfer/Teaching
- Development
- Contact

AMAP cirad cnrs INRAE IRD

The Capsis training online

fc-January 2021

This is an online version of the supervised exercises within the Capsis training, built to better fit the training by video conference.

- The Capsis training online
- Installation, video links and organisation
- The java exercises online (first afternoon)
- The Capsis exercises online (second afternoon)

Note: this training online material is part of the annual session of the Capsis training course, for registered modelers or students.

Installation, video links and organisation

Before d-day, please see the installation section below:

- 0. Installation

On d-day, video conference links (will be updated):

- **Foxtrot** video (**F**rancois), click or copy this link in your browser: https://meet.google.com/quf-jrru-uxw
- **Papa** video (**P**hilippe) click or copy this link in your browser: https://meet.google.com/ces-eznb-mbi
- **Golf** shared document (**G**oogle Doc) editable by all (hopefully) click here

In the morning, **everybody connects to the Foxtrot** video conference for the courses. In the afternoon, we will start on Foxtrot, then some may switch to Papa.

Problems:

- I'm lost, I don't remember where to go… → go to the Foxtrot video link upper, will always stay open (hopefully)
- I can not connect to this video link
  - try with **another browser** (Chrome, Firefox…)
  - try **from your phone** (if it is smart enough), you might join us this way and you could download the presentation pdfs on your computer to follow the courses

The java exercises online (first afternoon)

- 1. Create a minimal program
- 2. Create a Tree class
- 3. Create a SpatializedTree class
- 4. Add instance variables in the tree
- 5. Add methods in the tree
- 6. Write a method to create a list of trees
- 7. Write the trees in a file
- 8. Pass parameters on the command line

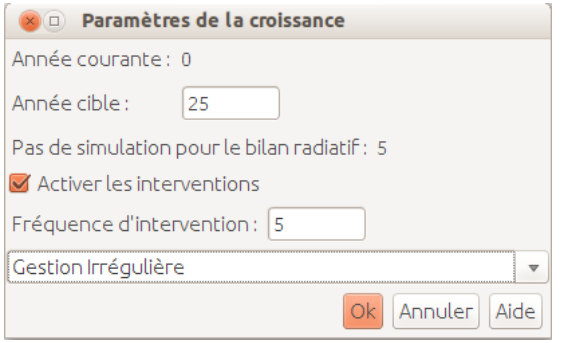
The Capsis exercises online (second afternoon)

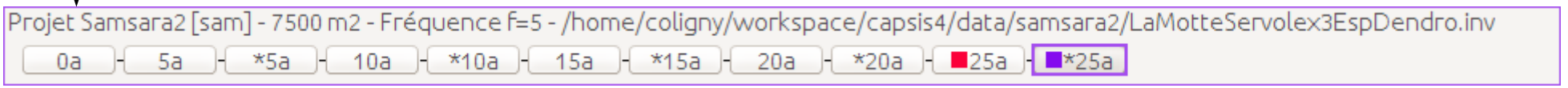
- 10. Create a new module in Capsis called training
- 11. Random regeneration
- 12. Mortality
- 13. Add a geometrical plot made of square cells
- 14. Make a graph: N / Time
- 15. Script
- 16. Regeneration around the mothers

Simulations in Capsis

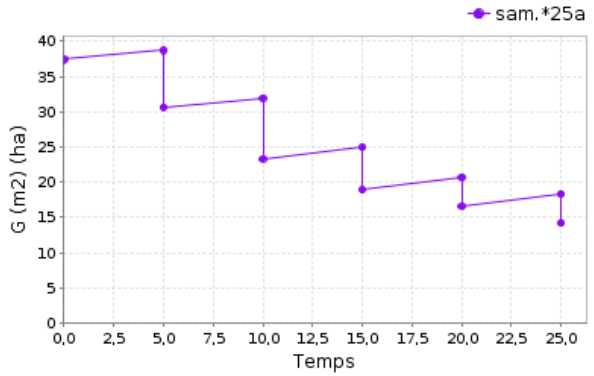
1. choose a growth model
2. initialize
3. build **silvicultural scenarios** : growth / interventions
4. integrated control
5. export to other software

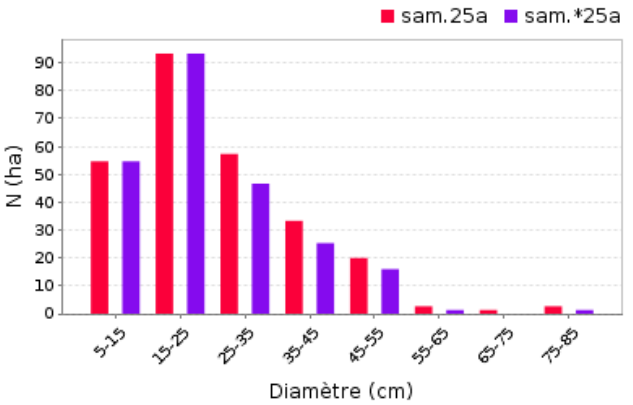
initialisation





growth

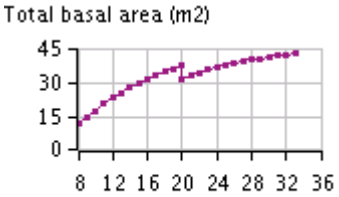




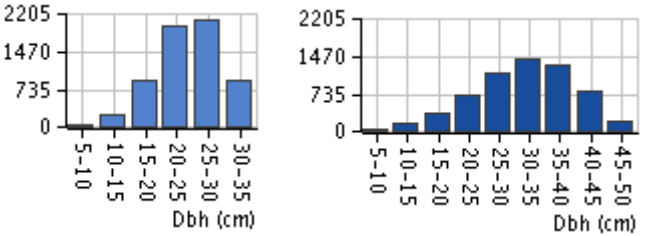
export

Relevant for various kinds of forestry growth models

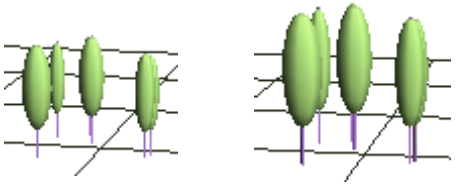
Stand level models



Distribution models

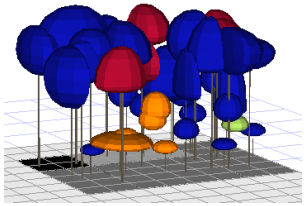


Spatialized models

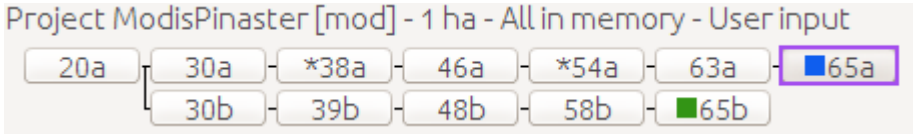


... and others

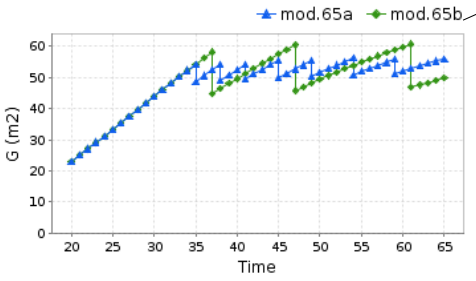
- Process-based
- Distribution + spatial structure
- Individual based + genetics
- ...



-> Scenarios in Capsis

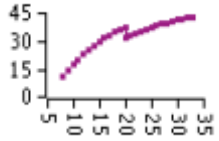


Export

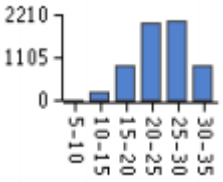


Céline Meredieu, Thierry Labbé (INRAE Biogeco, Bordeaux)

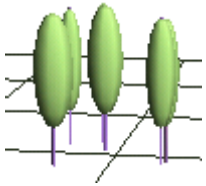
Models for maritime pine in the *Landes de Gascogne*



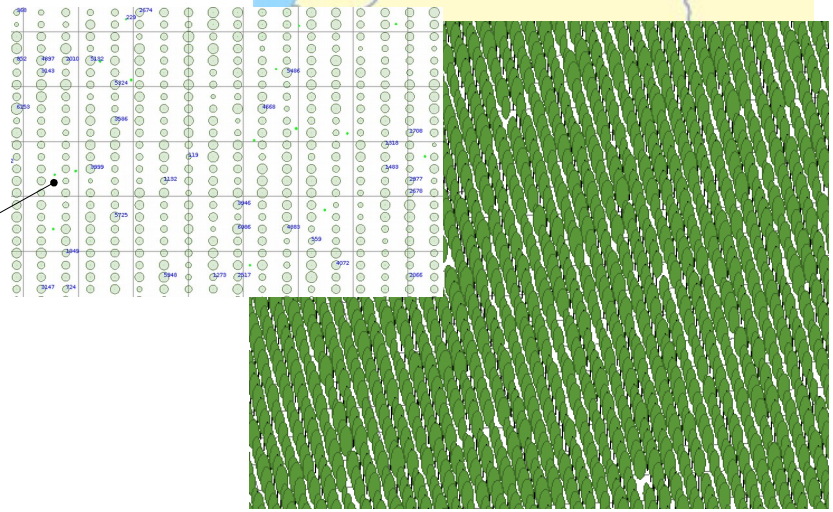
Lemoine model (stand level, plantation):
- age, number of trees, girth (dominant, mean), basal area, height (dominant, mean), volume (mean)



PP3 model (distribution model, plantation):
- a list of trees
  - age, diameter, height, volume of each tree, crown (height, diameter), other information (biomass, carbon, etc.) + number



Pinus Pinaster (individual-based, spatialized)
- a rewriting of PP3
- integration of spatialized processes



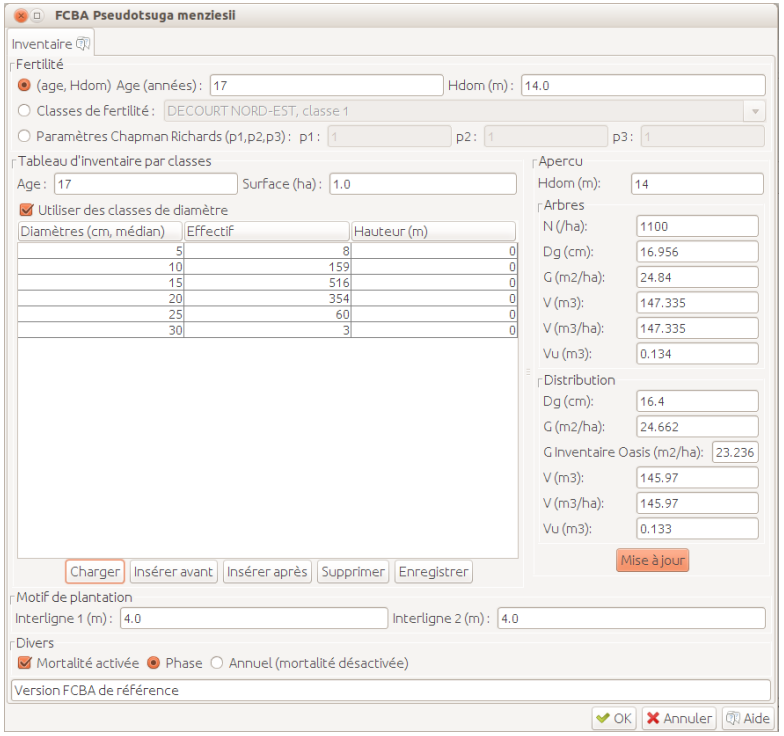
stumps

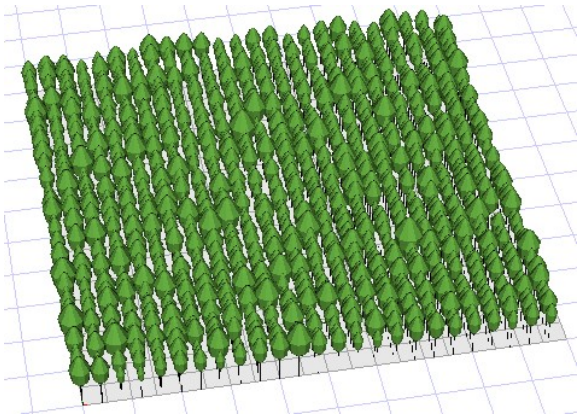
Applications, further works:
- a permanent resource analysis system (with IFN - National Forest Inventory)
- dead wood modelling and biodiversity
- models transfer to the silviculture prescribers

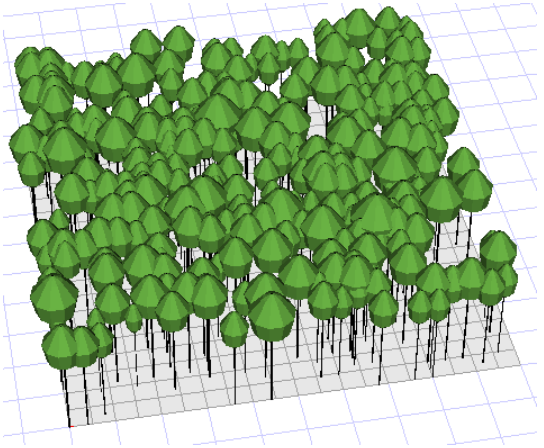
FCBA Spruce and Douglas fir models

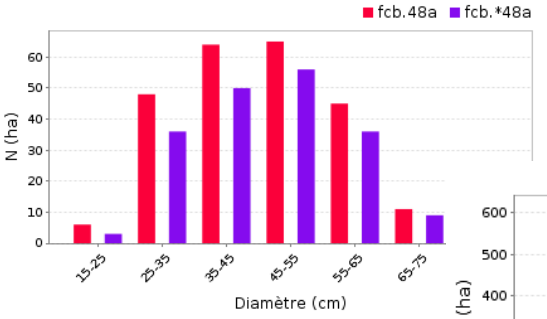
Models ported from a former software Oasis (Afocel / FCBA)

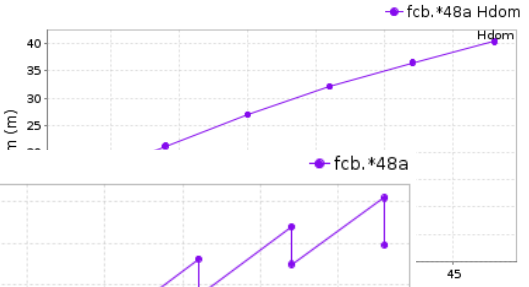
- stand level + tree level models
- former version in Delphi
- new versions were validated / Oasis
- included in the Capsis-ONF-2015 distribution

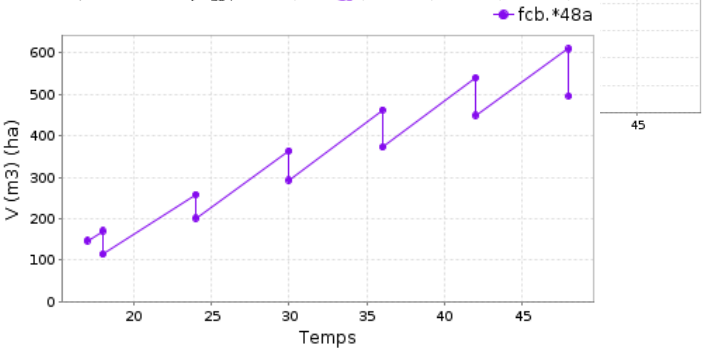












Philippe Dreyfus (INRA URFM / ONF R&D, Avignon)

Ventoux: modelling a forested massif

Realistic sylvicultural scenario and evolution over 100 years

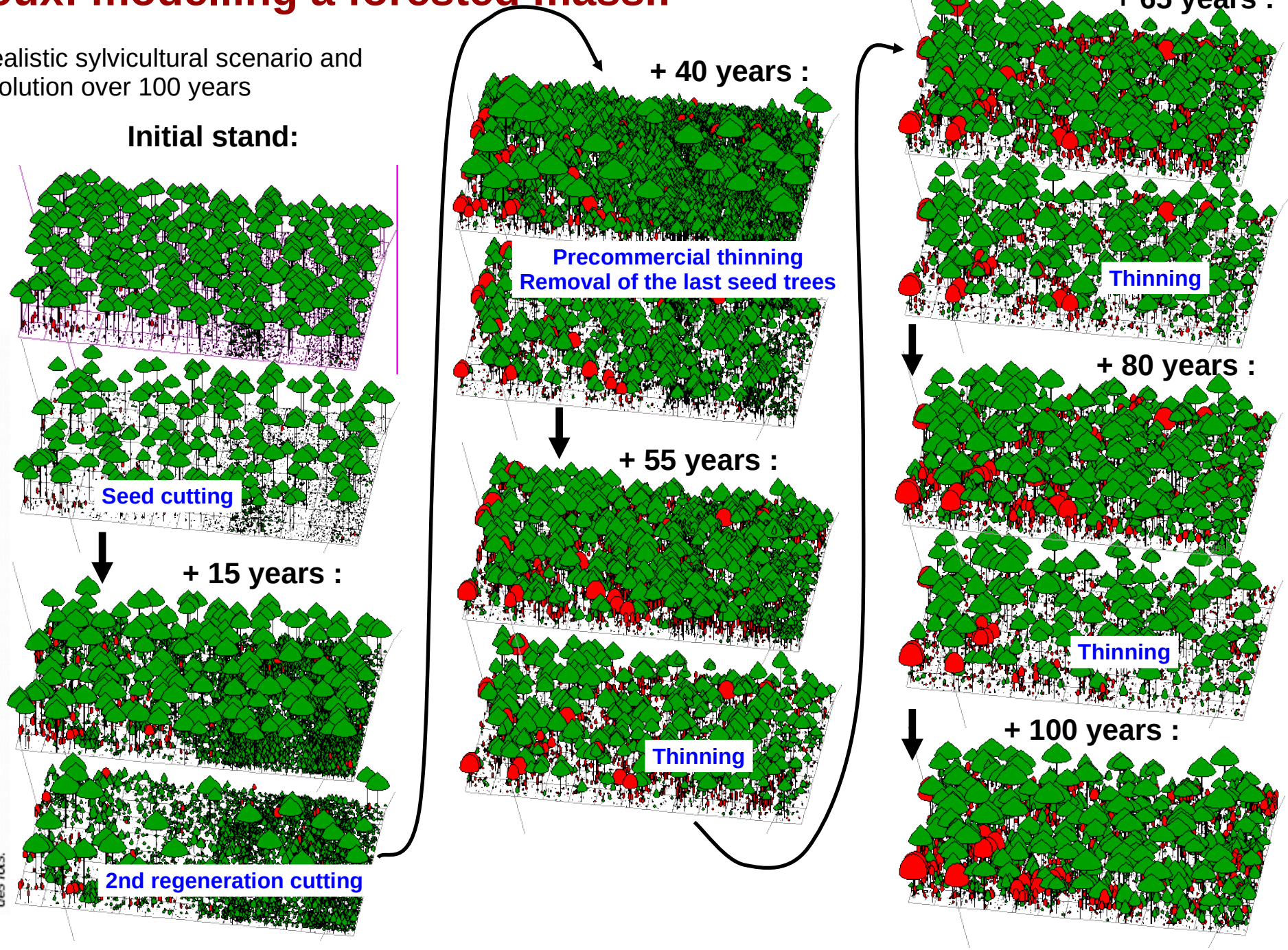


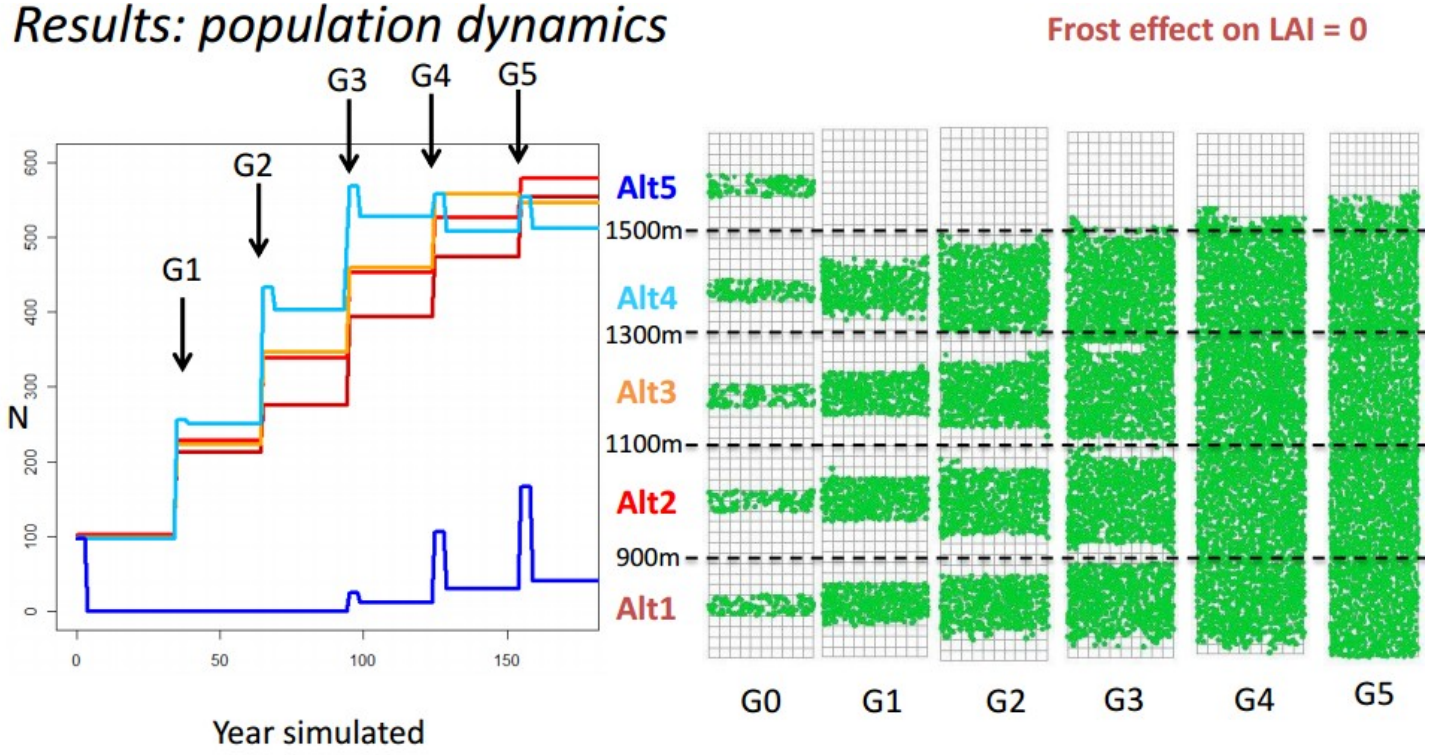
***Figure 7** : Simulation d'un scénario sylvicole complet réaliste et évolution sur 100 ans d'une plantation de Pin noir (en vert) en cours de colonisation par le Hêtre (en rouge) : régénération par coupes progressives du couvert de Pin, qui bénéficie autant au Hêtre qu'aux semis de Pin ; dépressage unique, à l'occasion duquel la proportion des deux essences peut être en partie modifiée (mais le dynamisme du Hêtre et sa faculté à rejeter ne permettent pas de l'éliminer, même si on souhaite favoriser au maximum le Pin) ; éclaircies, en nombre limité compte tenu de la nécessité d'offrir un volume suffisant à chaque intervention pour favoriser la vente des lots.*

Sylvie Oddou-Muratorio, Hendrik Davi (INRA URFM, Avignon)

PhysioDemoGenetics

PhysioDemoGenetics aims at studying the genetic adaptation through natural selection driven by climatic variables in a continuous tree population
-> accounts for complex interactions among genes, functional traits and climate when environment or demography are unstable.

It relies on (1) explicit modelling of the genetic determinism of ecophysiology-related traits and (2) the coupling of ecophysiological processes at tree level (Castanea library in Capsis) with dynamical processes (dispersal, growth, mortality) and genetic processes (Genetics library in Capsis)



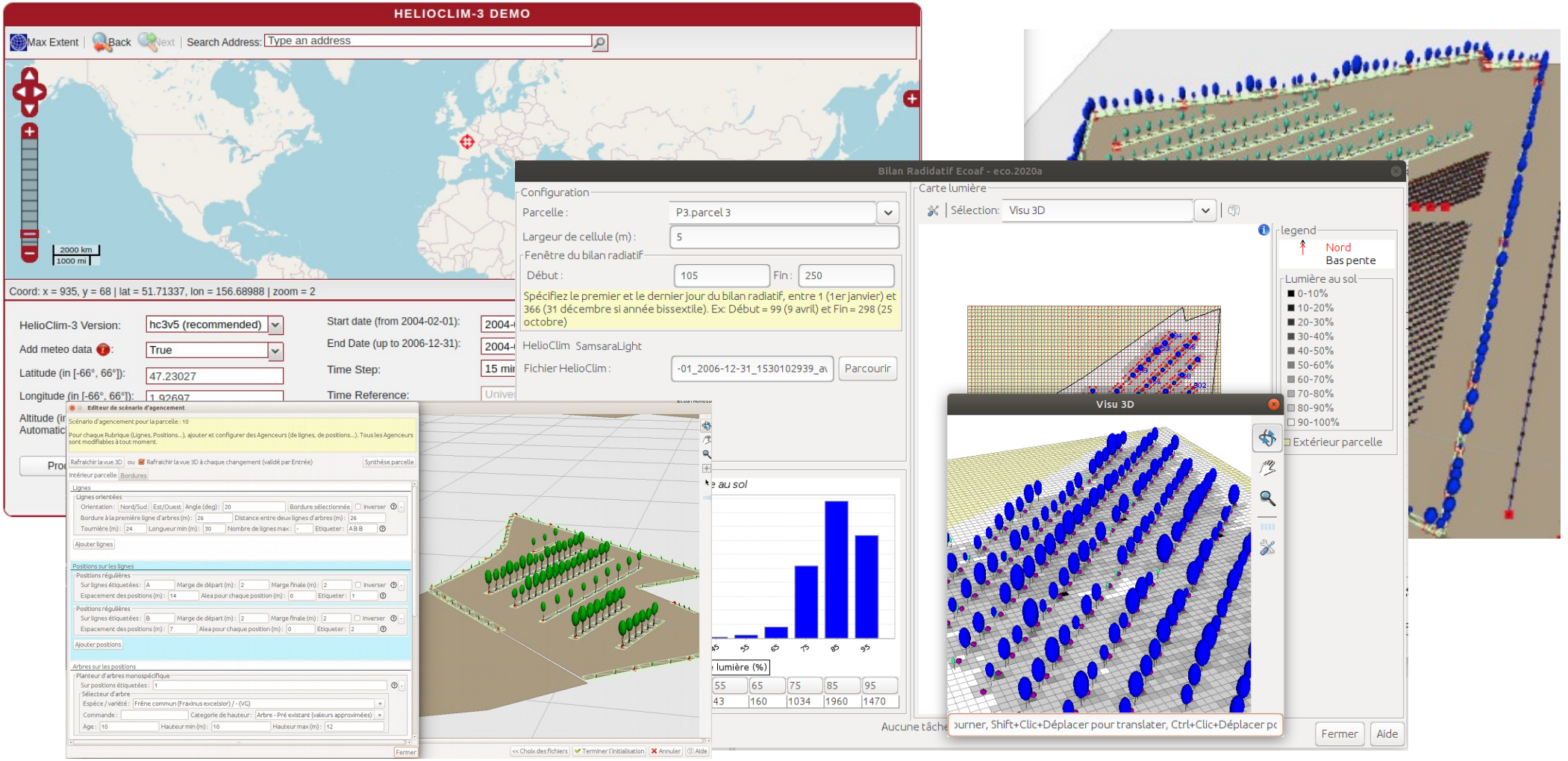
- Extinction of Alt5 at G0 and recolonisation at G3
- Treeline at 1620 m (versus observed =1700 m)

Frédérique Santi (INRAE Biofora Orléans), Francois Warlop (GRAB Avignon), Fabien Liagre (Agroof Anduze)

Ecoaf: an Agroforestry model

Species production over time graph

- Production export
- Possible to run a **SamsaraLight simulation** on a given parcel
- The plot **radiative conditions are picked from the HelioClim / Soda website**

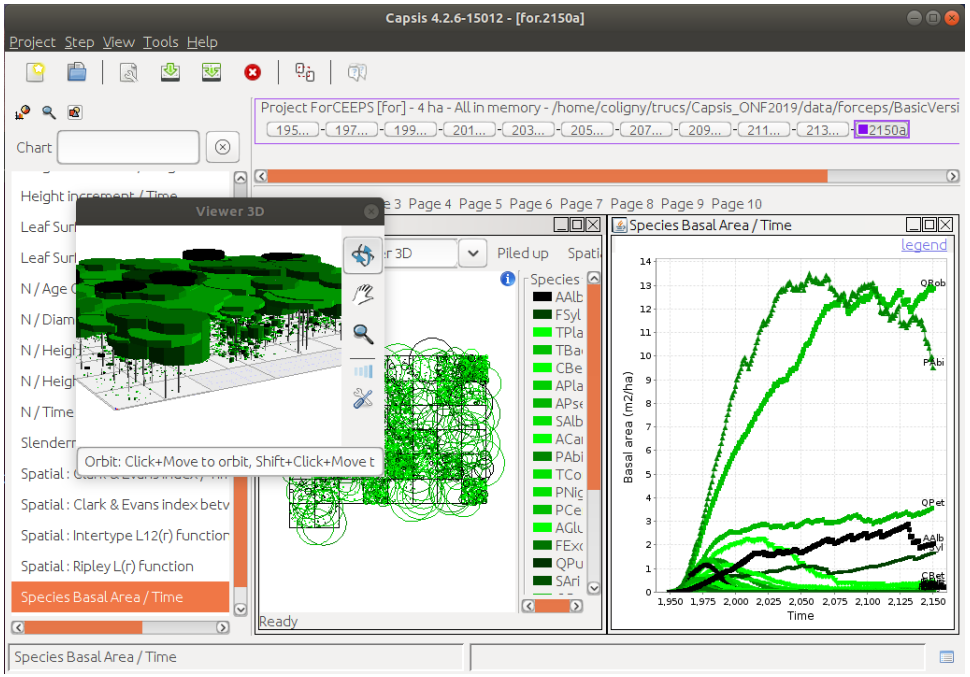


Forceeps

A forest dynamics model

- based on the ForCLIM gap model (H. Bugmann): cyclical successions on small plots
- tree population dynamics: establishment / growth / mortality
- limiting factors: light, climate, soil nitrogen
- validated on several sites

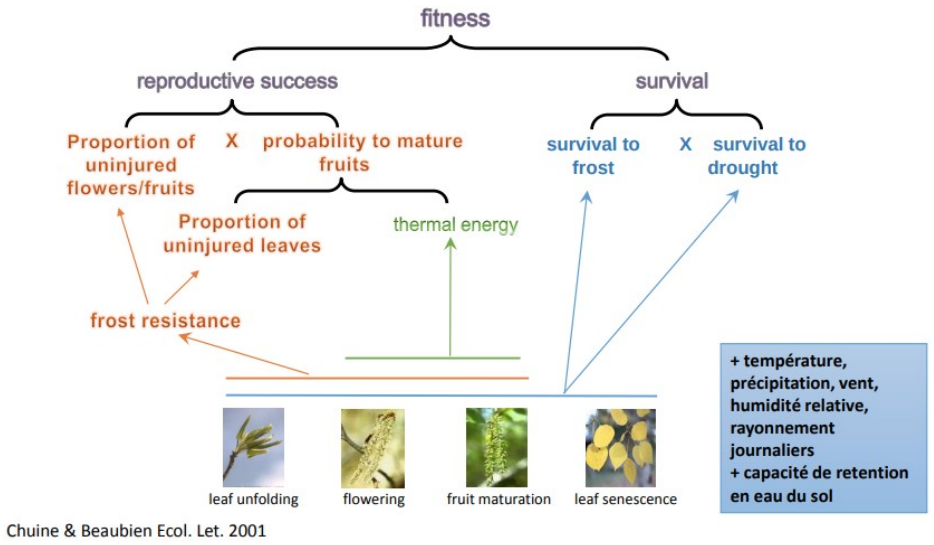
Forceeps specificities: individual based, genotype instead of species, water competition, more complex regeneration, finer competition for light...



Virtual experiments with modelisation (including impact of climate change)

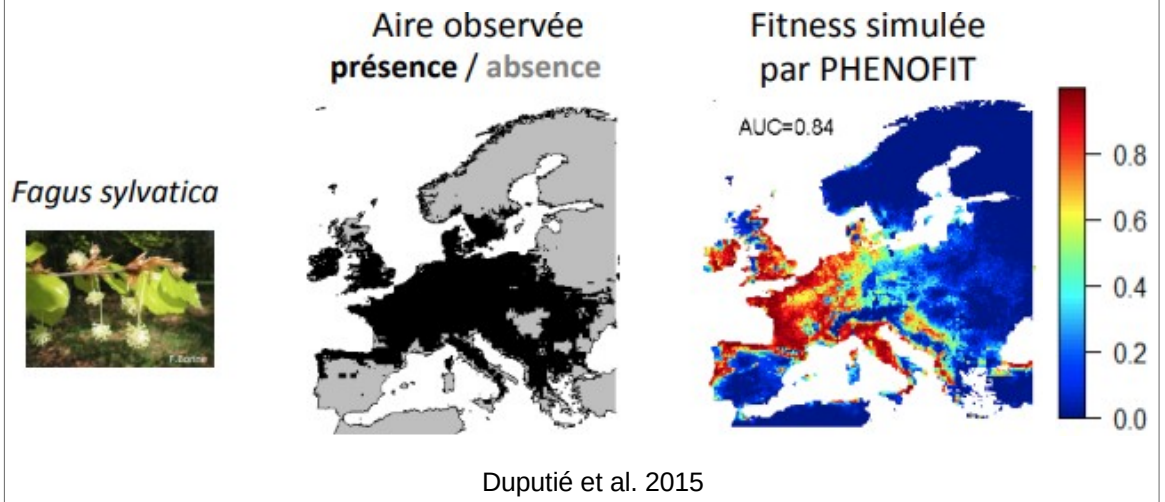
Phenofit

A distribution area model linking phenological models and life cycle
- mechanistic modelling of the response of species to environmental variables
- focuses on **phenological traits** rather than productivity traits or competition
- coincidence between life cycle and climate determines survival and reproductive success (= selective value) of individuals



Chuine & Beaubien Ecol. Let. 2001

Validated for 15 temperate species in North America and Europe



Duputié et al. 2015

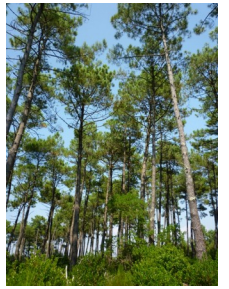
-> Possible projections with climate change scenarios

Phenofit4: simulates an average individual. It is composed of different sub-models: phenology models for leaves, flowers, fruits, frost resistance model, drought resistance model, reproductive success model, survival model

Phenofit5: simulates several trees of different species and ages (3 classes). It thus includes a competition model which is driven by water and light availability. Phenofit5 also includes a fecundity model (number and biomass of fruits produced), a growth model and a more detailed water budget

Patrick Vallet, Véronique Cucchi (Irstea, Nogent sur Vernisson)

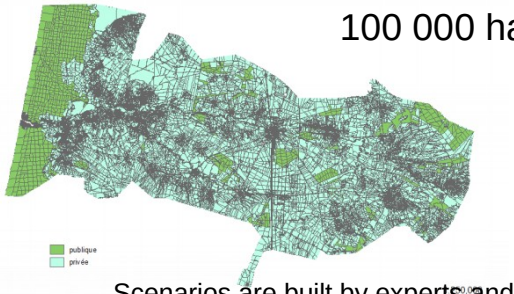
Simmem: modelling several forests



Simmem is a model simulating the management of several forests at the same time
Each forest grows with a specific Capsis model according to its species and forest structure
Connections to Fasy, Fagacées, FTChene, Gymnos, Lemoine, Melies, Laricio, Sylvestris...

integral — Future-oriented integrated management of European forest landscapes

Forêt publique - Forêt privée

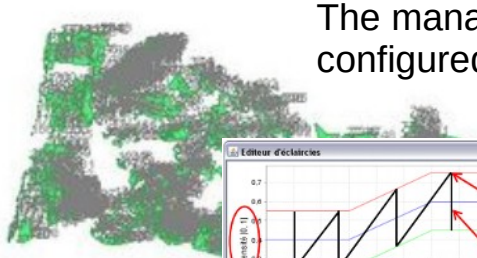


100 000 ha

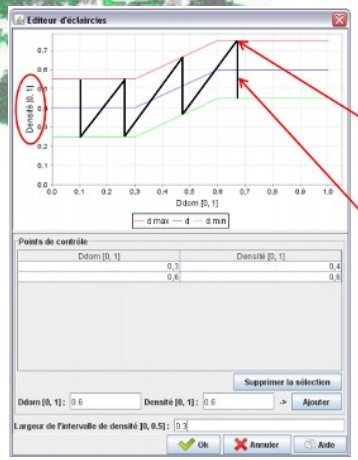
Scenarios are built by experts and stakeholders according to forest owner behaviour

scenario 1: Unfinished bioenergy
scenario 2: Biorefinery innovation & land-use tensions
scenario 3: The European biomass sink
scenario 4: The 'Green' innovative cluster
scenario 5: The territorial partnership
...

Capsis4
Simmem



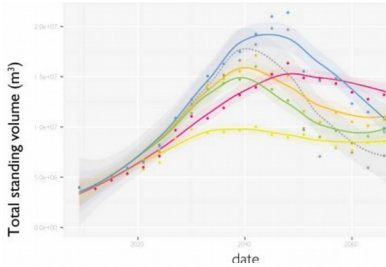
The management rules are configured for the whole site

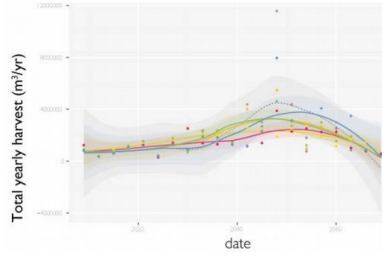


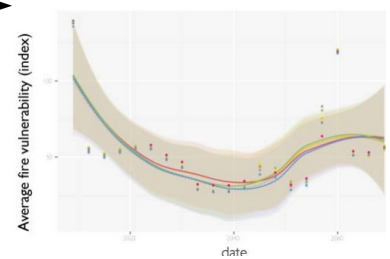
Inspiré de l'éclaircisseur « auto par le rdi » (F. Mothe, G. Le Moguedec)

déclenchement de l'éclaircie :
→ commune aux modules

méthode d'éclaircie :
→ spécifique à chaque module







Several teams work together on Simmem...

- P. Vallet, T. Cordonnier (Irstea, Nogent sur Vernisson & Grenoble) **Forgeco project** (ANR)
  -> Foret d'Orleans, Massif du Vercors
- P. Lejeune, G. Ligot (ULG, Gembloux, Belgium)
  -> Ardennes belges
- C. Orazio (EFIATLANTIC, Bordeaux) **Integral project** (EU)
  -> Aquitaine

Mathieu Fortin, Luc Langevin (MRNF Québec), Jean-Francois Lavoie (Arcane Technologies)

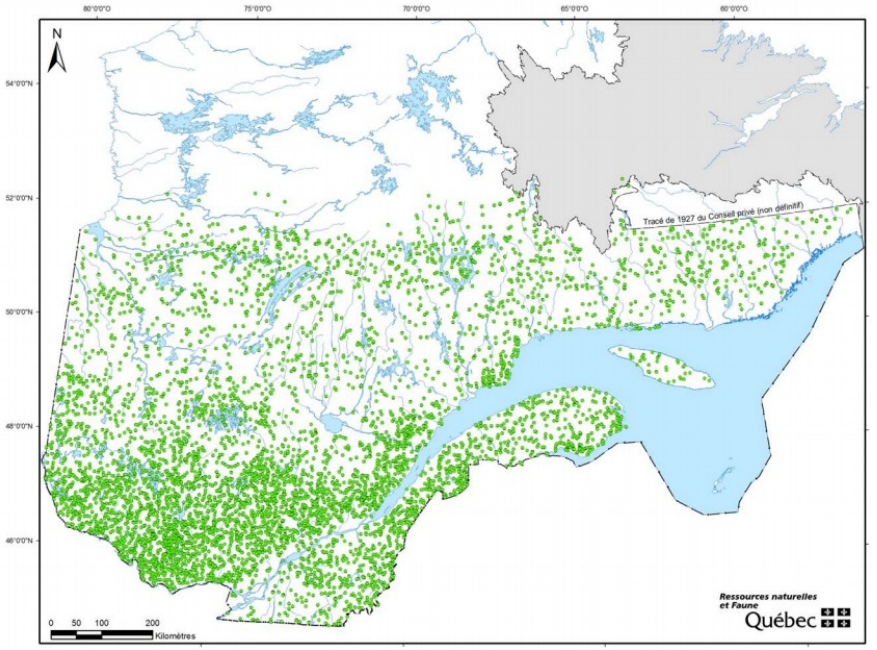
Artemis-2009

A distance-independent tree model for the main potential vegetations in the province of Québec

Objectives, at the provincial level:

- develop silvicultural strategies
- update sample plots
- calculate the allowable cut

Six sub-models to forecast (i) the temporal change of mortality, (ii) diameter growth at breast height (dbh) of surviving stems, (iii) the number of recruits, (iv) their diameters, (v) height and (vi) volume using dbh



http://www.mffp.gouv.qc.ca/publications/forets/connaissances/recherche/Fortin-Mathieu/Memoire156.pdf

Other models added in Capsis by the Québec MRNF / MFFP since 2002

Présage (Daniel Mailly, Sylvain Turbis): a model of production and evaluation of scenarios to help management of forests in Québec

SaMARE (Sadi Aid): a distance-independent tree model for sugar maple- dominated stands (sugar maple, yellow birch, American beech and other broadleaved species)

Natura (Davis Pothier, Isabelle Auger, Sadi Aid): a whole-stand model for the province of Québec

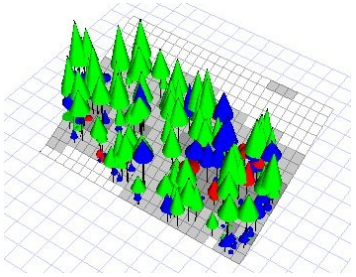
Succès (Jean-Pierre Saucier, Mathieu Fortin, Jean-Francois Lavoie): a succession model for the main forest types in Québec

And also: SaMARE-2014, Artemis-2014, Natura-2014, CroirePlant, Matapedia by Hugues Power, Isabelle Auger, Denis Haché...

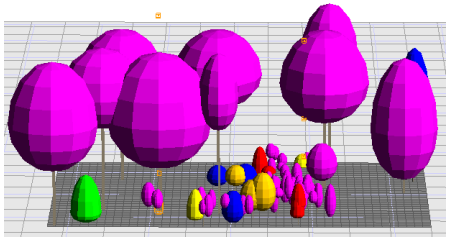
Capsis reusable libraries: e.g. SamsaraLight

A library to share the radiative balance algorithm in Samsara (B. Courbaud)

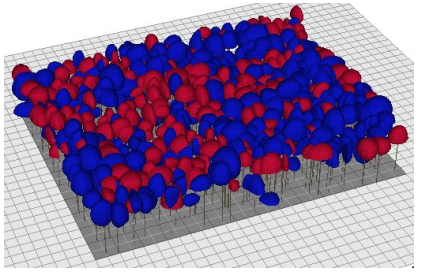
- the original model was written in Capsis in 2000 (B. Courbaud)
- then turned into a reusable library in 2008 (F. de Coligny, N. Donès)
- new features have been added in 2012 (B. Courbaud, G. Ligot, M. Jonard)



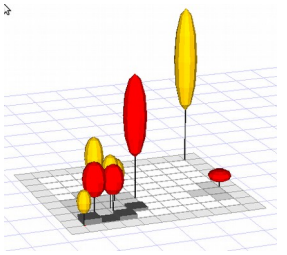
Samsara (B. Courbaud)



Quergus (G. Ligot)



Heterofor (M. Jonard)



RReShar (P. Balandier et al.)

Other Capsis libraries

Genetics (C. Pichot et al.), genotype modelling, used in 14 models

Alisier, PhysioDemoGenetics, Prunus, Transpoprege, Karite, Luberon, Quercus, Ventoug, Bidasoa, Mediterranea, Runaway, Dynet, Guppy, Kerguelen

Castanea (H. Davi et al.) a forest process-based model, used in 3 models

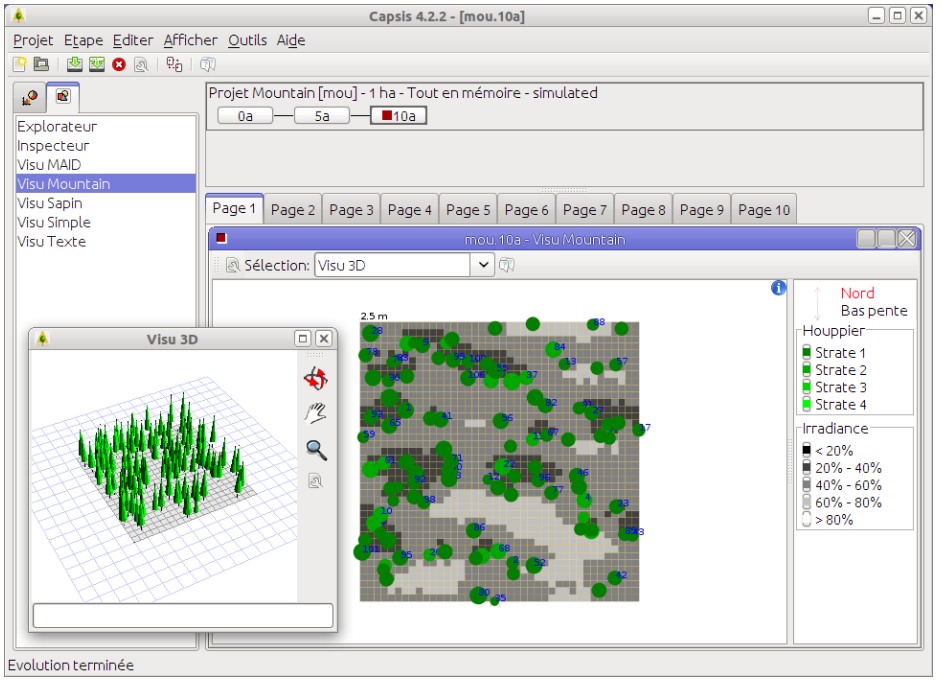
DynaClim, CastaneaOnly, PhysioDemoGenetics

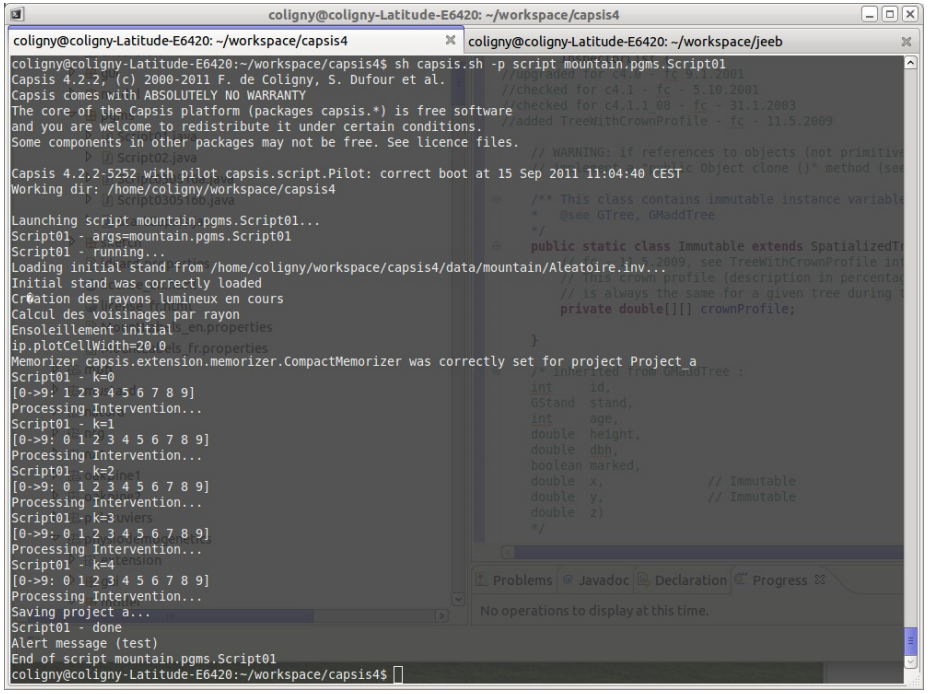
ForestGales (B. Gardiner et al.) estimates stand probability of wind damage, used in 3 models

fagacees, pinuspinaster, pp3

Capsis: several ways of use

Interactive (french / english)

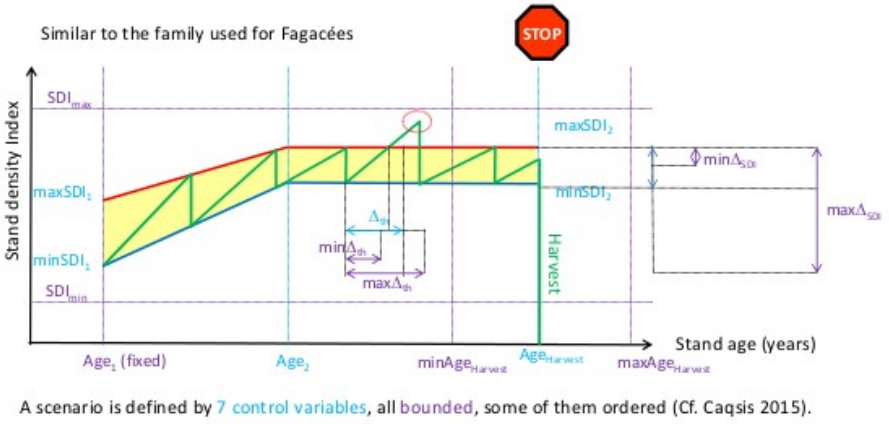




Not interactive: with scripts
- long simulations
- run on clusters
- sensitivity analyses...

Optimisation under Capsis: ModisOptimizer

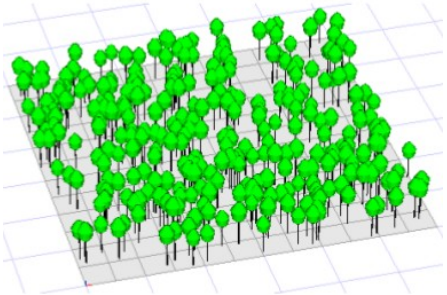
Growth model: ModisPinaster (déterministic)
- objective function: e.g. maximise volume, biomass...
- a family of sylvicultural scenarios
- an optimisation method: Nelder-Mead algorithm
- benefit of previous optimisation projects on the Fagacées model
- publication under progress

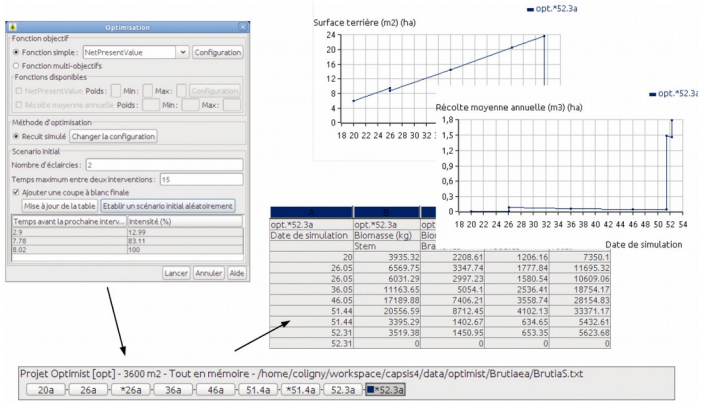


a family of sylvicultural scenarios (Le Moguedec et al. CAQSIS 2016)

Other optimisation works

Optimist
(S. de Miguel, University of Eastern Finland)





Transfer: each year, a Capsis-ONF distribution

The **Capsis-ONF-2021** distribution

- packaged by Christine Deleuze (ONF RDI) in January 2022
- **25 modules in 2021** : abial, artémis, CA1, castaneaonly, economics, fagacees, forceps, gymnos, heterofor, laricio, lemoine, luberon2, mathilde, modispinaster, oakpine 1 et 2, picea-abies, pseudotsuga menziesii, pp3, regix, salem, samsara2, sydy, sylvestris and simcop

Office National des Forêts

Direction Forêt et Risques Naturels – Département RDI

Tel : 06 10 33 10 47, Mél : christine.deleuze@onf.fr

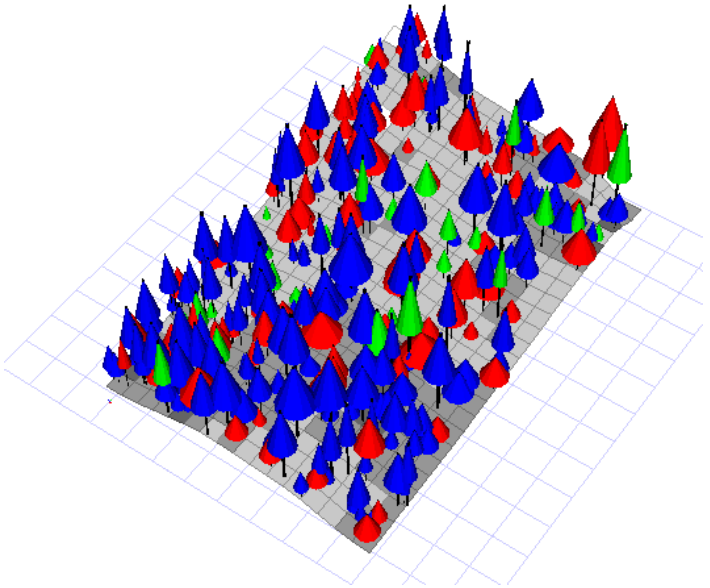
Objet :	🕮	**CR d'installeur Capsis ONF 2021 version 4.2.6**
Date :		31 janvier 2022
Rédacteur :	✎	Christine Deleuze
Destinataires :		DFRN-RDI, Thierry Sardin, Médéric Aubry, Fabrice Coq, Marie-Claire Maréchal, Anna Schmitt, Paul Del-Rey, Stéphane Dumas, Francis Maugard, Denis Feuillerat, Pauline Delord, Sébastien Laguet, tous les développeurs CAPSIS participants et François de Coligny !

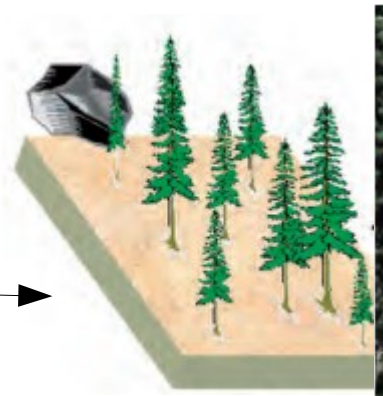
Dossier partagé : PartageRDI\04-Outils\06-Capsis\Capsis_ONF2021

Frédéric Berger, Luuk Dorren, Eric Mermin, Eric Maldonado, Benoit Courbaud (INRAE Grenoble)

Rock fall risk - Samsara2 and RockforNet

Samsara2 (B. Courbaud) : a Distance-Dependent Tree Model for several mountain species (Spruce, fir, broadleaved…)





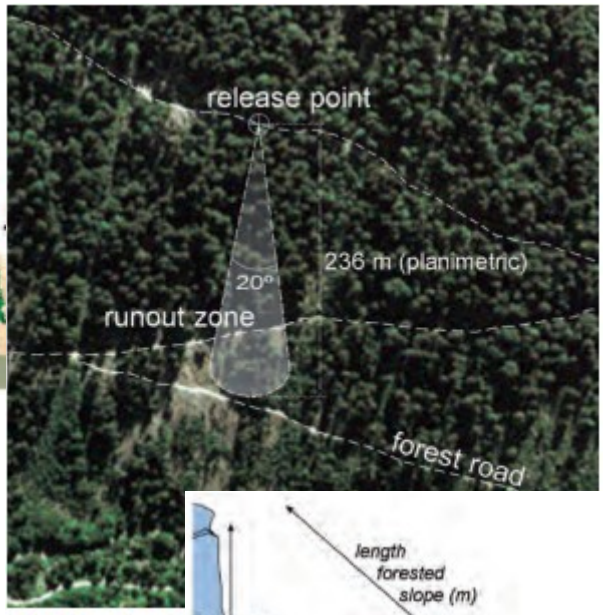


Fig 1 Overview of t

RockforNet : Rockfornet calculates the Probable Residual Rockfall Hazard (PRH) under a forested slope

F. Berger, L. Dorren. Principles of the tool Rockfor.net for quantifying the rockfall hazard below a protection forest. *Schweizerische zeitschrift für forstwesen*, 2007, 158 (6), pp.157-165. ⟨hal-02589145⟩

An extension in Capsis: 2006

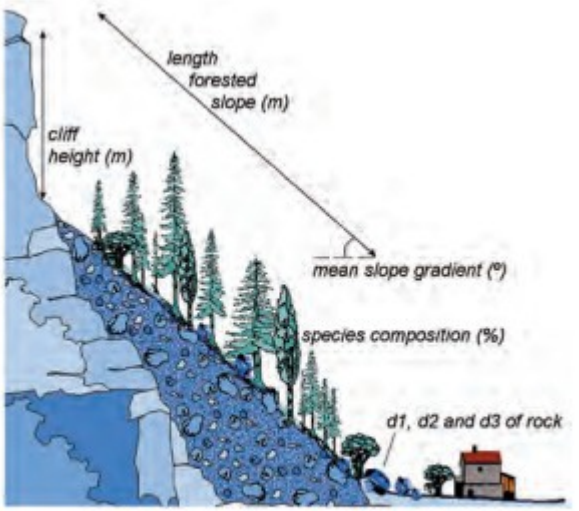
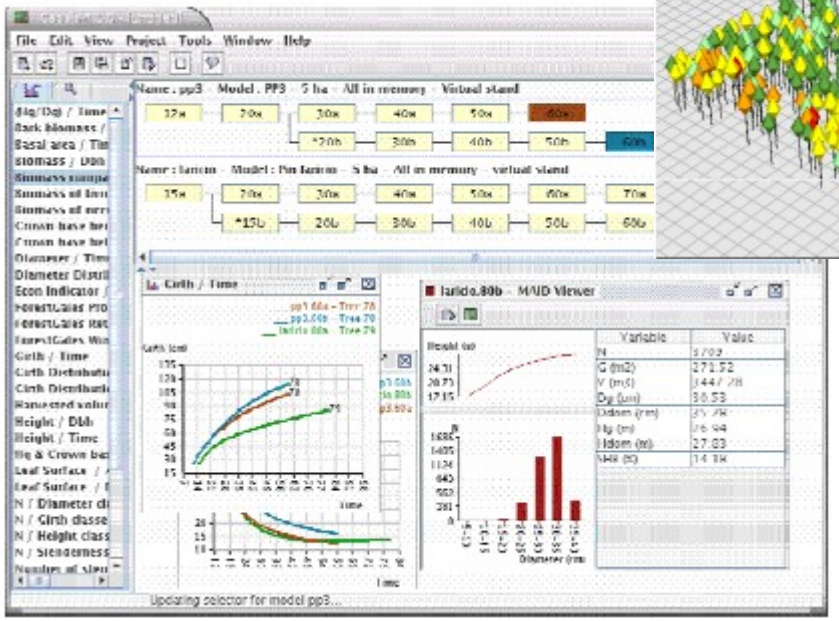


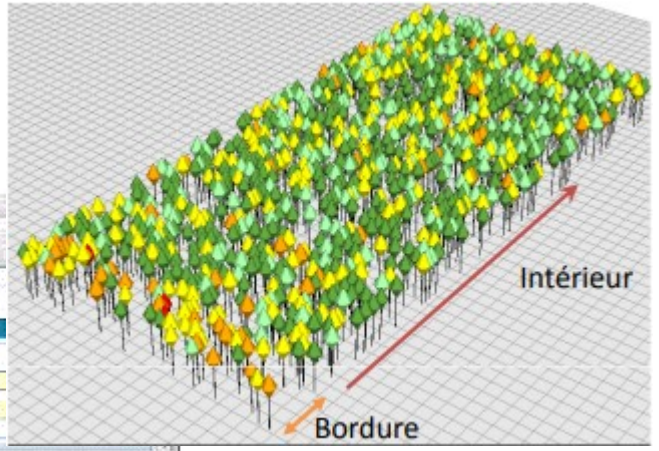
Fig 7 Scheme showing the input parameters required for the web tool Rockfor.net.

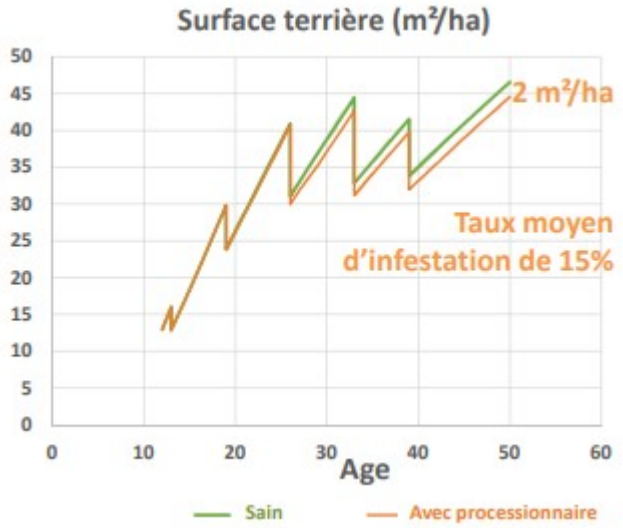
Pest risk (1/2) - PinusPinaster

Pine processionary (Thaumetopoea pityocampa)

Loss of trees individual growth depending on their geographic location in the stand and their relative dimensions. Global warming is causing the species to affect forests progressively further north.







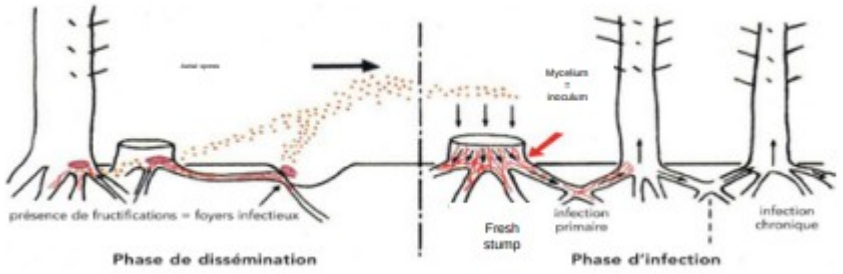
In PinusPinaster: 2015

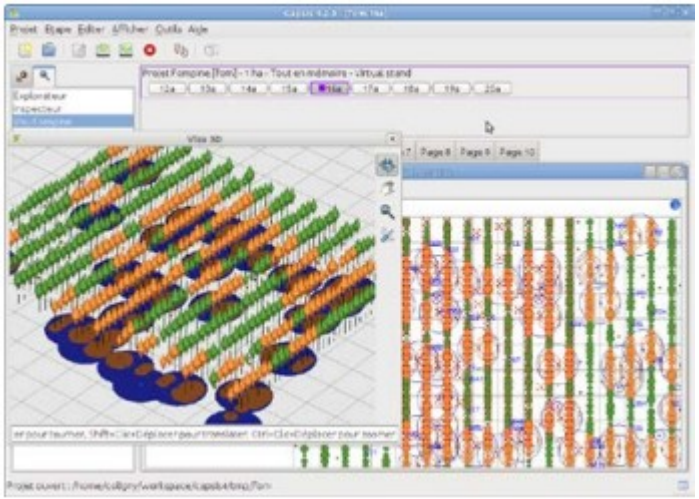
Brigitte Lung-Escarmant, Didier Bert, Xavier Capdevielle, Thierry Labbé, Jean-Baptiste Lasnier, Raphael Segura, Gilles Saint-Jean, Céline Meredieu (INRAE Biogeco)

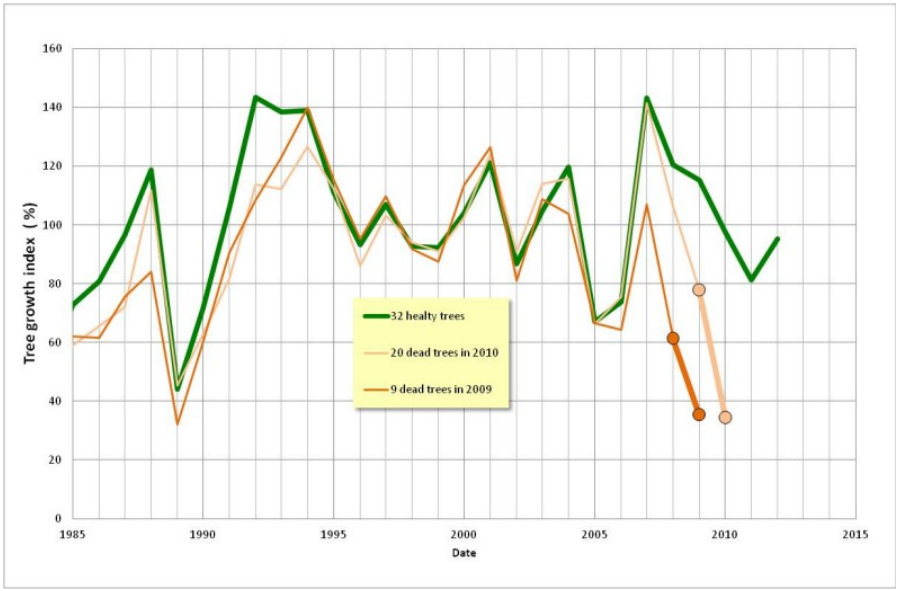
Pest risk (2/2) - PinusPinaster

Fomes (Heterobasidion annosum)

This fungus eats the wood in the soil. Simulate the stand vulnerability, the fungus growth speed between the trees roots, the tree loss of growth and its mortality







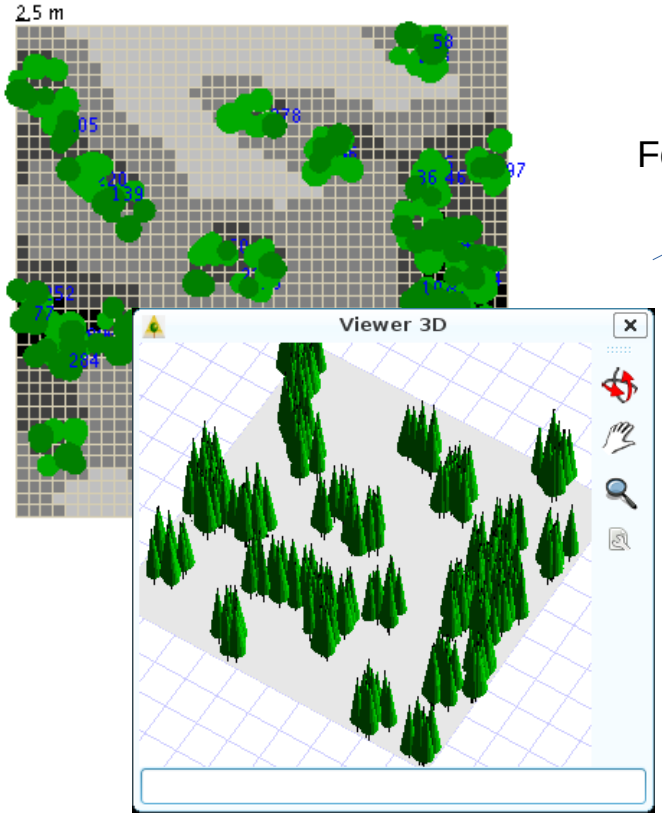
In PinusPinaster: 2014

... and both pine processionary and fomes combinated

Philippe Ancelin, Benoit Courbaud (Irstea, Grenoble), Thierry Fourcaud (Cirad AMAP)

Wind risk 1/3 - Samsara and Foreole

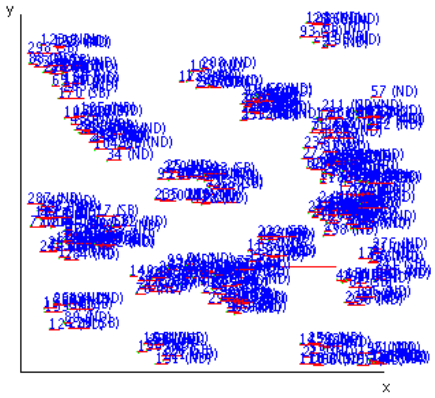
An integrated library
- assess the wind risk
- simulate trees removal



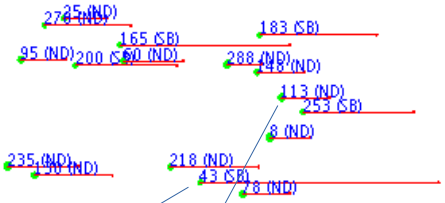
Samsara / Mountain growth model (Spruce)

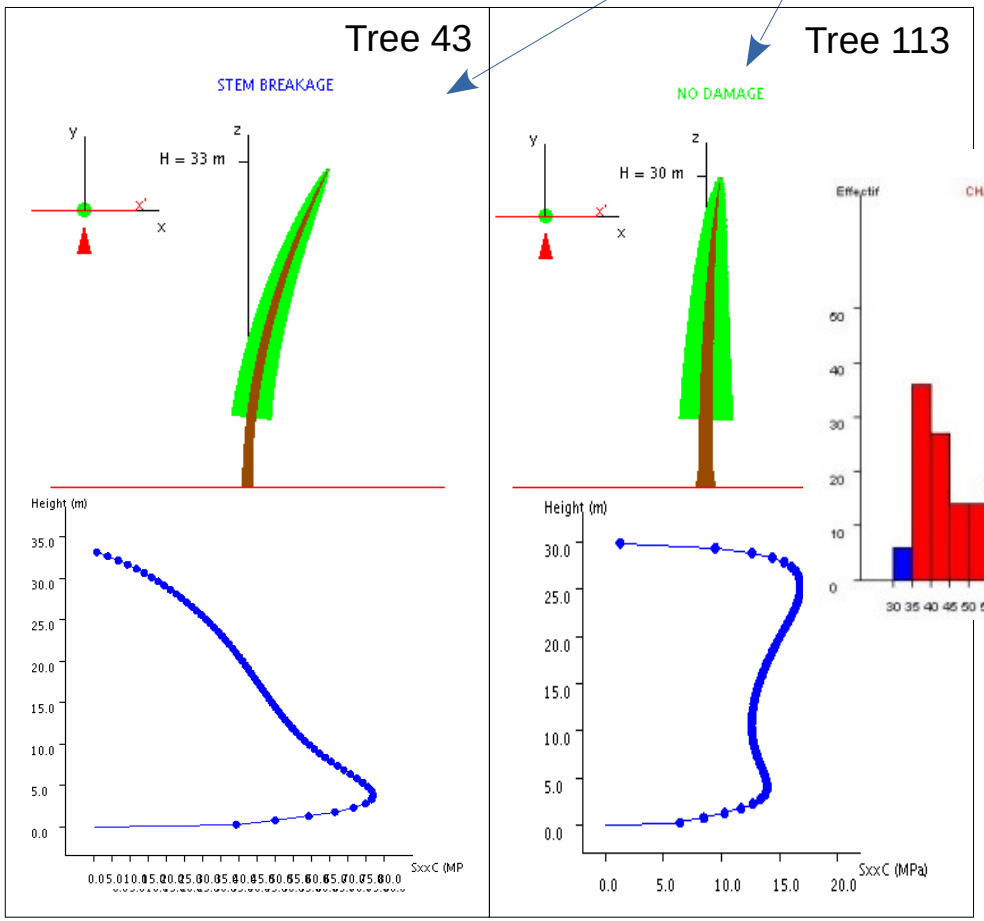
A library in Capsis: 2001

Foreole



Zoom





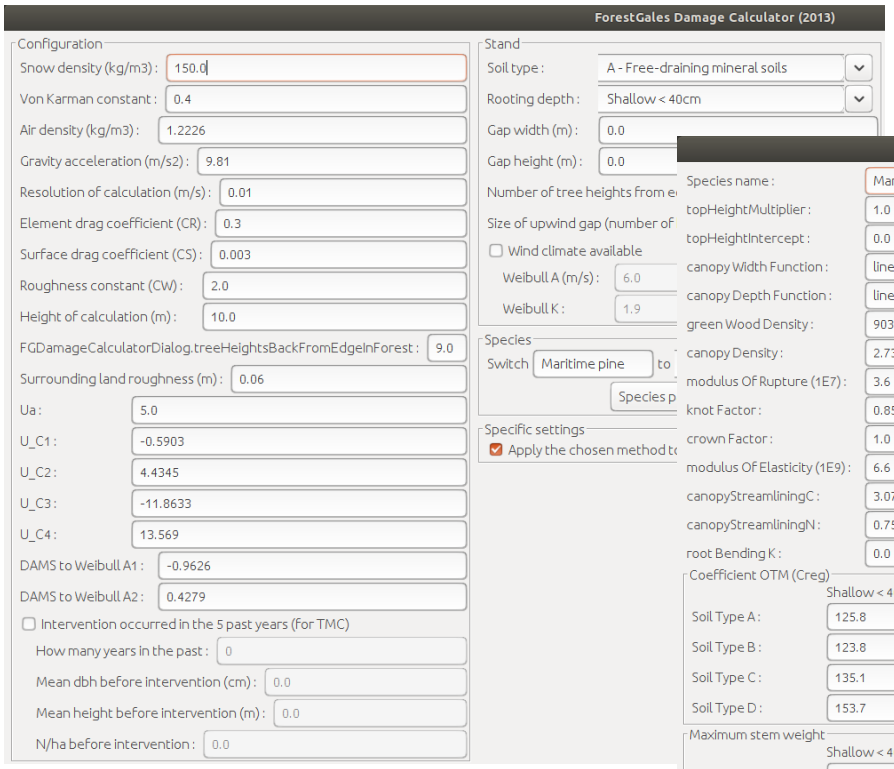
C. Meredieu, T. Labbé (INRAE Biogeco), B. Gardiner, K. Kanimura (Inrae ISPA)

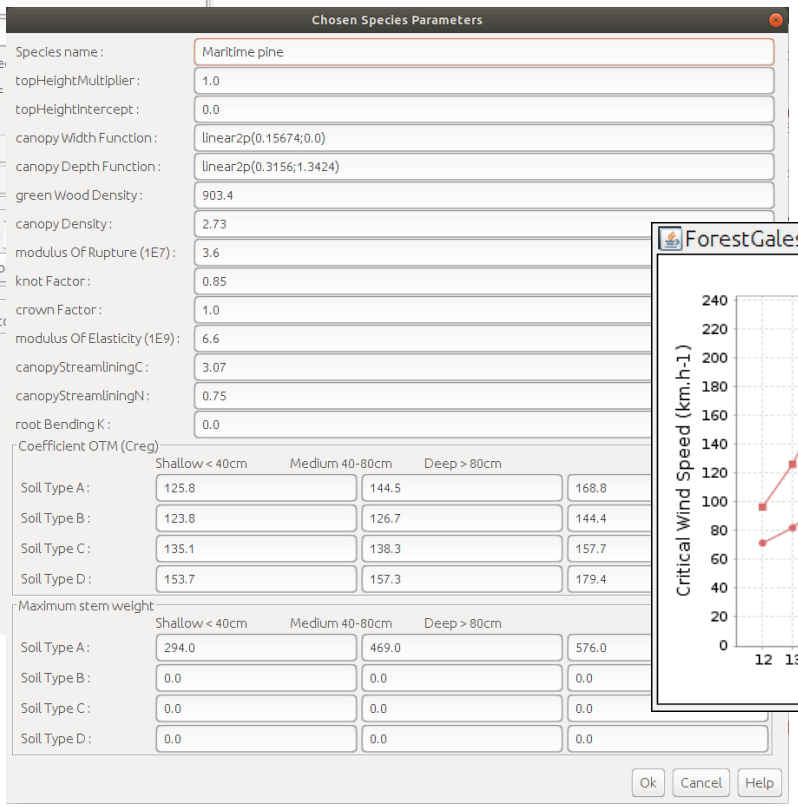
Wind risk 2/3 - PP3 and ForestGales (stand level)

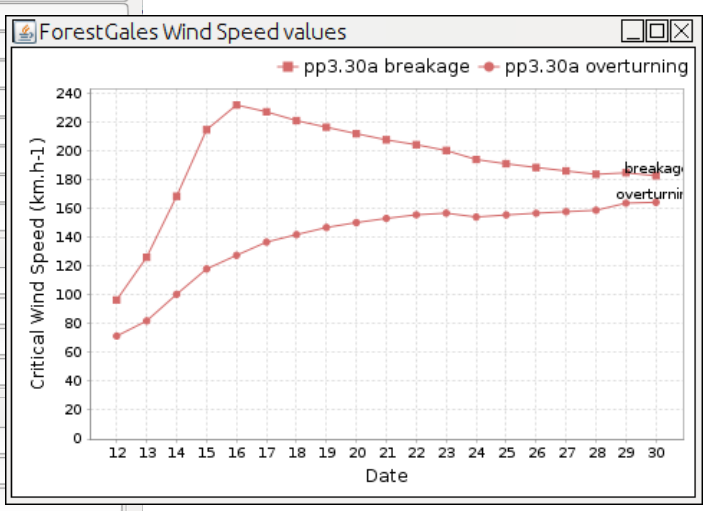
PP3, Maritime pine (C. Meredieu)

ForestGales mechanistic model for wind damage risk assessment (B. Gardiner, UK Forestry Commission / Inrae ISPA)

-> Relative vulnerability of a stand







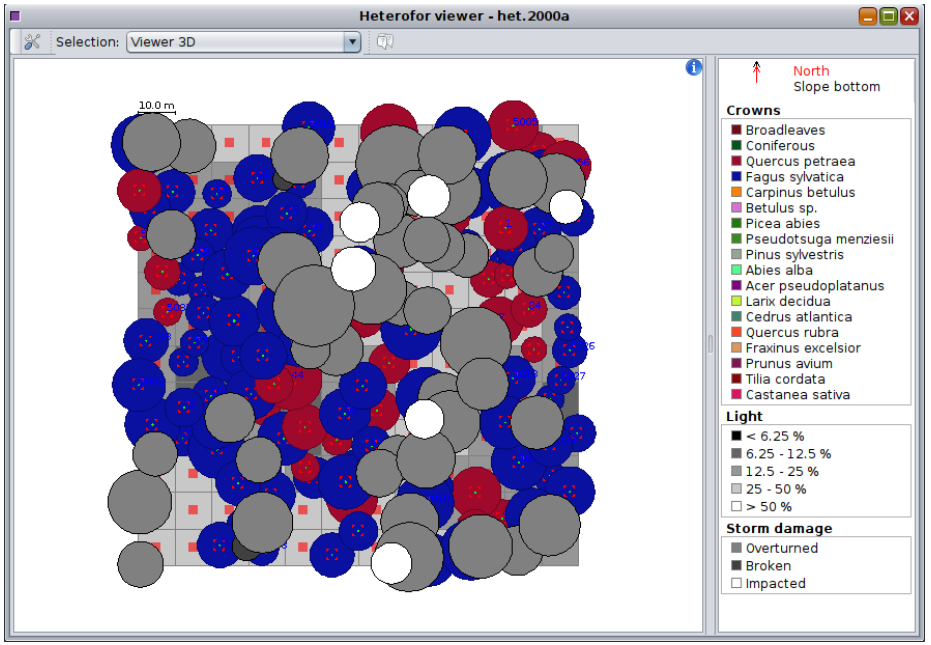
A library in Capsis: 2014

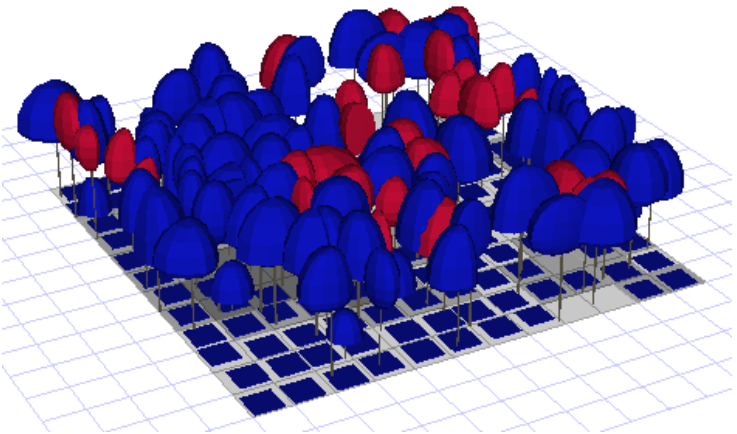
Arthur Guignabert, Frédéric André, Mathieu Jonard (UCL, Belgium)

Wind risk 3/3 - Heterofor and ForestGales (tree level)

Heterofor is a spatially-explicit and individual-based model. The objective is to elaborate a model describing tree growth and resource use (solar radiation, water and nutrients) in heterogeneous forests (mixed and uneven-aged).

- Added a **ForestGales Tree Level** library (Nicoll et al. 2006) capsis.lib.**forestgalestreelevel2022**
- Detect wind gusts from the climate file, with a direction and a strength
- Apply it to the scene, find falling trees (broken or uprooted)
- Report their impact: neighbouring trees may fall too





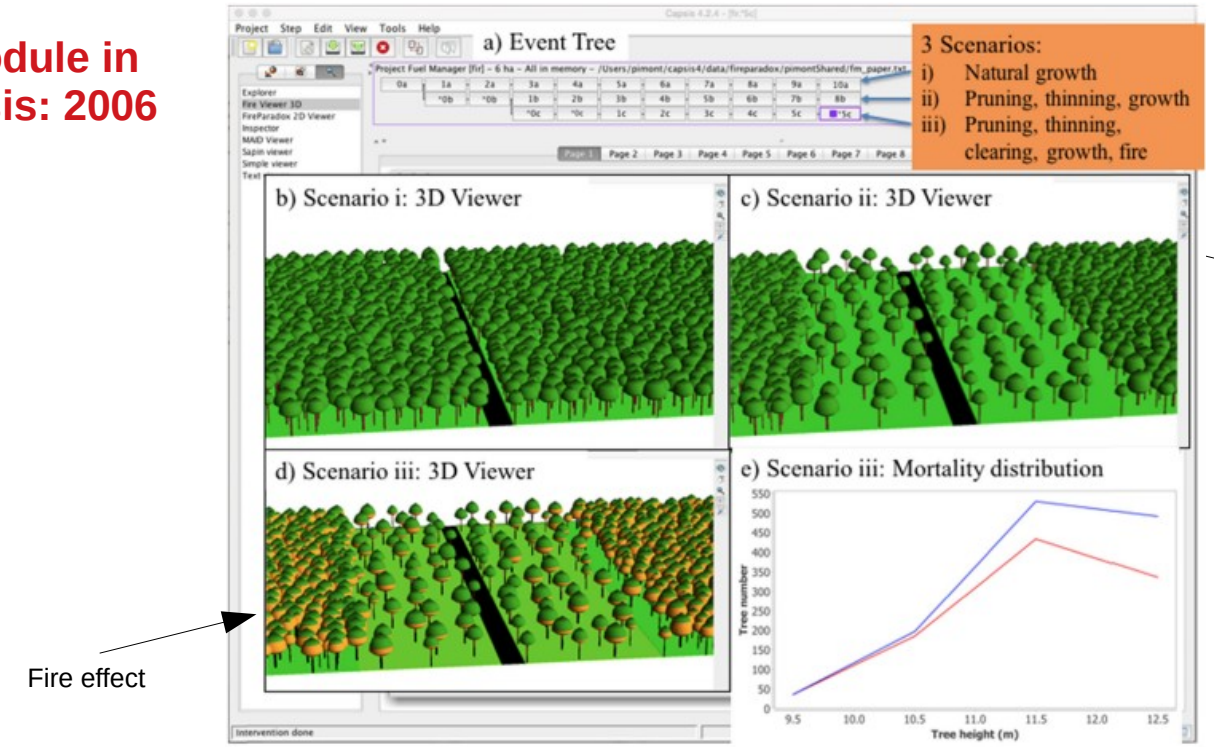
A library in Capsis: 2022

F. Pimont, E. Rigolot, J.L. Dupuy, P. Dreyfus (INRAE URFM), R. Linn (US LANL),
R. Parsons, W. Mell (USFS), N.L. Crookston (USDA)

Fire risk - FuelManager / StandFire

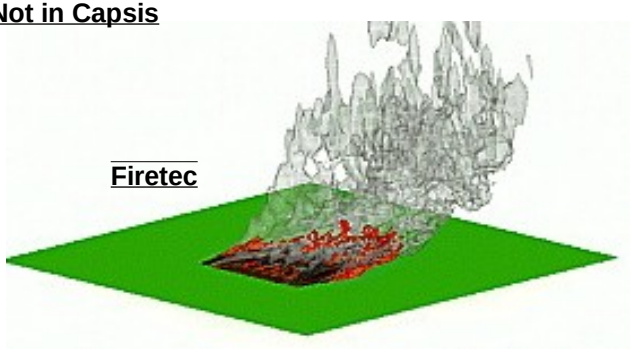
Fuel modelling systems
Connected to Firetec (US LANL, R. Linn et al.) and WFDS (USFS, W. Mell et al.) fire simulation software

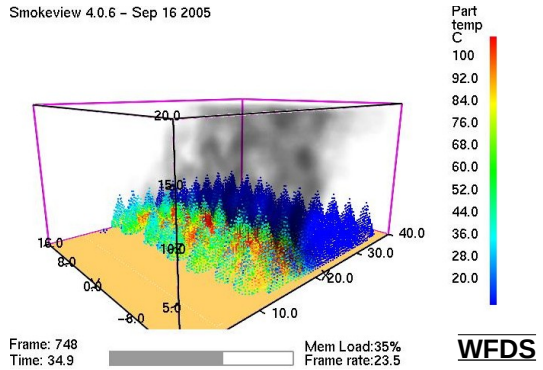
A module in Capsis: 2006



Not in Capsis

Firetec





WFDS

Objectives
- generate vegetation scenes in 3D to be used as input data for fire behavior models;
- account for the effects of natural and human disturbances;
- allow analysis of fire effects on trees.

Pimont F., Parsons R., Rigolot E., de Coligny F., Dupuy, J.-L., Dreyfus P., Linn R., 2016. Modeling fuels and fire effects in 3D : model description and applications. Environmental Modelling and Software 80, 225-244

Drought risk - Sureau

Nicolas Martin, Francois Pimont, Julien Ruffault (INRAE URFM Avignon),
Hervé Cochard (INRAE Piaf, Clermont-Ferrand)

A plant hydraulic model that represents explicitly water flow between the soil, the plant and the atmosphere and the process of **cavitation** that leads to plant desiccation and mortality

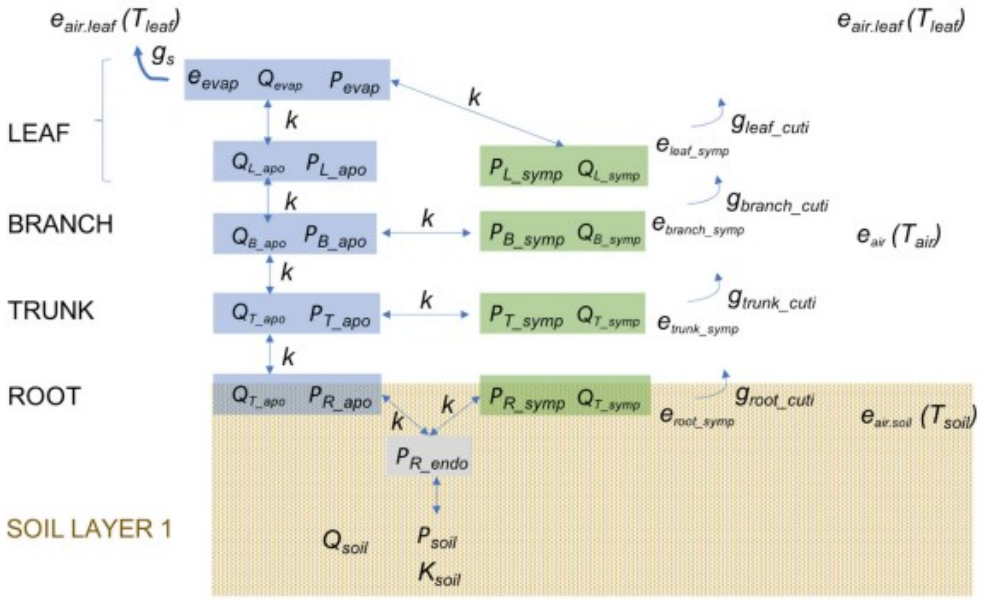


Fig. 7 Simplified representation of the plant architecture in relation to the environment as implemented in the *SurEau* model. *Q* and *P*, the water quantity and water potential defined within a compartment (or "computational cell"); *K*, the hydraulic conductance defined between two compartments (materialized by arrows); *g*, the gas-phase conductance; *e*, the actual vapor pressure; *T*, the temperature

The most critical applications of SurEau concern understanding and predicting the effects of extreme water stress related to future climate change on plant survival.

Cochard, H., Pimont, F., Ruffault, J., Martin-StPaul, N. 2021 . SurEau: a mechanistic model of plant water relations under extreme drought. Annals of Forest Science 78, 55 (2021)

A library in Capsis: 2019

Main publication

Dufour-Kowalski S., Courbaud B., Dreyfus P., Meredieu C., de Coligny F., **2012**. Capsis: an open software framework and community for forest growth modelling. **Annals of Forest Science** (2012) 69:221–233

With a list of **50** growth models integrated until 2012

Table 2 Modules in Capsis: scope and main characteristics (see also Online resource 1)

Climatic zone	Stand composition[a]	Stand structure	Simulation levels[b]	Main processes[c]	Specific features[d]	Species[a]	Module name
Temperate	Pure	Regular	Average tree, stand	Gr (DI), Mo, Re, Di		*Cytisus scoparius*	Cytisus
			Average tree, stand	Gr (DI), Mo	Phy	*Abies alba, Fagus sylvatica*	Dynaclim
			Average tree, stand	Gr (DI), Mo	Phy, Ge	*A. alba, F. sylvatica*	PhysioDemoGenetics
			Average tree, stand	Gr (DI)	Th	*Pinus pinaster*	Lemoine
			Average tree, stand	Gr (DI)		Many species	Natura
			Average tree, stand	Gr (DI)		*Eucalypt* ssp., *Populus* ssp.	Regix
			Tree, stand	Gr (DI), Mo	Th	*A. alba*	Abial
			Tree, stand	Gr (DI), Mo		*Picea alba*	Afocelpa
			Tree, stand	Gr (DI), Mo		*P. pinaster*	Afocelpp
			Tree, stand	Gr (DI), Mo		*Cedrus atlantica*	CA1
			Tree, stand	Gr (DI), Mo		*Pseudotsuga menziensii, Larix* spp., *Picea abies*	Douglas
			Tree, stand	Gr (DI), Mo	Th	*Quercus petraea, F. sylvatica*	Fagacees
			Tree, stand	Gr (DI), Mo	Br	*Pinus halepensis*	Fiesta/NRG
			Tree, stand	Gr (DI), Mo		*Pinus nigra laricio*	Laricio
			Tree, stand	Gr (DI), Mo		*Abies balsamea*	Matapedia
			Tree, stand	Gr (M/D), Mo	Th	*P. pinaster*	ModisPinaster
			Tree, stand	Gr (DI)	Br	*Pinus radiata*	NZ1
			Tree, stand	Gr (DI), Mo	Br	*Pinus nigra nigra*	PNN/Pnn2
			Tree, stand	Gr (DI)		*P. pinaster*	PP3
			Tree, stand	Gr (DI), Mo		*Q. petraea*	QS1
			Tree, stand	Gr (DI), Mo		*Pinus sylestris*	Sylvestris
			Average tree, stand, forest	Gr (DI)	Th	2 virtual species	Mustard
			Tree, stand, forest	Gr (M/D)	Th	Many species	IFNCA
			Tree, stand, forest	Gr (DI), Mo, Re, Di	Ge	*C. atlantica*	Luberon
			Tree, stand, forest	Gr (DI), Mo		*Pinus contorta*	MPB
			Tree, stand, forest	Gr (DD), Mo, Re		Many species	Presage
			Tree, stand, forest	Gr (DI), Mo, Re	Ge	*Q. petraea*	Quercus
			Tree, stand, region	Gr (DI), Mo		*Pinus sylvestris, Quercus* sp.	Simmen
			Tree, stand, region	Gr (DI)	Th	*P. pinaster*	Sylvogene
		Irregular	Tree, stand	Mo, Re, Di	Ge	*Prunus mahaleb*	Prunus
			Tree, stand, forest	Re, Di		*C. atlantica*	Abccedrus
			Tree, stand, forest	Gr (DI), Mo, Re, Di		*A. alba*	Migration
			Tree, stand, forest	Gr (DD), Mo, Re		*P. abies*	Mountain
	Mixed	Regular	Average tree, stand	Gr (DI)		*P. abies, A. alba*	Melies
			Tree, stand	Gr (DI), Mo		*Q. petraea, F. sylvatica, P. sylvestris*	Fagacees–Sylvestris
			Tree, stand	Gr (DD)		*Q. petraea, F. sylvatica, P. sylvestris*	Oakpine1
			Tree, stand	Gr (DI)		*Q. petraea, F. sylvatica, P. sylvestris*	Oakpine2
			Tree, stand	Gr (M/D), Mo	Th	*Larix olgensis, Picea jezoensis, Abies nephrolepis*	LSFMGM
			Tree, stand, forest	Gr (DI), Mo		*Pinus banksiana, Picea glauca, Picea mariana*	JackPine
			Tree, stand, region	Re		Many species	Succes
		Irregular	Tree, stand	Gr (DD)		*Populus* spp., *Juglans nigra x regia, Prunus avium*, crops	Hi-sAFe
			Tree, stand	Re		Broadleaved species of north-eastern France	Regelight
			Tree, stand	Gr (DD), Mo, Re		*Quercus* sp., *P. sylvestris*	RReShar
			Tree, stand	Gr (DD), Mo, Re		*Acer saccharum, Betula alleghaniensis, Fagus grandifolia*, other broadleaves	Samare
			Tree, stand	Gr (DD), Mo, Re		*P. abies, A. alba*, other species	Samsara
			Tree, stand, forest	Gr (DI), Mo, Re, Di	Ge	*Sorbus torminalis, Q. petraea, F. sylvatica*	Alisier
			Tree, stand, forest	Gr (DI), Mo, Re, Di	Ge	*F. sylvatica*, virtual species	TranspopRege
			Tree, stand, forest/ landscape	Gr (DI), Mo, Re, Di	Ge, Th	*A. alba, F. sylvatica, P. nigra nigra, P. sylvestris, Pinus uncinata*	Ventoux/VentouG
			Tree, stand, forest	Gr (DI), Mo	Th	*P. halepensis, P. sylvestris, P. pinea, P. pinaster, P. nigra laricio, P. nigra nigra*	FireParadox
			Tree, stand, region	Gr (DI), Mo, Re	Th	Many species	Artemis
Subtropical	Pure	Regular	Average tree, stand	Gr (DI)	Th	*Pinus massoniana*	ISGM
Tropical	Pure	Irregular	Tree, stand	Gr (DI)		*Eucalyptus* spp.	Eucalypt
			Tree, stand	Gr (DD)		*Rhizophora* spp.	Mangrove
			Tree, stand	Gr (DD), Re		*Avicennia* spp., *Rhizophora* spp.	Paletuviers
			Tree, stand, forest	Gr (DI), Re	Ge	*Vitellaria paradoxa*	Karite
	Mixed	Irregular	Tree, stand	Gr (DD), Mo, Re		Many species	Selva
			Tree, stand	Gr (DD), Mo, Re	Br	Many species	Stretch

[a] "Pure" with a list of species means that the model either works with a pure stand of one of these species at a time or can simulate concurrently several pure stands of different species in the same forest

[b] Scale levels at which the model works or the module gives outputs (with more or less details depending on the model)

[c] Forest dynamics processes: growth (diameter and, possibly, height) (Gr), mortality (Mo), recruitment/regeneration (Re), dispersal (seeds/seedlings) (Di). Details for growth submodel: distance-independent tree growth (Gr (DI)), distance-dependent tree growth (Gr (DD)), growth submodel relying on a transition matrix or a diameter distribution curve (Gr (M/D))

[d] Genetics (Ge), ecophysiological processes (Phy), branching model (Br), automated thinning (in addition to Capsis' interactive intervention tools) (Th)

In 2022, approximately **100 growth models** in Capsis

More details on the Capsis web site: https://www.inrae.fr/capsis

Capsis

Computer-aided projection of strategies in silviculture

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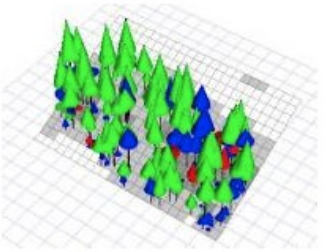
Capsis is a simulation platform for forestry growth / dynamics models. It is a tool for forest scientists, forest managers and education. It has been developed in the AMAP laboratory since 1999.

See the Capsis presentation page, download the Capsis brochure (fr) or go to the projects page for a quick overview. Have a look at the documentation page or the Capsis impact



Communi

Thank you

- A **short Cap** ple at the CNRS CEFE
- Benoit Courb **Potential Biodiversity Index (IBP) in Samsara2**. IB itanie / INRAE UMR Dynafor) and P. Gonin (CNPF-IDF) s
- CAPSIS website upgraded to DokuWiki 2022-07-31a "Igor". *phv-12.9.2022*
- Xavier Morin, Tanguy Postic (CNRS CEFE) and Nicolas Martin (INRAE URFM) have been working two weeks on **a connection between the Forceeps growth model and the Sureau library**, still under progress. *fc-17.8.2022*
- Frédérique Santi, Yannick Yang (INRAE BioForA Orléans) and Francois de Coligny (INRAE AMAP) went two days last June **to visit Agroof in Anduze for a trainaing around EcoAF**, new features have been listed and are under developemnt. *fc-24.6.2022*
- An **interview with forest scientist Dr. Teresa Fidalgo Fonseca** (UTAD CIFAP, Vila Real, Portugal) on silvicultural simulations and the joy of modeling. *fc-24.6.2022*
- The FOREM network has managed a topical collection named 'Mensuration and modelling for forestry in a changing environment' in Annals of Forest Science in 2017-2021 with **11 edited papers**. *fc-20.4.2022*

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