Laboratoire d'Ecologie, Systématique et Evolution
GIS Climat, Environnement, Société – Paris, Nov 2010

Impacts du changement climatique sur les forêts : quelles stratégies d'adaptation ?

Programme
ADAPTATION AU CHANGEMENT CLIMATIQUE
FORÊTS, ESPACES NATURELS ET BIODIVERSITÉ

N.S.S. Dialogues
CLIMAT ENVIRONNEMENT SOCIÉTÉ
Groupement d'Intérêt Scientifique
Institut des Sciences de l'Environnement
UQÀM
Avec le soutien financier du MEEDDM

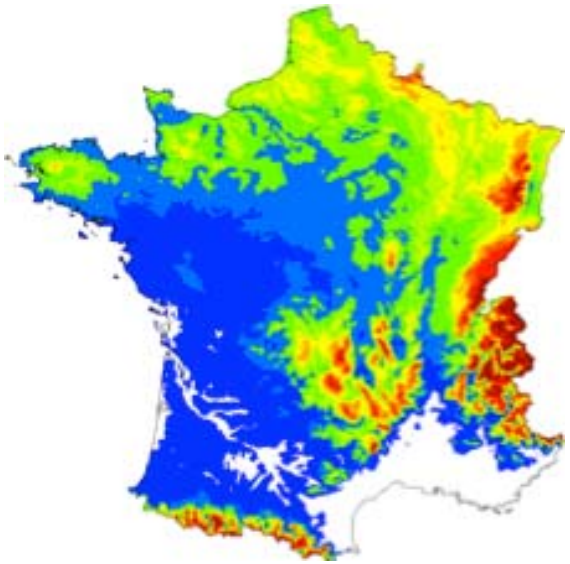
Colloque "Forêt et enjeux d'avenir"

La forêt, une question d'avenir

UNIVERSITÉ PARIS-SUD 11
SÉNAT
AgroParisTech
FRB FONDATION POUR LA RECHERCHE SUR LA BIODIVERSITÉ
ECOFOR ECOSYSTEMES FORESTIERS
CLIMAT ENVIRONNEMENT SOCIÉTÉ
Groupement d'Intérêt Scientifique

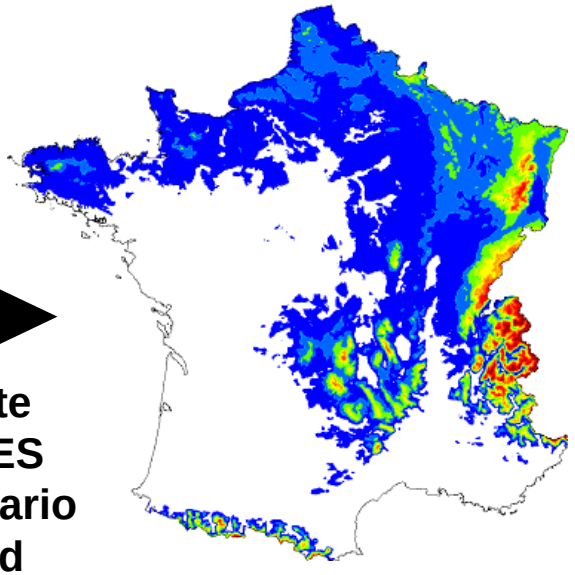
Foresters are very aware of the dangers that climate change poses.

Now they want to know what to do!!!!!



Current distribution

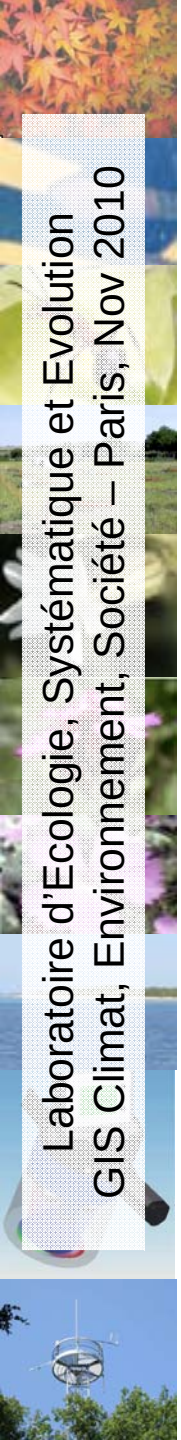
Arpège climate model, A2 SRES emissions scenario + Niche-based distribution model



2100

Fagus sylvatica

Nancy NBM - Badeau et al. (2005)



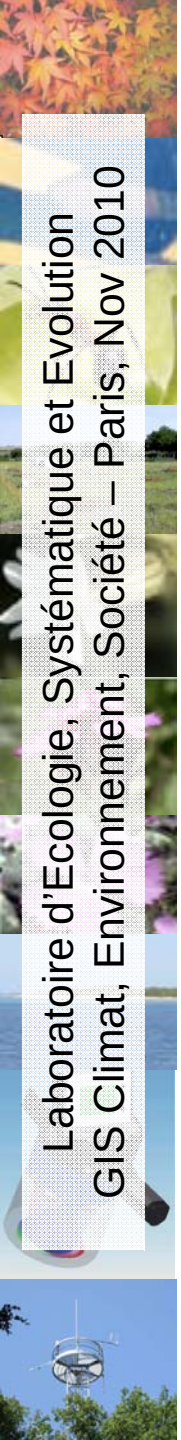
Recommendations Concernant la Gestion Future des Forêts (J-L Peyron, GIP Ecofor)

"• Développer des méthodes de gestion dans l'incertain car on ne peut tout prévoir

• Évaluer chaque solution de façon multicritère

• Favoriser la coexistence de plusieurs solutions

• Identifier l'ensemble des solutions acceptables plutôt que la solution semblant la meilleure"



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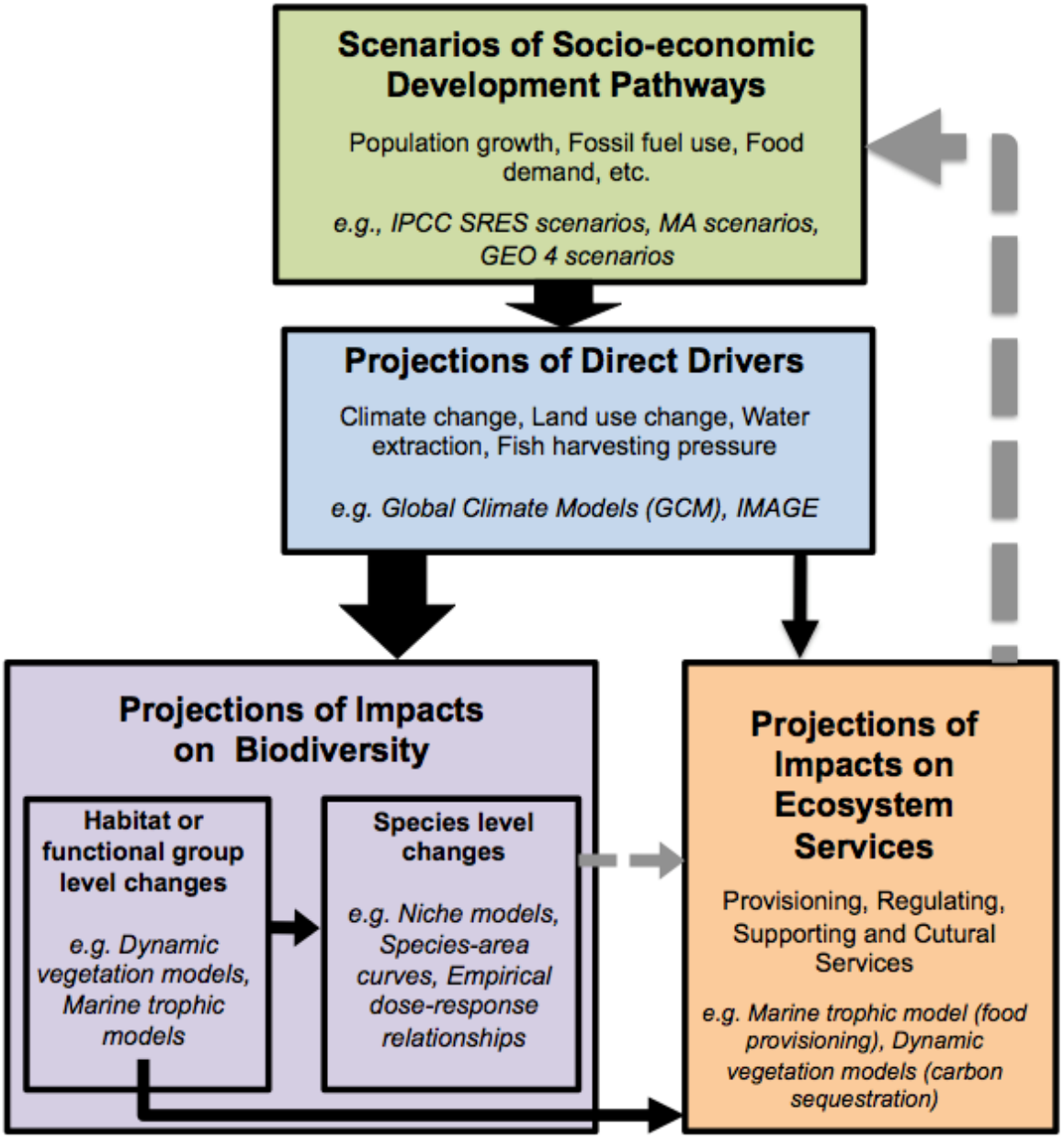
Uncertainty in Projections of Future Climate Impacts on Forests

Sources of uncertainty in projections



Building Scenarios of Biodiversity and Ecosystem Services:

How things work

Pereira et al. 2010

Uncertainty in Climate Projections

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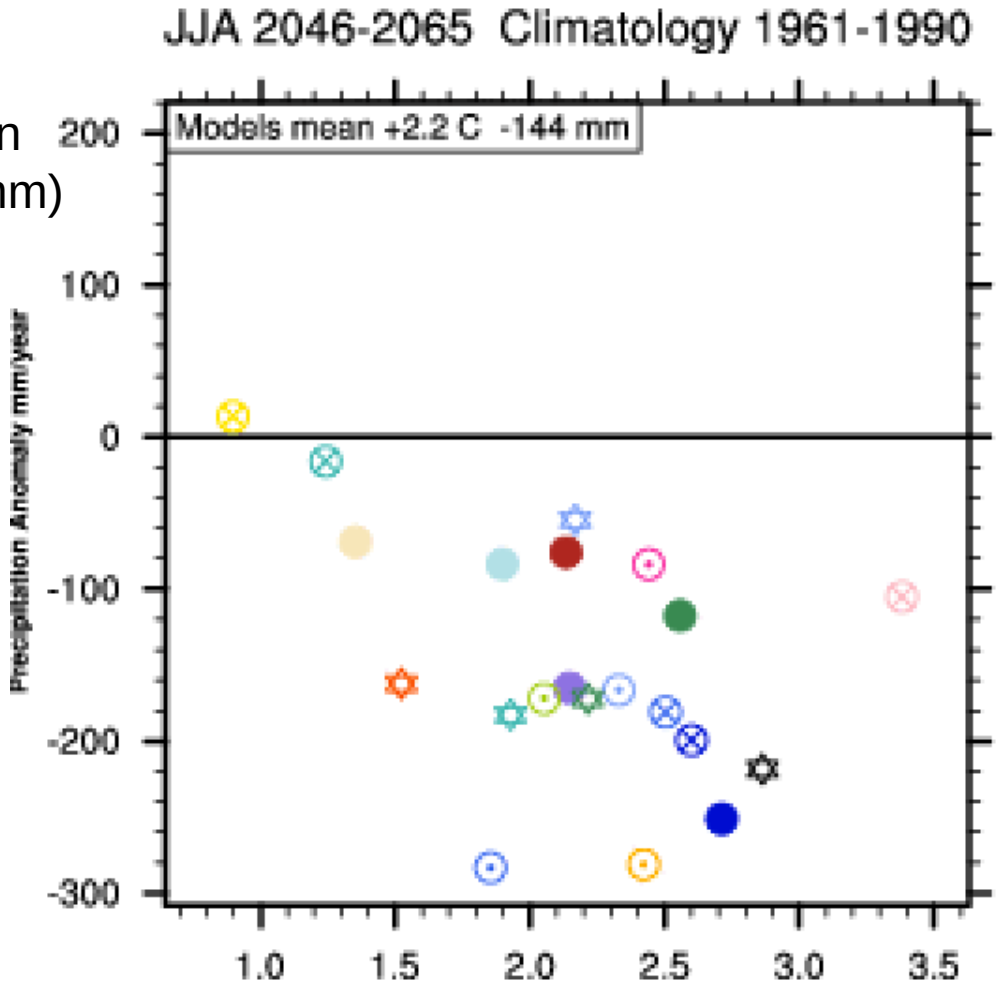
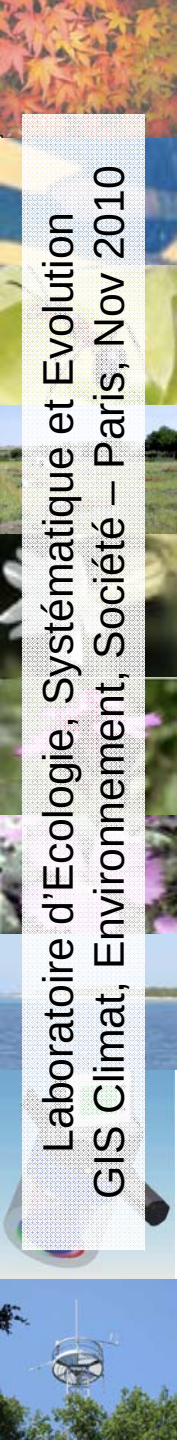
Precipitation anomaly (mm)



Temperature anomaly compared to 1961-90 (°C)

Christian Pagé - CERFACS



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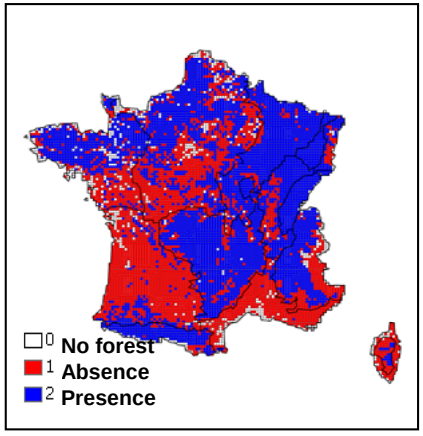
Ecological Uncertainty

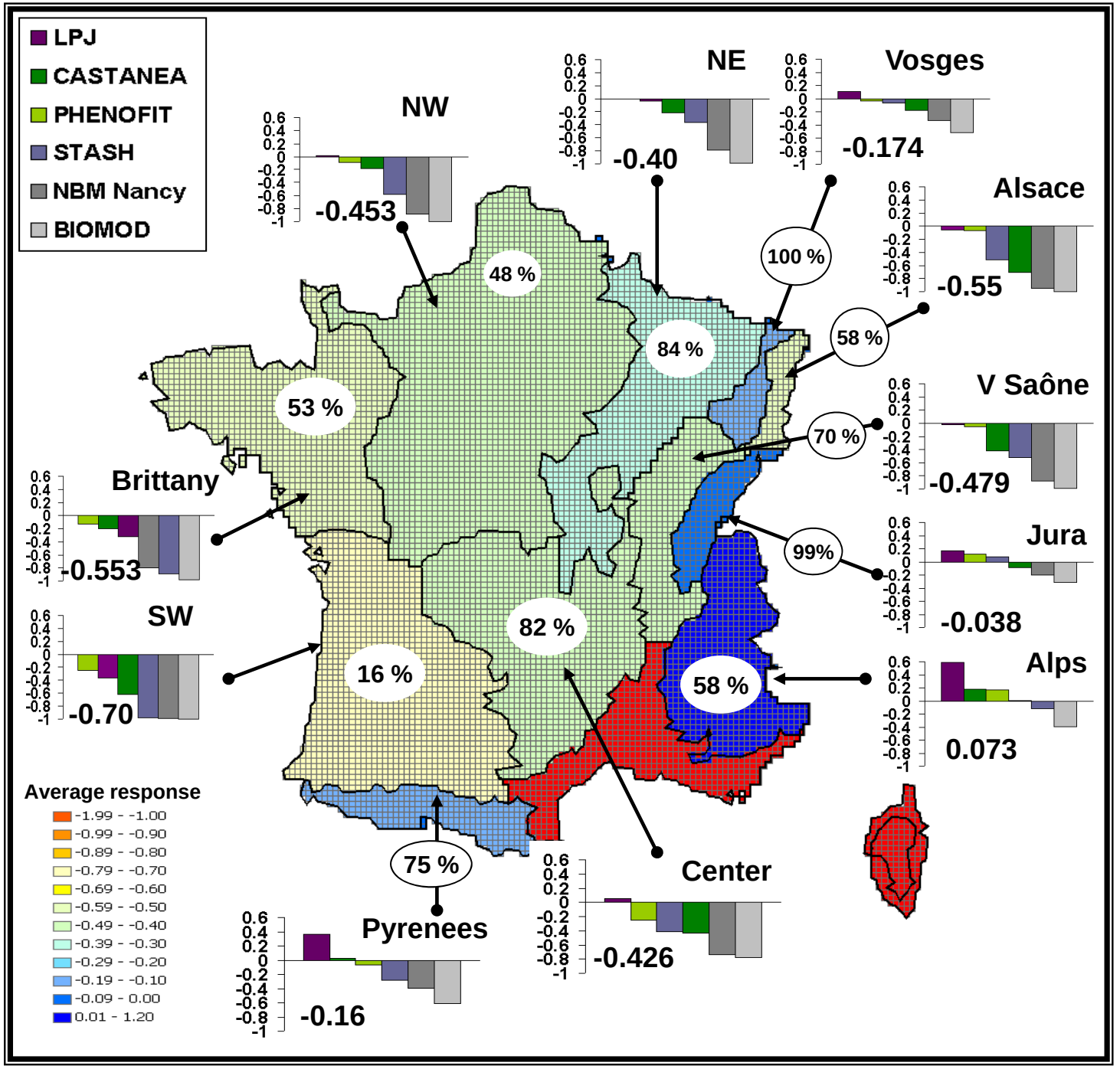
Fagus sylvatica

2050 Projections of distribution

Cheaib et al. in prep

(Sum 2050 - Sum Current)
Sum Current





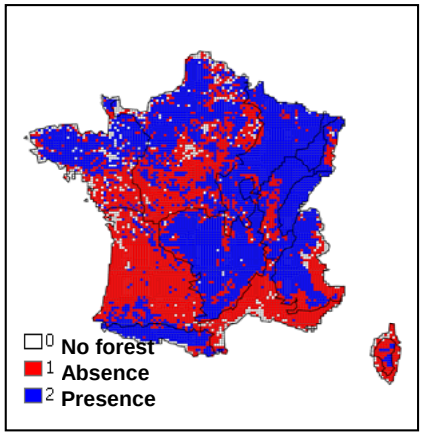
Fagus sylvatica

2050 Projections of distribution

Cheaib et al. in prep

Y axis

(Sum 2050 - Sum Current)
Sum Current



LPJ
CASTANEA
PHENOFIT
STASH
NBM Nancy
BIOMOD

NW

0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8 -1

-0.453

48 %

53 %

Brittany

0.6 0.4 0.2 0 -0.2 -0.4 -0.6

-0.553

Fagus sylvatica

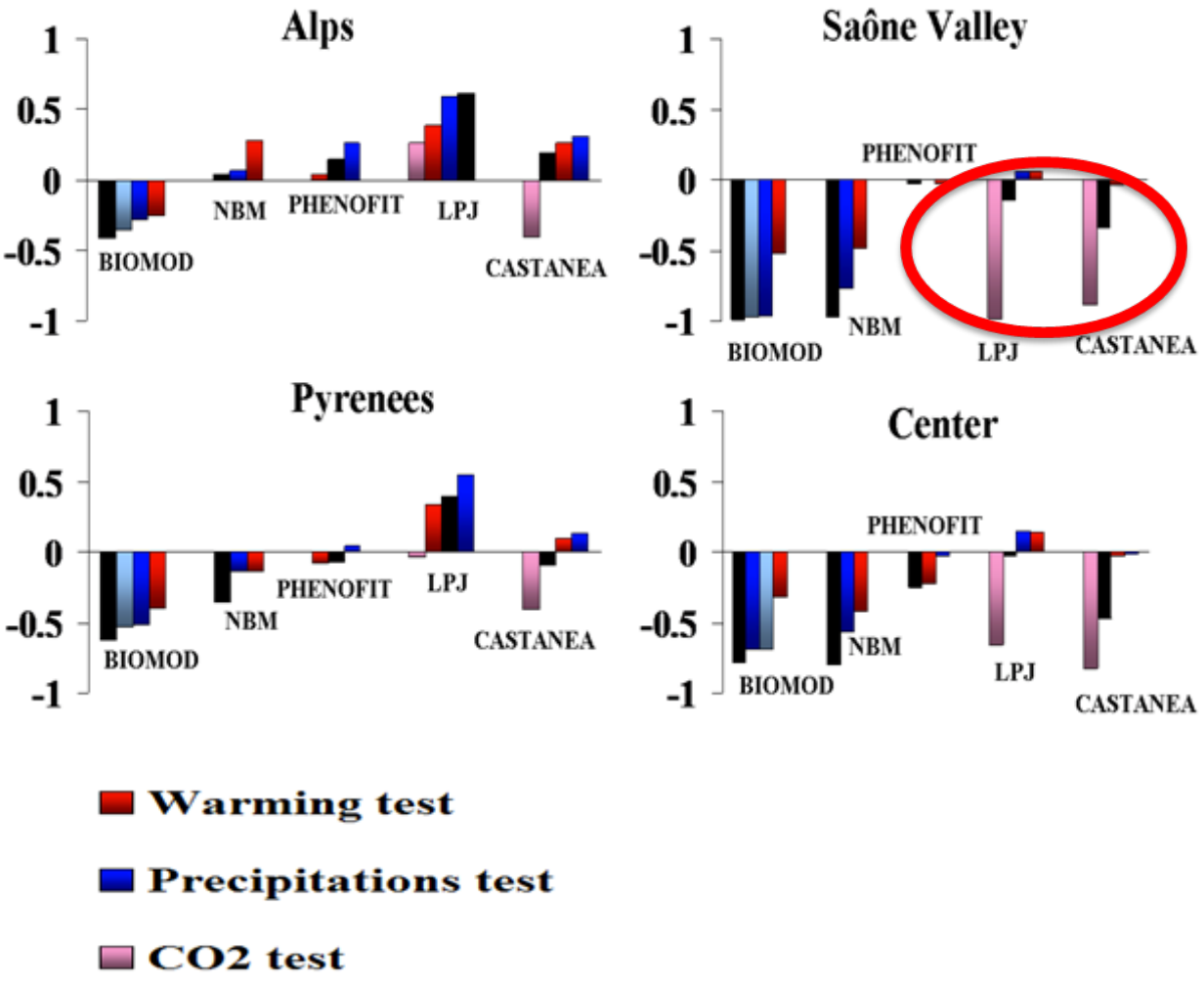
Tests of mechanisms

1 Niche models show a strong negative response to warming, this response is weaker or even reversed in mechanistic models

2 Mechanistic models are very responsive to reductions in precipitation

3 Rising CO_2 offsets negative climate change impacts in mechanistic models (not accounted for in niche models)

Examples



Cheaib et al. in prep

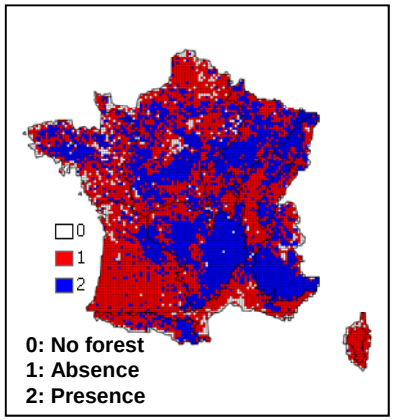
Pinus sylvestris

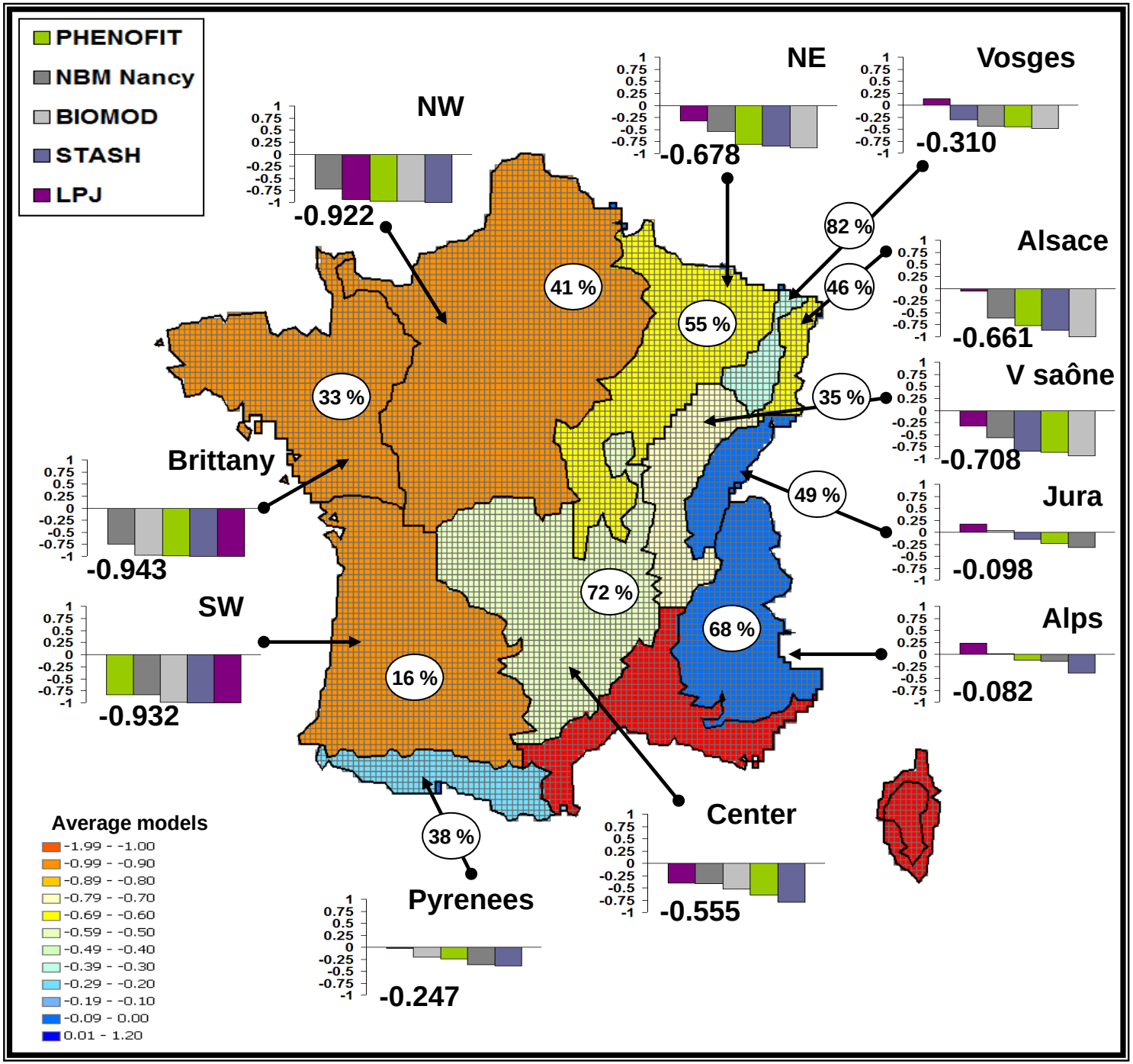
Projections for 2050

Cheaib et al. in prep

Y axis

(Sum TS2-SumTS1)
SumTS1





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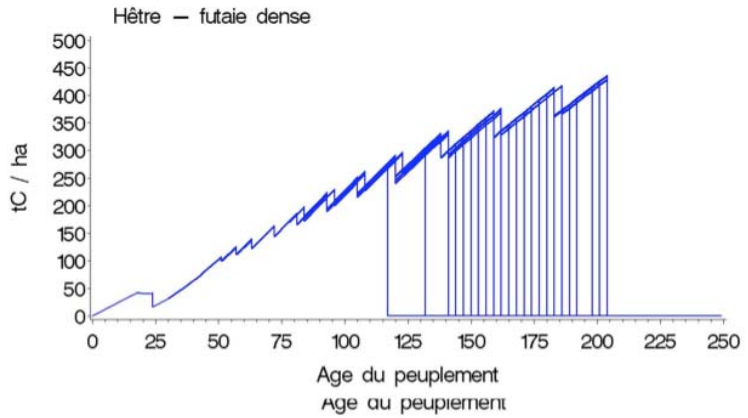
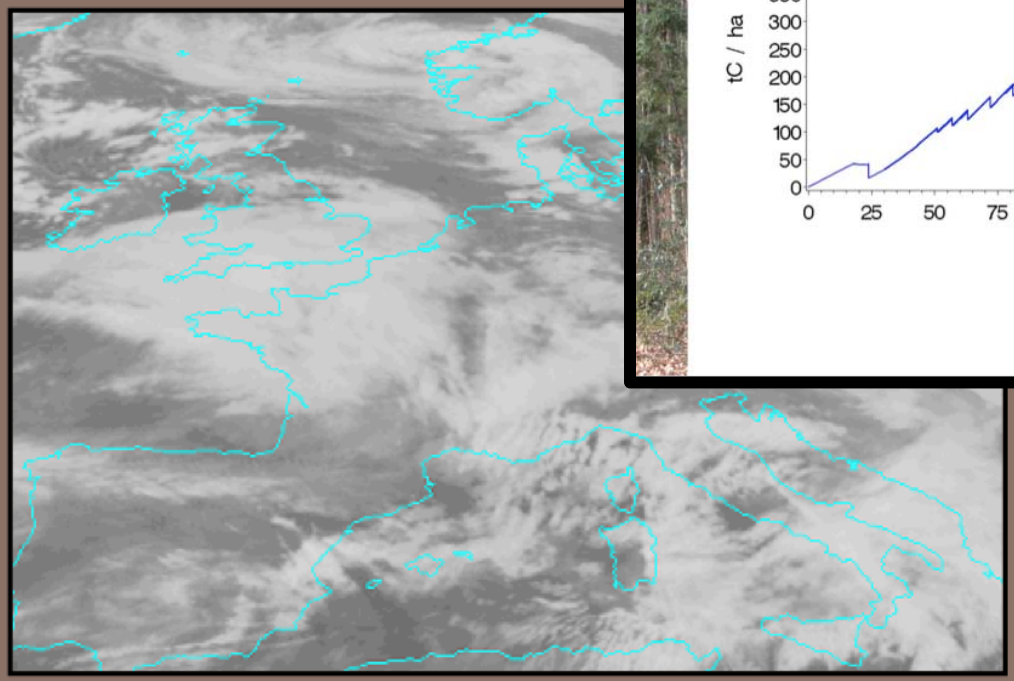
LE BILAN CARBONE DES FORÊTS ET LE RISQUE DE TEMPÊTE

Mathieu Fortin, LERFoB
François Ningre, LERFoB

Fréquence – 50 ans





26 déc 1999

Tempêtes Lothar et Martin

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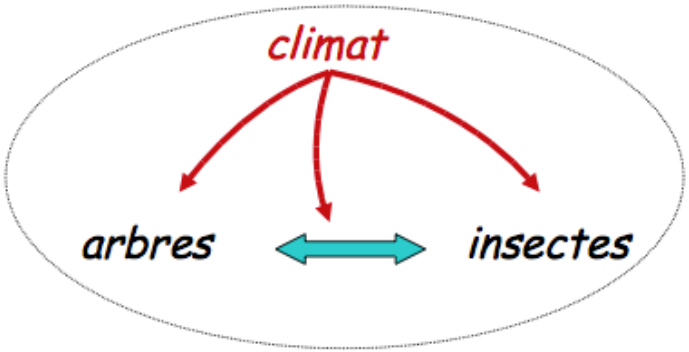
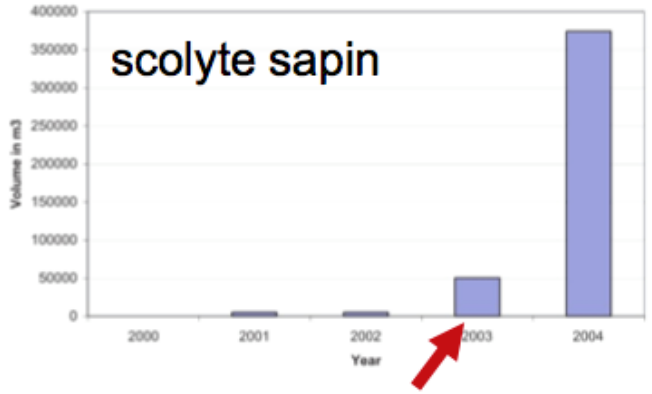
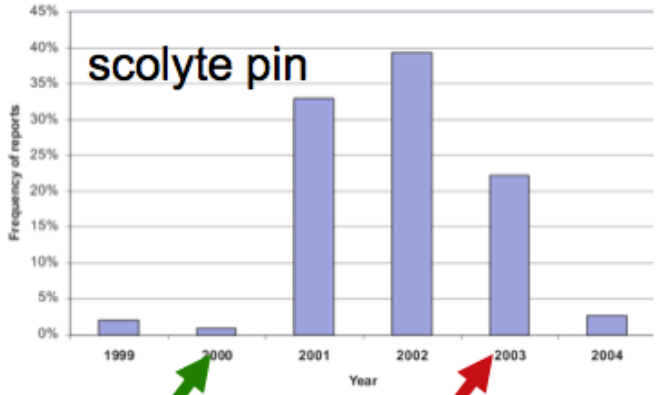
Le changement : de multiples incertitudes

Incertitudes sur la réponse de systèmes complexes



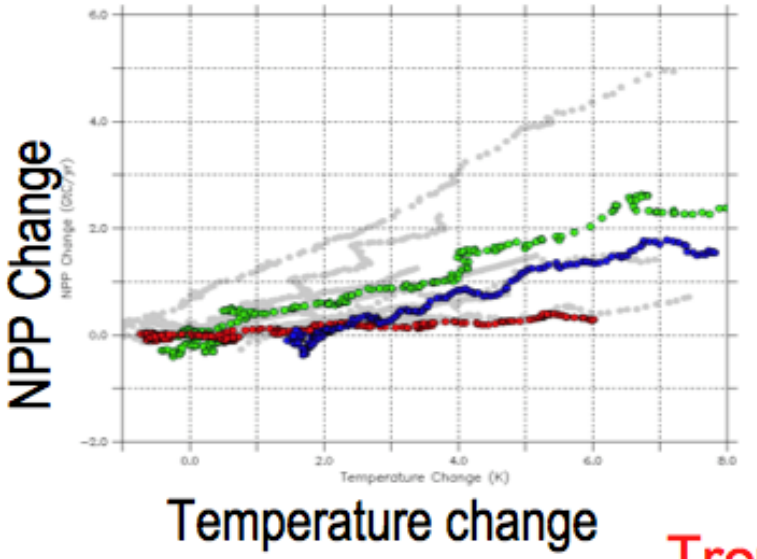




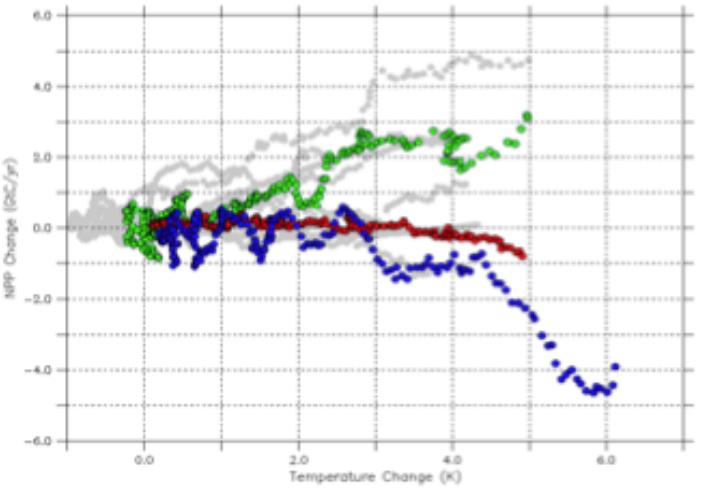
Rouault et al, 2006

Evolution future de la productivité des forêts

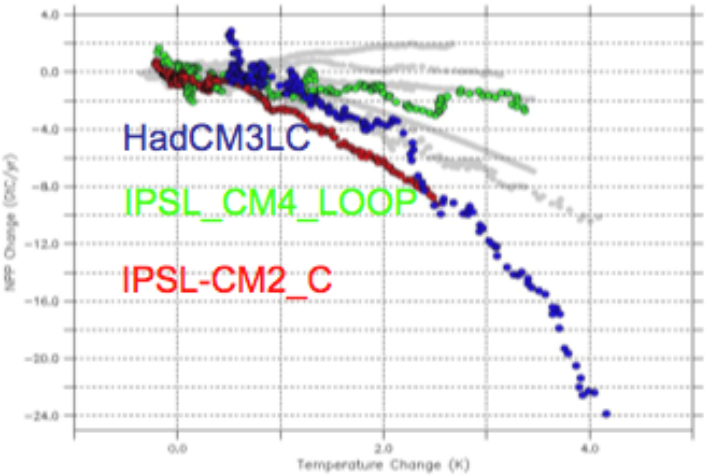
Boreal regions



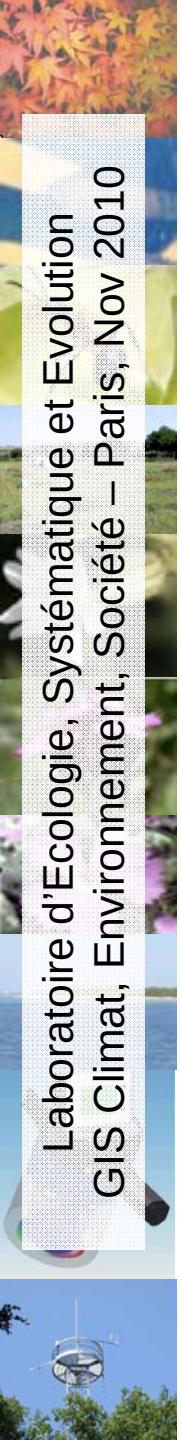
Temperate regions



Tropical regions



P. Ciais



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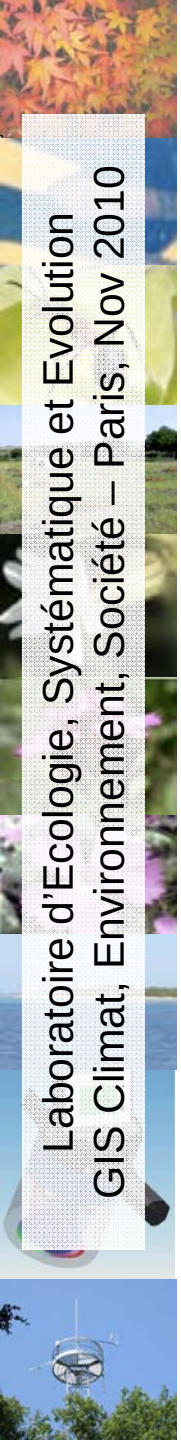
Socio-Economic Uncertainty



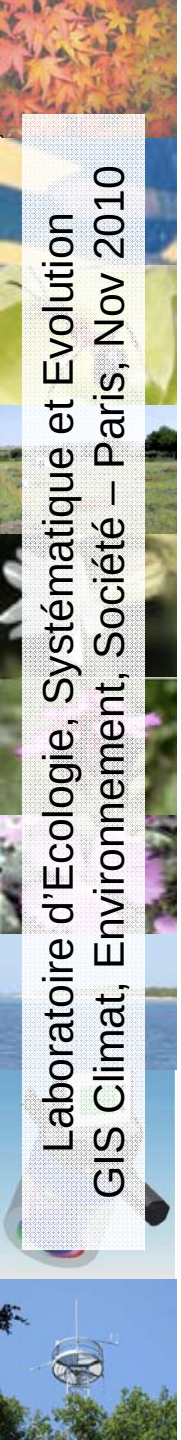
• Will new social changes or technological innovations alter the attractivity of wood, wood fibers and other wood products?

• Will (should?) bioenergy targets still be as abmitious as they currently are? Will technological advances make bioenergy more or less attractive?

• What priorities with society have in terms of the enviroment in general and forests in particular?

• Will significant payments for a broad range of ecosystem services exist? Will producers of diffuse pollution be required to pay?


Forest ecosystems provide
a wide range of ecosystem
services



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Ecosystem Services From Forest Ecosystems

PROVISIONING
Timber
Fuelwood
Non-wood forest products

REGULATING AND SUPPORTING
Water regimes / Water quality
Soil quality / Soil erosion
Climate regulation / Carbon storage
Pollination
Seed dispersal (e.g., by forest animals)
Natural Pest control (e.g., of ajoining crop lands) …

CULTURAL SERVICES
Recreation
Tourism
Amenity values - e.g., effects on house prices
Cultural values

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But….

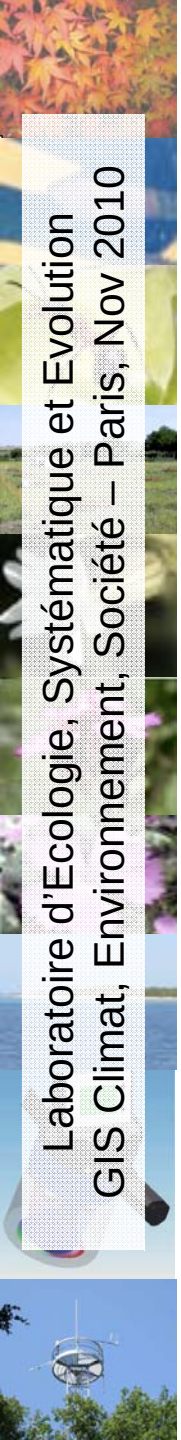
Payments for Ecosystem Services (PES) for services other than production are currently very limited.

Will there be real incentives for managing for a broad range of ecosystem services in the future?

Services	Valeur proposée
Services de prélèvement	
- bois	75 € (75 à 160 €)
- autres produits forestiers (hors gibier)	10 à 15 €
Services de régulation	
- fixation carbone	115 €
- stockage carbone	414 € (207 à 414 €)
- autres gaz atmosphériques	Non évaluée
- eau (quantité annuelle)	0 €
- eau (régulation des débits)	Non évaluée
- eau (qualité)	90 €
- protection (érosion, crues)	Non évaluée
- biodiversité	Non évaluée directement
- autres services de régulation (santé, etc.)	Non évaluée
Services culturels	
- promenades (hors cueillette et chasse)	200 € (0 à 1 000 €)
- chasse	55-69 €
- autres services culturels	Non évaluée
TOTAL (min.-max.)**	**env. 970 €** 500 à plus de 2 000 €

VIVATERRE

FIPAN©



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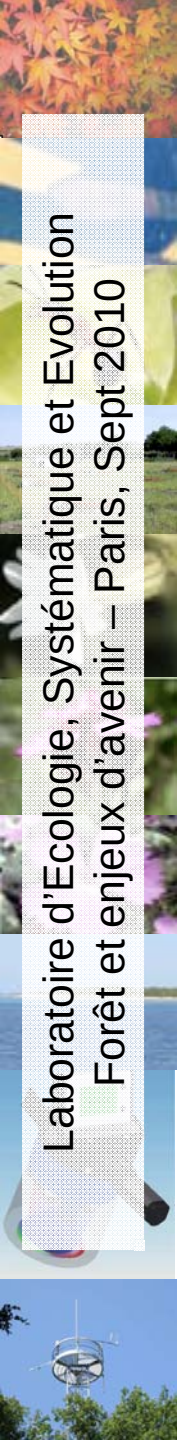
Management Options in the Face of Climate Change



Examples of adaptive management strategies in the face of uncertainty

- Reinforce "natural" processes to increase resilience

- Shorten rotation times to reduce exposure to social, economic and environmental change

- Use species or genotypes, including introduced species, that are more tolerant of projected future global change

Reinforce “natural” processes to increase resilience

- Increase the use of mixed species stands

- Maintain or increase genetic diversity, e.g., through natural regeneration rather than the planting of clones

- Respect knowledge of tree ecology (e.g., soils, climate)

- Avoid soil compaction during forestry activities

- Reduce evapo-transpiration through management of leaf area

Shorten rotation times to reduce exposure to global change

• Reduce rotation times. Shift to fast growing trees (esp. conifers) or to very short rotation “coppice” plantations (especially if 2nd generation biofuels take off).

Douglas fir (*Pseudotsuga sp.)* plantation

Coppice willow plantation

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Forêt et enjeux d’avenir – Paris, Sept 2010

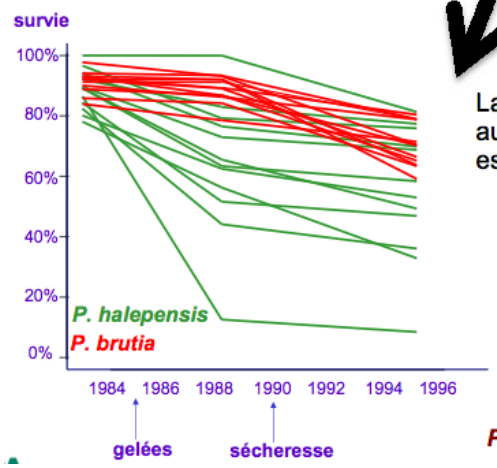
Plant species or genotypes that are more tolerant of "predicted" changes in climate

- Introduce new drought and heat tolerant species and genotypes, i.e., introduced species and possibly GM trees.

- Use transplants exploiting the natural differences in genotypes across species range, while maintaining genetic diversity in the transplant population!

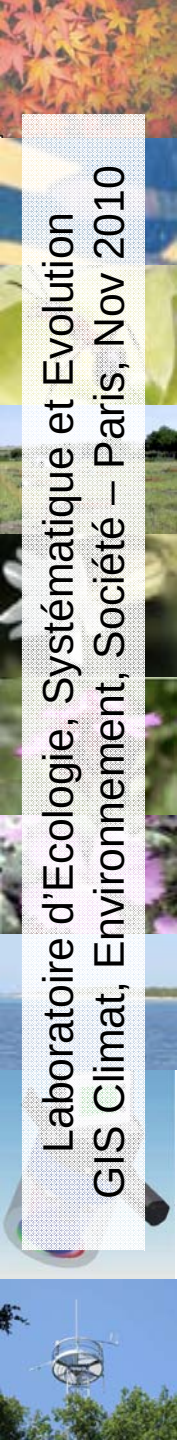
Eucalyptus plantation

"Pin laricio"



La diversité génétique au sein des espèces est très grande

Pichot et al, in prep



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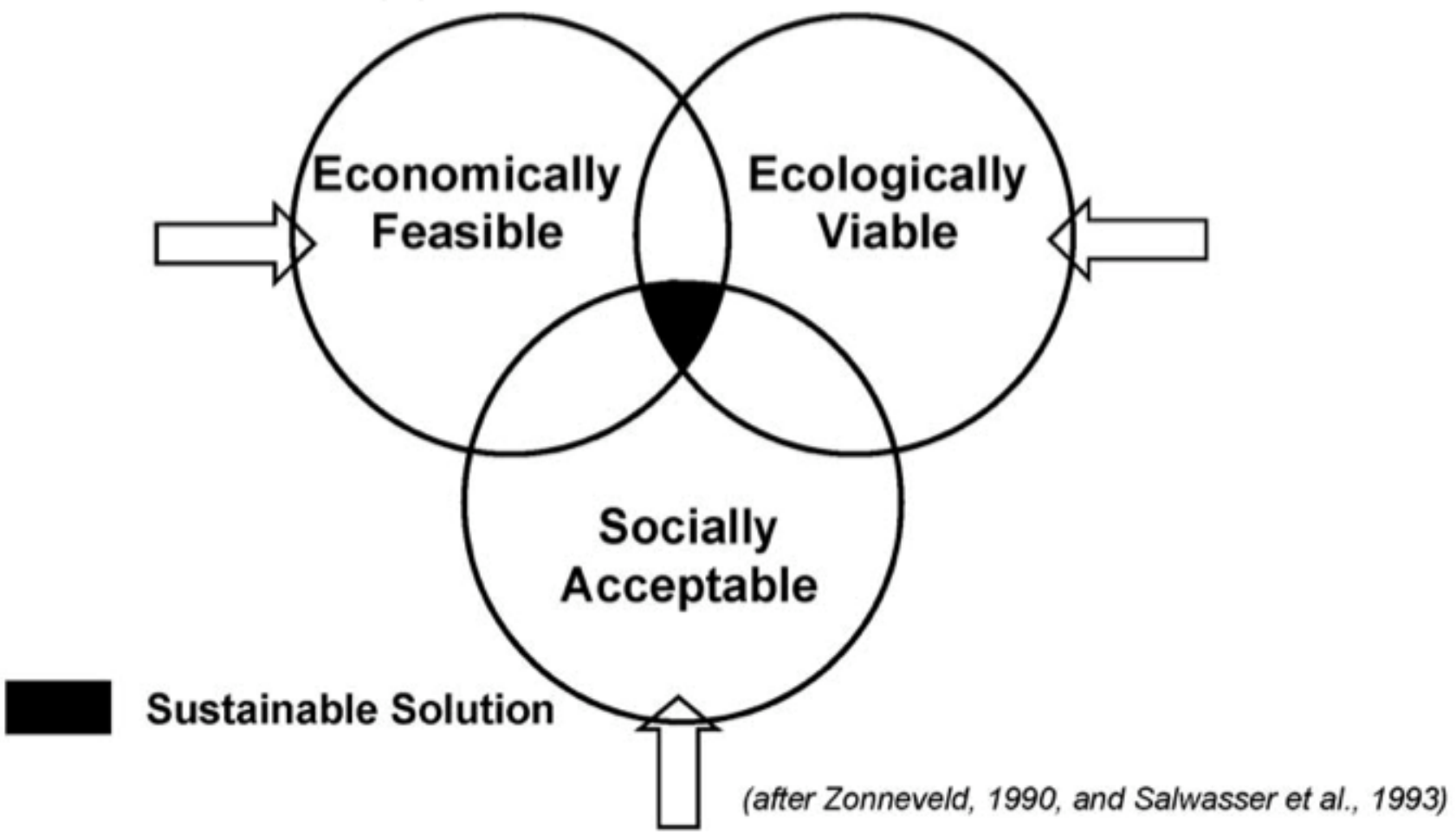
Identify Acceptable Solutions Together


Economically Feasible
Ecologically Viable
Socially Acceptable
Sustainable Solution
(after Zonneveld, 1990, and Salwasser et al., 1993)

“Acceptable” Solutions: getting specific!

NOW

FUTURE

Managed mixed forest with natural regeneration

Managed forest with natural regeneration, but reduced rotation times. Continued efforts to reduce env. impact.

Monospecific plantations (e.g., ‘Pin noir’)

‘Climate-tolerant’ plantations (e.g., ‘Pin laricio’)

Abondoned field

Coppice willow plantation
Major efforts made to reduce env. impact

“Acceptable” Solutions: getting specific!

Managed mixed forest with natural regeneration

Plantation of fast growing, climate change tolerant ‘local’ species

Plantation of fast growing, climate change tolerant ‘exotic’ species (Eucalyptus plantation)

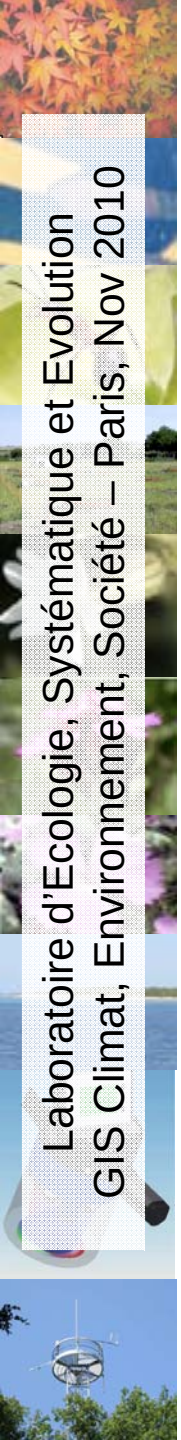
Coppice willow plantation. Continued efforts made to reduce env. impact

Conclusions (J-L Peyron)

"• De manière générale, il semble judicieux
- de voir large pour éviter le réductionnisme
- de sérier les problèmes pour éviter les amalgames (d'où l'approche multicritère)

• Pour une vision large et suffisamment détaillée, des approches collectives sont nécessaires

• Une approche multicritère peut faciliter l'interfaçage :
- entre critères et disciplines
- entre science et décision"



The Way Forward

- **Develop tools for <u>decision support</u> that focus on viability and governance of coupled environmental-economic systems that include both land use and climate change drivers** (MOBILIS project for FRB call, PI: L. Doyen, MNHN / ACTE LabEx, PI: B. Ney, AgroParisTech)

- **Develop new tools to <u>improve models</u> of climate change impacts on forests** (e.g., ANR SCION, PI: I. Chuine, Montpellier / GIS-Climat Humboldt, PI: P. Leadley / TRY & BBS programs, PI's: many)

- **Continue the <u>dialog</u> between scientists, forest managers and policy makers** (e.g., "Observer et s'adapter au changement climatique en forêt méditerranéenne" V. Badeau, Marseille, 30 Nov & 1 Dec 2010)

- **Develop simple <u>indicators</u> of climate change impacts on forests** (GIS-Climat Humboldt / FRB MOBILIS?)

The Way Forward

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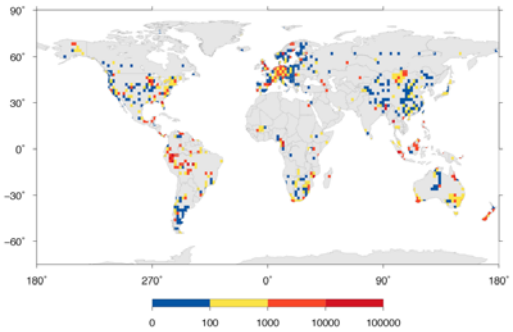
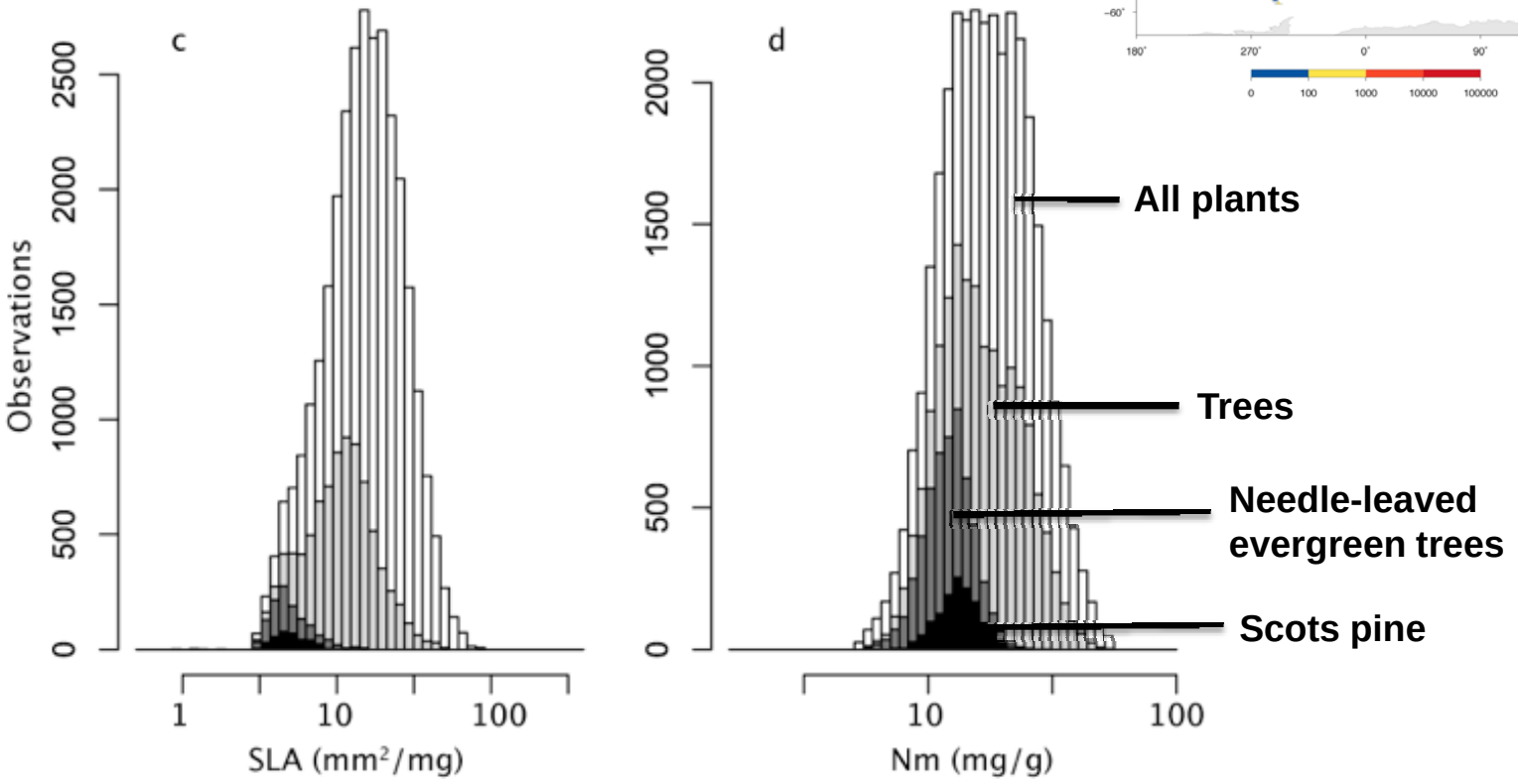
TRY: towards a unified global database of plant traits - DIVERSITAS, IGBP, MPI-Jena, GIS-Climat (Kattge et al. submitted)





Specific Leaf Area

Leaf Nitrogen Content

Building Interdisciplinary Scenarios

Programme Phare: Modélisation et scénarios de la biodiversité

‘Humboldt’ project