Capacity of silver fir (*Abies alba* Mill.) migration on Mont Ventoux

Annabelle Amm[(1)]; Christian Pichot[(1)]; Philippe Dreyfus[(1)]; Hendrik Davi[(1)]; François De Coligny[(2)]; Bruno Fady[(1)]

(1) INRA, Unité des Recherches Forestières Méditerranéennes, Domaine St Paul, Site Agroparc, F-84914 Avignon, France

(2) INRA, UMR AMAP, botAnique et bioinforMatique de l'Architecture des Plantes TA40/PS2, Boulevard de la Lironde, 34398 Montpellier Cedex 5 (FRANCE)

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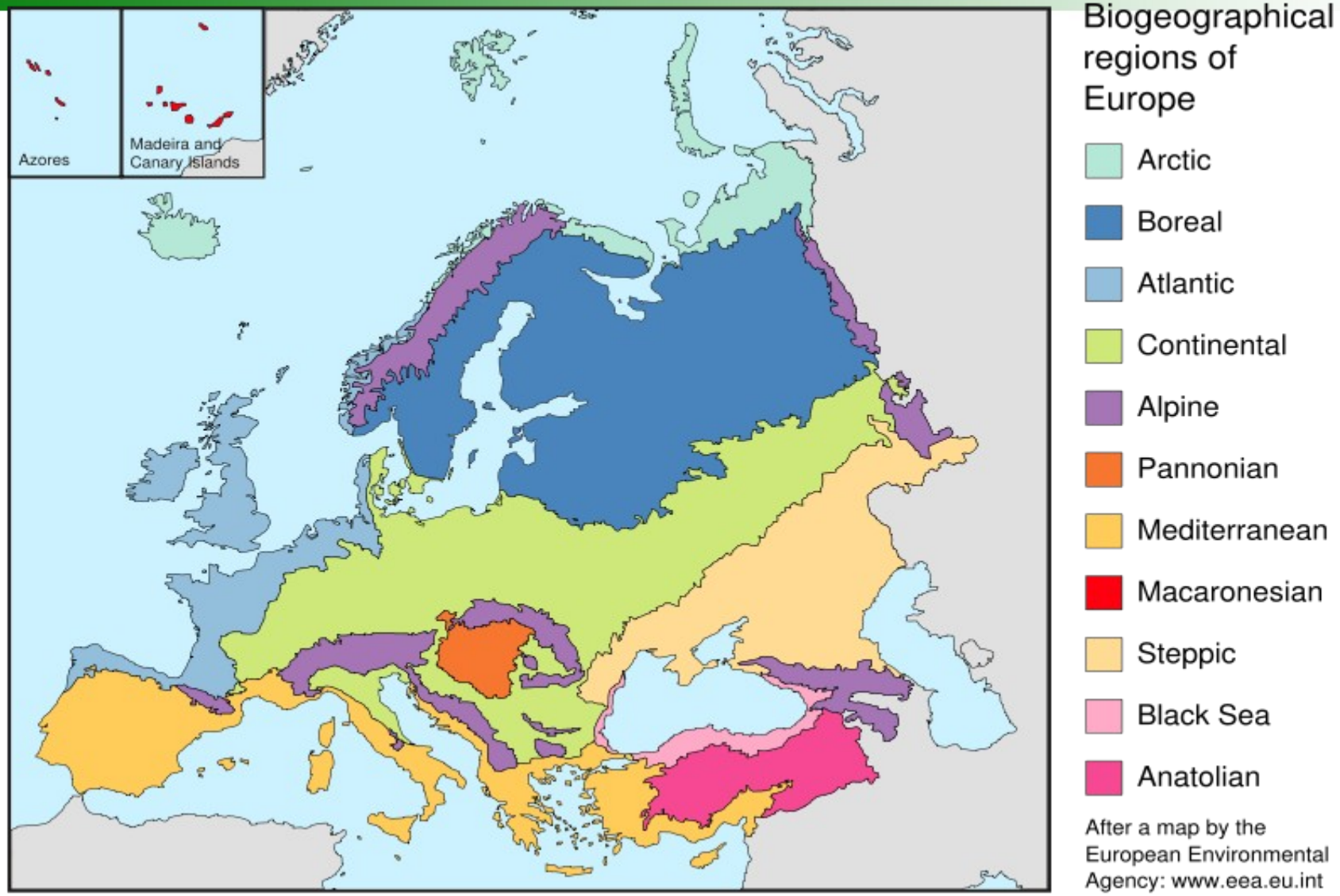
Species are distributed in bioclimatic zones



Species are distributed in stable distribution area when climate is constant and when human impact is weak.

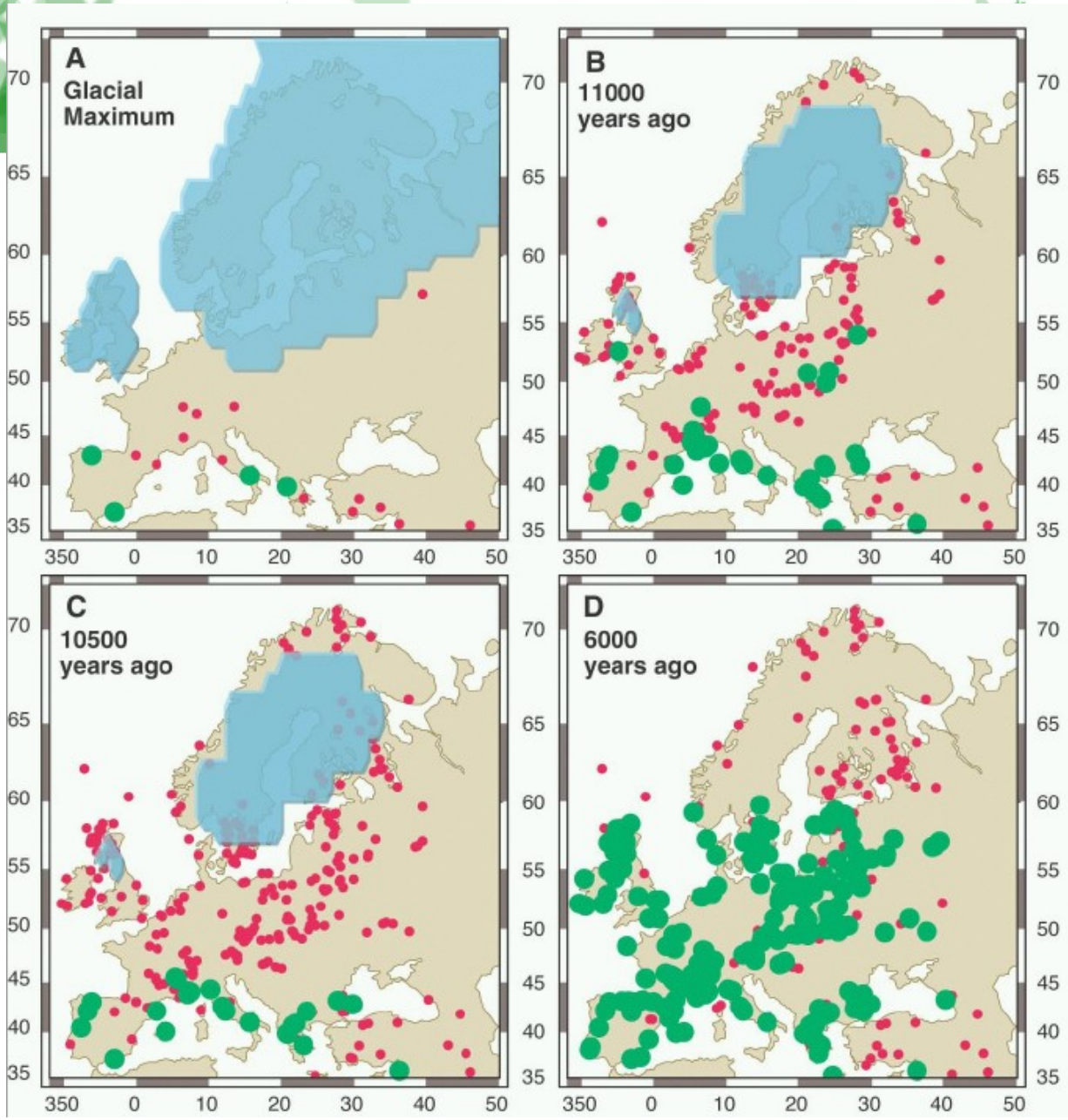
Climatic change

Adaptation Migration

Current climatic change:

Fast

Capacity of **migration?**



Oak recolonisation during the last interglacial period.
Taberlet & Chaddadi, Science 2002.

Migration

Modification of distribution zones

Results of various processes: Seed production, **Dispersion,** Recruitment, Growth and Mortality.

Dispersion: Movement in space

Silver fir: Short dispersal distance (median dispersion distance) is 8m for seeds and 13m for seedlings.

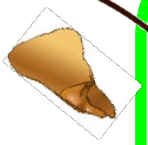
Displacement of bioclimatic zones:

Many hundred kilometres

Will long-lived forest tree species be able to migrate fast enough?

Compatibility with climatic change?

Forest dynamics



Dispersion

Seed production

Recruitment

Climate and station effects

Decline

Mortality

Growth

Influence of the climate

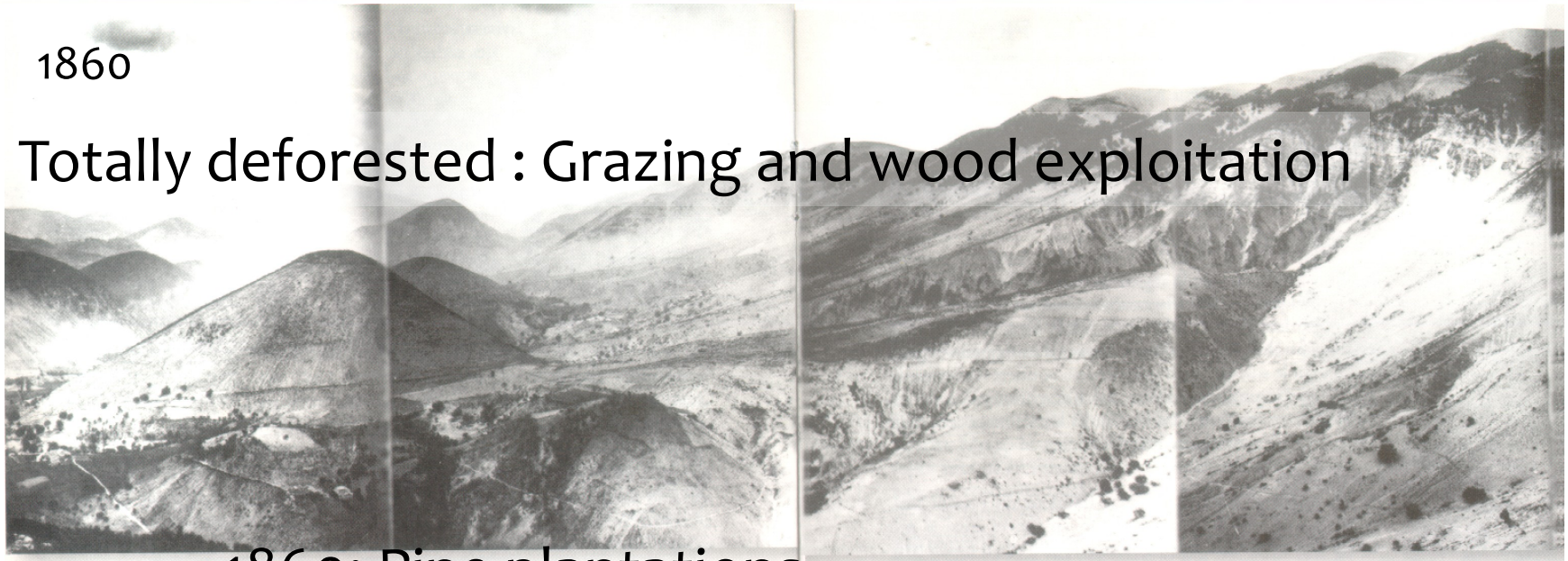
Independent of the climate

URFM: The cycle is described by many researchers

Specific context: Mont Ventoux

1860

Totally deforested : Grazing and wood exploitation



1860: Pine plantations

2000

2100 ???

Specific context: Mont Ventoux

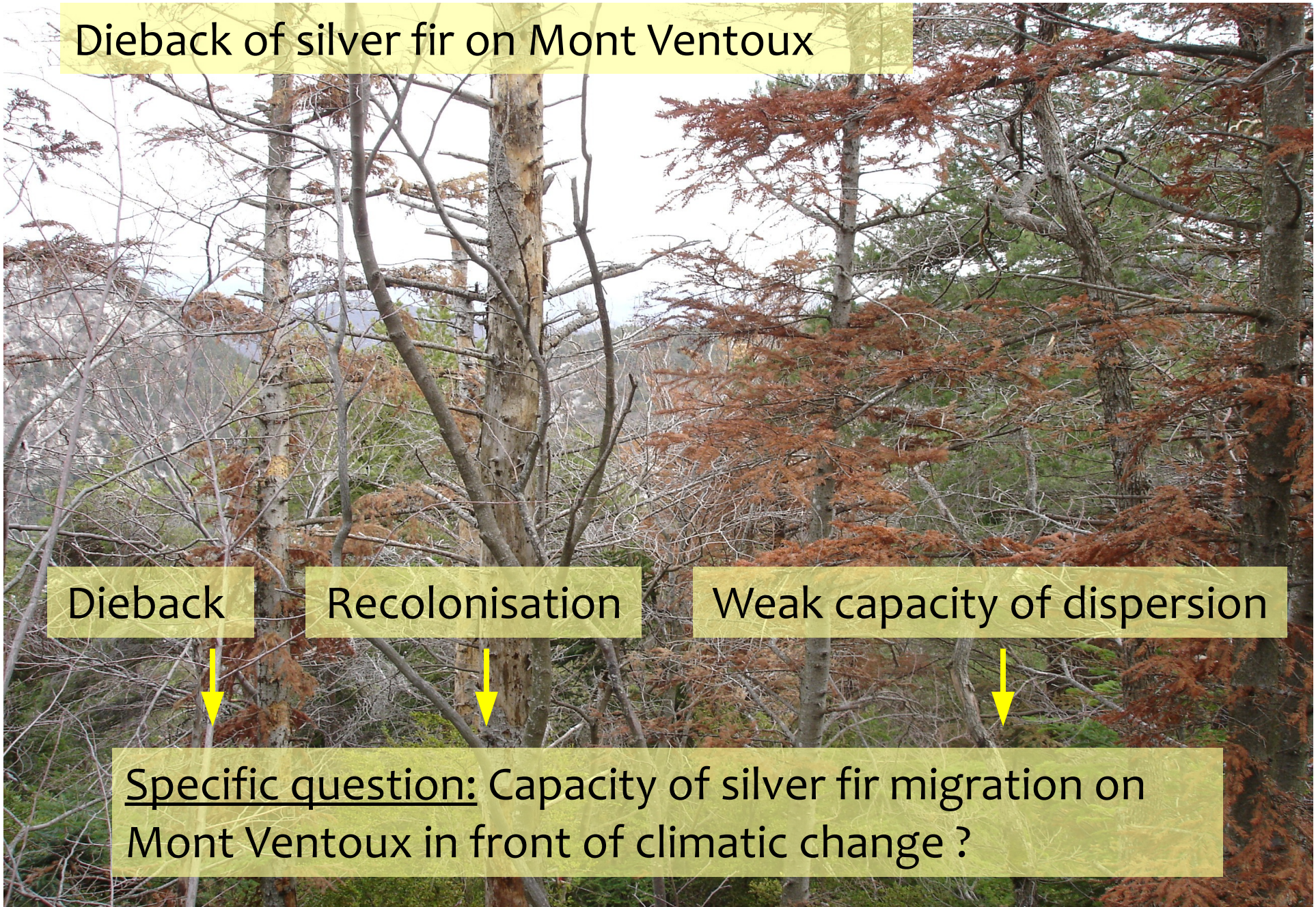
***Abies alba* :**

- Keystone tree species
- Shade tolerant
- Late successional
- Recolonise planted pine-forests
- Anemochorous
- Weak capacity of dispersion (MDD=13m).

- Southern limit in France

This distribution map was compiled by members of the EUFORGEN Noble Hardwoods Network and was published in:
Wolf, H. 2003. EUFORGEN Technical Guidelines for genetic conservation and use for silver fir (Abies alba). International Plant Genetic Resources Institute, Rome, Italy. 6 pages.

Specific context: Mont Ventoux



Objective : Creation of a process/ individual based model

Calibration

↓

Integration

↓

Simulation

Calibration of the processes driving the migration.
Calibration on two model species: beech and silver fir.

Integration of the processes in the model, with climatic variables.

Simulation: Effect of the climate on the repartition.

```
/** MigModel is the main class for module Migration
 *  @author A. Amm - april 2008
 */
public class MigModel extends GModel {

    private TicketDispenser cohortIdDispenser;
    private Random random;                          // a random number generator
    private Random cohortSpatialisationRandom; // a random number generator
    //~ private MigSpecies species; // fc - 1.2.2005
    private MigSettings migSettings;
    private MigSpecies speciesSpecimen;             // one of the species objects, see the automatic groups below


    /** Constructor
```

Calibration

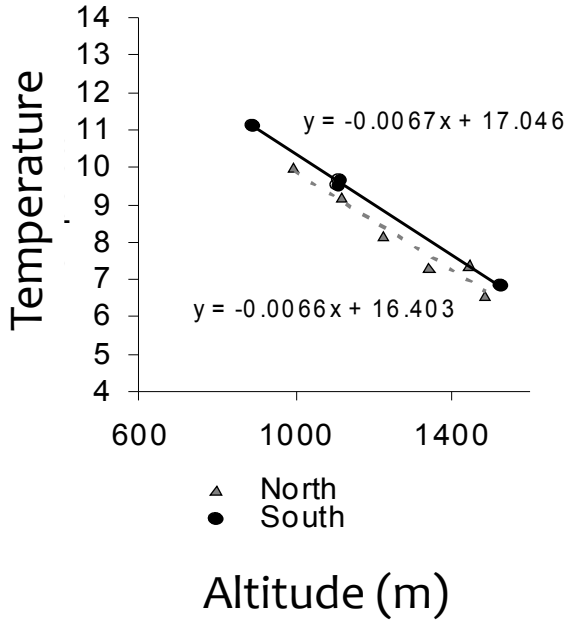
Data collection

➢ 120 plots (100m²) are installed on the north face of Mont Ventoux:

→ Growth

→ Recruitment

→ Mortality



➢ Seed traps:

→ Seed dispersal

➢ Elevational gradient:

→ Seed production

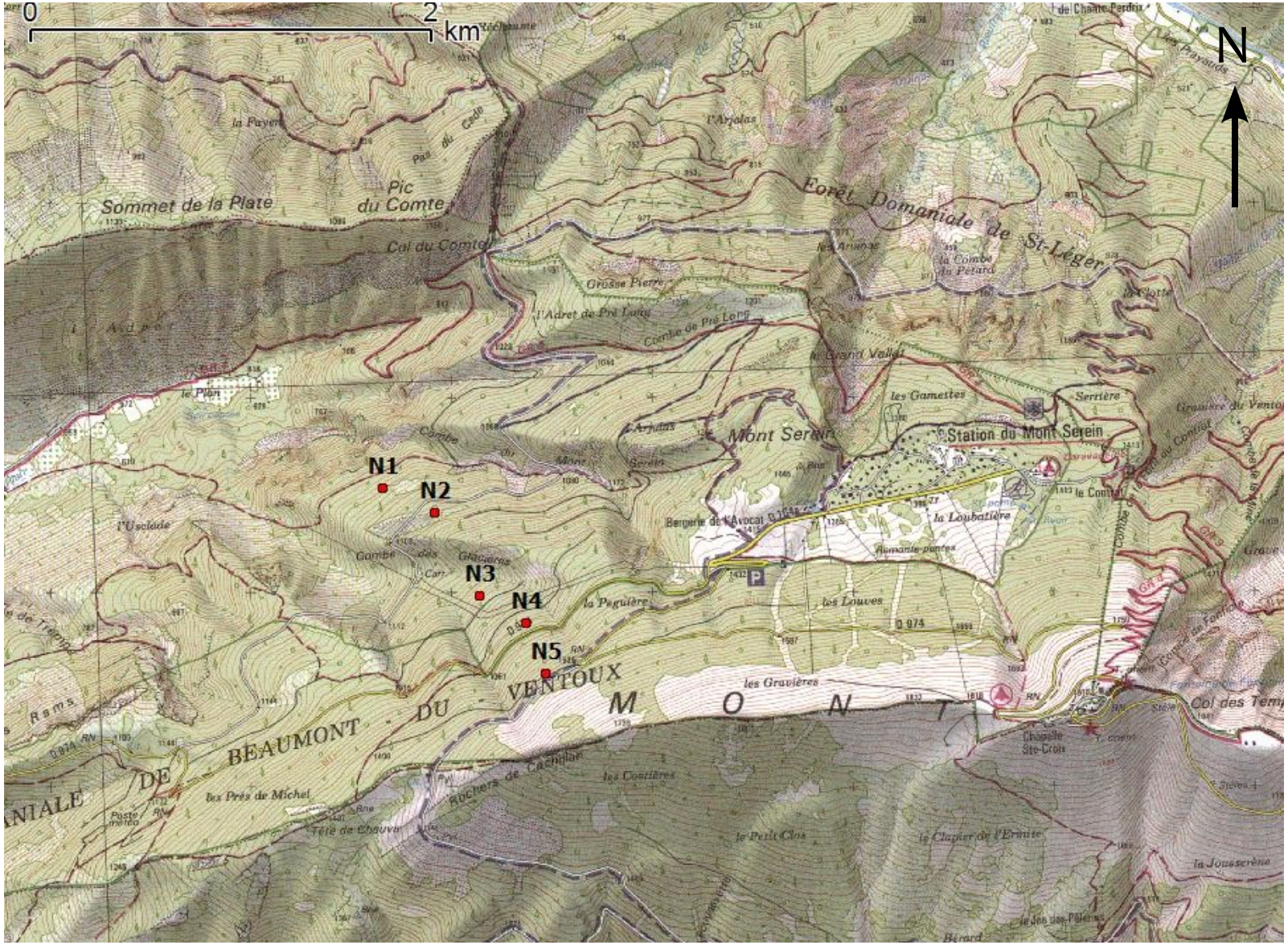
→ Dieback

➢ Climatic data:

→ Meteorologic captors on elevational gradient (precipitation + temperature: linear relation with elevation)

Calibration

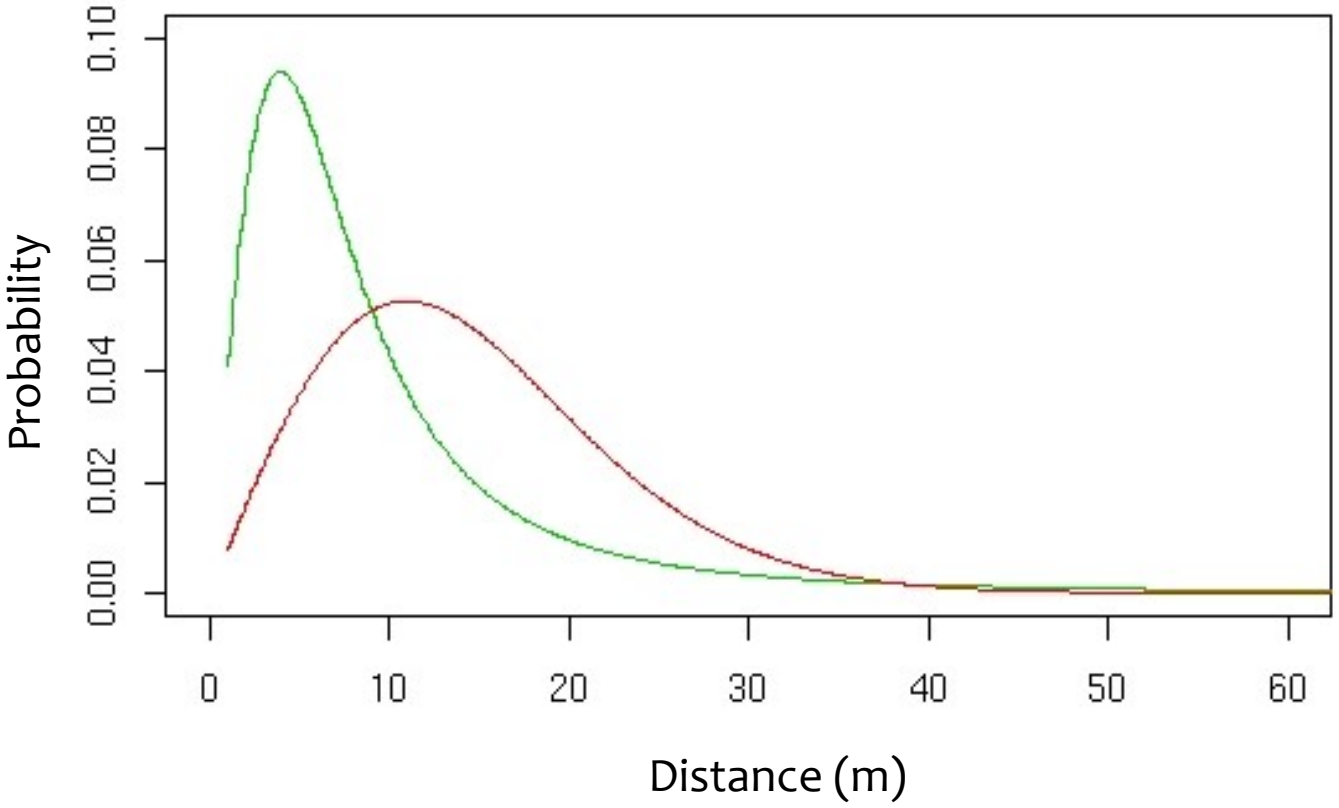
Data collection



Calibration

Dispersion

Dispersion curves of *Abies alba* (kernel of dispersion: 2Dt)



f(dist)= $\frac{p}{\pi u\left[1+\frac{r^2}{u}\right]^{p+1}}$

Green: Seed

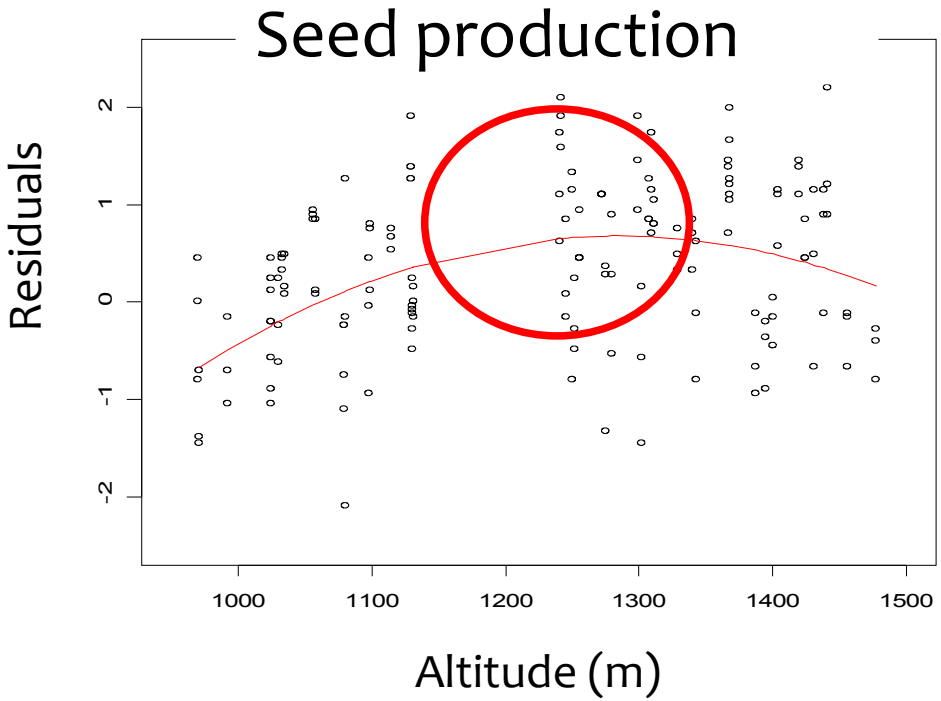
Red: Seedling

- Dispersion in a short distance process: MDD = 8m for seeds and 13m for seedlings

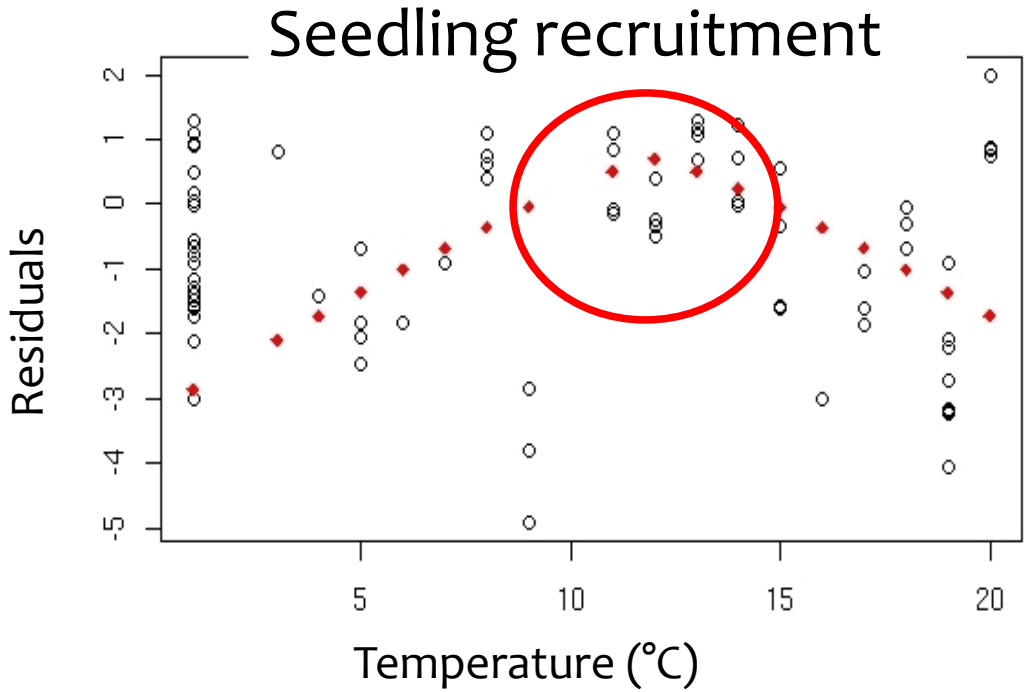
⇒ Need of precision for the model

Calibration

Seed production and seedling recruitment



Laurent Catrice (2007)



Amm *et al*. in prep

- Optimum for seed production and recruitment

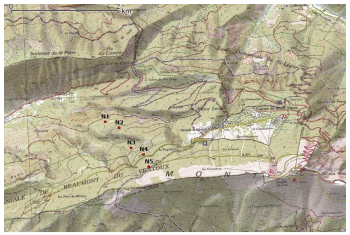
Linear relation between elevation and temperature

- Processes calibrated with climatic variable: temperature

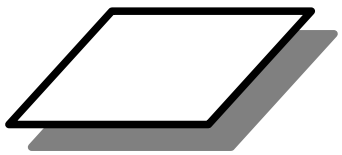
Integration

Description of the model

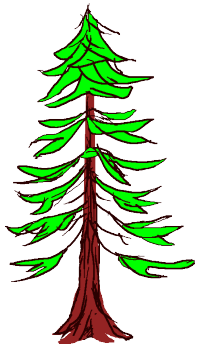
➢ Developed in CAPSIS: simulation platform for dynamics models (F. De Coligny, 2005); Population model.



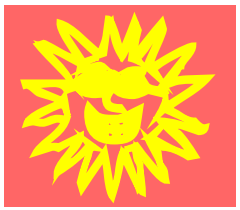
• Scene: Rectangular plot, divided in cells. Scale: 1km x 500m



• Cell: Square cell; Environmental factors (station + climate); Scale: 100m²



• Tree: Grouped in cohorts (seedling + trees), according to their height.



• Climate: climate files are included.
Temperature augmentation; Precipitation decrease + variance (various scenarios)

Integration

Description of the model

To be continued…

A cell contains the environmental information

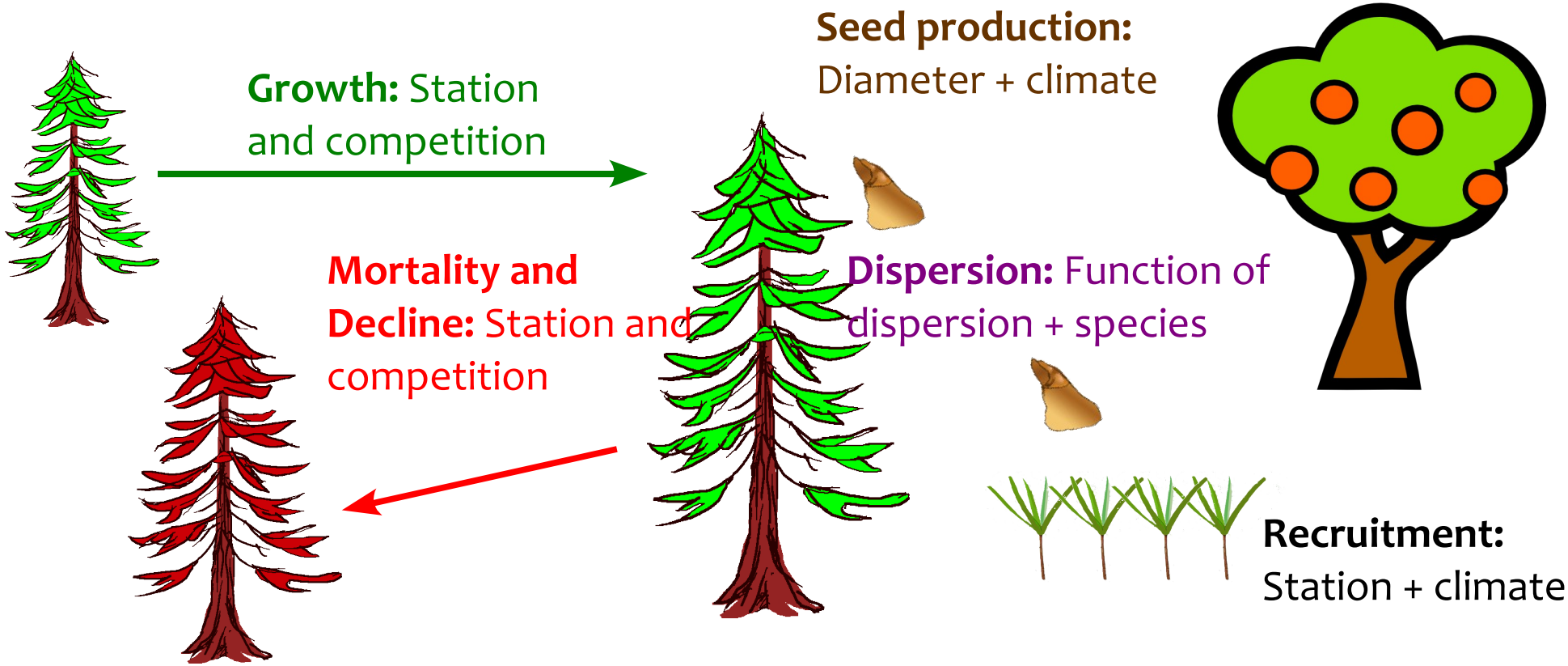
- Environmental factors:

Elevation; Slope; Trees density; Exposition

- Climatic factors:

Temperature and precipitation (linear relation with the elevation)

Other species:
Do not evolve



Not all the processes are calibrated with climatic variables

Simulation

Function of dispersion

$$f(dist) = \frac{p}{\pi u \left[1 + \frac{r^2}{u}\right]^{p+1}}$$

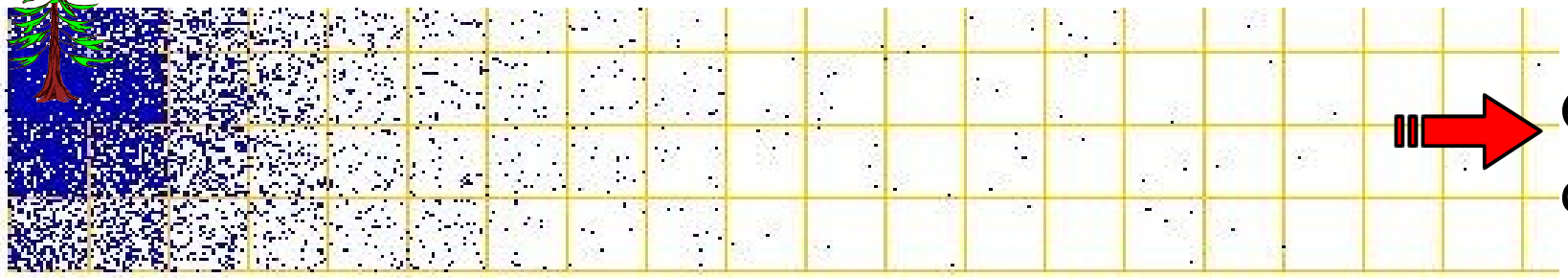
p: shape parameter (Clark *et al.*, 1999)

p<1: Fat tail dispersion

p>1: Light tail dispersion

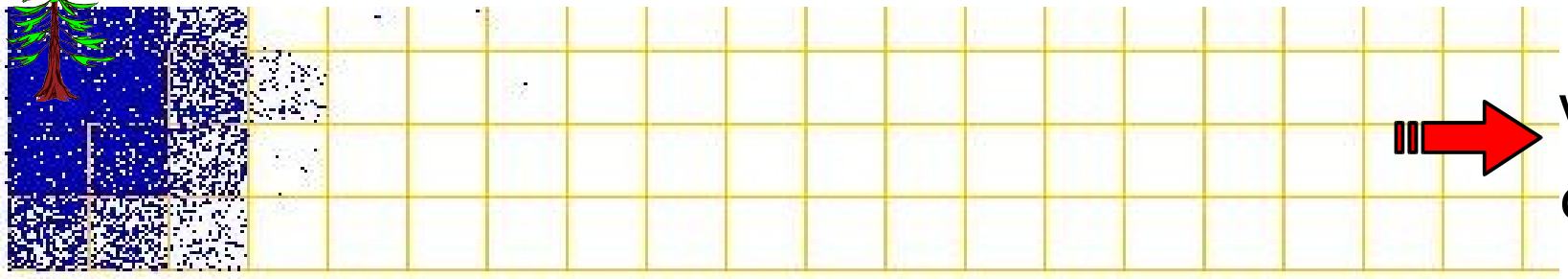
20 years of dispersion

Case 1: p<1



Good capacity of dispersion

Case 2: p>1



Weak capacity of dispersion

➢ Importance of calibrating the function of dispersion

Simulation

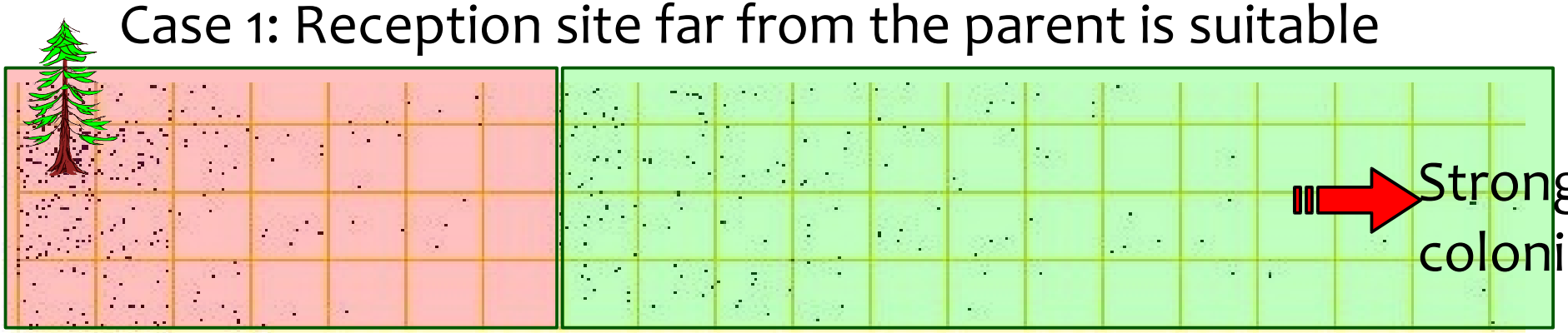
Suitability of site reception

- p<1
- 20 years of dispersion

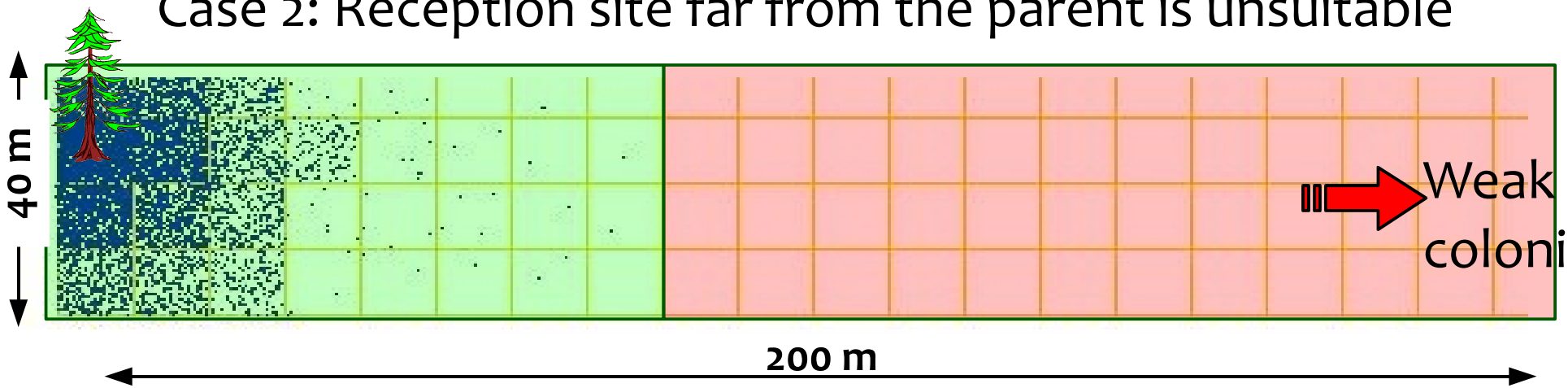
Suitable site

Unsuitable Site

Case 1: Reception site far from the parent is suitable



Case 2: Reception site far from the parent is unsuitable



➢ The suitability of reception site will influence colonisation speed

Perspective and conclusion

- Improving knowledge of climate:

Integrate relation with elevation and with exposition

- Evaluate the effect of processes as:
  - Seed production
  - Dispersion
  - Recruitment

Best interaction between theses processes?

- Difficult point:

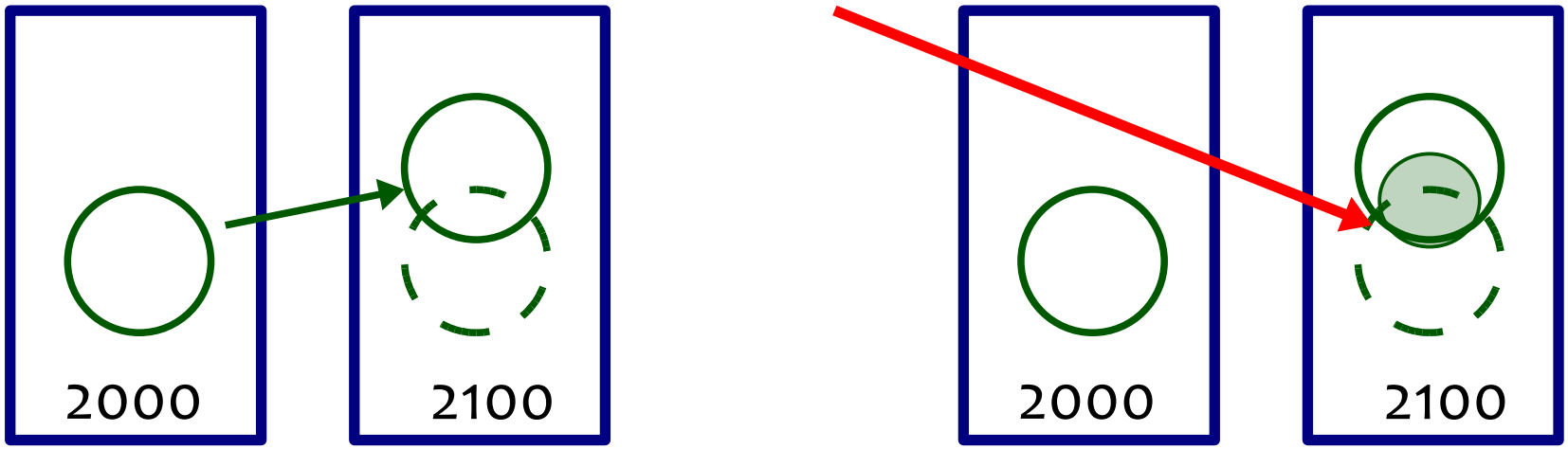
Relation between climate and processes may not be linear at the scale of the century.

Perspective and conclusion

➢ Originality of the model:

• Scale + precision (especially for dispersion)

• Not only match between climate and species repartition, but integration of **dispersion**.



➢ Model "Migration": Not a predictive model.
Evaluate the potentiality of migration in worst and best conditions.

Thanks for your attention !!!