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## **Adaptation to climate change: which are the main challenges for the French wine industry?**

Nathalie Ollat, Hervé Quénol, Gérard Barbeau, Cornelis van Leeuwen, Philippe Darriet, Inaki Garcia de Cortazar Atauri, Hernan Ojeda, Eric Duchêne, Eric Lebon, Philippe Vivin, et al.

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# Adaptation to climate change : which are the main challenges for the French wine industry ?

**Ollat N., Quénot H., Barbeau G., Van Leeuwen C., Darriet P., Garcia de Cortazar Atauri I., Ojeda H., Duchêne E., Lebon E., Vivin P., This P., Sablayrolles J.M., Teil G., Lagacherie P., Giraud-Hérait E., Neveu P., Touzard J.M.**

# French wine industry

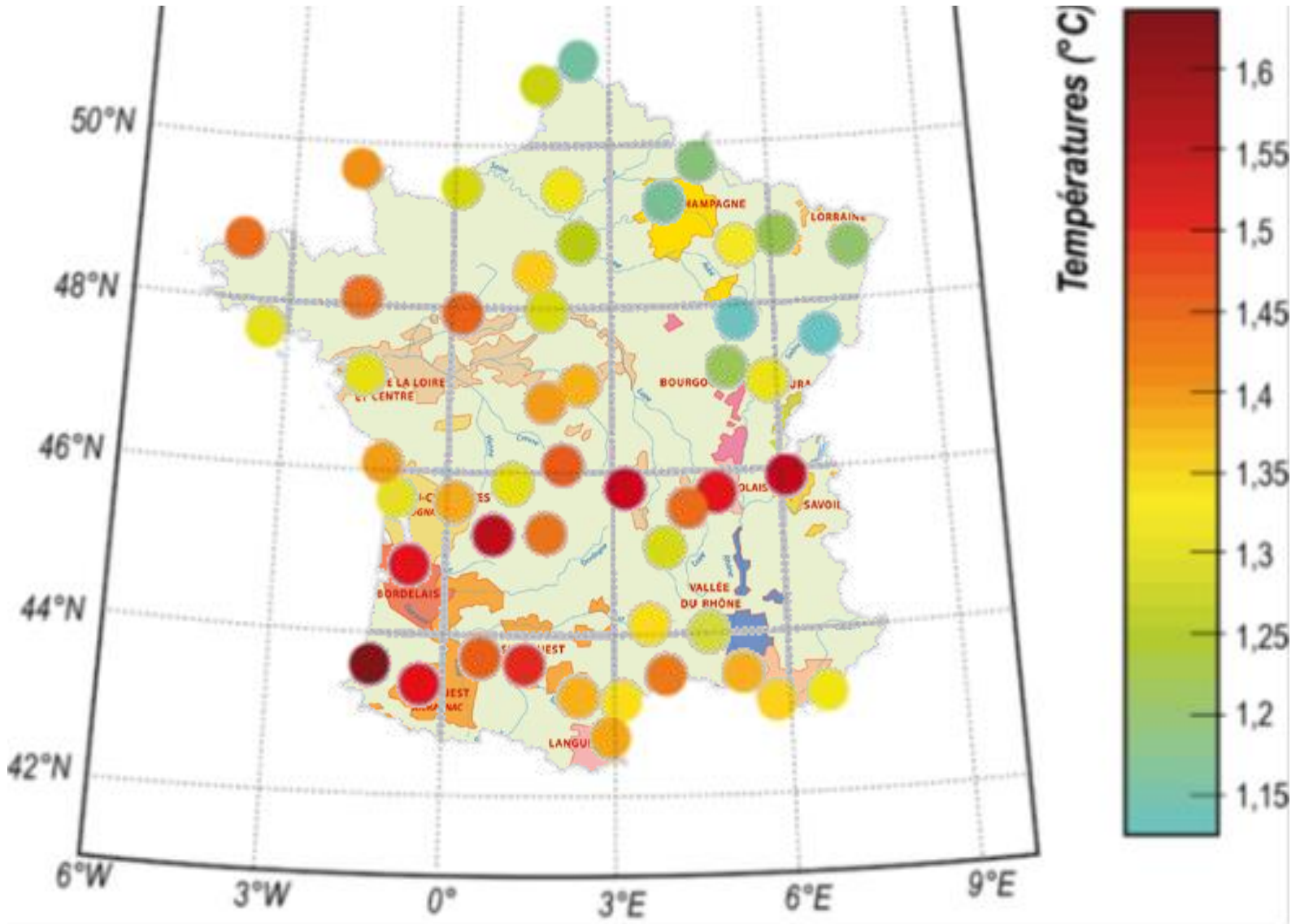


- 788 700 ha
- 87 400 estates
- 62% of vineyards in AOP
- 10,3 billions € in value
- 24% of agricultural green products





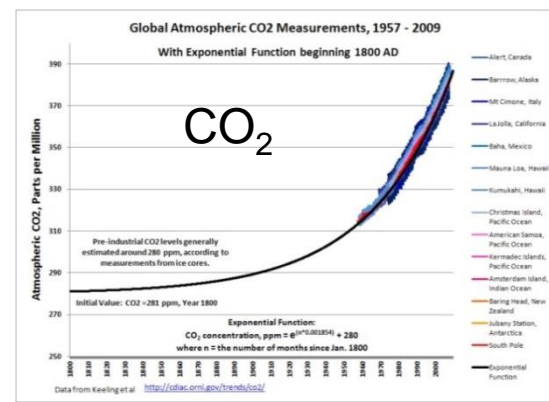
# France and climate change



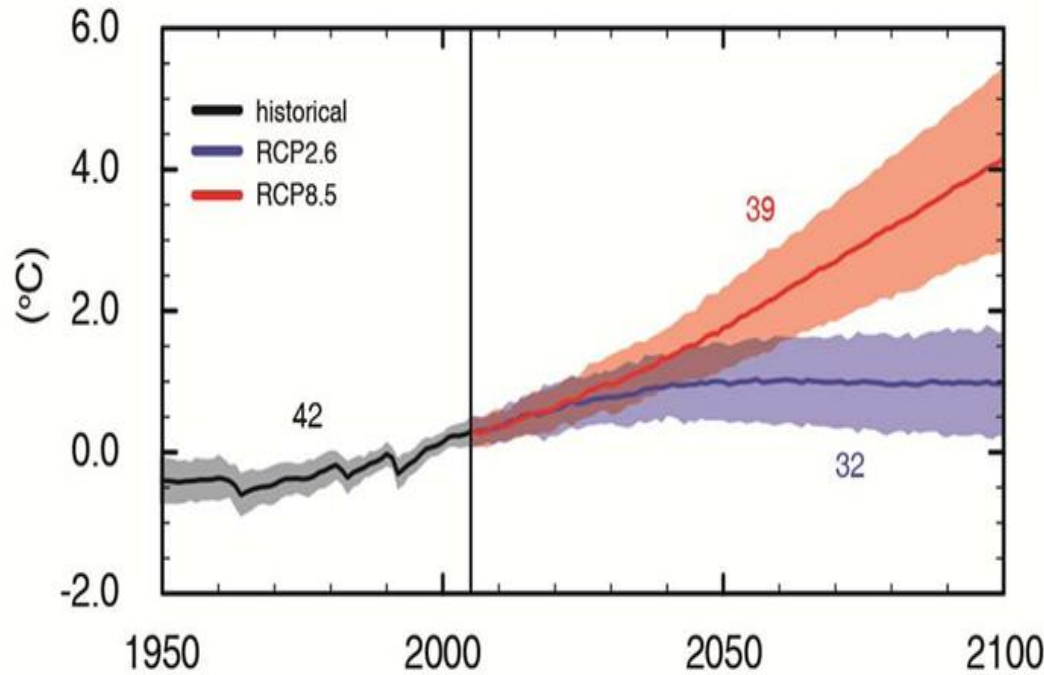
Le Treut *et al.*, 2013



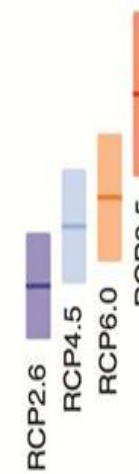
# What next ?



(a) Global average surface temperature change



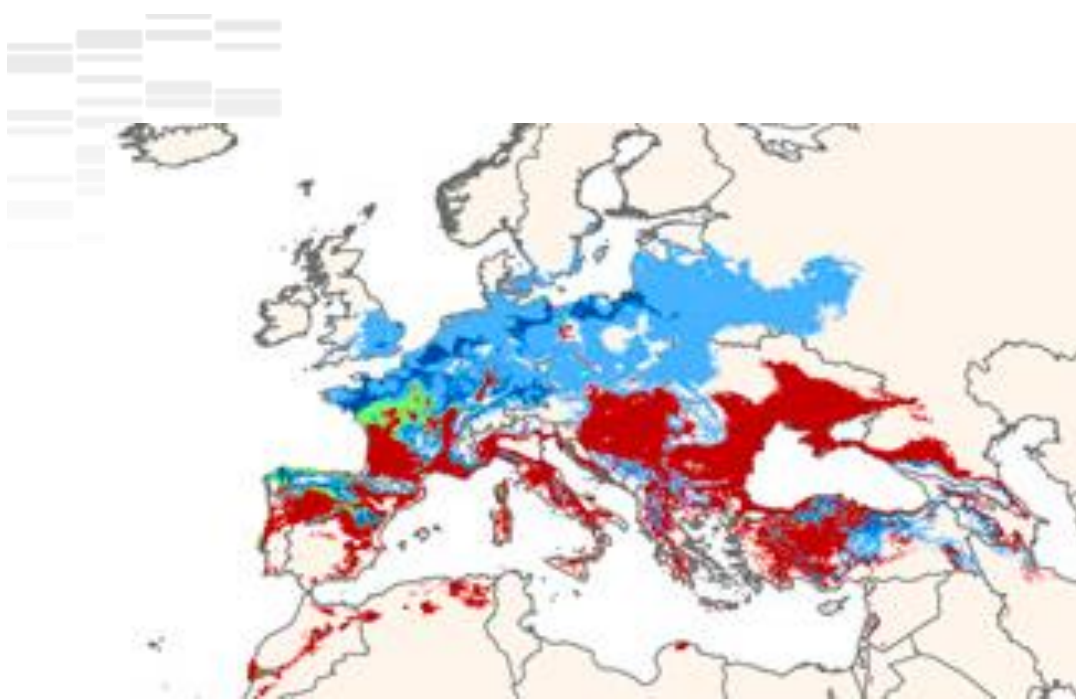
Mean over  
2081-2100



IPCC, 2013



# And for grape growing and viticulture ?



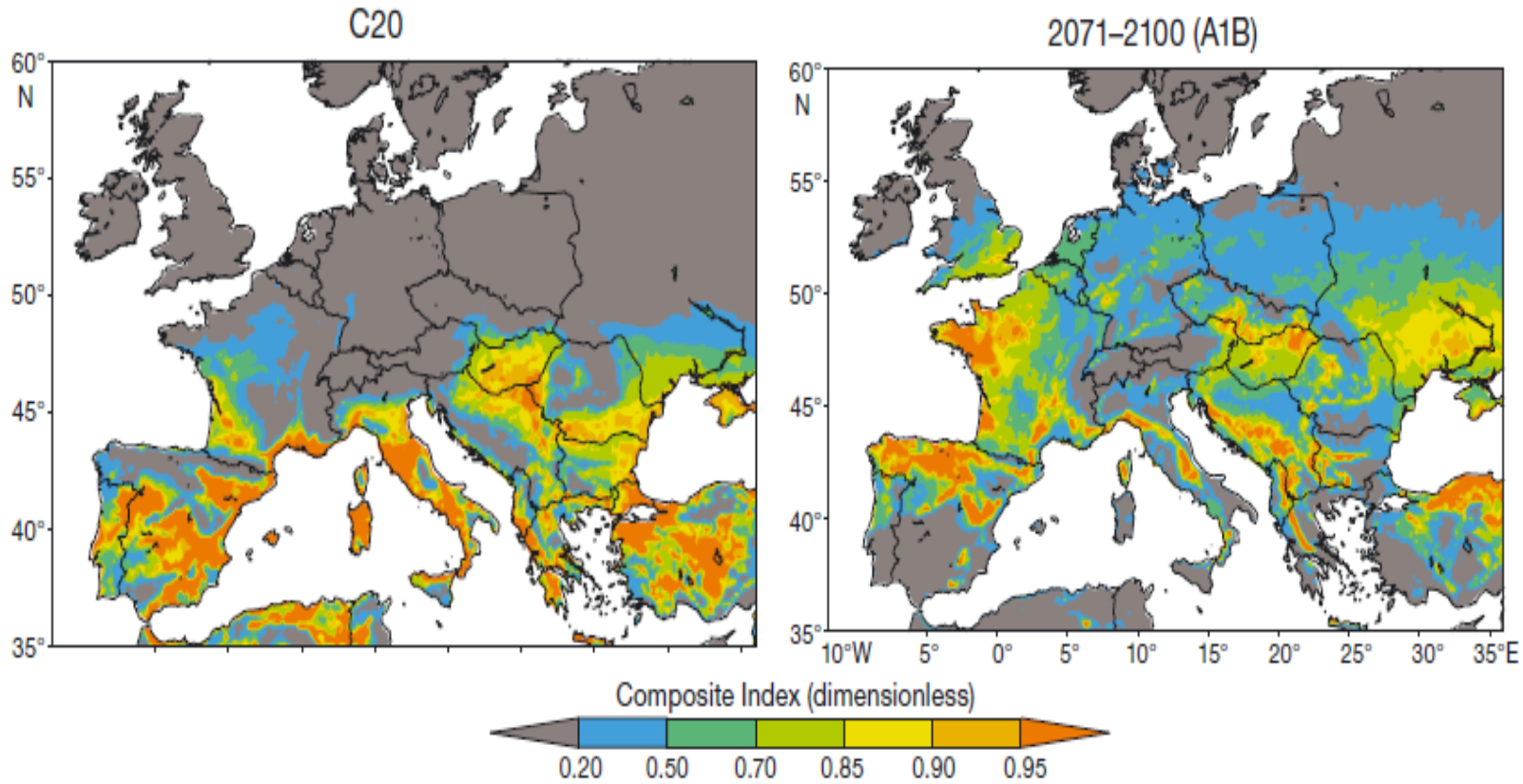
Hannah et al., 2013  
RCP8,5  
> 2050

-  Current Suitability
-  Suitability Retained > 50% GCMs
-  Suitability Retained > 90% GCMs
-  Novel Suitability > 50% GCMs
-  Novel Suitability > 90% GCMs





# And for grape growing and viticulture ?



Fraction of years suitable for grape growing

HI > 1400, DI > - 100, Hyl < 5100, Tmin > -17°C

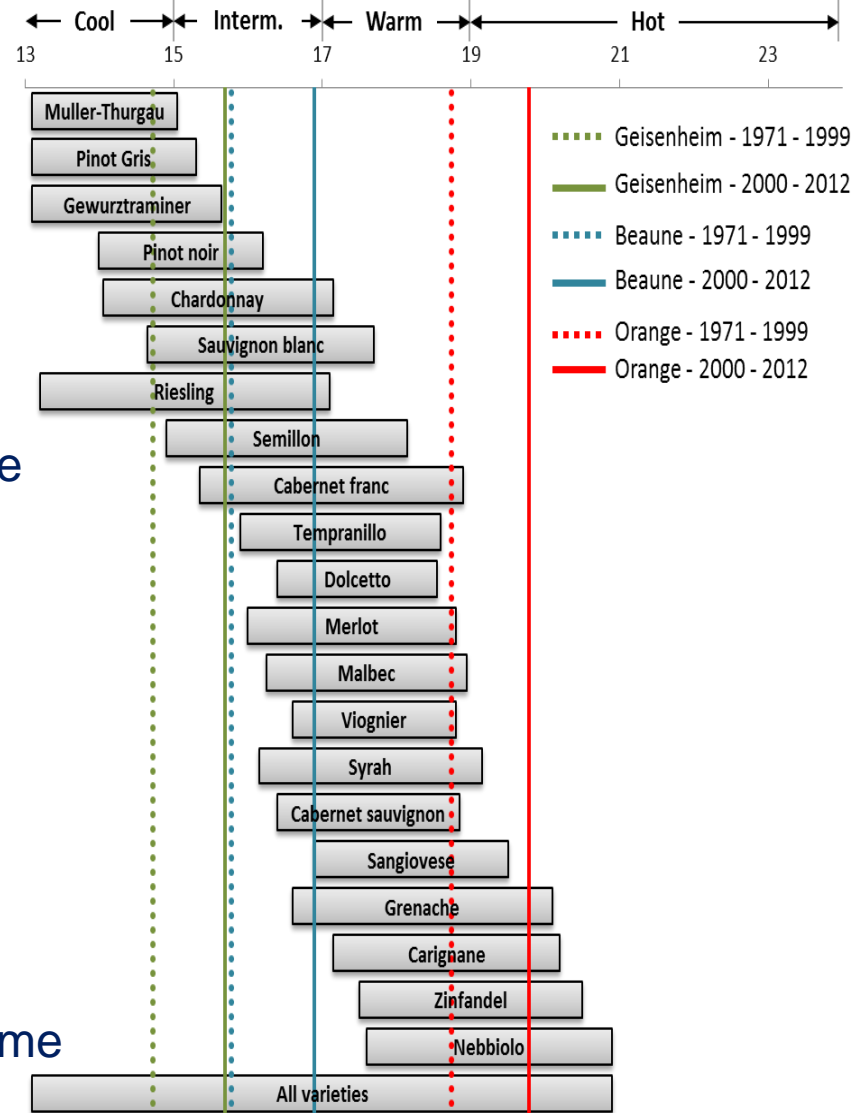
Malheiro et al., 2010



# Adaptation is a key issue

- ✓ Climate change is a challenging issue for grape growing
- ✓ Suitability of regions may change
- ✓ Positive for some, negative for others
- ✓ Phenology, Yield, Water relationships, Ripening, Host-pathogens will be affected
- ✓ Viticulture and winemaking is a matter of adaptation for a long time

Average Growing Season Temperature (NH Apr – Oct; SH Oct-Apr)





# **LACCAVE : Long term impacts and adaptations to Climatic Changes in Viticulture and Enology**

## **Objectives:**

- 1- to predict at a long term scale, the impacts of climate change on grape growing and wine making,**
- 2- to build-up the knowledge necessary to develop innovations allowing the required adaptations,**
- 3- to propose adaptation strategies at the level of the wine industry (including viticulture) and**
- 4- to evaluate their economic, sociological and environmental consequences.**
- 5- to structure the french research on this issue, in order to interact with the growers and wine industry, and to be part of the international network on CC.**

*“The set of actions and processes which societies must utilize to limit the negative impacts of changes and maximize their beneficial effects”*

Hallegate et al., 2011





Lab COSTEL - CNRS



UE Vigne et Vin



UMR Geolab,  
Univ. de Limoges



UMR EGFV  
USC GAIA  
USC Œnologie  
UMR SAVE  
UE Viticole



INSTITUT DES SCIENCES  
DE LA VIGNE ET DU VIN  
BORDEAUX-AQUITAINE



ISVV

UMR ALISS  
UMR SADAPT

UMR SVQV

CR de climatologie  
/biogéosciences,  
Univ. Bourgogne

US Agroclim

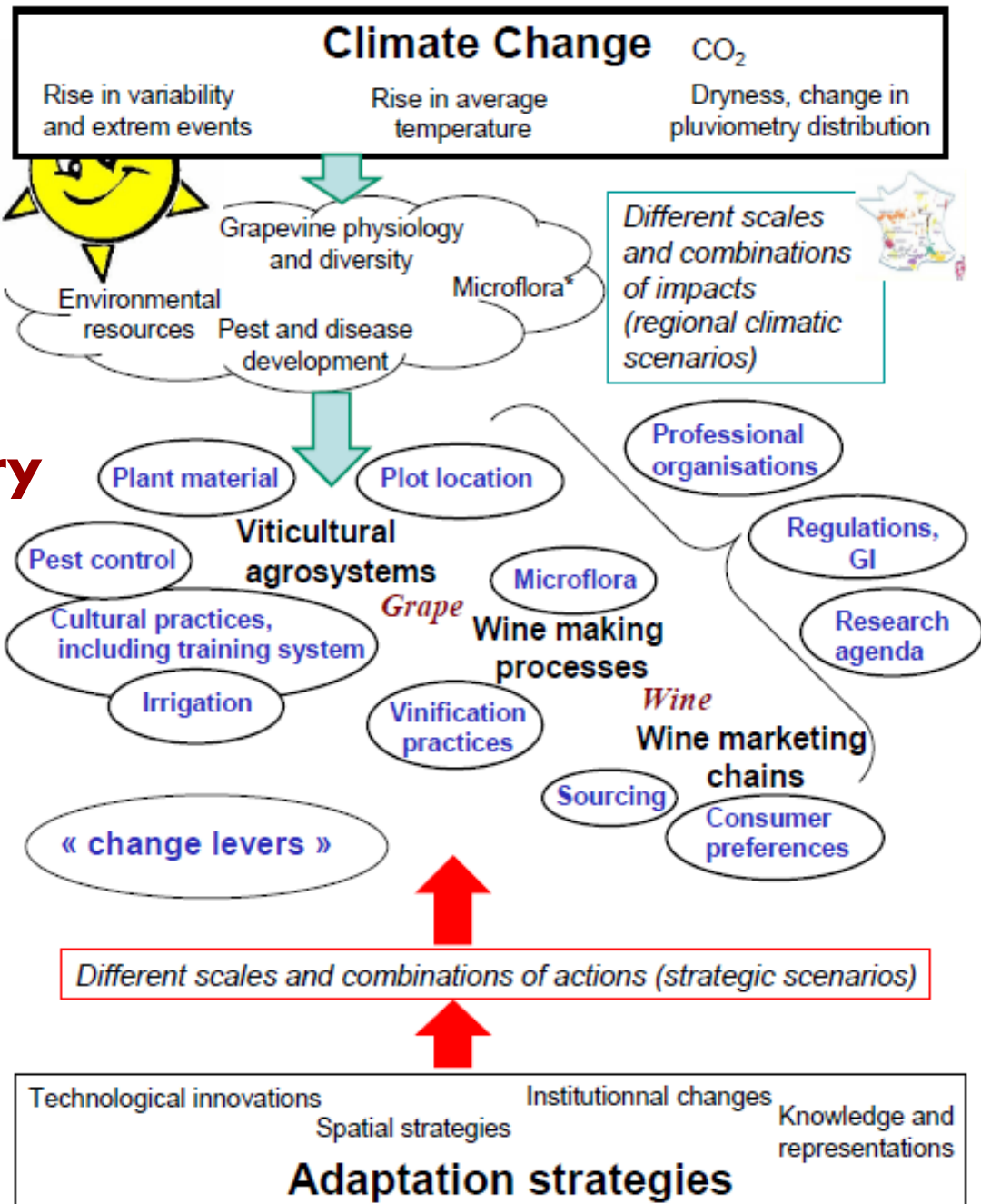
UMR Innovation  
UMR LEPSE  
UMR SPO  
TGU AGAP  
UMR LISAH  
UMR System  
UMR MISTEA  
UMR MOISA

UE Pech Rouge  
UE Vassal

**23 french laboratories : climatology, agronomy, genetic,  
plant physiology, pathology, human sciences, economic,  
mathematics**



# A systemic and multidisciplinary approach



\* Only grape microflora will be considered in the project. Soil microflora is also a very important issue but won't be taken into account



# Lines of studies in LACCAVE project

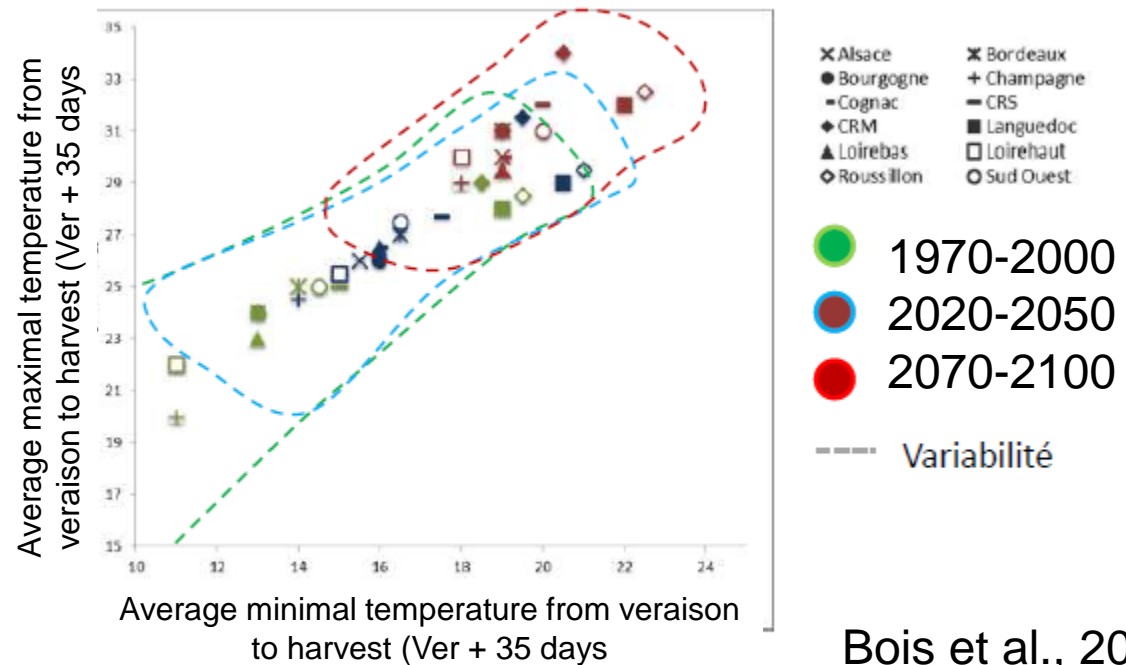
1. **Building a common knowledge and perception of CC**
2. **Modeling climatic scenarios at regional levels**
3. **Physiological and genetic bases of key adaptation traits**
4. **Innovative practices to adapt to CC**
5. **Innovative systems in territories**
6. **Economical impacts of CC and adaptation**
7. **Strategic scenario of adaptation**



# Modelling climatic scenario at different scales

## *Global to regional to local climatic models*

Example : maximal and minimal temperature during ripening



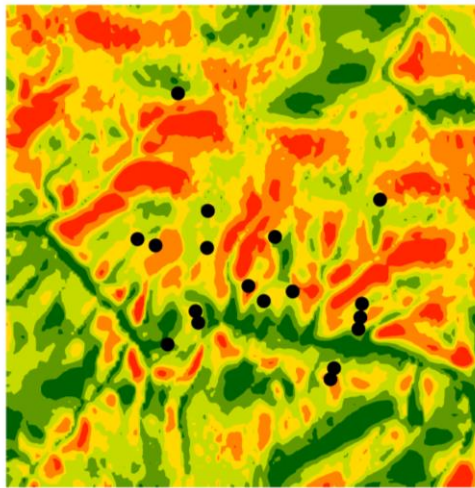
Bois et al., 2014

- In the future climatic conditions will overlap between regions and periods
- Decrease of temperature ranges between regions

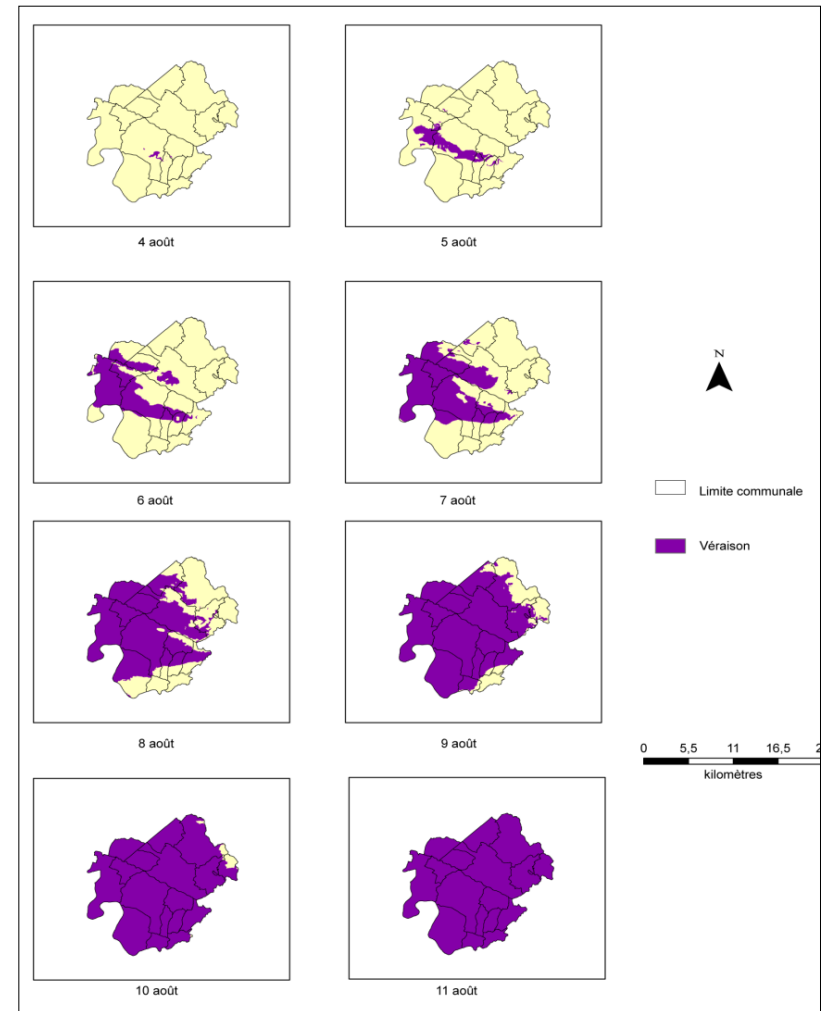
# Modelling climatic scenario at different scales

Agroclimatic indices at local scales (GFV)

Loire Valley



Bordeaux area



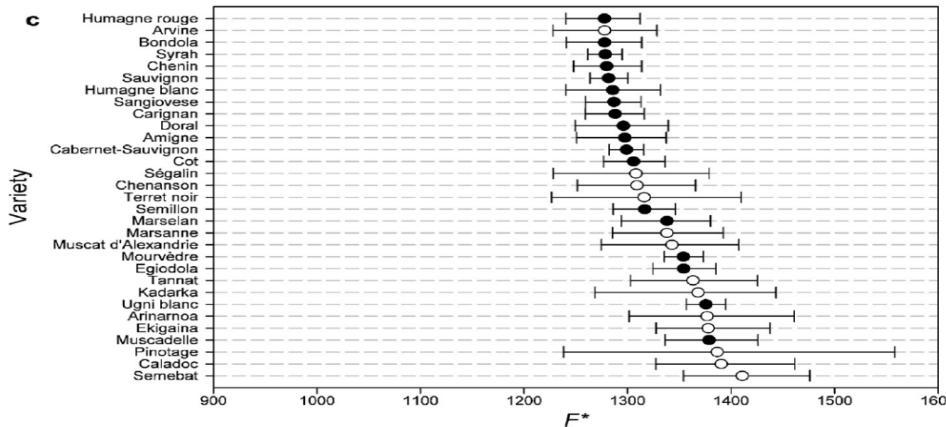
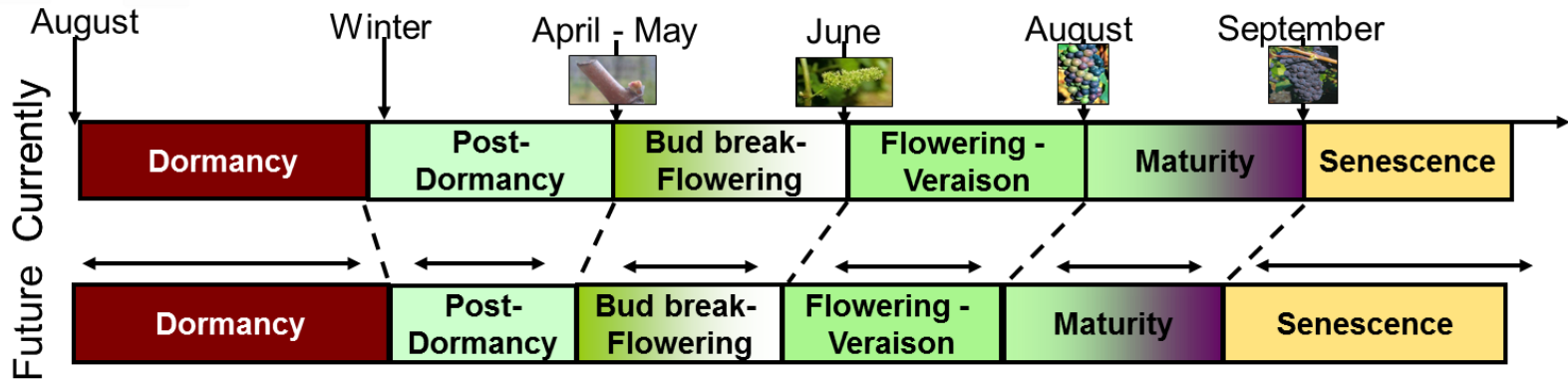
(Renan Leroux, 2013)



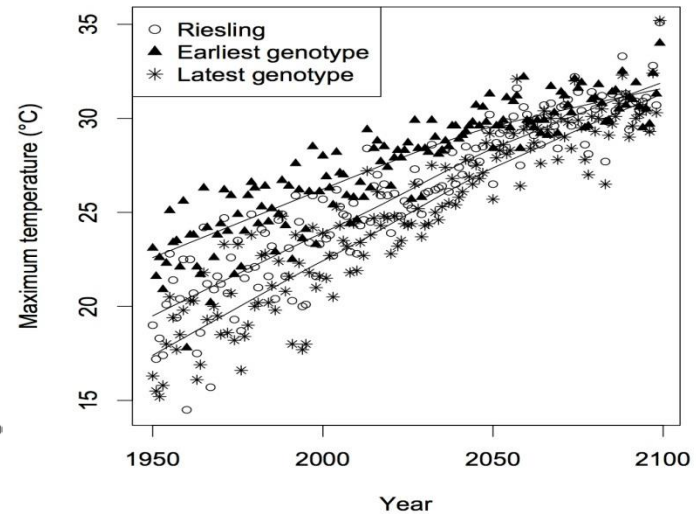


# Physiological and genetic bases of key adaptation traits

*Phenology as a key adaptative trait*



Parker et al., 2013



Duchêne et al., 2014



# Physiological and genetic bases of key adaptation traits

*How to sustain viticulture under drought conditions ?*



## Genetic diversity and improvement



⇔ understanding the mechanisms of transpiration adaptation to drought for scions and rootstocks

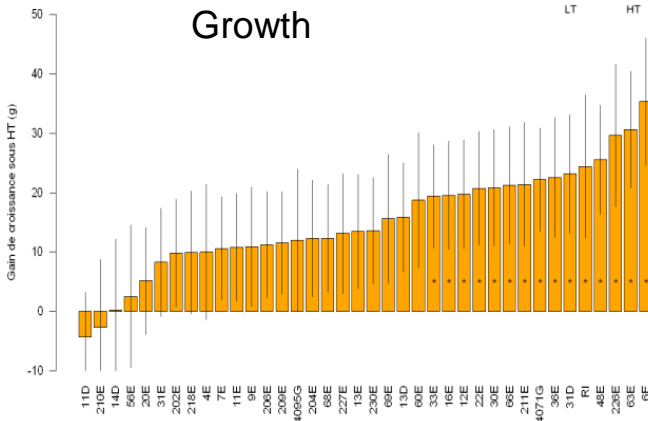
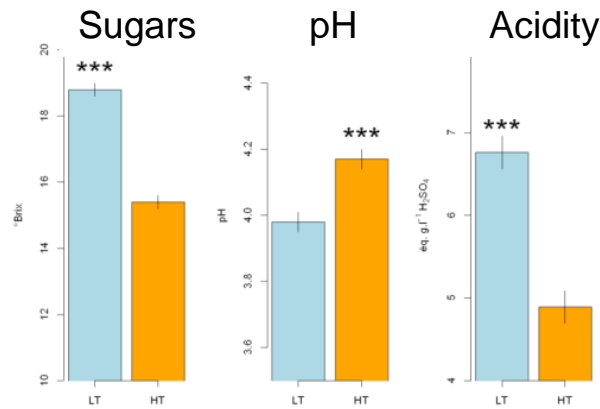
⇔ understanding their genetic determinisms to select or breed new cultivars



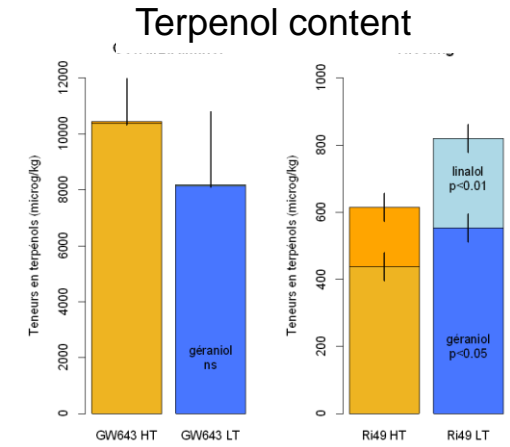
# Physiological and genetic bases of key adaptation traits

*Research on quality components and temperature effects*

- Effect of temperature on vegetative / reproductive equilibrium
- Acidity : genetic diversity , determinism, and effect of temperature
- Effect of temperature on aroma composition



Unpublished data from Duchêne



HT=21/30°C jour/nuit, LT=15/24°C jour/nuit

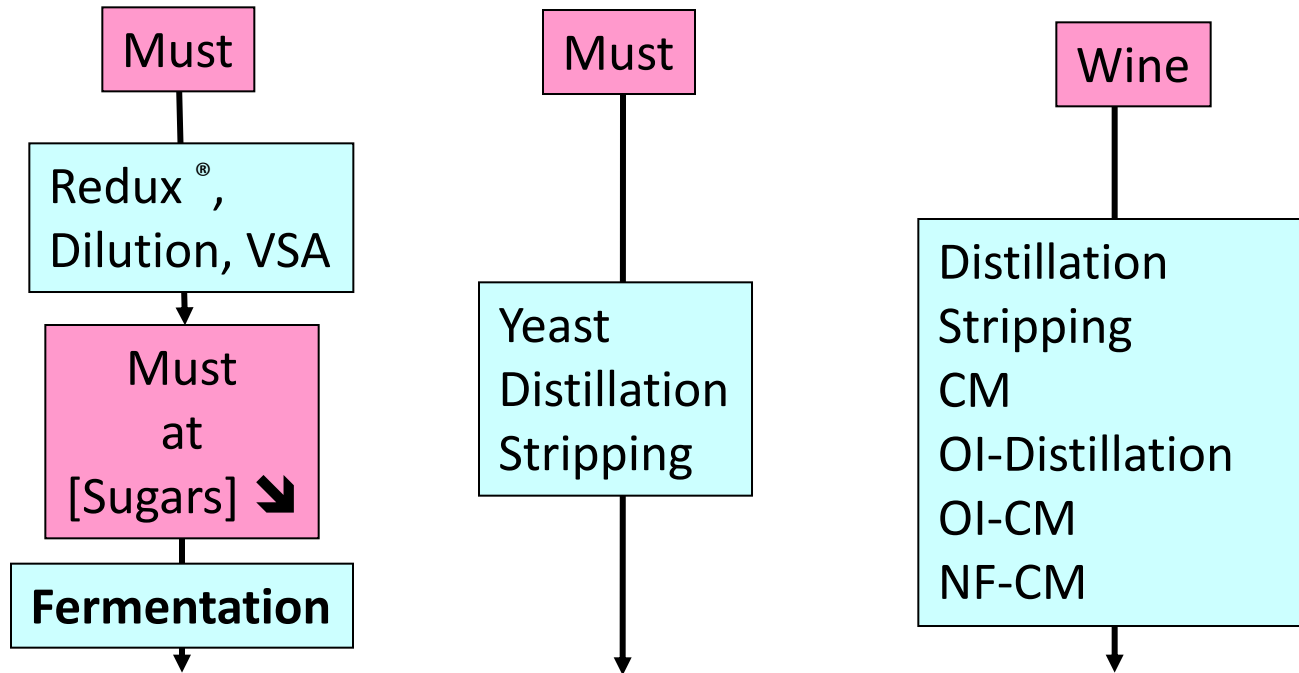


# Innovative practices to adapt to CC

*In the cellar*

Modified balance: High sugar, low acidity and high pH, modified composition

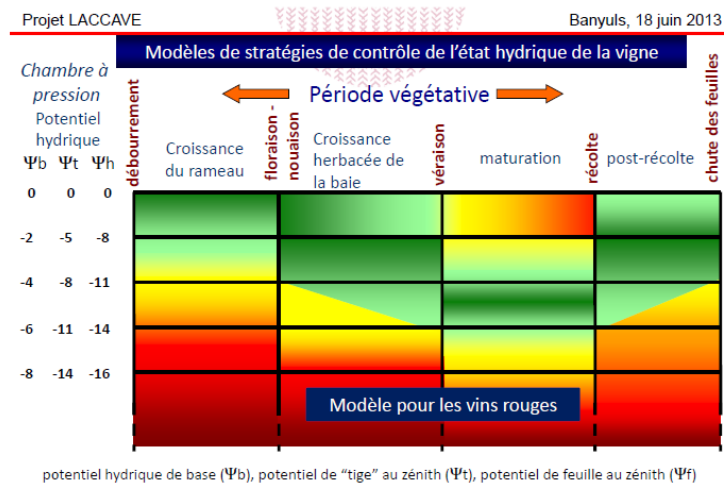
Control of alcohol content



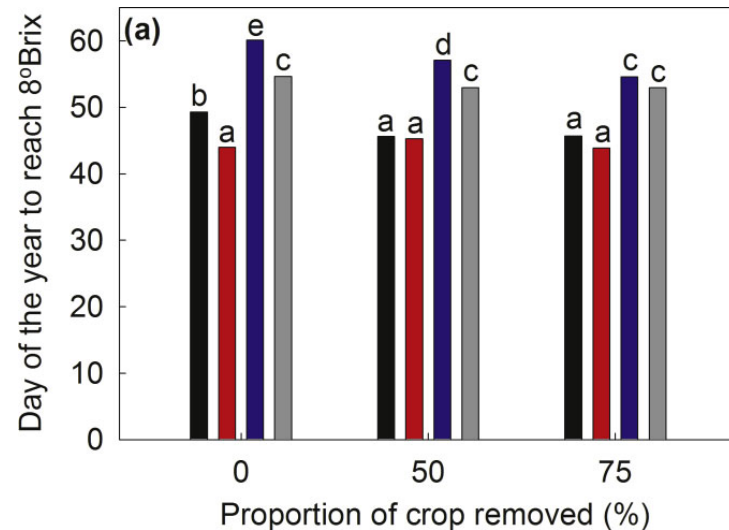
# Innovative practices to adapt to CC

## In the vineyard

	Short term	Middle term	Long term
Plot	Canopy management Soil management Irrigation	New clones, and rootstocks, harvest dates, training systems, plantation dates Irrigation Soil management	New varieties Training systems Stop or new plots
Estate	Enological practices Equipments against frost and hail, labor and harvest management	New rootstocks and more adapted varieties. Overgrafting, New types of wines Better allocations of plots within the estate	New plots New equipments in the winery Improvement of water management and alternatives sources of water
Terroir, small growing region	Variability analyses Modelling of practices Observatories New oenological and harvest practices (cooperative)	New reglementations for AOC/IGP productions Regulation for irrigation Relocalisation within AOC areas,	New zoning for appellations. Equipment for water ressources Relocalisations



Ojeda et al., 2013



Barbeau et al., 2014

Parker et al., 2014

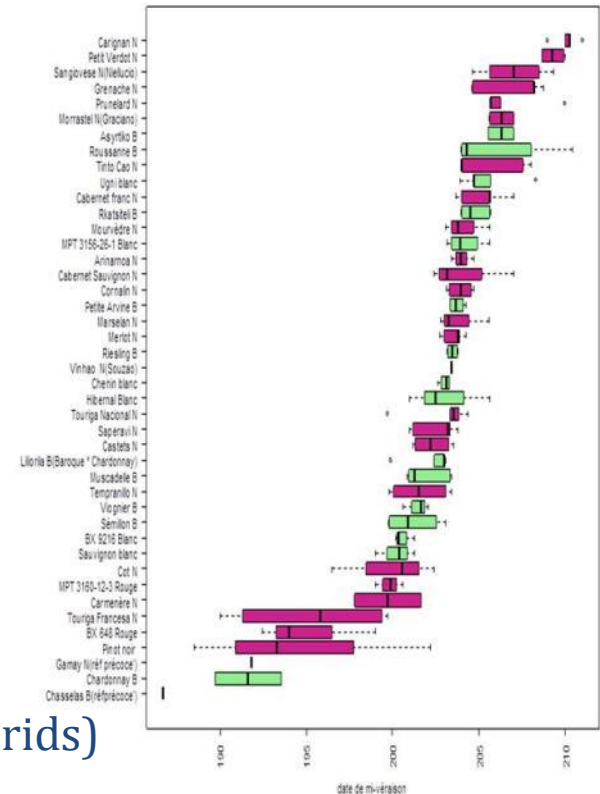
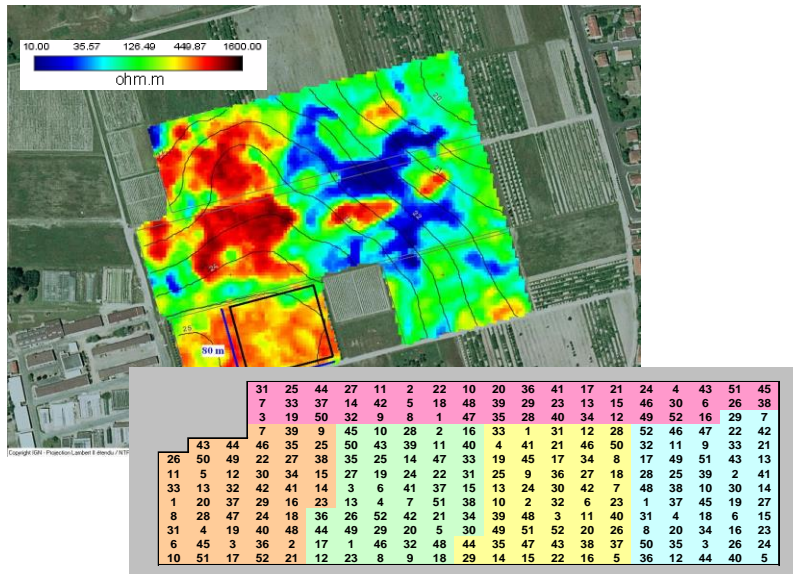
# Innovative practices to adapt to CC

## New plant material

Scions and rootstocks : existing variability or breeding new cultivars  
 > late varieties, low sugar, resilient to high temperature, adapted to drought, resistant to diseases, suitable to elaborate specific types of wines

Phenology  
 (date mi-veraison 2011)

Field experiment with exogeneous varieties in Bordeaux



52 varieties (20 whites, 32 red including, 5 hybrids)



# Innovative systems in territories

*What are the drivers of grower choice in term of adaptation practices ? Which consequences on environment ?*

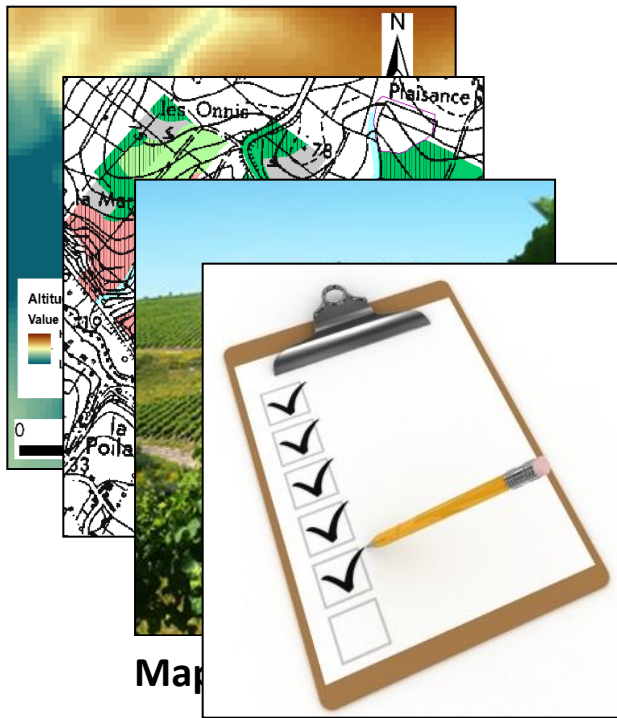
Analyses of the interactions between human activities, bio-physic components of the system and socio-economic parameters

- To model vine development in relation to environmental and climatic constraints
- To model human activities according to climate and vine development
- Model the effects of adaptation practices on soil water balance
- Evaluation the perception of climate change by the actors and their capacity to change and adapt,.



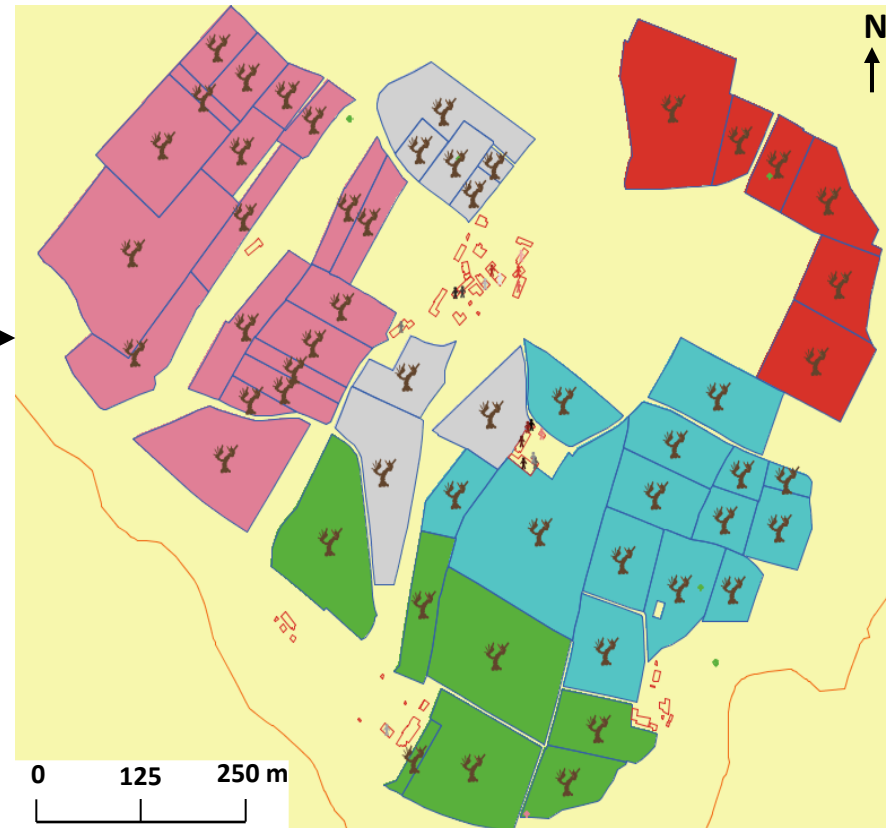
# Innovative systems in territories

*An example : a model prototype in Loire Valley*



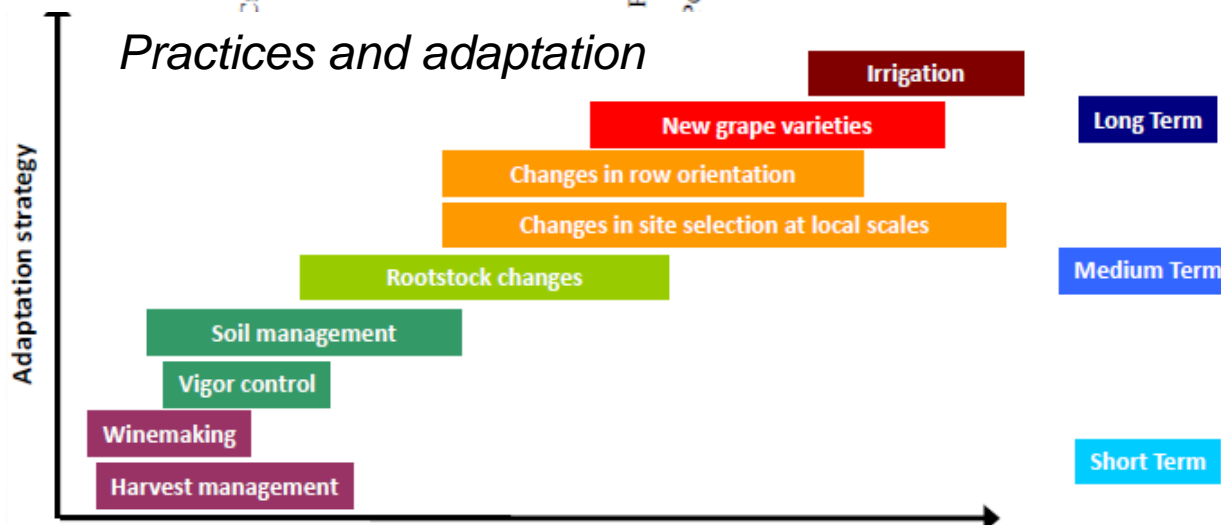
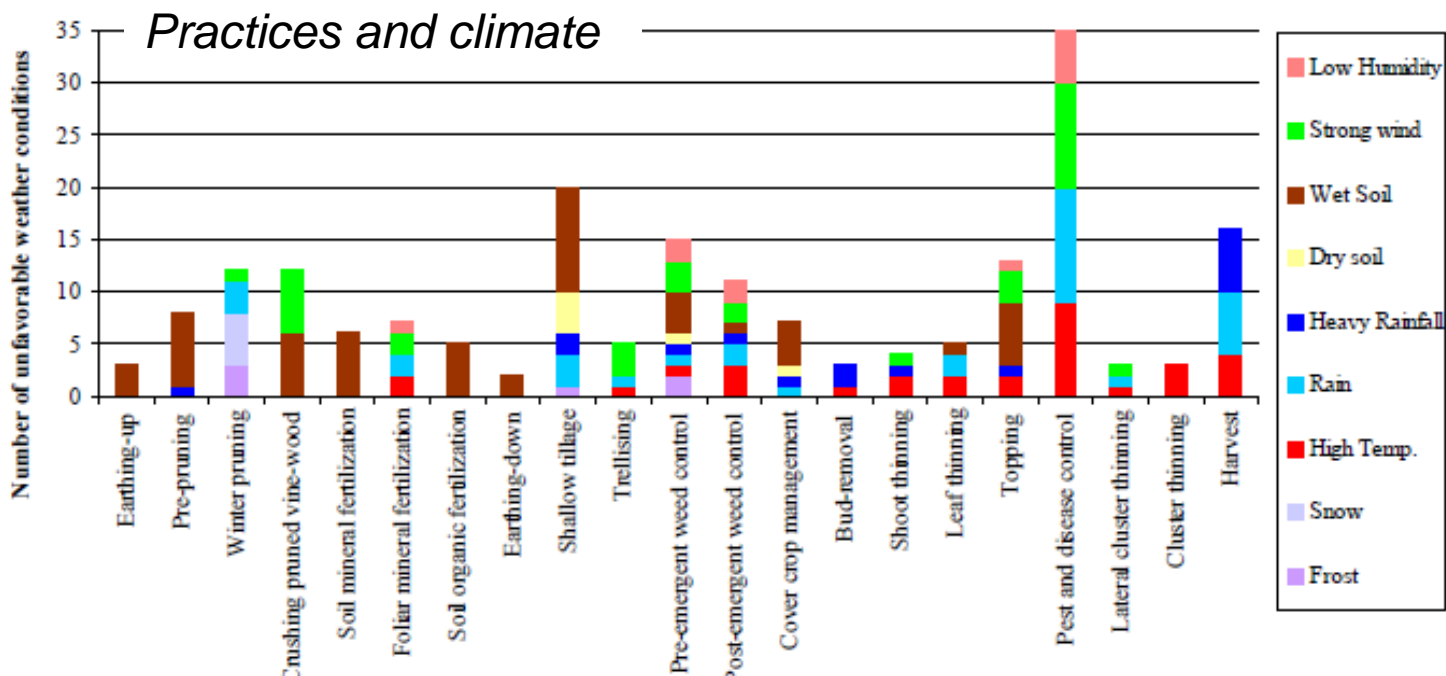
Map

Survey with growers  
about their practices



Neethling et al., 2014

# Innovative systems in territories





# Economical impacts of CC and adaptation



*Production activities*

to gather information and develop economical models **to evaluate the economical impacts of climate change**

- 1- Technical efficiency assessment in relation with climate change, especially for the plant protection strategies
- 2- Development of a bioeconomic model at the property level, which includes specific parameters to assess climate change effects and adaptation strategies
- 3- Combine crop model with economical models

# Economical impacts of CC and adaptation



*Consumption*

**Analyses of the perception and behaviour** regarding the new wine styles defined as « CC wines ». Consequences on wine marketing strategies and wine market

1- Sensory analysis: Organoleptic characterisation of wine traits related to climate change. Determinism of acceptance for these new wine styles

2. Experimental economy : Evaluation of the willingness to pay for these new wines, according to the available information, external and internal traits. Analyses of consumer choices taking into account internal characteristics and external influences.



# Strategic scenario of adaptation

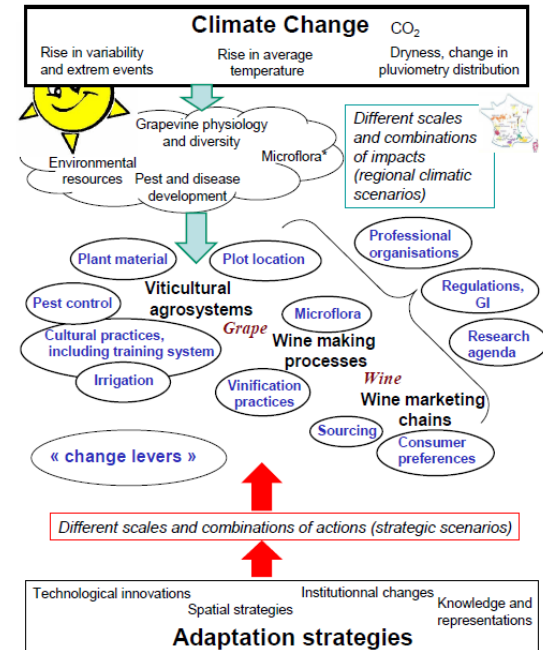
## 1. Different ways of adaptation

- Technical innovation technique, one by one vs as a system
- Infrastructures
- Localisation
- Organisational and reglementations changes
- Human capacity building

## 2. Different scales

- Vineyard, estate, winery
- Terroir, small region
- Production bassin (grower associations)
- National, International

## 3. Different time scales: short, medium, long term



\* Only grape microflora will be considered in the project. Soil microflora is also a very important issue but won't be taken into account



# Strategic scenario of adaptation

*Which are the main strategies ?*

## 1. No changes

## 2. Conservatory strategy

To keep the reglementary frame, incremental innovations, constant zones of productions

## 3. Innovation to stay

Abrupt innovations (for example new varieties), to remain at the same place

## 4. Nomad viticulture

New vineyards according to climatic borders. New terroirs and new definition of terroirs

## 5. Liberalisation

We plant where and how we want !



# Conclusions

- ✓ Climate change is a challenging issue
- ✓ Frame to re-analyse the relationship between grape production and climate
- ✓ Frame to consider changes and adaptation from a general point of view
- ✓ Multidisciplinary research is required

**Thank you for your attention**

