Climate change impacts on viticultural yields in Europe using the STICS crop model

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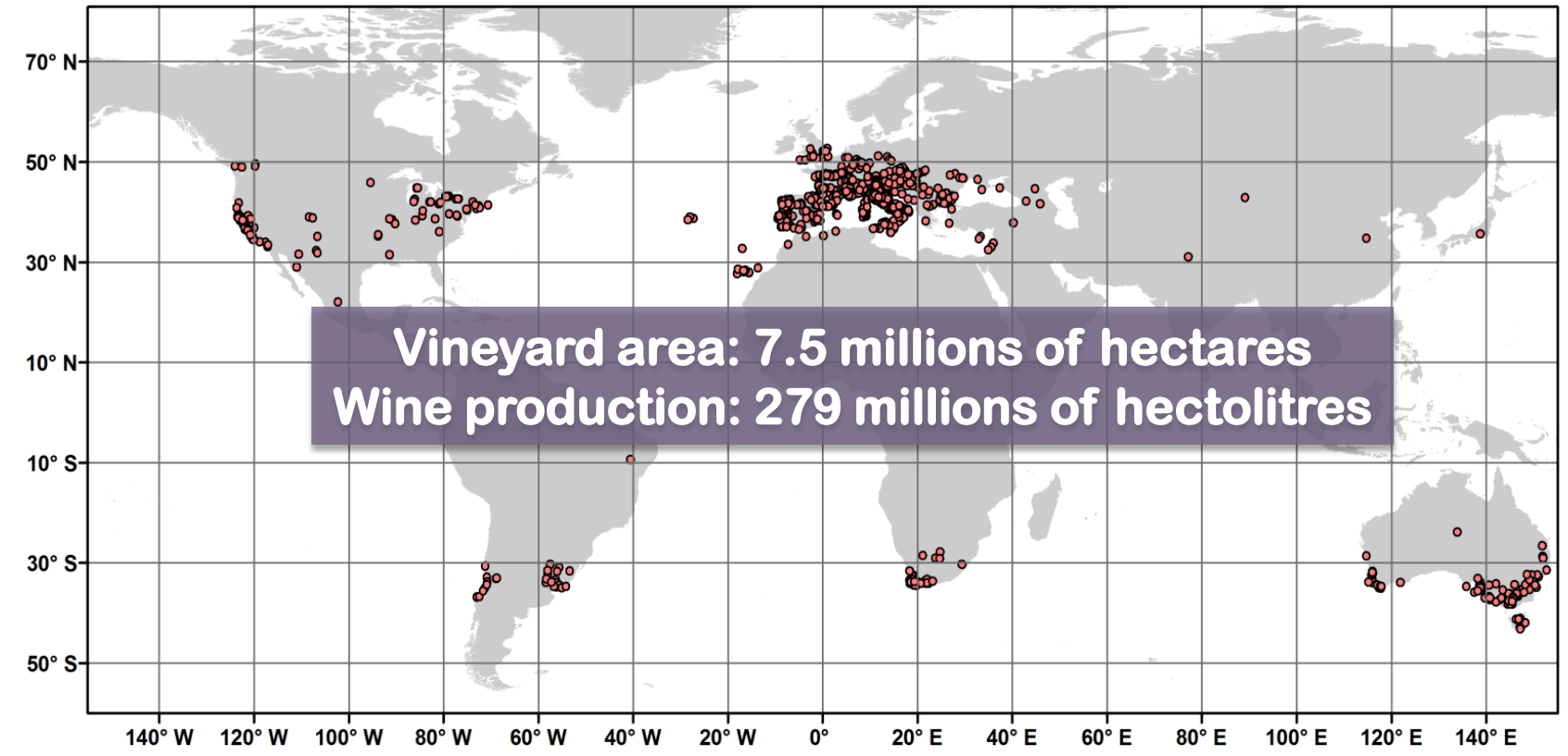
Main world winemaking regions



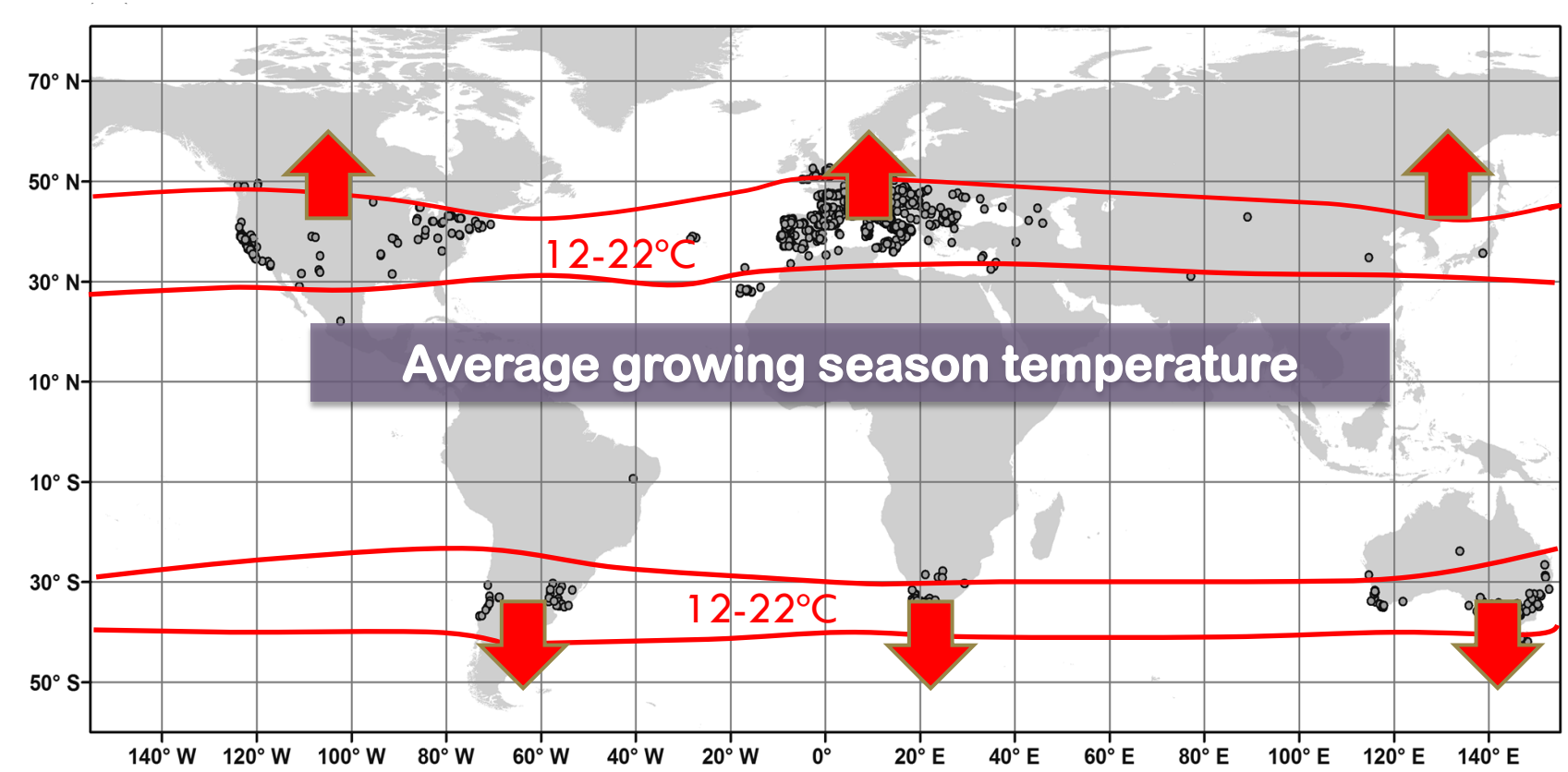
Top 15	Wine Prod. (10^6 hl)	Vineyard Area (10^3 ha)
France	46698	792
Italy	44739	690
Spain	41620	1021
USA	22300	425
Argentina	15197	227
Australia	12000	152
South Africa	11316	132
China	11178	799
Chile	10500	211
Germany	9334	102
Portugal	6195	224
Romania	4093	192
New Zealand	3204	38
Greece	2900	110
Hungary	2734	65

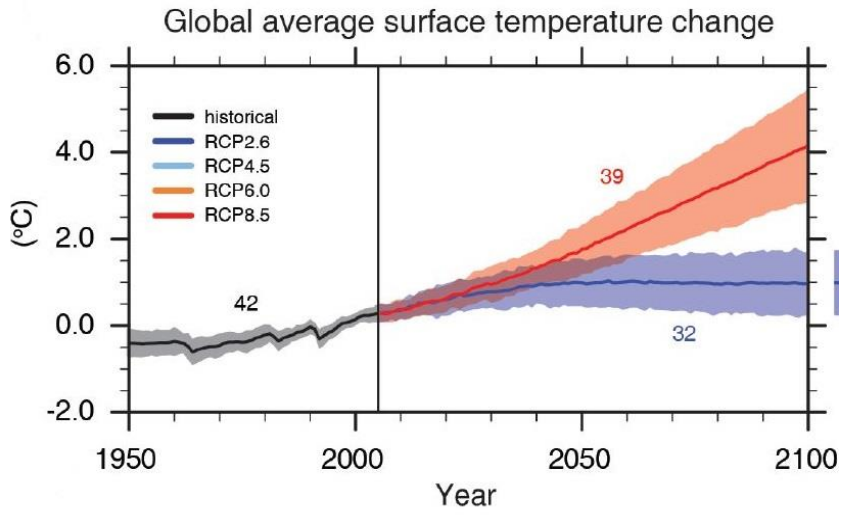
Wine production:

Europe: 65% **America: 20%** **Oceania: 6%** **Africa: 5%** **Asia: 5%**

***OIV, 2015**

Climate change?



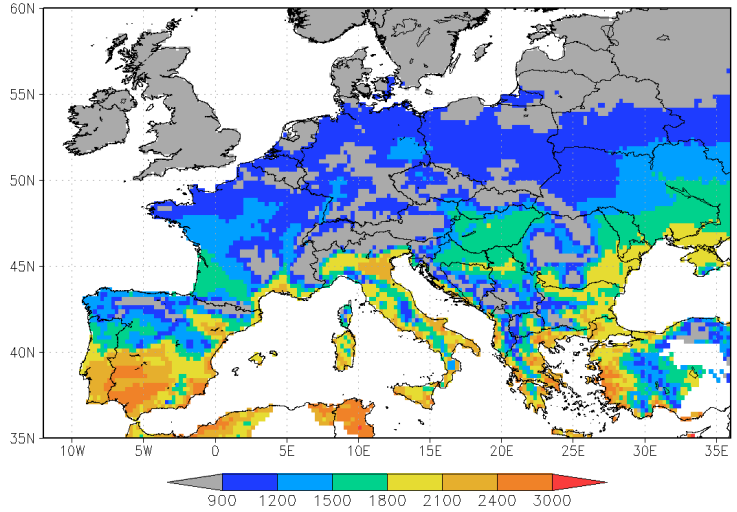


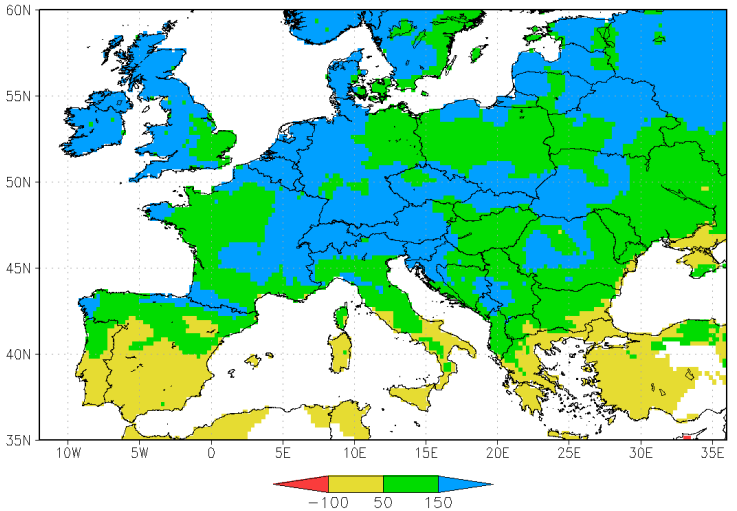
Increase in global temperature: 1 to 4°C (**depending on the scenario**)

*IPCC, 2013

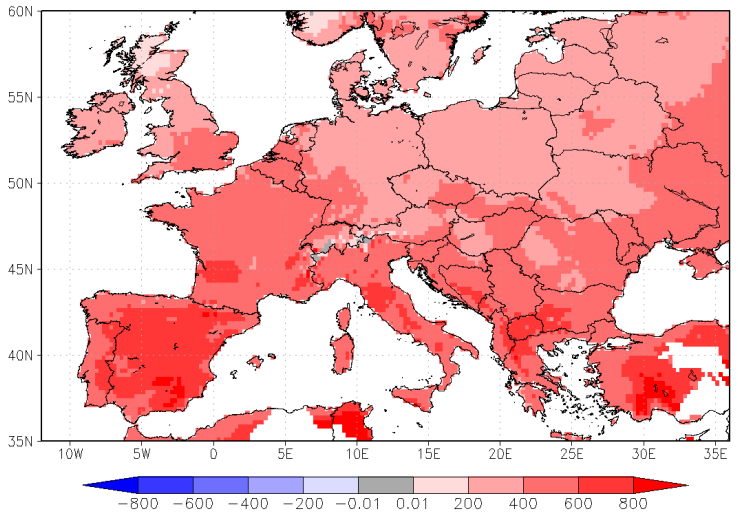
Climate change risks

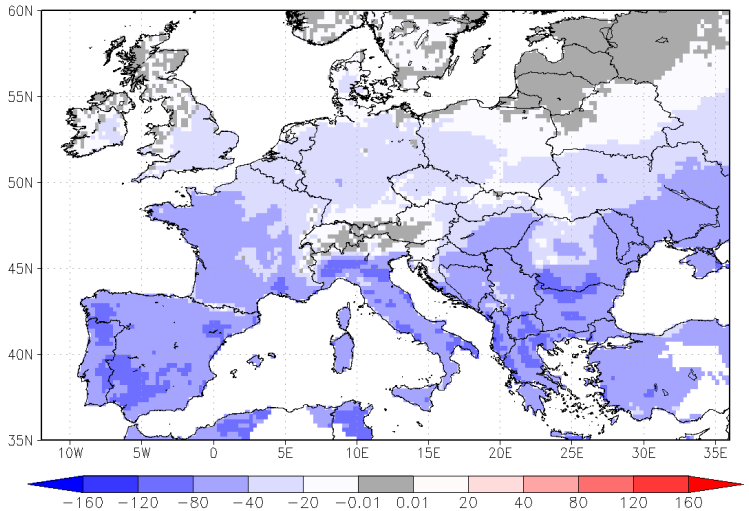
Recent-Past





2041-2070 Difference





- Increase in thermal accumulation
- Increase in extreme temperatures
- Increase in dryness conditions
- …

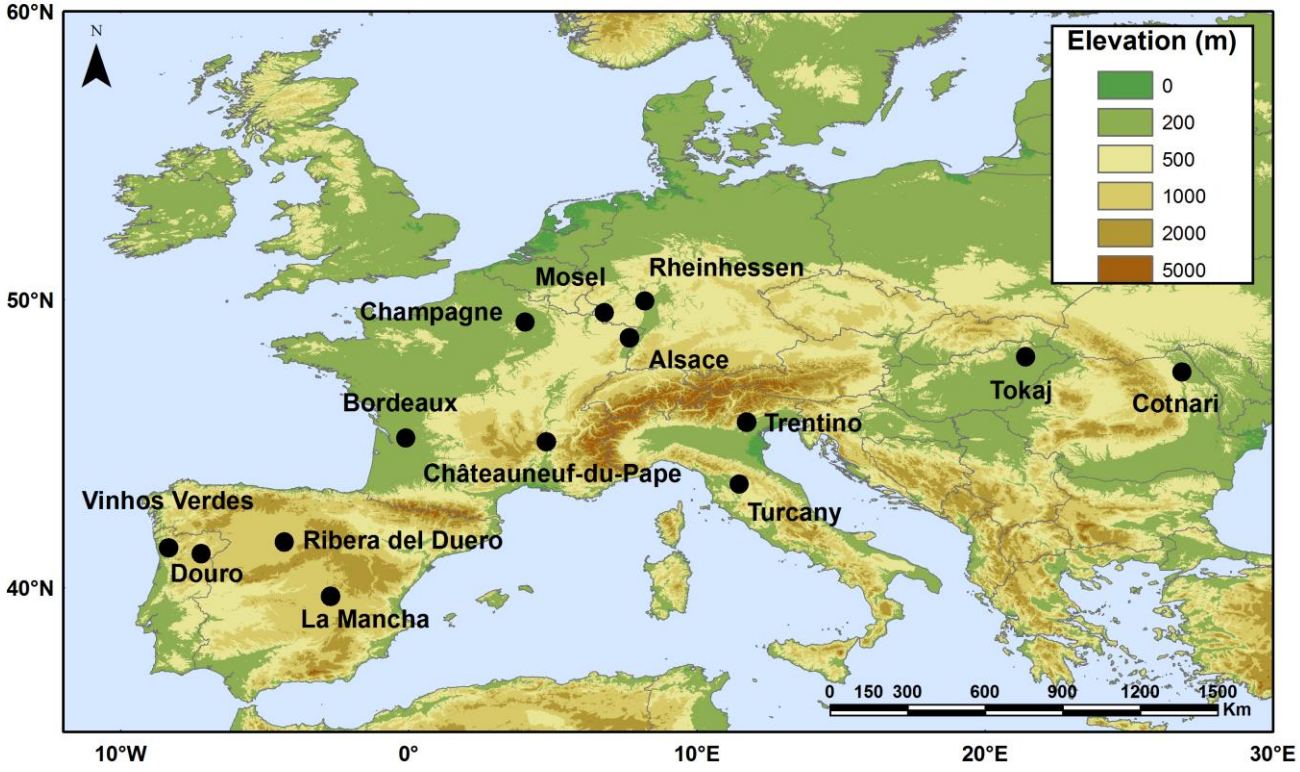
Fraga et al. 2013

Previous studies (some examples)

- For Bologna (Italy), Bindi et al. (1986) projected yield increases under future scenarios;
- Douro region in Portugal (western sub-region), Santos et al. (2013) projected a net increase in productivity for 2100;
- For France, Brisson & Levrault (2010) project positive yield trends for the future;
- Moriondo et al. (2011) predicted a decrease in yields in Tuscany (Italy);
- Many other studies focused on phenology, growth, etc. under climate change scenarios.

Implications for viticulture

- Yields
- Phenology
- Varietal suitability
- Land use
- Manadgment practices
- Soil characteristics
- Quality atributes?



How will climate change affect the spatial variability in Europe?

STICS crop model

Main principles

Main inputs

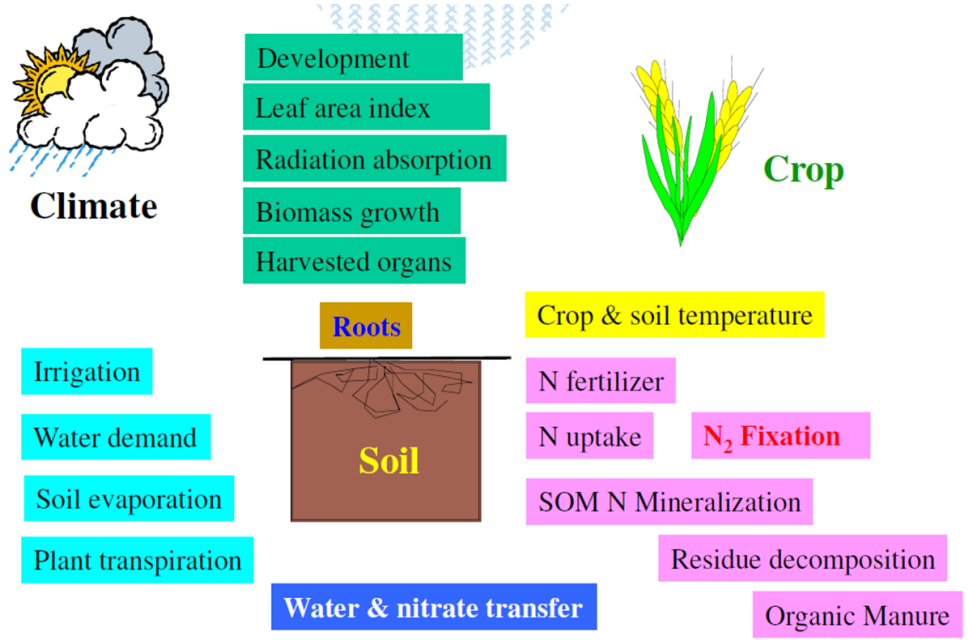
Daily Weather

Crop Management

Soil characteristics

Crop species (cultivar)

Initial status of the system



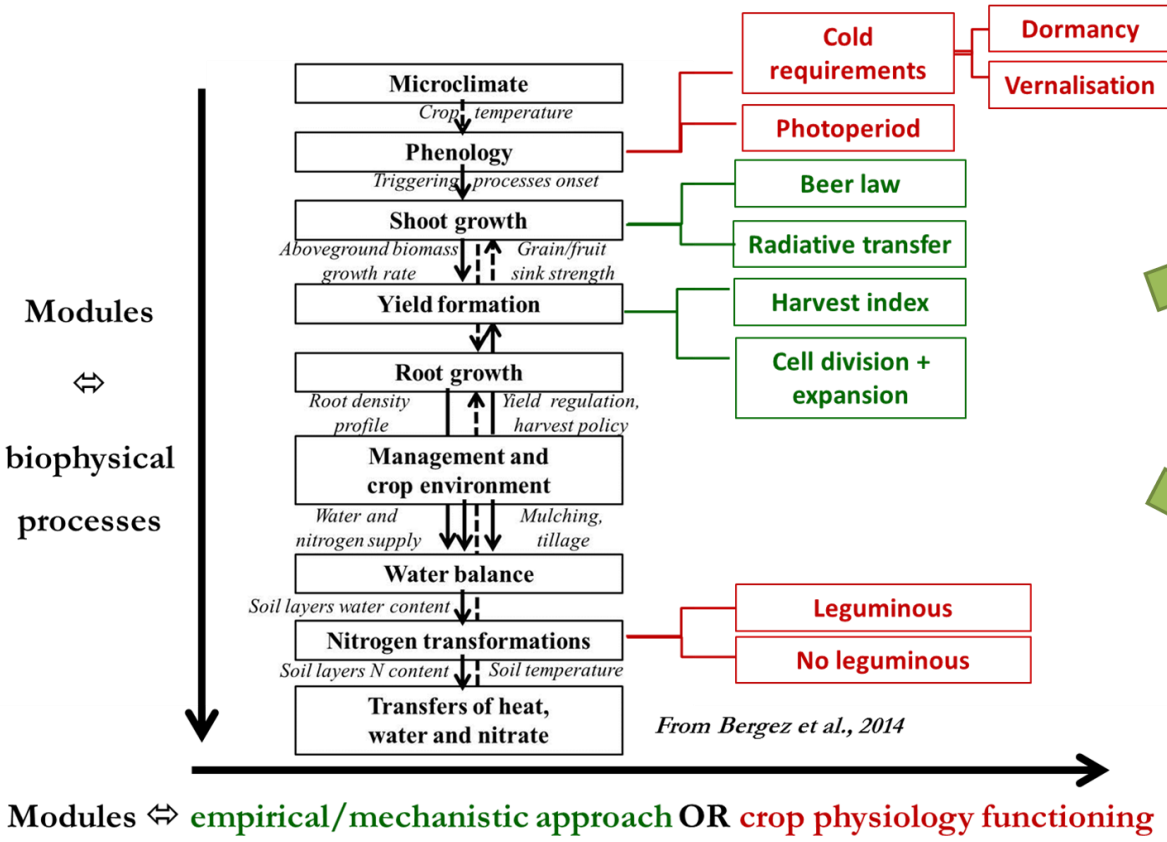
- All the processes simulated at a day-time scale
- In interaction with technical acts at the rotation scale

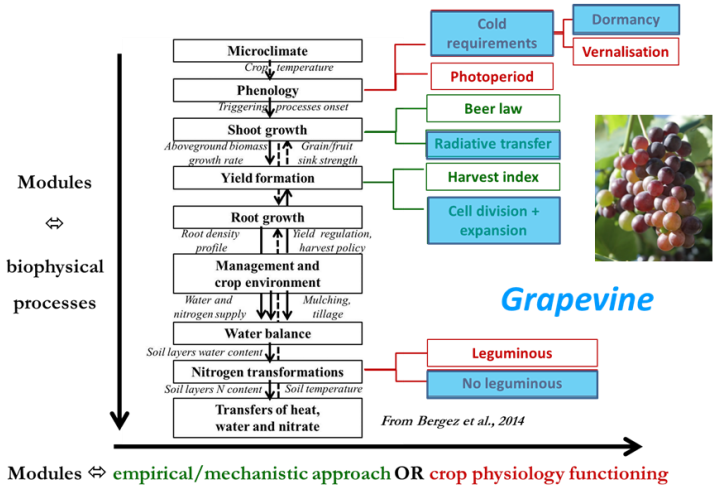
Main Outputs

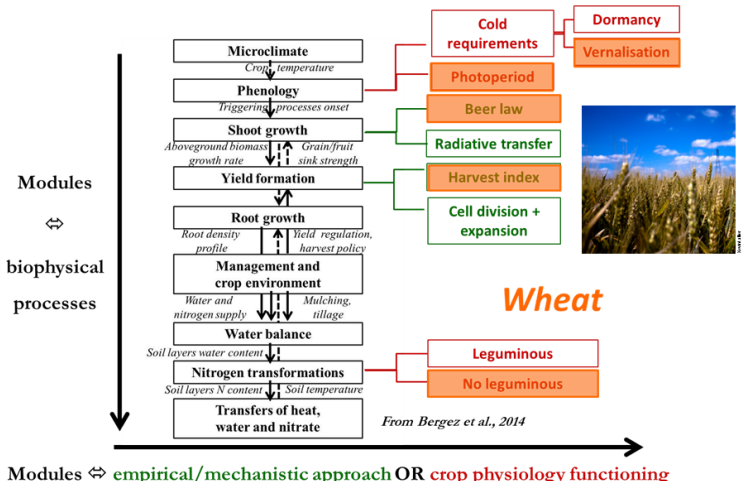
Crop microclimate
Phenology
Growth
Root growth
Yield components
Modification of soil
Water stress index
Nitrogen stress index
Frost
High temperature
Anoxia index

STICS crop model

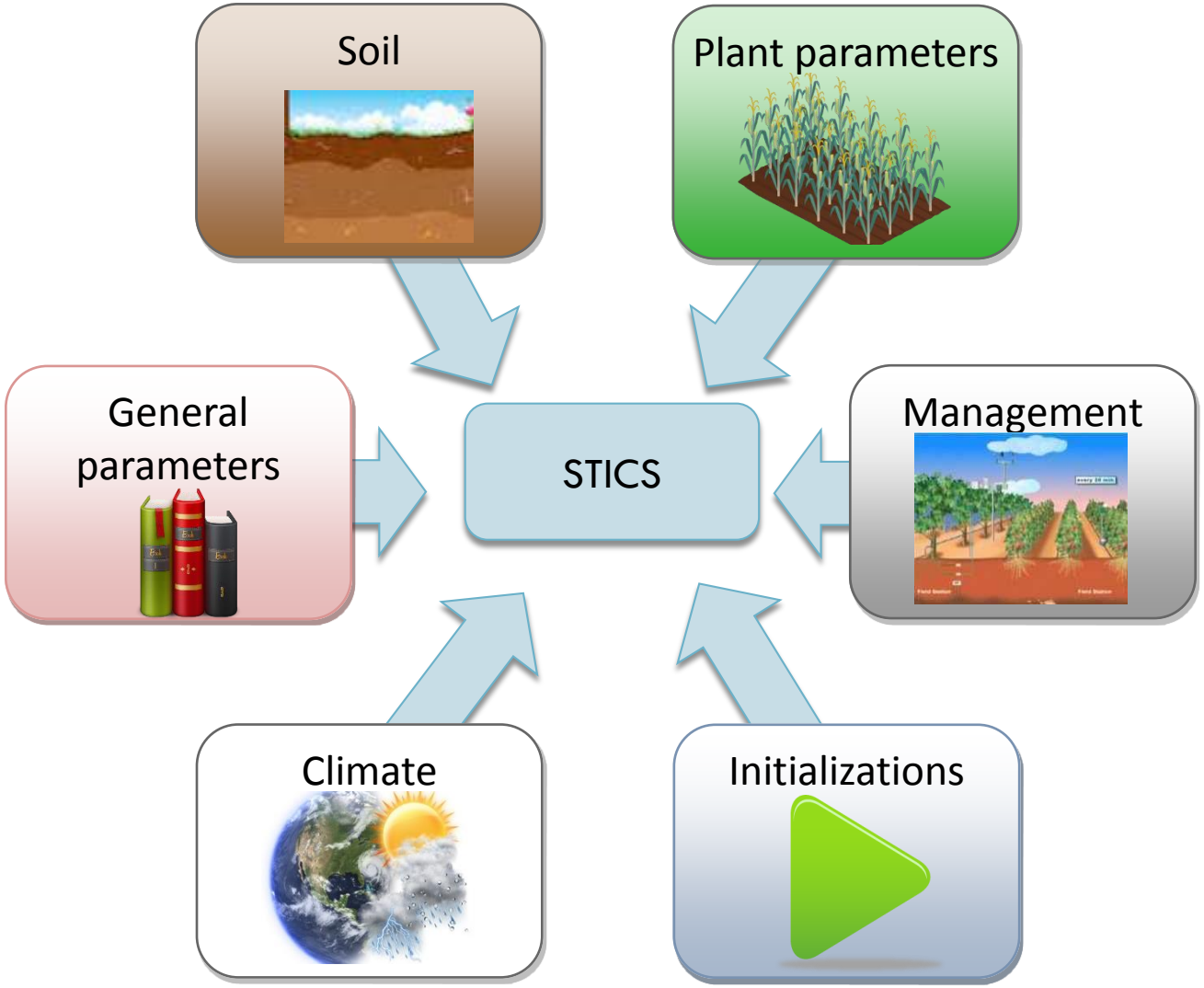
Conceptual modularity

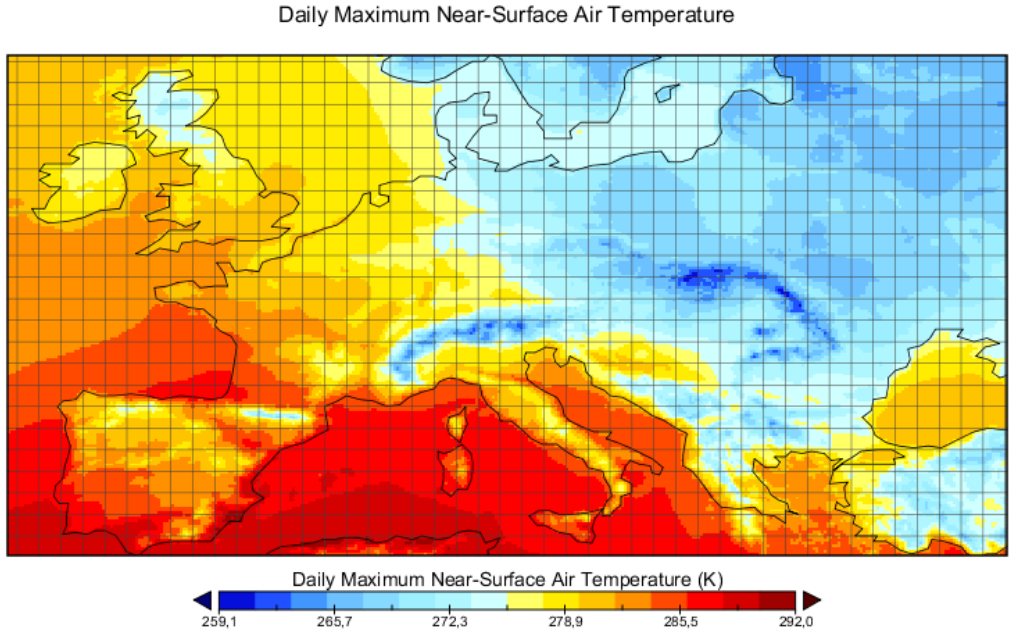






Spatial data at European level





Inputs

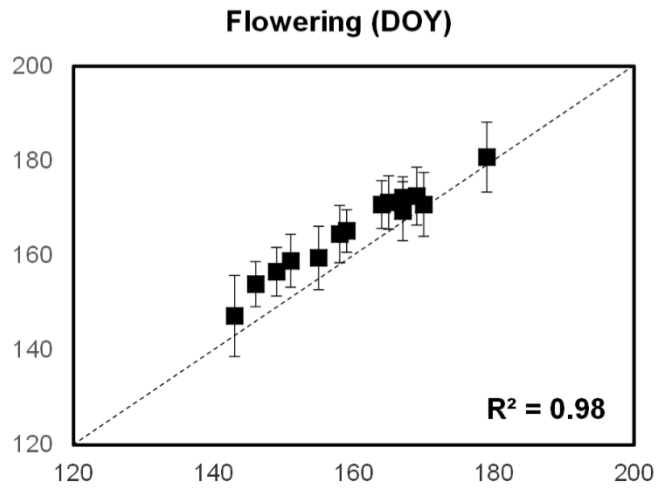
- **Gridded daily climatic data (Euro-Cordex);**
- **Soil characteristics (USDA – Soil database);**
- **Optimized management practices;**
- **Selected grapevine variety (Pinot-Noir);**
- **Future projections under RCP4.5 and 8.5.**

Main results

- For 1950-2000, the crop model shows lower yields in Southern Europe and higher yields in more central/northern regions.
- For 2041-2070, the results depict an increase in yield in the later regions, and a decrease in the former, mostly over inner Iberia.
- The projections also show a northwards extension of the potential grapevine growth areas, emerging new potential winemaking regions up to 55°N.

Limits

- In order to study impacts on different vineyards and define adaptation strategies we need to describe local practices (density, variety, type of wine…)
- In this study we only use one variety with one field protocole.
- Simulations are time consumming – One average year



Conclusion & Perspectives

- Climate change will impact all vineyards in Europe with different intensity
- Crop models are a powerful tool for evaluating impacts on growth and development, even if in some cases they need a lot of resources
- Adapting and testing crop models locally can allow to improve them and test adaptation strategies to climate change

Thank you!

References:

Fraga et al. 2015. Modeling Phenology, Water Status, and Yield Components of Three Portuguese Grapevines Using the STICS Crop Model. Am J Enol Vitic, 66(4): 482-491.

Fraga et al. 2016. Climatic suitability of Portuguese grapevine varieties and climate change adaptation. Int. J. Clim., 36(1): 1-12.

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Outputs and limitations

Outputs

- **Yield;**
- **Phenological timings;**
- **Alcohol content;**
- **Biomass/leaf area índex;**
- **Nitrogen stress;**
- **Water stress;**
- **...**

Limitations

- **Vineyard microclimatic condition;**
- **Multiple varieties;**
- **Different cultural practices;**
- **Extreme events;**
- **Plant diseases;**
- **Regional policies (yield enforcements);**