LIÈGE université
Gembloux
Agro-Bio Tech

PATHWAYS TO CLIMATE RESILIENT AGRI-FOOD SYSTEMS IN BELGIUM

What Climate Change Means for Belgian Agriculture: Insights from Modeling Projections in Wallonia

C. Lacroix, J. Bindelle & B. Dumont

https://inondations.wallonie.be/home/ruissellement/ruissellement-naturel-et-en-zone-rurale/ruissellement-erosion-et-coulees-de-boue.html

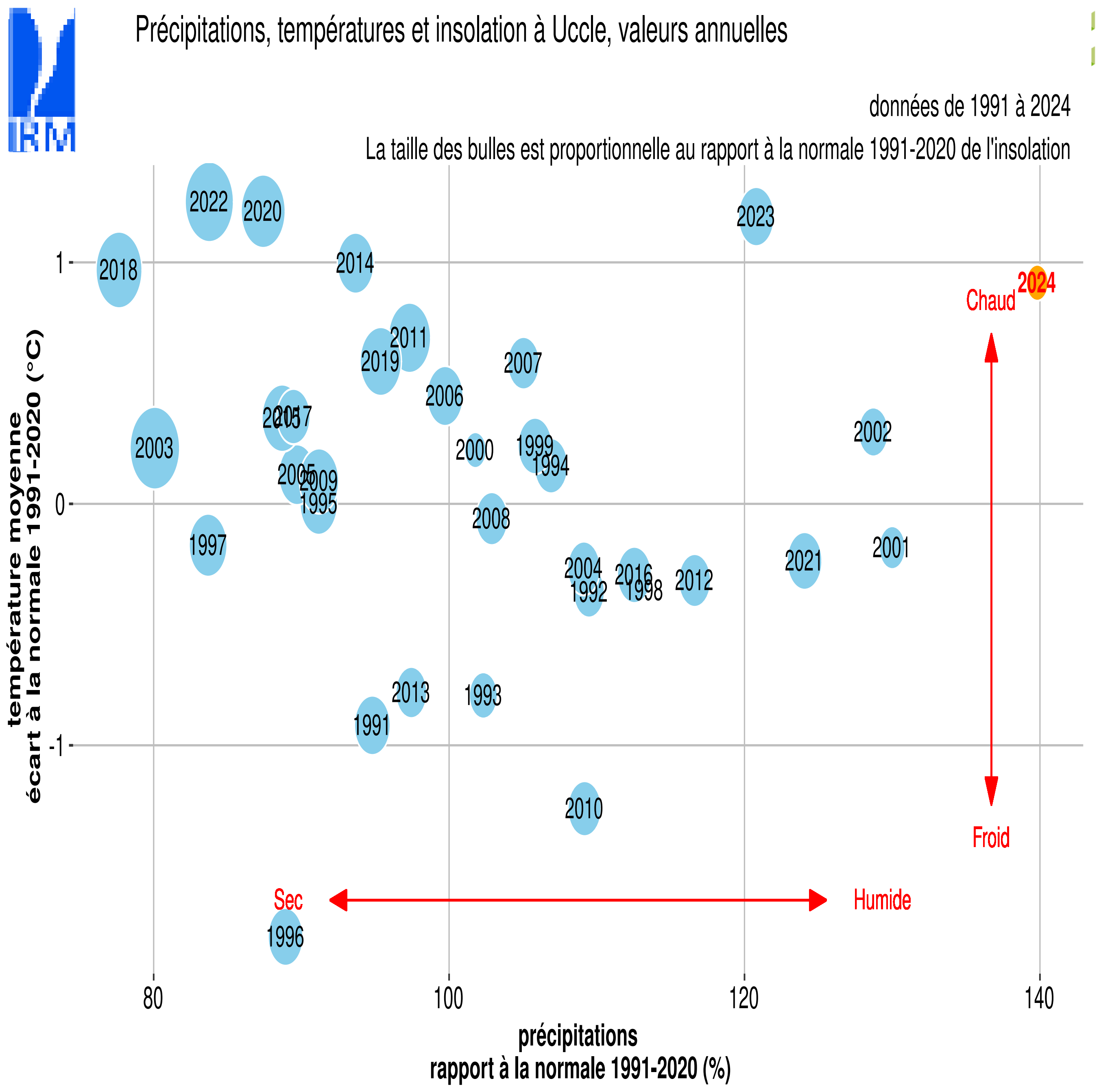
https://environnement.wallonie.be/home/gestion-environnementale/risques-climatiques.html

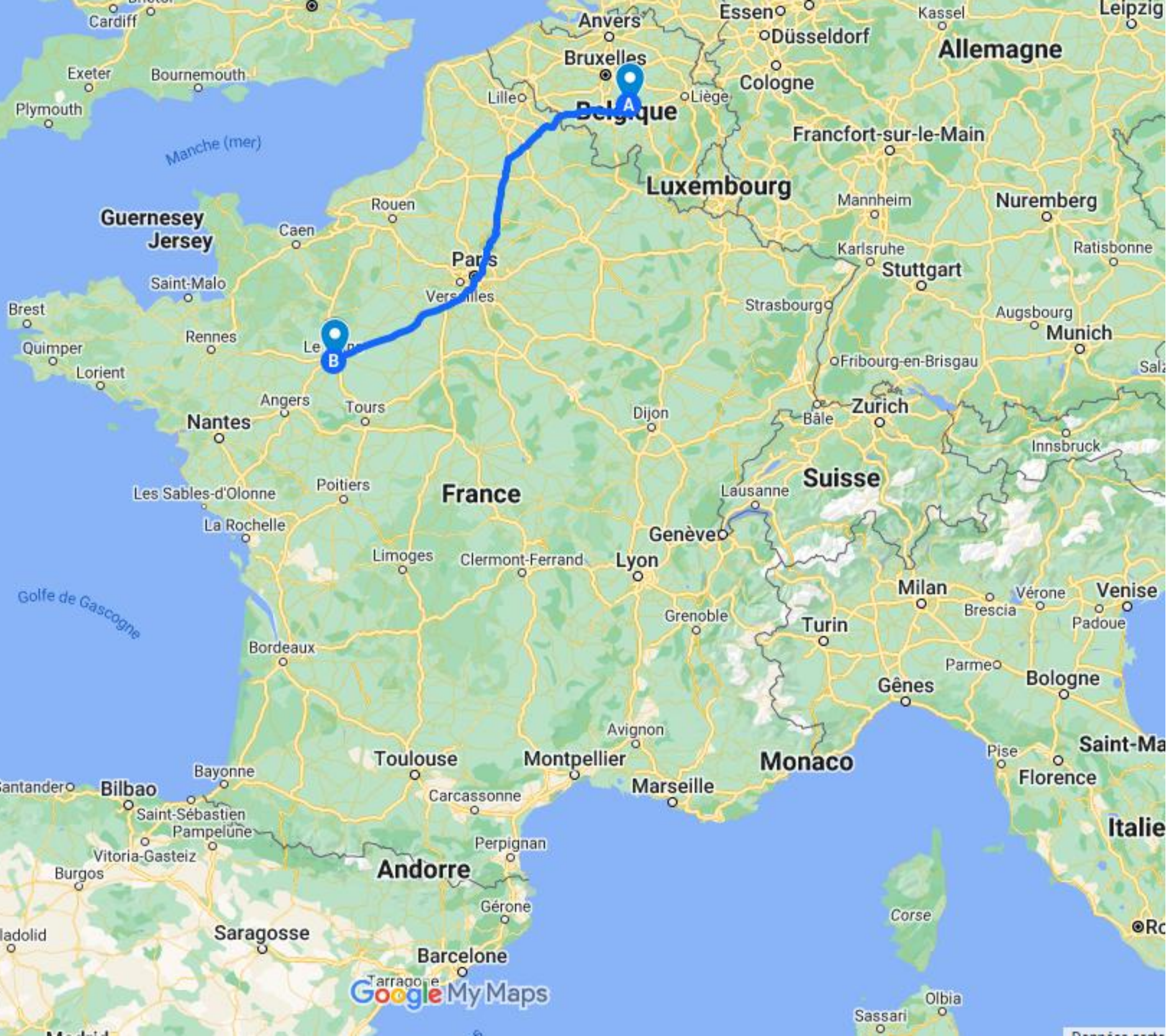
2020 drought year

2021 wet summer

2022 drought year

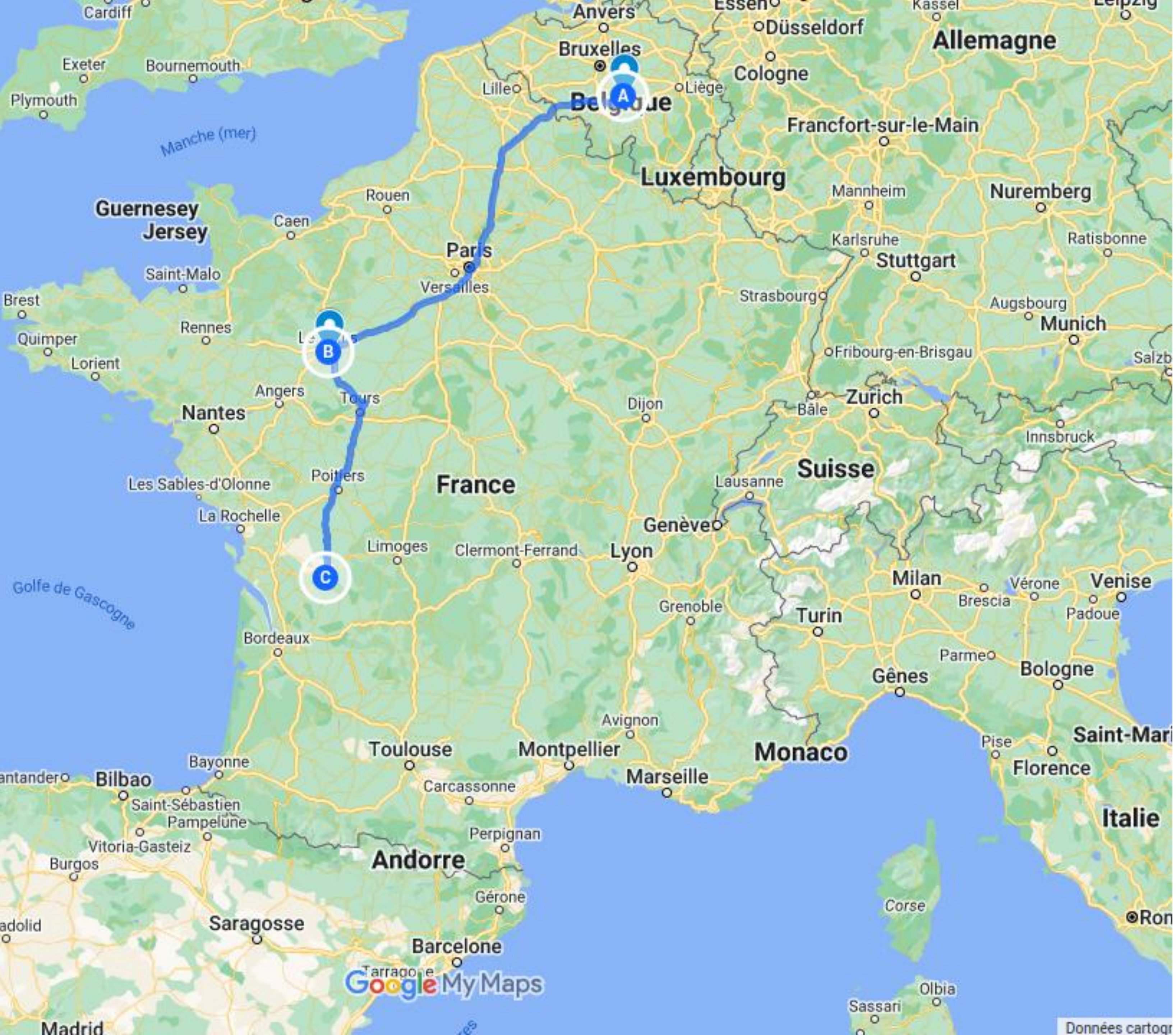
2024 wet year





In 2030 Gembloux will have the climate of Mans

According to Xavier Fetweys (Climatologist Uliège)



In 2030 Gembloux will have the climate of Mans

In 2070 the climate of Angoulême

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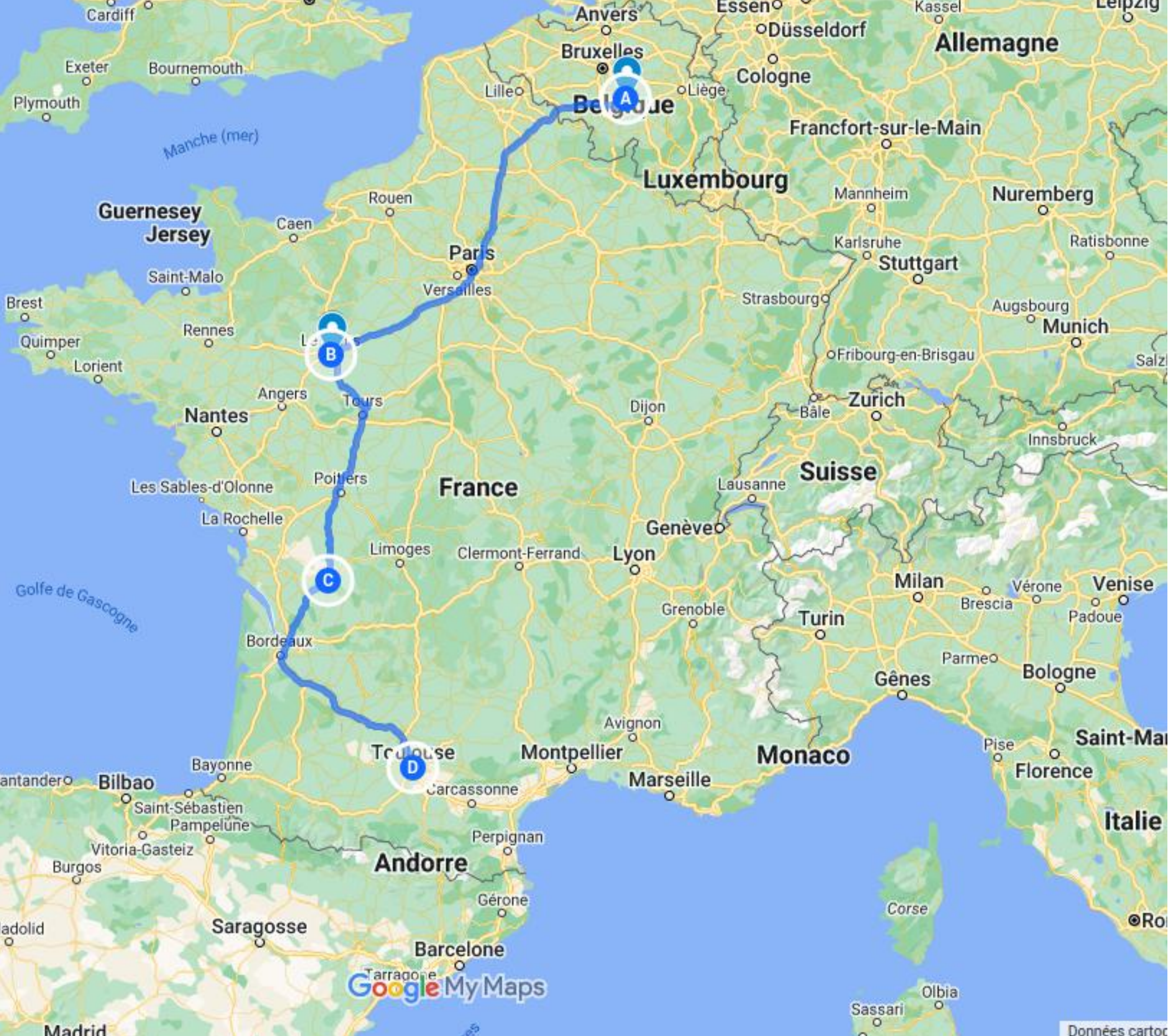


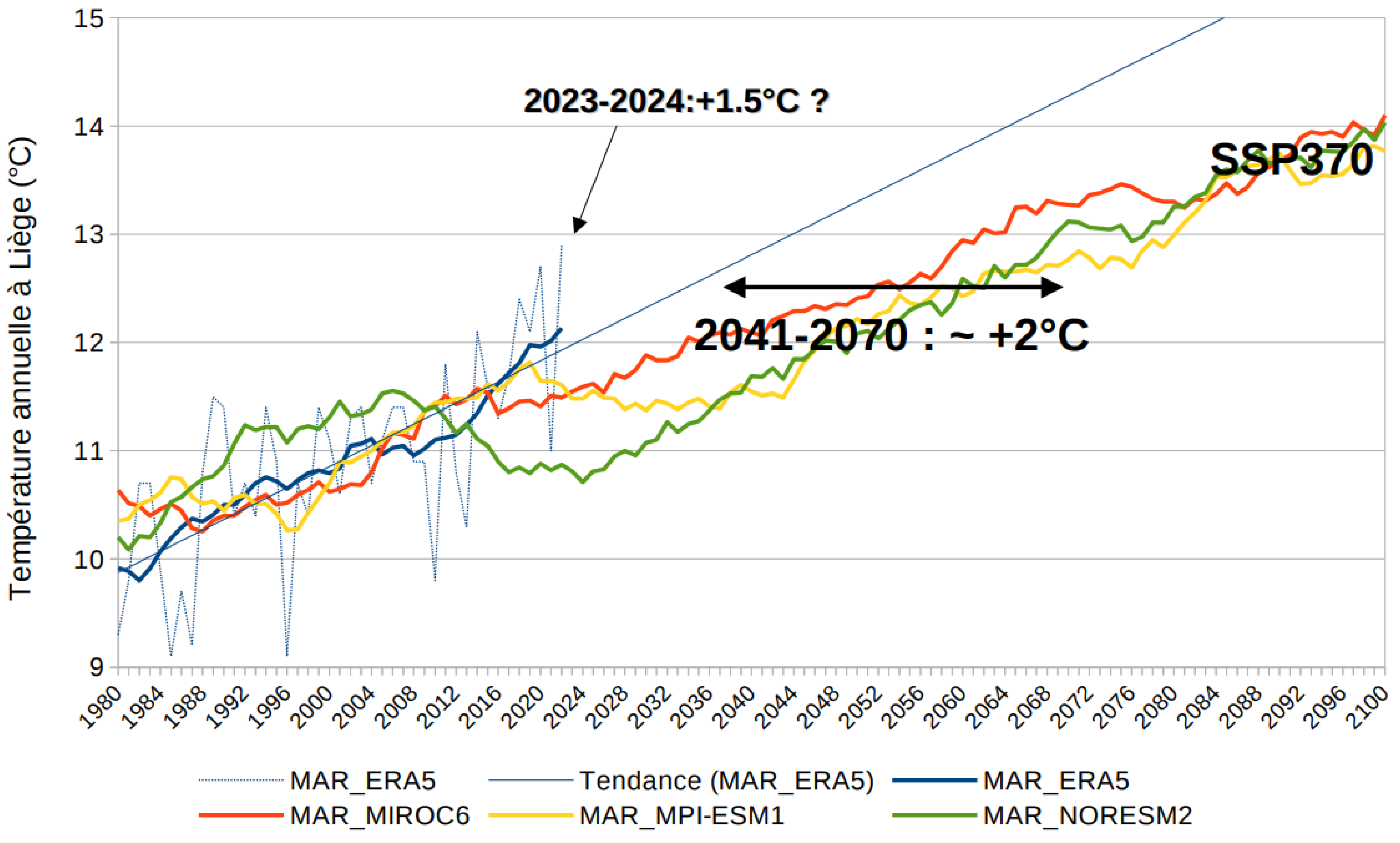
In 2030 Gembloux will have the climate of Mans

In 2070 the climate of Angoulême

In 2100 the temperature of Toulouse

According to Xavier Fetweys (Climatologist Uliège)

Where are we going?



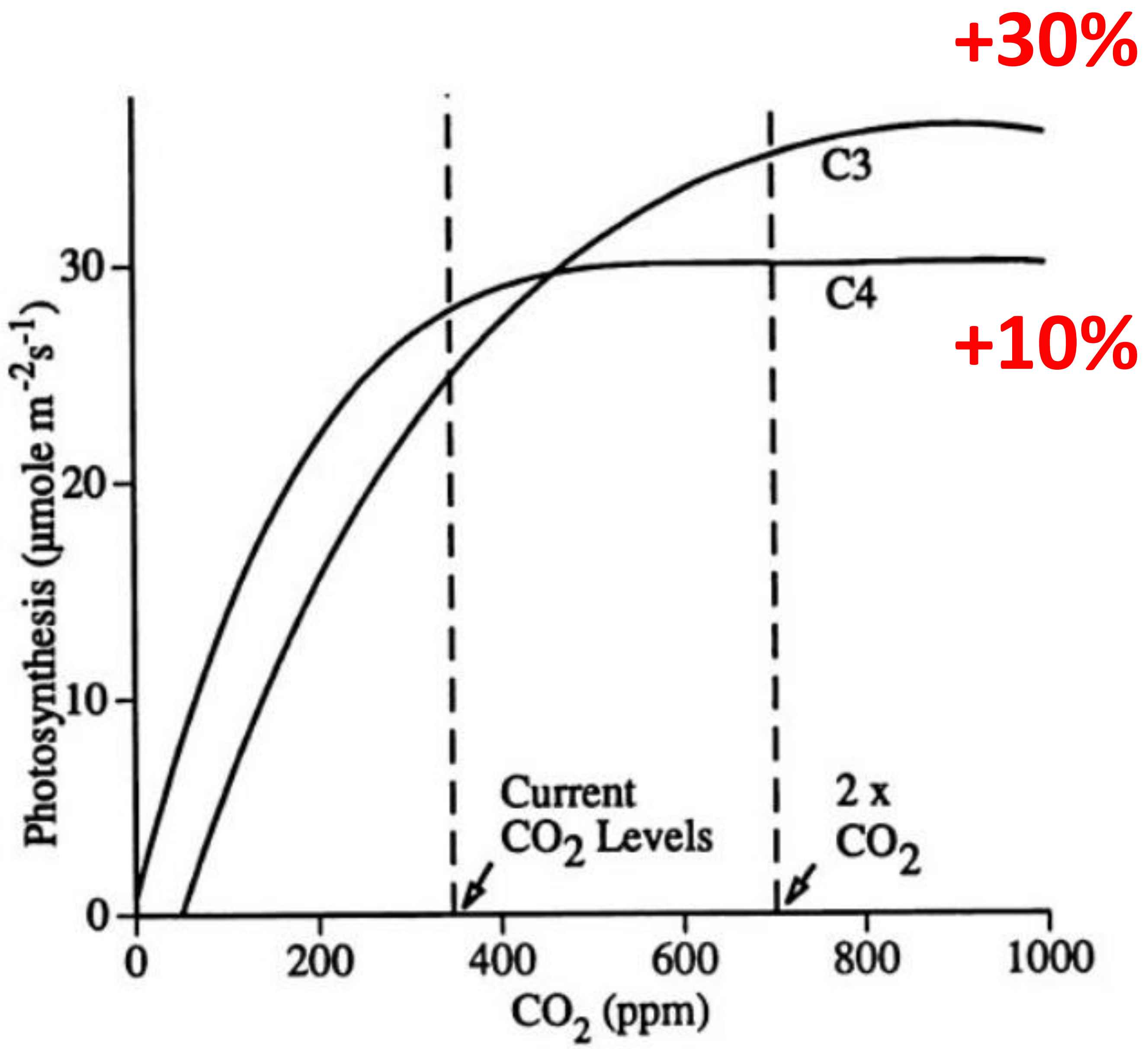
Different Global Circulation Model (GCM):

- CMCC
- MIROC
- MPI
- ...

One direction!

Effect of CO2

Don't forget the CO_2 fertilizer effect !



Kaiser, 1997

Predicting the impact of climate change with crop models

Main inputs

Daily climatic conditions
- Solar radiation
- Temperature : minimum and maximum
- Rainfall
- Air humidity
- Wind speed
- CO_2 concentration

Management itinerary
- Sowing : date, depth & density
- Soil tillage
- Residue & organic matter restitution
- Irrigation & fertilization : date, amount & type
- Special techniques : pruning, cutting, …
- Harvest

Cultivated plants
- Species and cultivars
- Ecophysiological properties
- Initial status

Soil permanent and initial properties
- Soil depth
- Bulk density
- Water content at wilting point & field capacity
- Stone content
- Initial water and N contents
- Clay content, organic N, pH, $CaCO_3$, etc.
- …

STICS modules

Ecophysiology of aerial parts
- Phenological and aerial development
- Above- and belowground growth
- Yield elaboration

Crop microclimate
- Soil temperature
- Crop temperature

Plant, soil & management interactions
- Water demand and management
- Nitrogen demand, fixation and management
- Organic matter cycling and management

Soil – root interactions
- Root density profile
- Water balance
- Nitrogen balance
- Water, nitrogen and heat transfer

Main outputs

Plant development
- Phenological development
- Leaf area index
- Plant/tiller density
- …

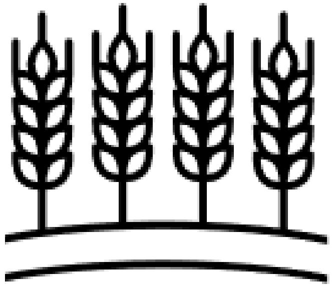
Root system growth
- Root front growth
- Root density profile

Aboveground growth
- Aboveground biomass & organs' repartition
- Yield components
- Yield quality (water, protein, oil, …)
- Plant N uptake & grain N content

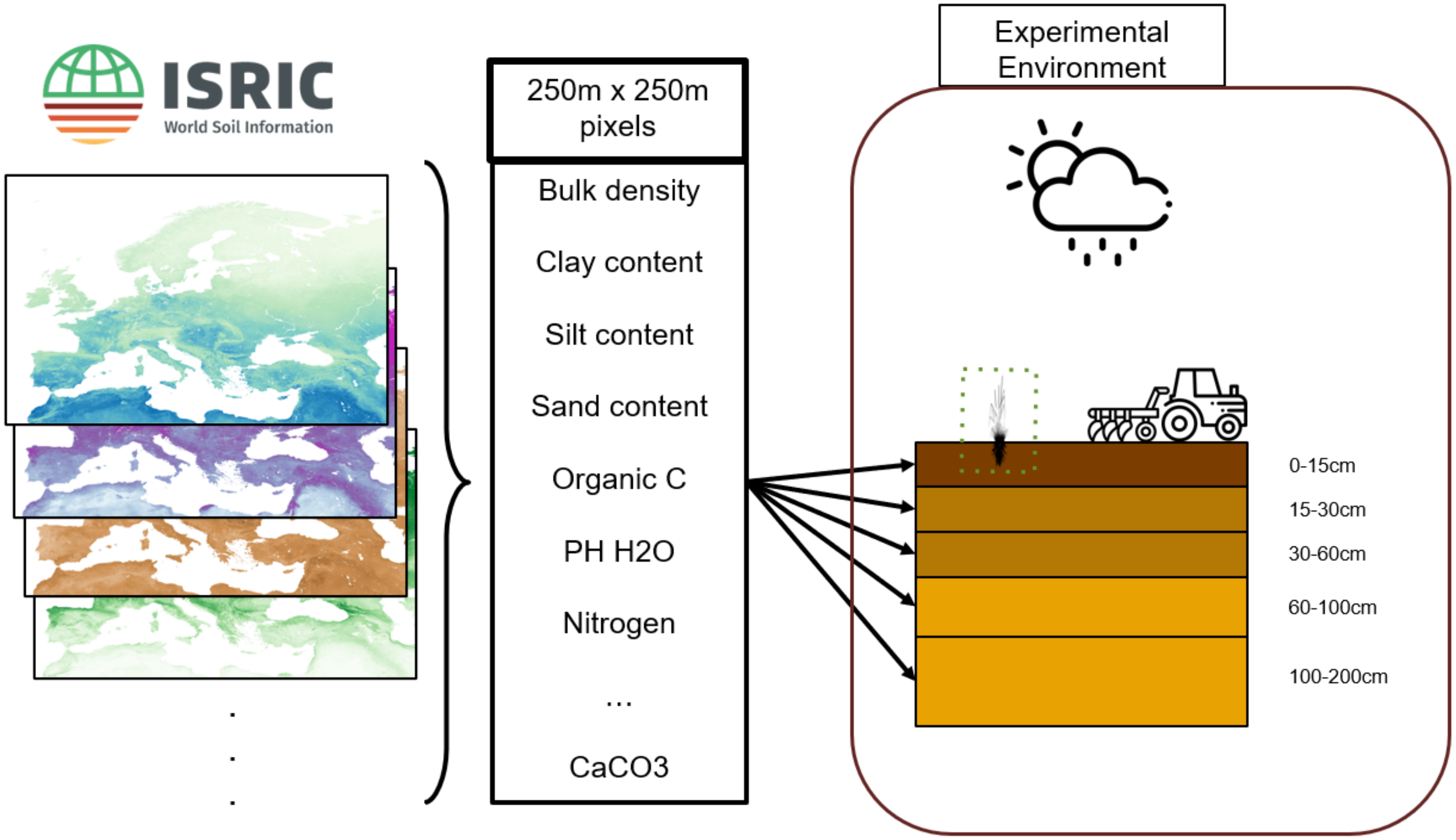
Plant sensed stresses
- Water (deficit and anoxia) stress indices
- Nitrogen stress index
- Frost and high temperature stress indices

Soil water & nitrogen balances
- Soil water content, soil/mulch evaporation and plant transpiration
- Soil mineral N content, soil organic C and N content, soil CO_2 and N_2O emissions
- Water deep infiltration & N leaching

Soil structure
- Soil organic C and N dynamics
- Compaction and fragmentation



Predicting the impact of climate change with crop models

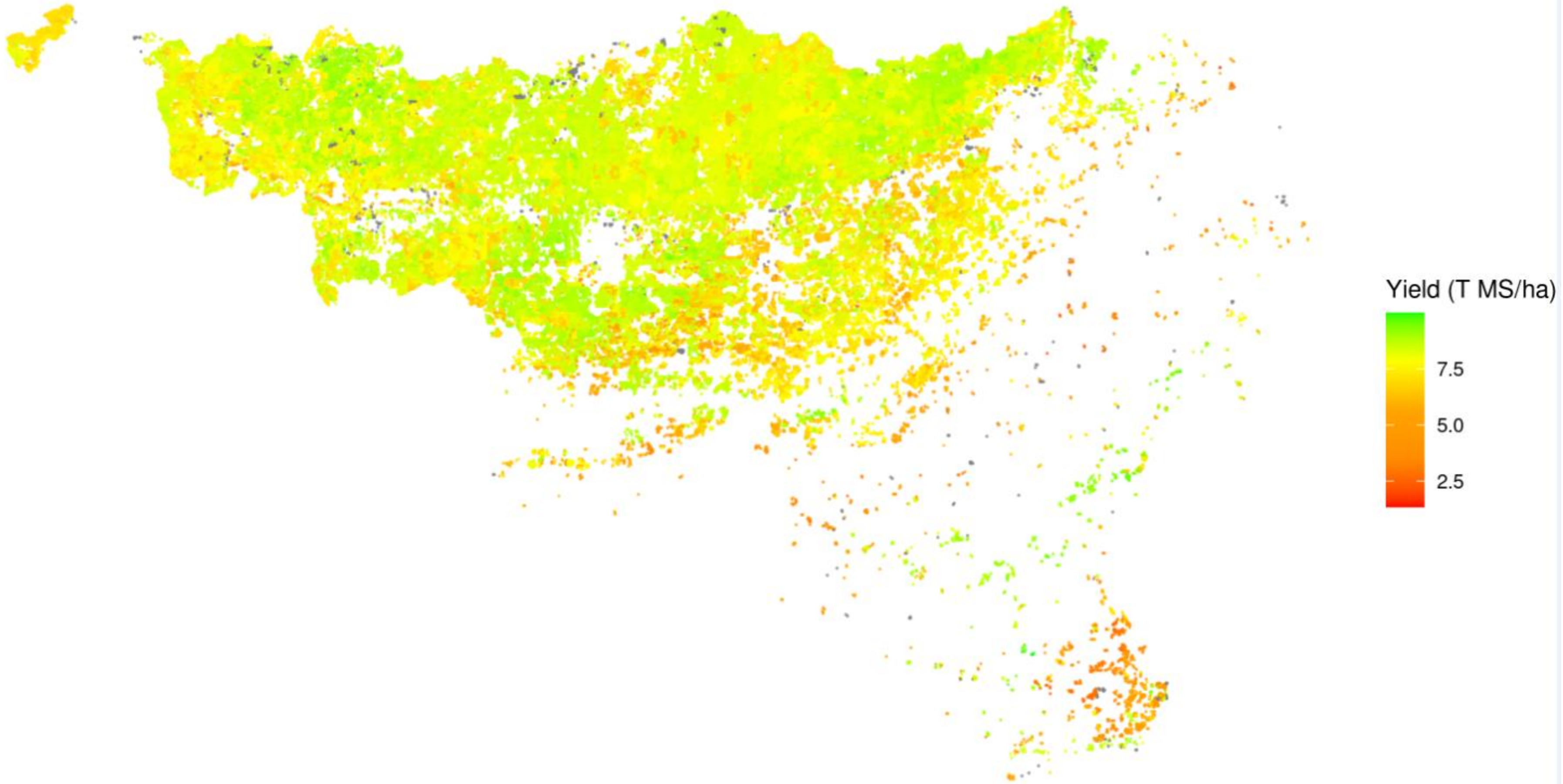


Soil data : 250*250m

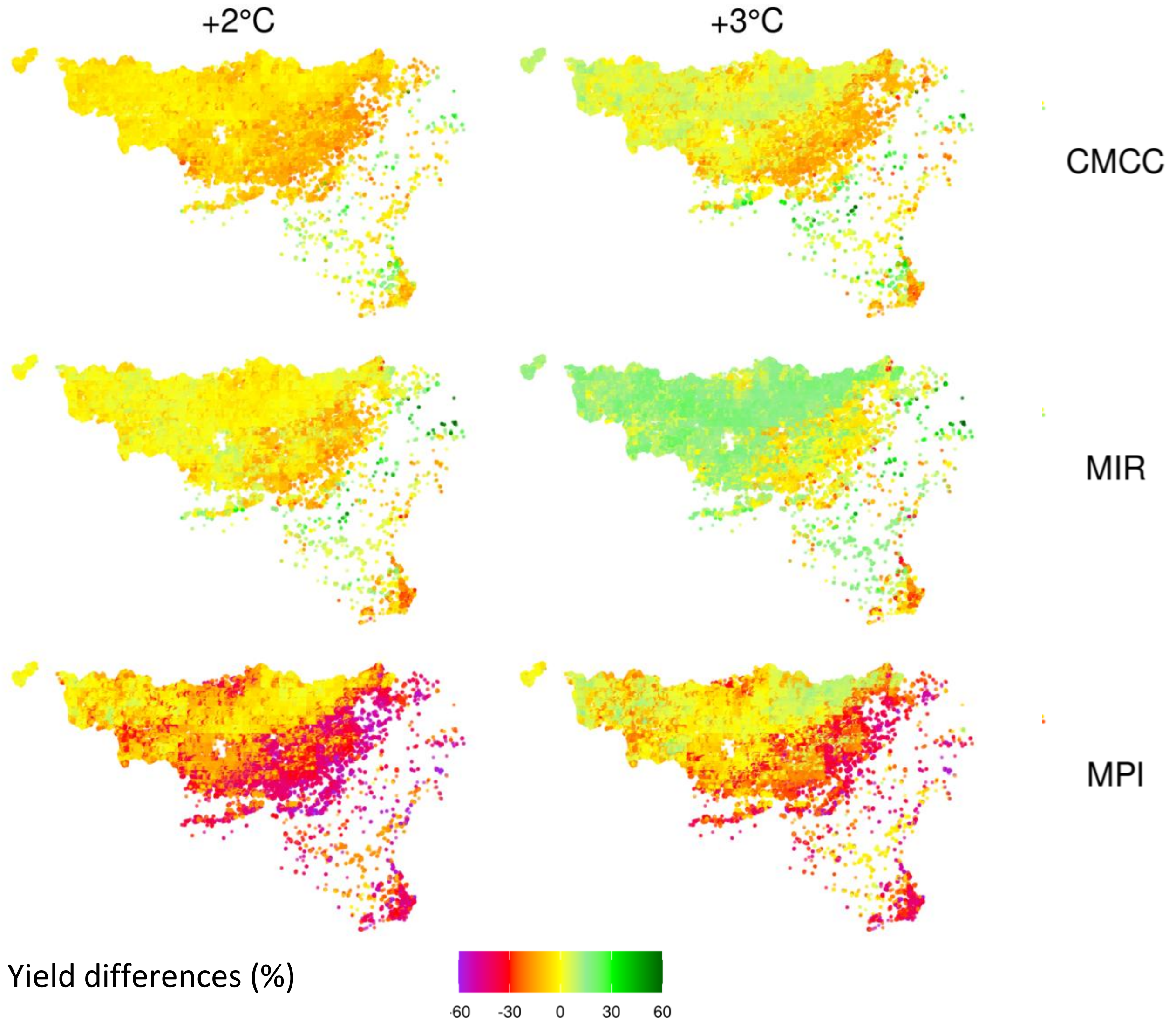
Climate Data : 10*10km

Winter wheat

Historical



Winter wheat

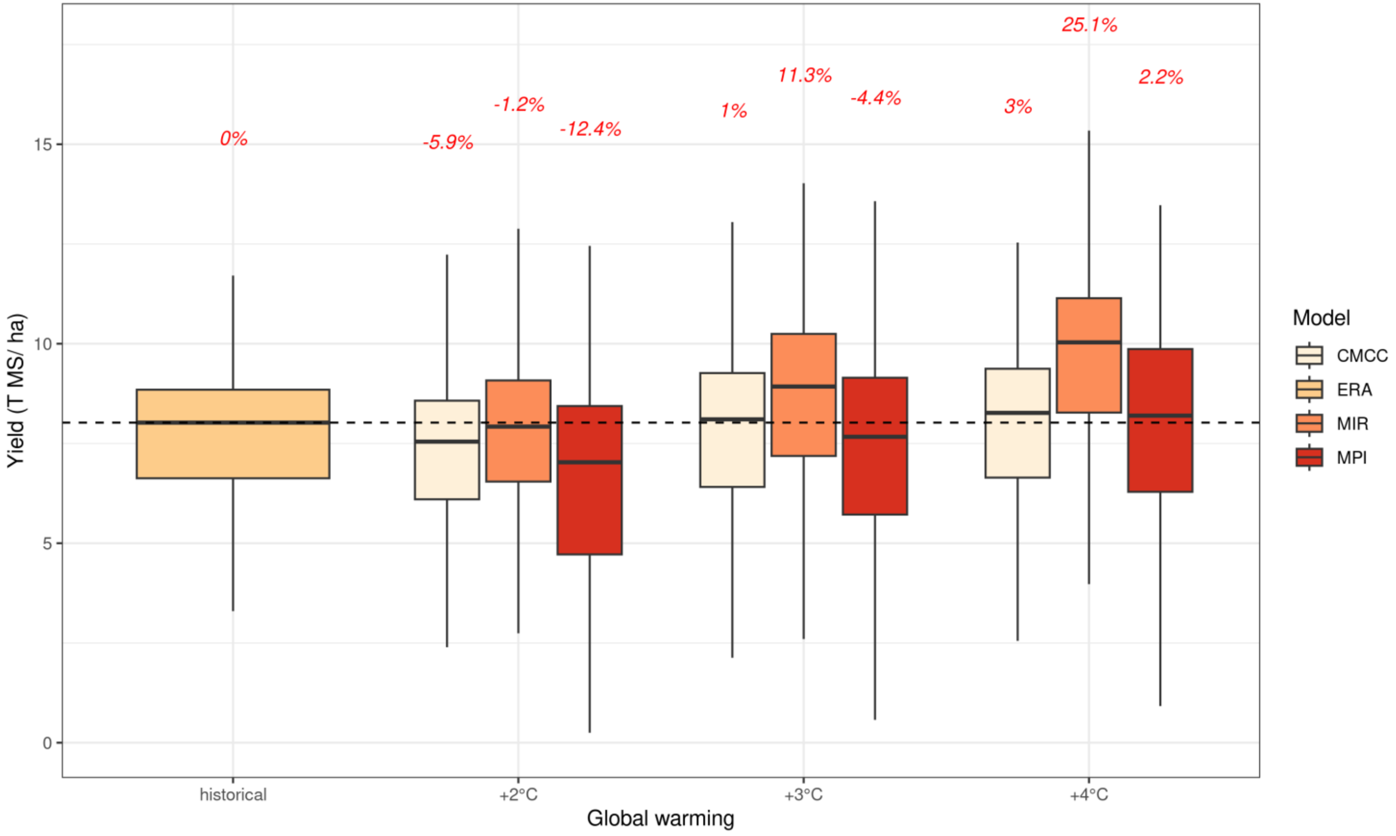


Spatial response is different

Winter wheat

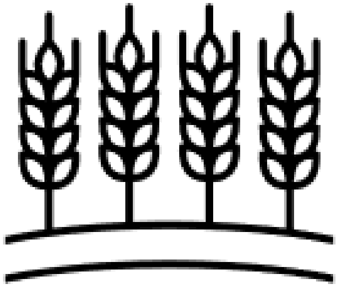
Historical

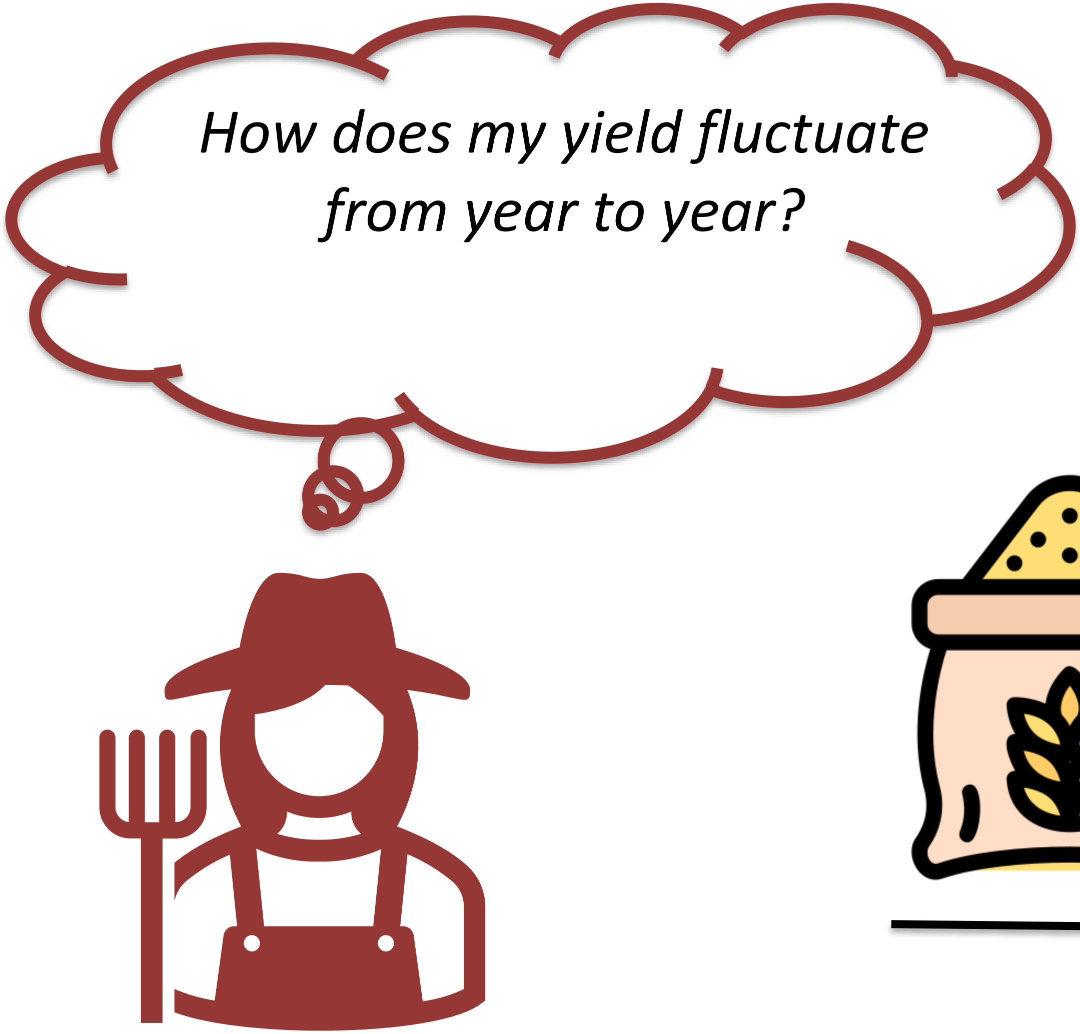
Under climate change

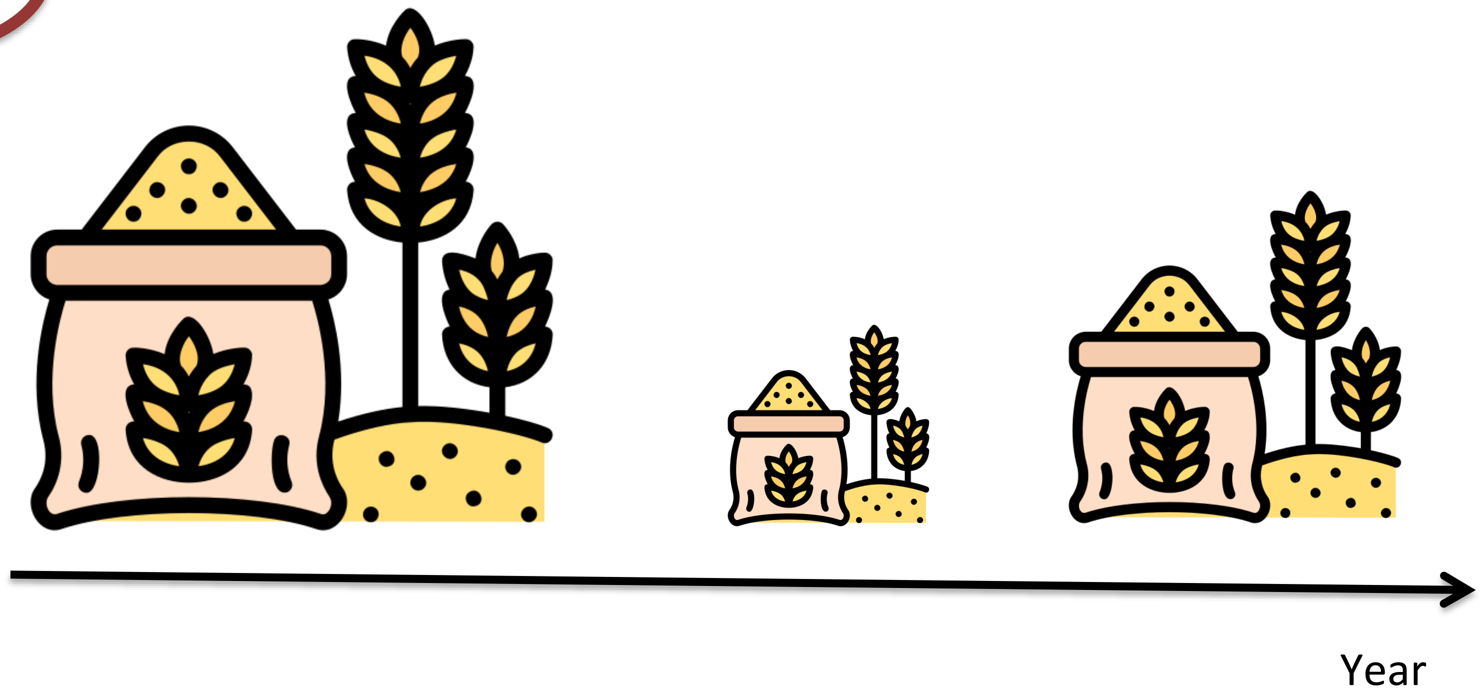


==>Yield at the short term will tend to decrease !

Winter wheat

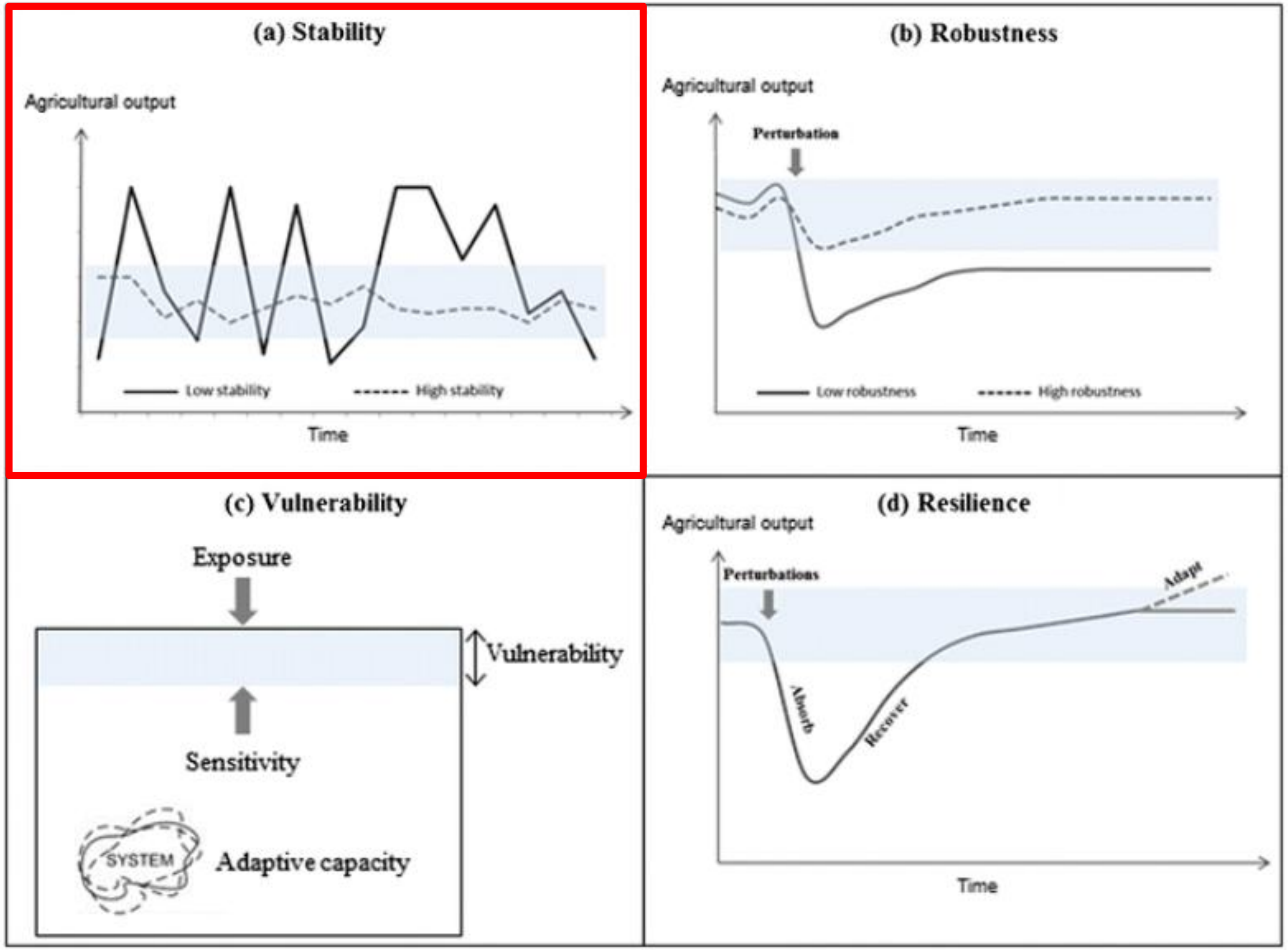






Median yield is not enough. Yield stability is also important for farmers.

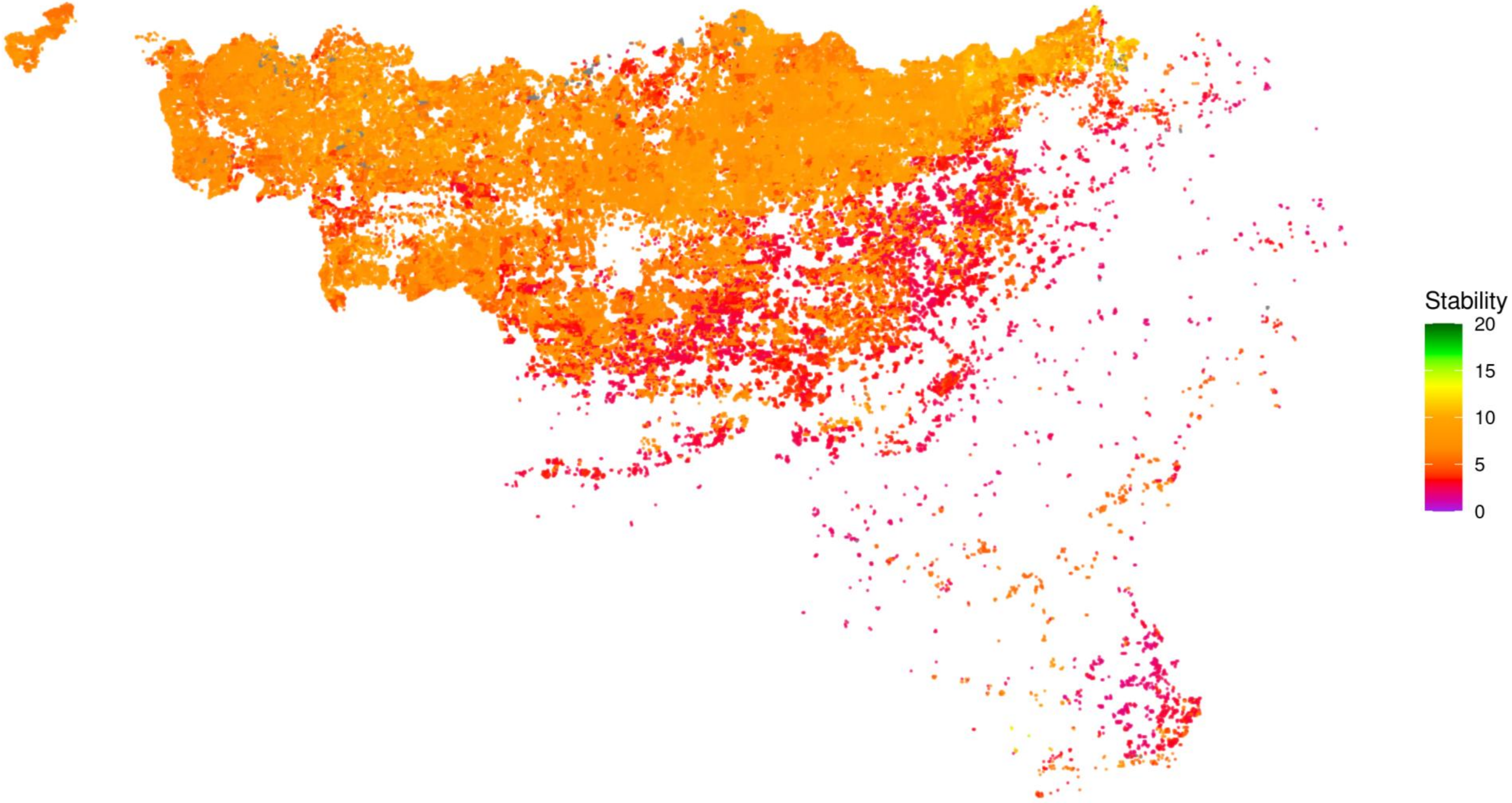
Stability



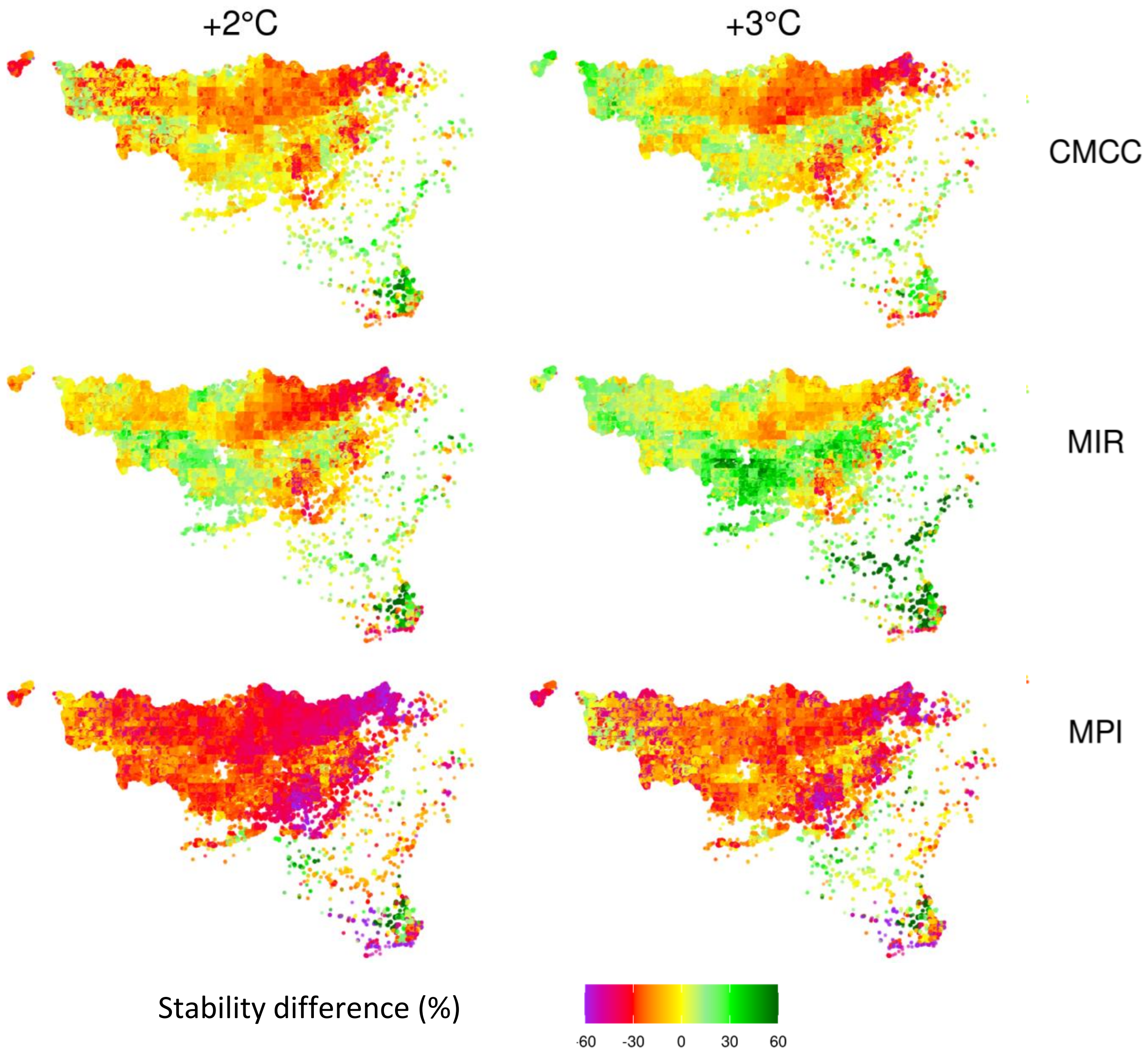
Stability = μ/σ

Urruty et al., 2016

Winter wheat



Winter wheat



In the north of Wallonia: decrease of the stability.

MPI GCM induces high unstability

For other crops

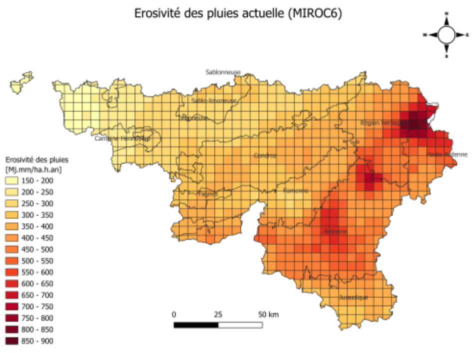
	Global warming					
	+2°C			+3°C		
	CMCC	MIROC	MPI	CMCC	MIROC	MPI
Winter wheat	↘	↘	↘	≃	↗	↘
Rapeseed	≃	↗	↘	↘	↗	≃
Sugar beet	↗	↗	↗	↗	↗	↗
Potato	↘	↘	↘	↘	↗	↗
Maize	↘	↘	↗	↘	↘	↗

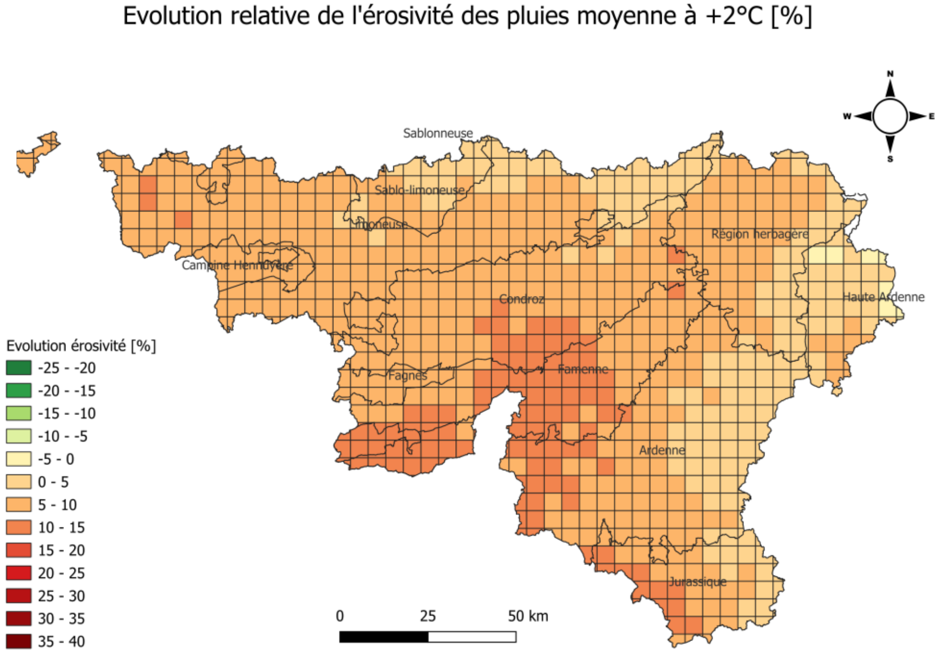
The response is inconsistent between crops.

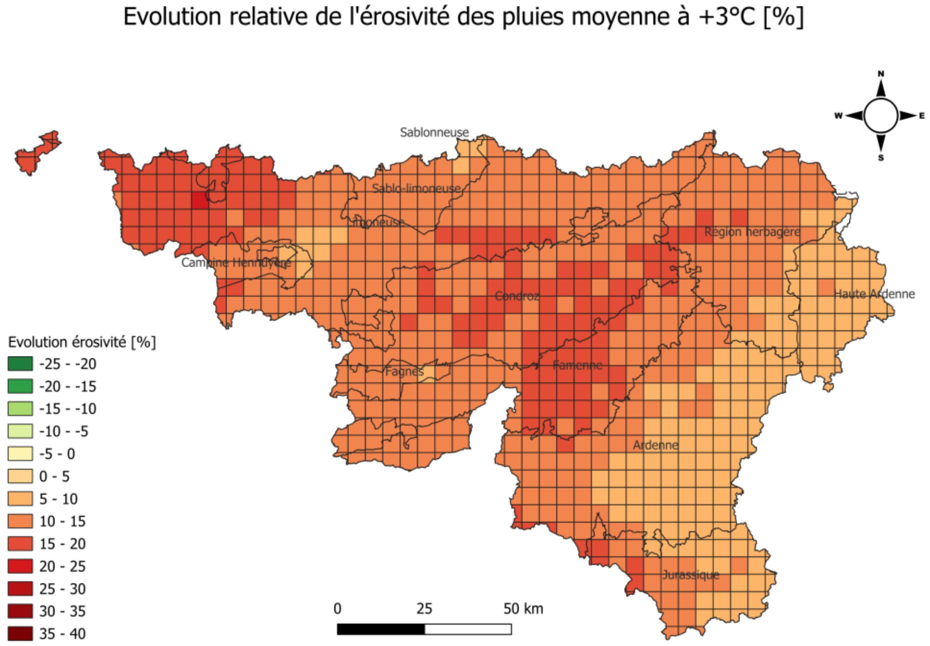
Response depends on GCM

Under a +2°C warming scenario, most crops tend to show a decrease in mean yield.

Erosivity of rain







Pirlot et al. (2025)-Projet AWAC

A 1°C increase allows the air to hold 7% more moisture => **more intense rainfall**.

What would happen if extreme climatic events were to become synchronized globally?

nature communications

Article

https://doi.org/10.1038/s41467-023-38906-7

Risks of synchronized low yields are underestimated in climate and crop model projections

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Check for updates

Kai Kornhuber[1,2,3], Corey Lesk[1,4], Carl F. Schleussner[2,5], Jonas Jägermeyr[6,7,8], Peter Pfleiderer[2,5] & Radley M. Horton[1]

Simultaneous harvest failures across major crop-producing regions are a threat to global food security. Concurrent weather extremes driven by a strongly meandering jet stream could trigger such events, but so far this has not been quantified. Specifically, the ability of state-of-the art crop and climate models to adequately reproduce such high impact events is a crucial component for estimating risks to global food security. Here we find an increased likelihood of concurrent low yields during summers featuring meandering jets in observations and models. While climate models accurately simulate atmospheric patterns, associated surface weather anomalies and negative effects on crop responses are mostly underestimated in bias-adjusted simulations. Given the identified model biases, future assessments of regional and concurrent crop losses from meandering jet states remain highly uncertain. Our results suggest that model-blind spots for such high-impact but deeply-uncertain hazards have to be anticipated and accounted for in meaningful climate risk assessments.

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Thank you for your attention

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Effect of climate change on livestock and grass production

Livestock effect

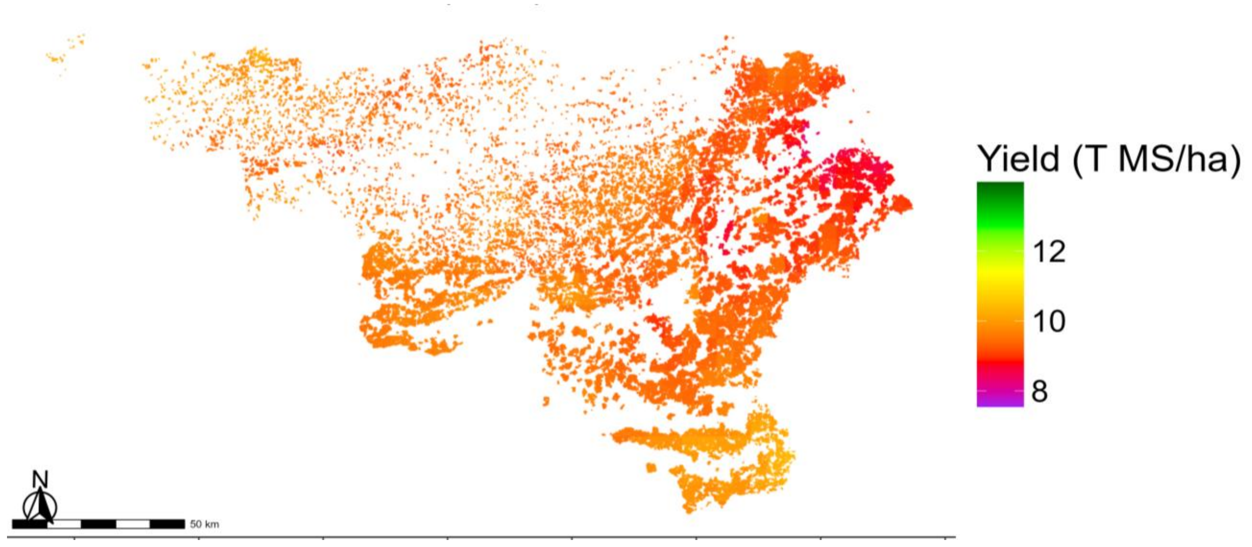
==> Changes of grass dynamic
==>Changes in fodder management

/!\ variability under year is also present
==> Interannual stock needed ?

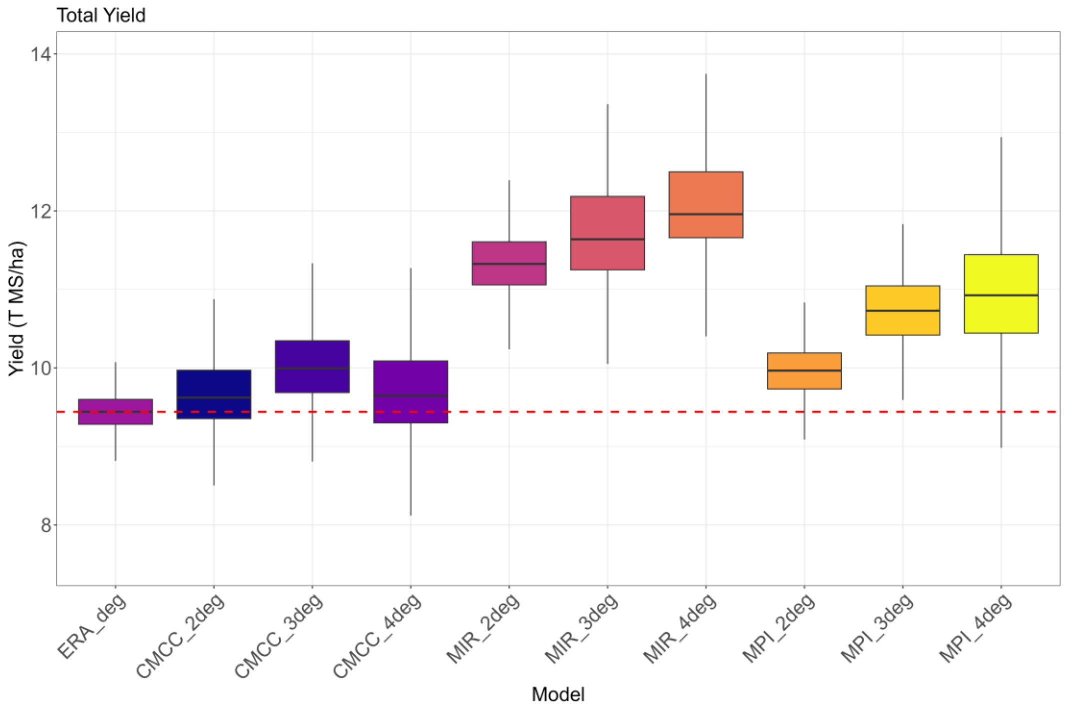
Rising heat stress in livestock ; mortality risk for broiler and pigs (results not shown).

Grassland

Historical



Under Climate change



Yield increases under +2°C and +3°C, but **dynamics change**

Higher growth in spring

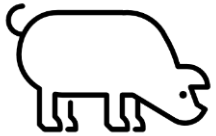
Lower growth in summer

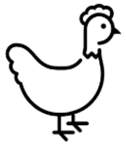
Higher growth in autumn

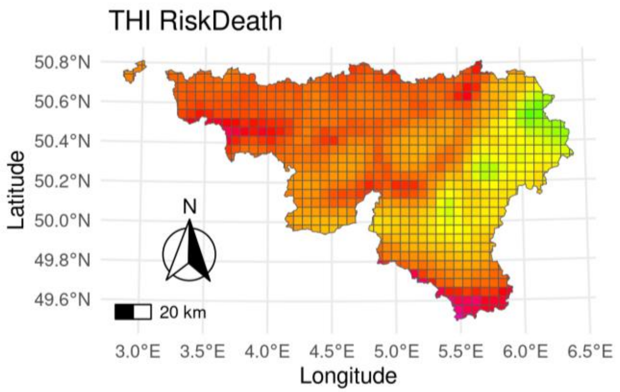
THI

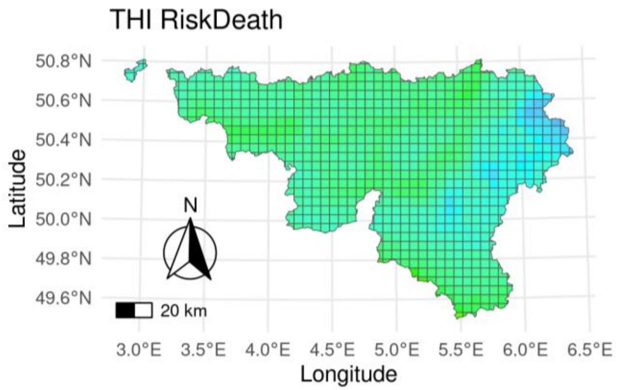
Under +3°C (Multi Model Ensemble)

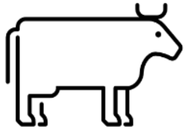
/ !\ no risk of death doesn’t mean no impact on productivity !

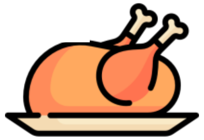


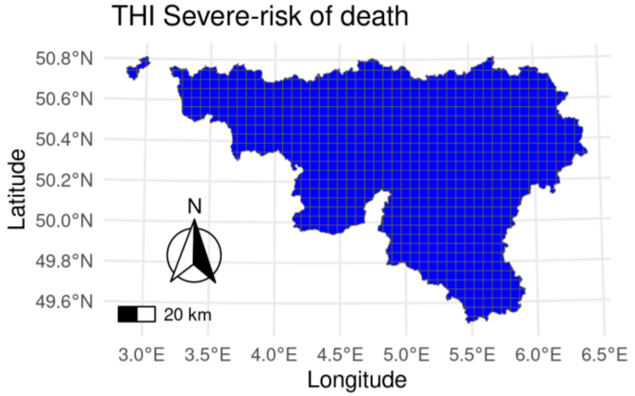


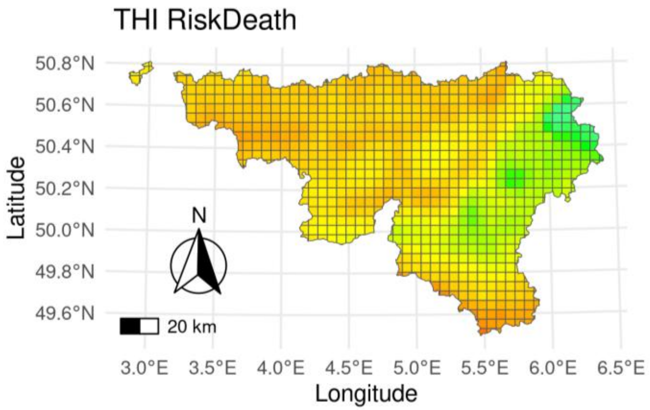




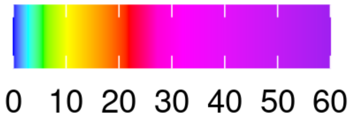








Number of stress in the categories/year



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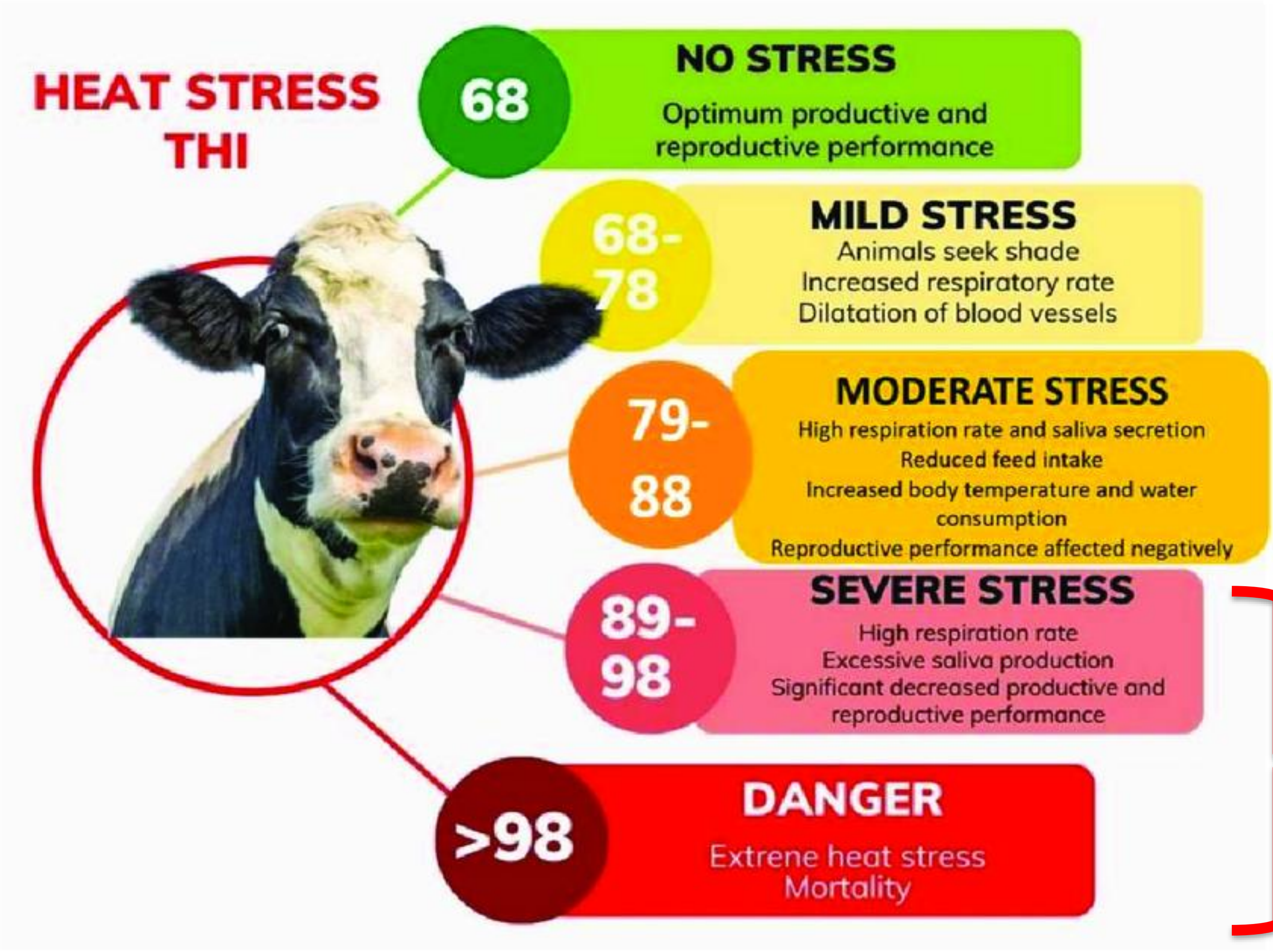
Categories



one category

DOI: [10.3390/bioengineering9110608](https://doi.org/10.3390/bioengineering9110608)