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Will climate change affect sugar beet crop emergence of the 21st century? Insight from a simulation study

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Will climate change affect sugar beet establishment of the 21st century? Insights from a simulation study

Jay Ram Lamichhane, Julie Constantin, Jean-Noël Aubertot, Carolyne Dürr

INRA, France

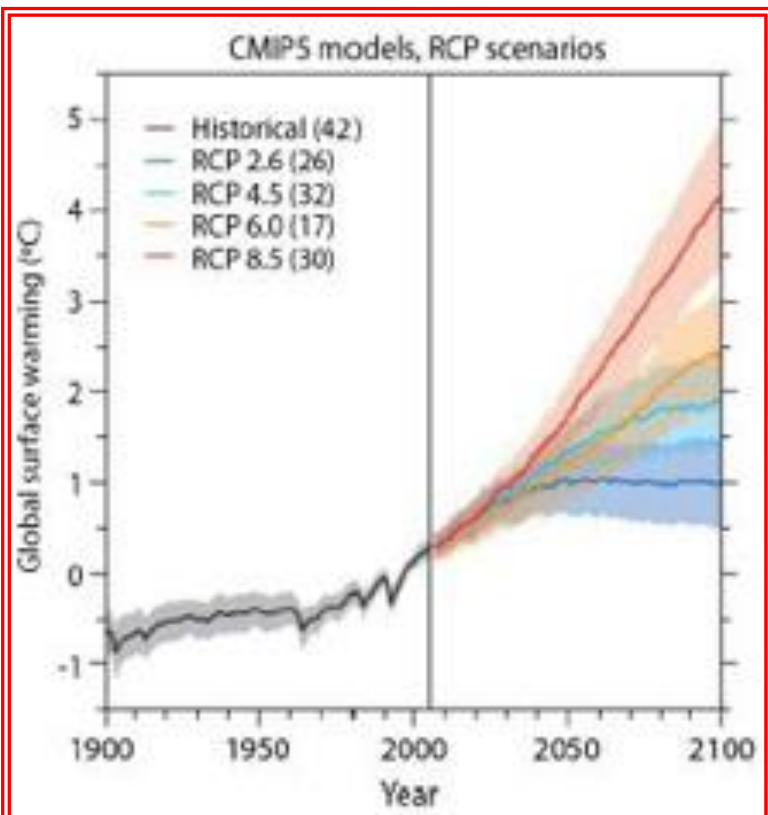
carolyne.durr@inra.fr



AMERICAN SOCIETY OF
SUGAR BEET
TECHNOLOGISTS

40th Biennial Meeting – Anaheim, CA 25th – 28th February 2019





STICS: a generic model for the simulation of crops and their water and nitrogen balances.
I. Theory and parameterization applied to wheat and corn

Nadine Brisson ^{a*}, Bruno Mary ^a, Dominique Ripoche ^a, Marie H el ene Jeuffroy ^a, Fran oise Ruget ^a, Bernard Nicoullaud ^a, Philippe Gate ^b, Florence Devienne-Barret ^a, Rodrigo Antonioletti ^a, Carolyne Durr ^a, Guy Richard ^a, Nicolas Beaudoin ^a, Sylvie Recous ^a, Xavier Tayot ^c, Daniel Plenet ^a, Pierre Cellier ^a, Jean-Marie Machet ^a, Jean Marc Meynard ^a, Richard Del ecolle ^a

^aD epartement environnement et agronomie, Inra, site Agroparc, 84914 Avignon cedex 9, France
^bInstitut technique des c er ales et fourrages, France
^cAgrotransfert Poitou-Charentes, France

(Received 13 March 1998; accepted 9 July 1998)

Predicted variables
 Seedbed temperature
 Seedbed water content

2



Daily predicted variables at a local scale

Air temperatures, rainfalls, wind, global radiation,....

1

SIMPLE: A Model for SIMulation of PLant Emergence Predicting the Effects of Soil Tillage and Sowing Operations

C. D urr,* J.-N. Aubertot, G. Richard, P. Dubrulle, Y. Duval, and J. Boiffin

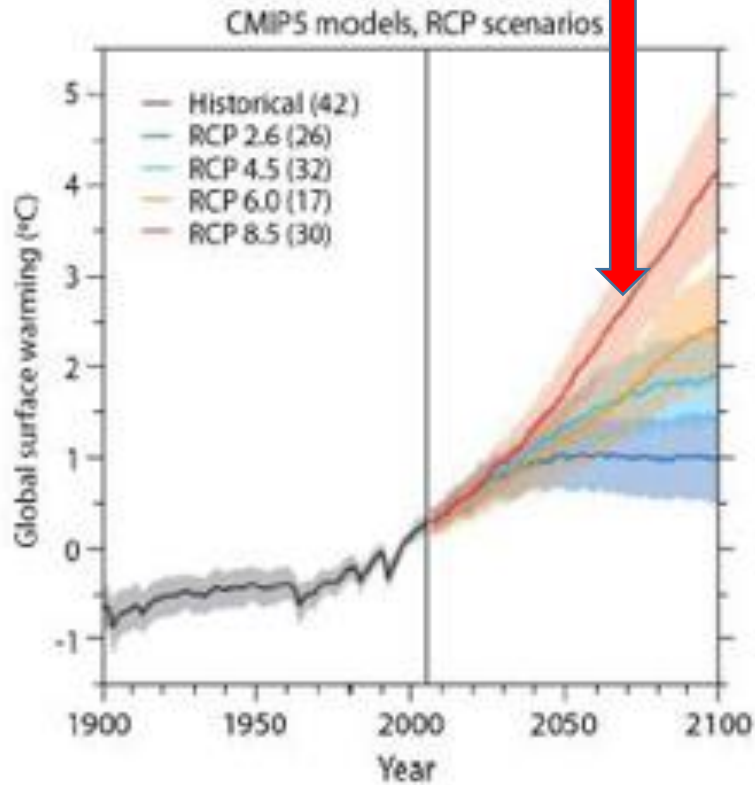
Reprinted from the *Soil Science Society of America Journal*
 Volume 65, no. 2, Mar.-April 2001
 677 South Segoe Rd., Madison, WI 53711 USA

Predicted variables
 % germination
 % emergence,
 Time to Germ-Emer
 Causes of non emergence
 % of bolting

3

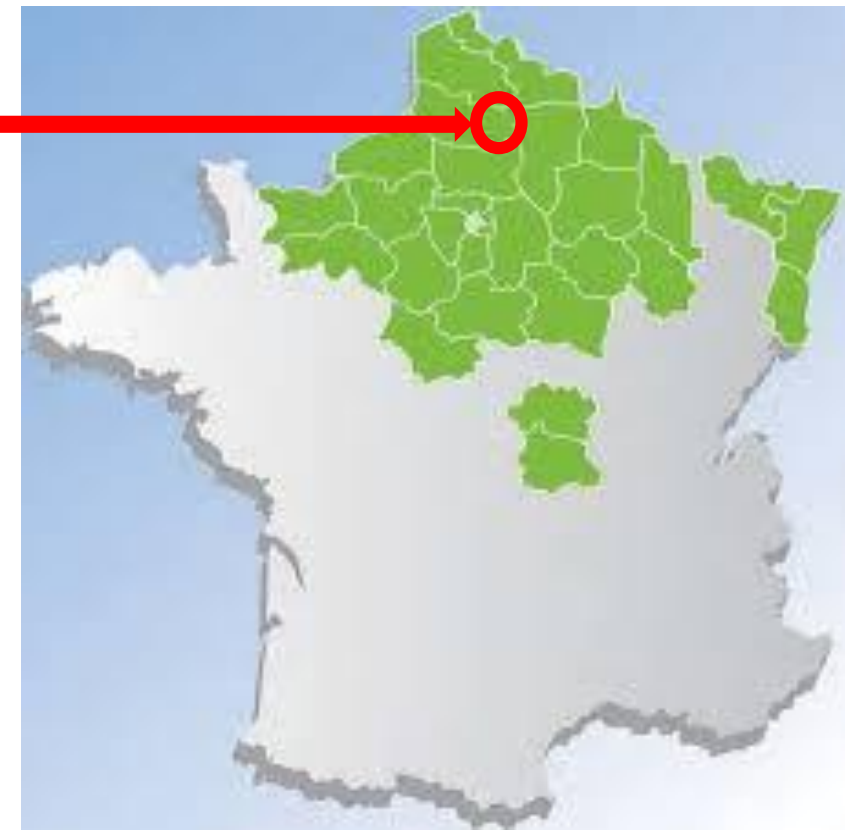
Regionalized scenarios of climate change

1



Northern France
Air temperatures
wind, global radiation
Rainfalls

2020 - 2100

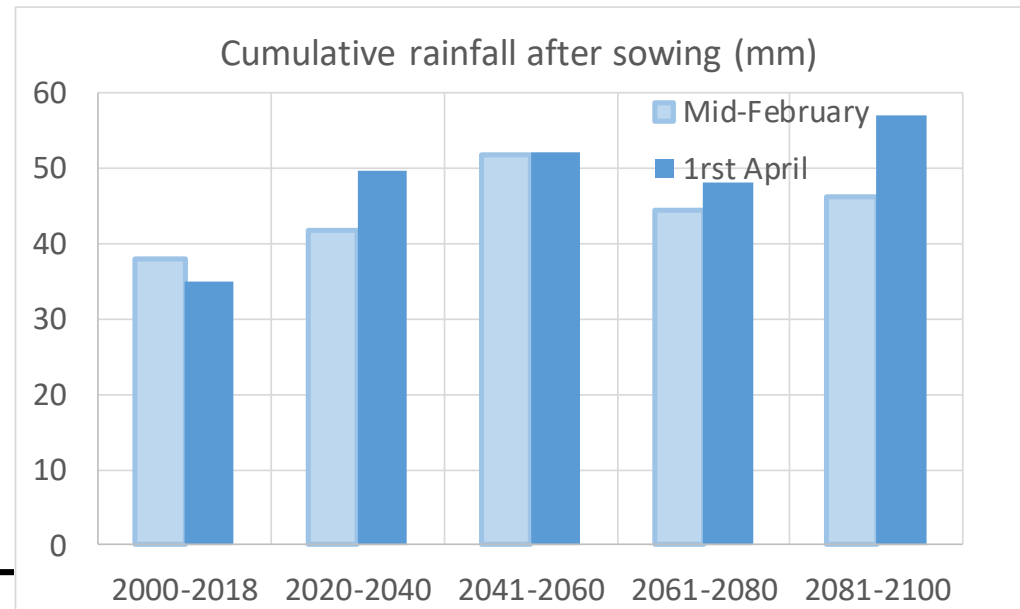
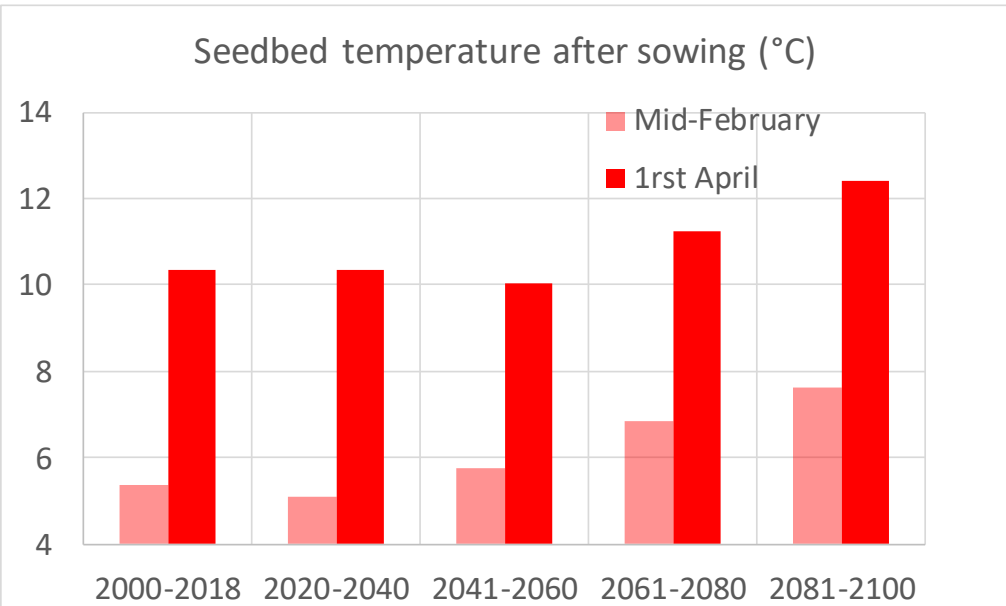
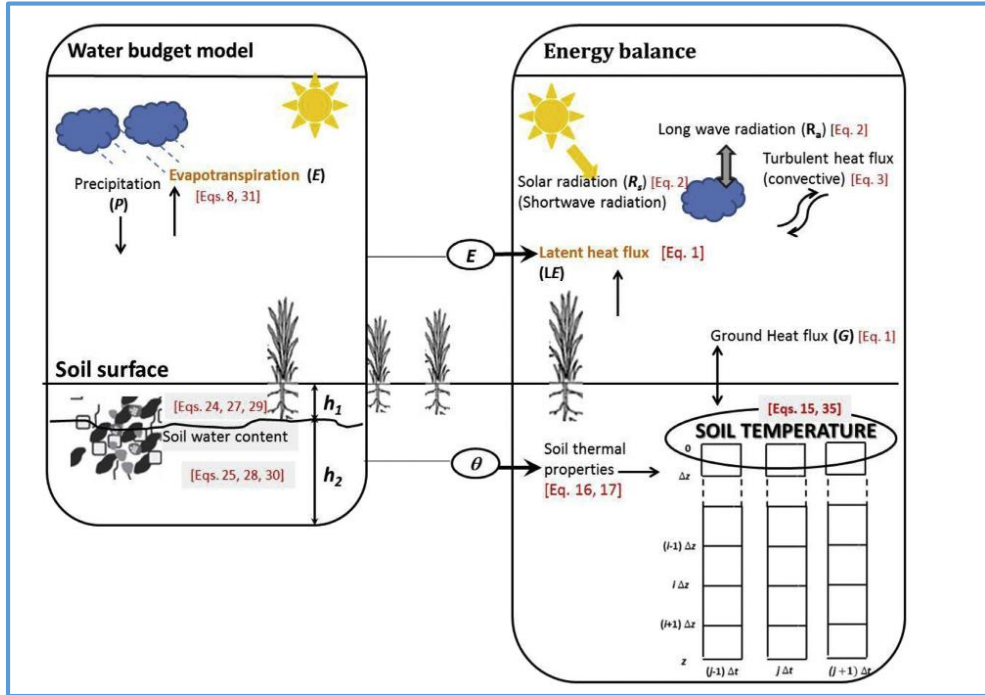


Sugar beet cropping area in France

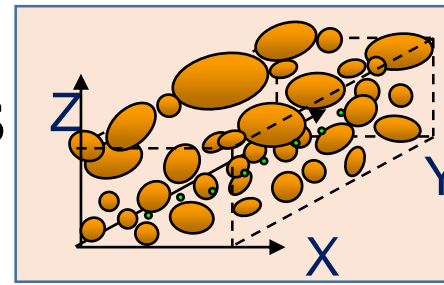
Simulated seedbed climate

2

STICS



The SIMPLE model's main principles



3

Input variables

Soil structure
= f (tillage and sowing operations)

Species and seed lot characteristics

Climate and soil characteristics

3D seedbed generator

Equations for prediction of Germination and seedling growth

T° , H_2O , soil surface crusting

Output variables

Germination times and rates

Emergence times and rates

Seedling's early growth

Simulation of sugar beet establishment

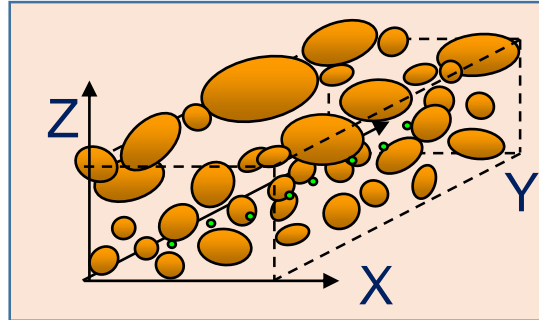
5 sowing dates

- Mid-February
- 1st March
- **Mid-March**
- 1st April
- Mid-April

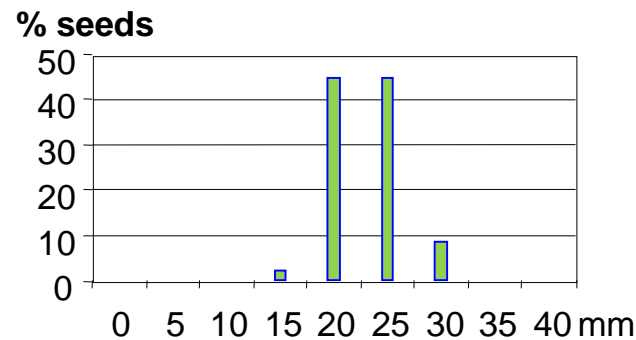
2020 -2100

- Seedbed temperatures
- Seedbed water content
- Daily rainfalls
- Air temperatures

Seedbed structure



Sowing depths

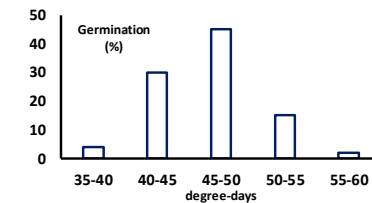


Total : 405 simulations
(405 000 individual seeds)

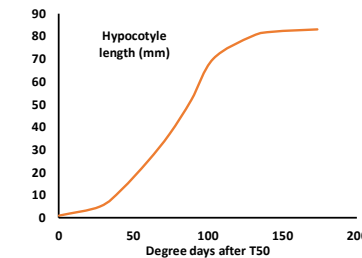
Sugar beet parameter values

Tb 3.5°C; ψ_b 1.96 MPa

Germination speed



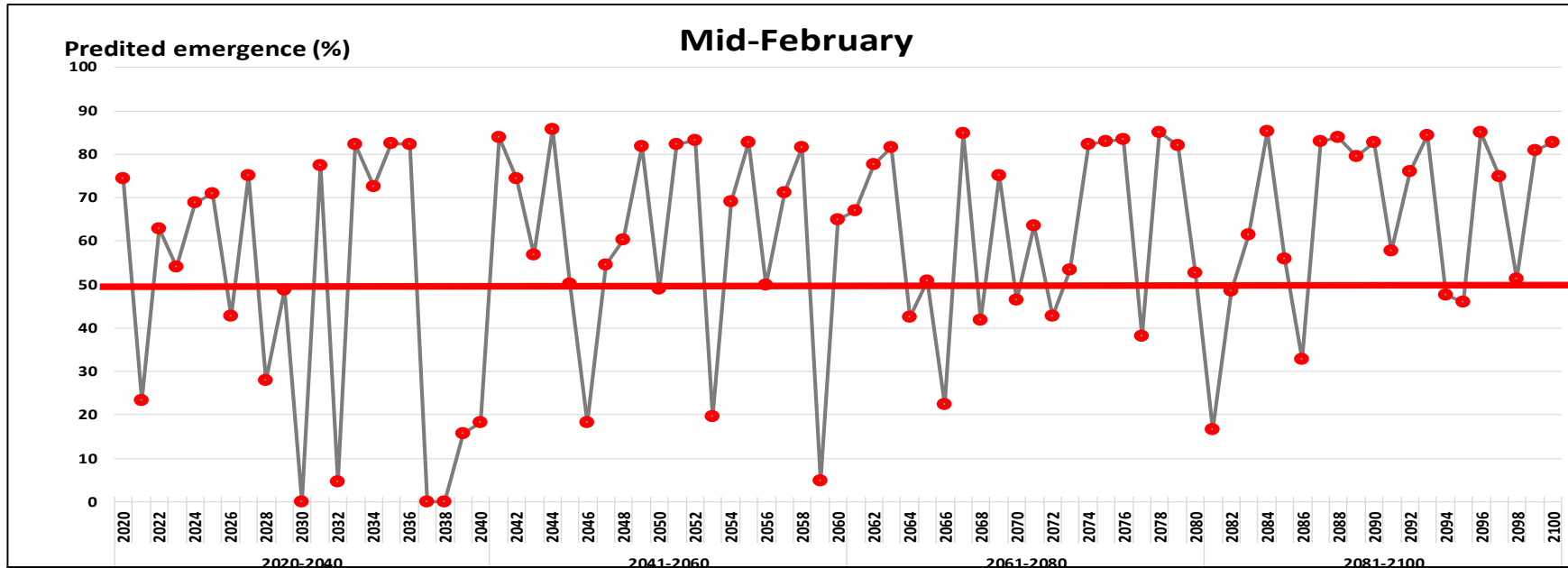
Radicle and hypocotyl elongation



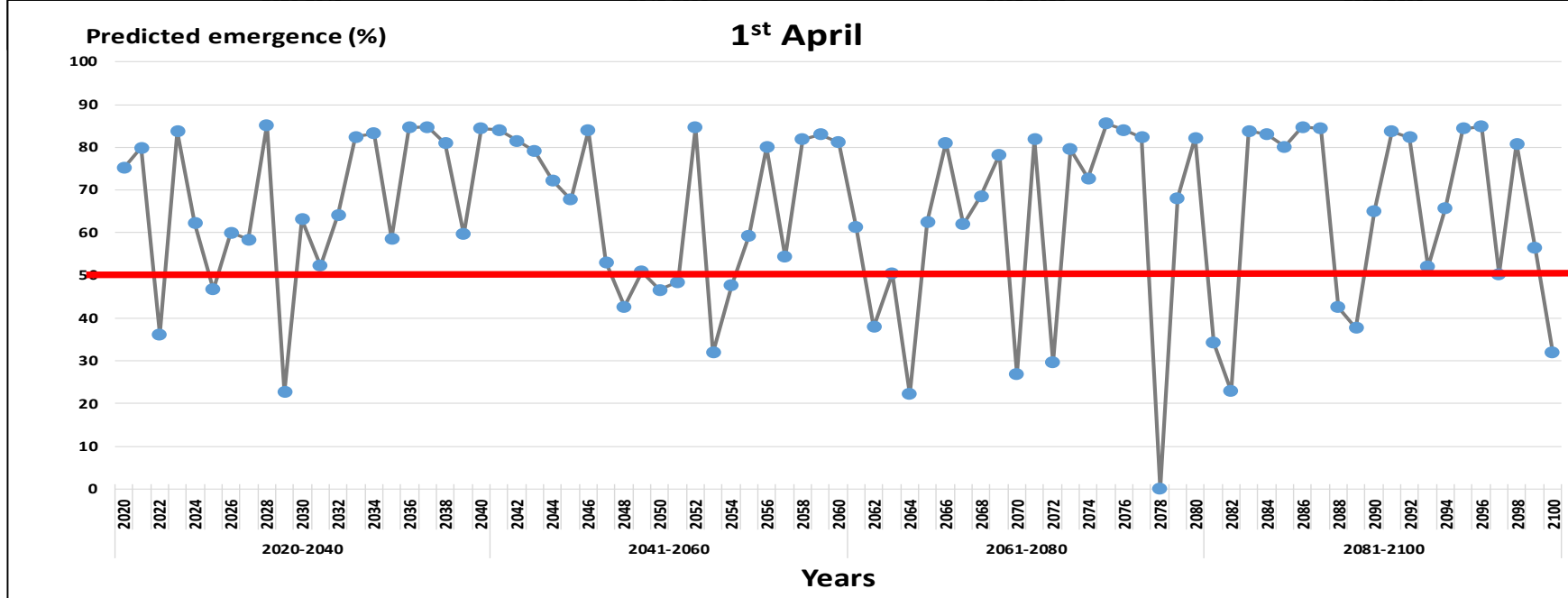
Clods and crust sensitivity



Results

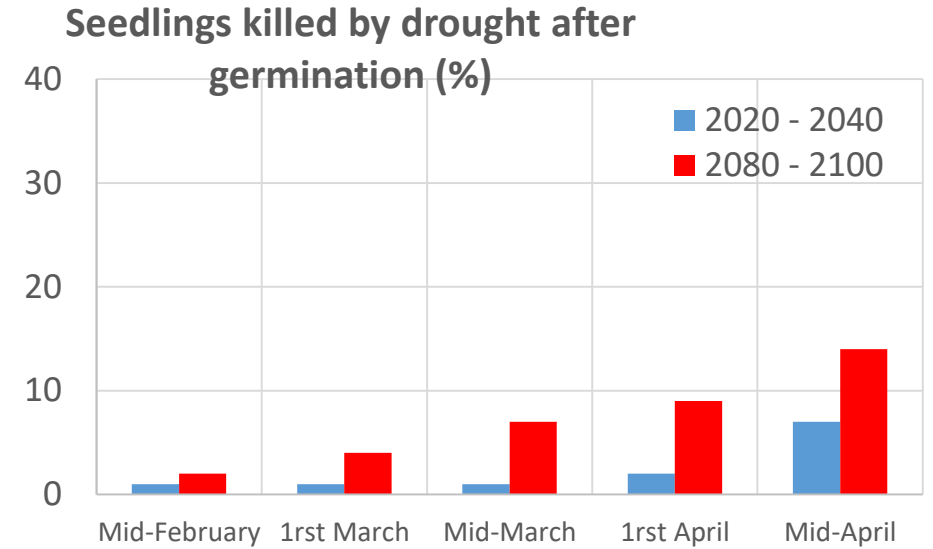
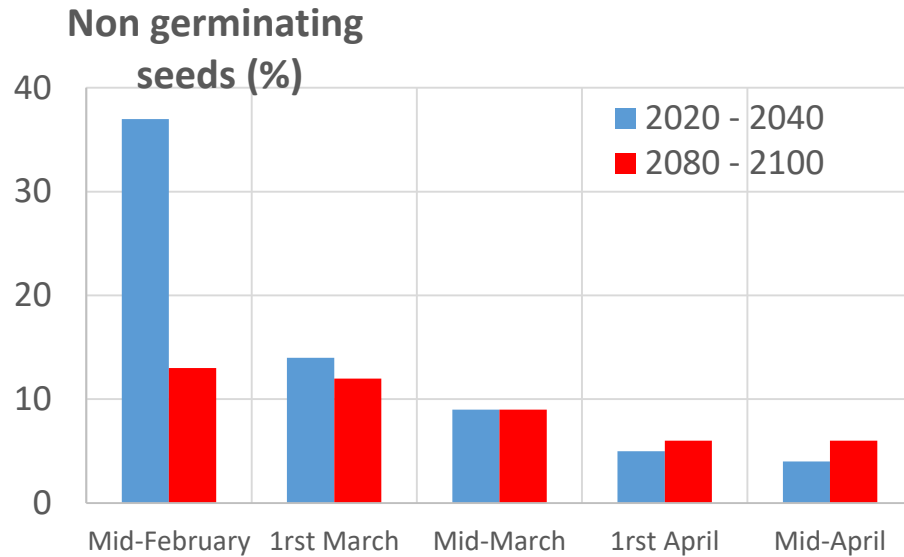


	2020 -2040	2080 -2100
Emergence rate %	48 ± 32	68 ± 20
Nb days to max emergence	45 ± 24	37 ± 10

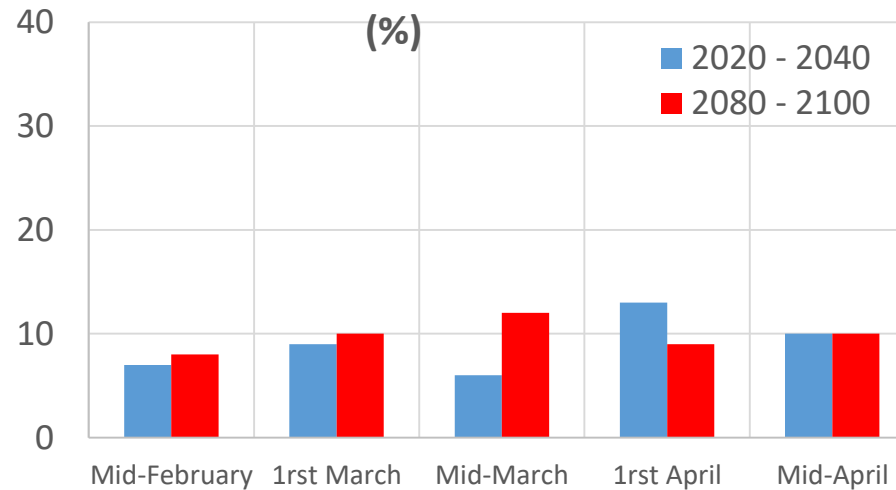


	2020 -2040	2080 -2100
Emergence rate %	69 ± 15	74 ± 15
Nb days to max emergence	28 ± 7	23 ± 8

Causes of non emergence



Seedlings blocked by soil surface crusting

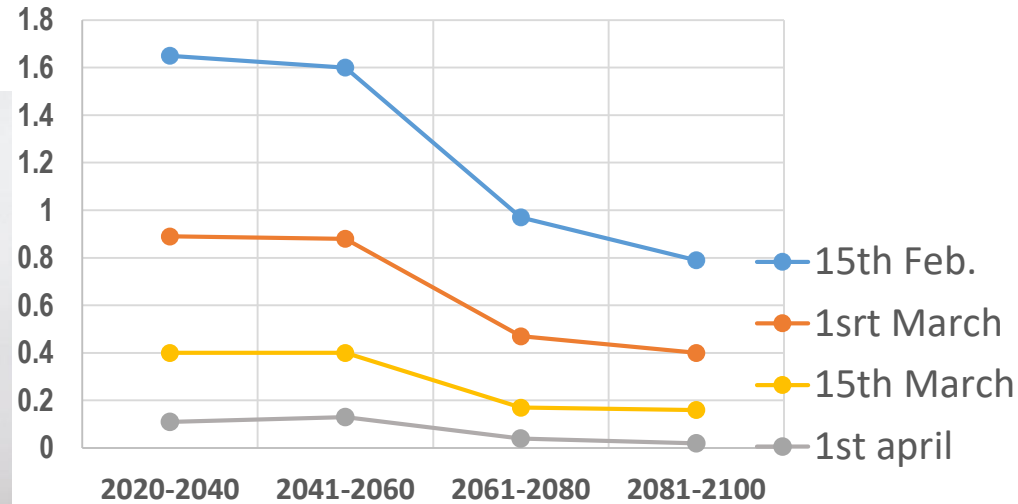


Bolting risks

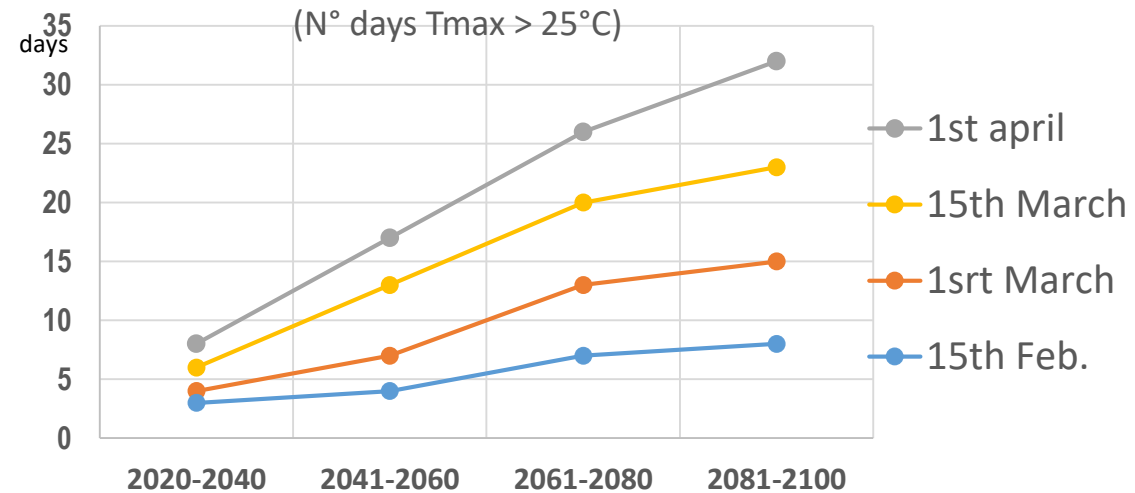


Source image IRBAB

Predicted bolting rate (%)



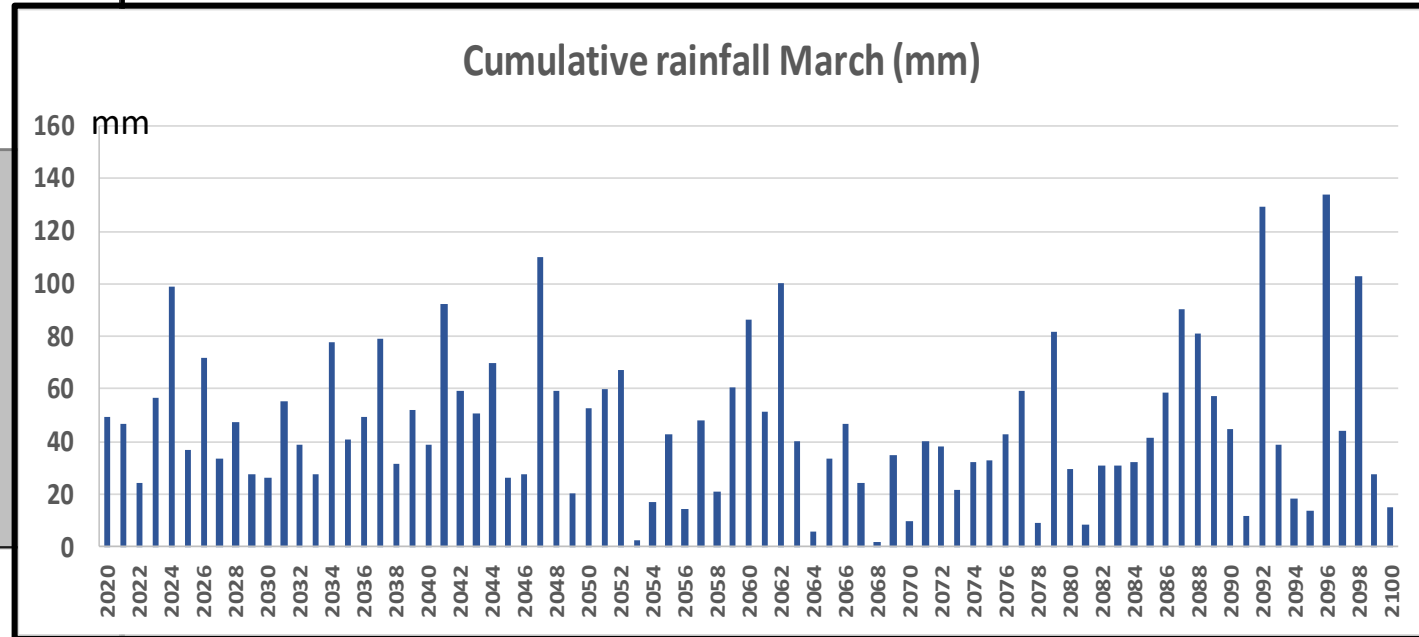
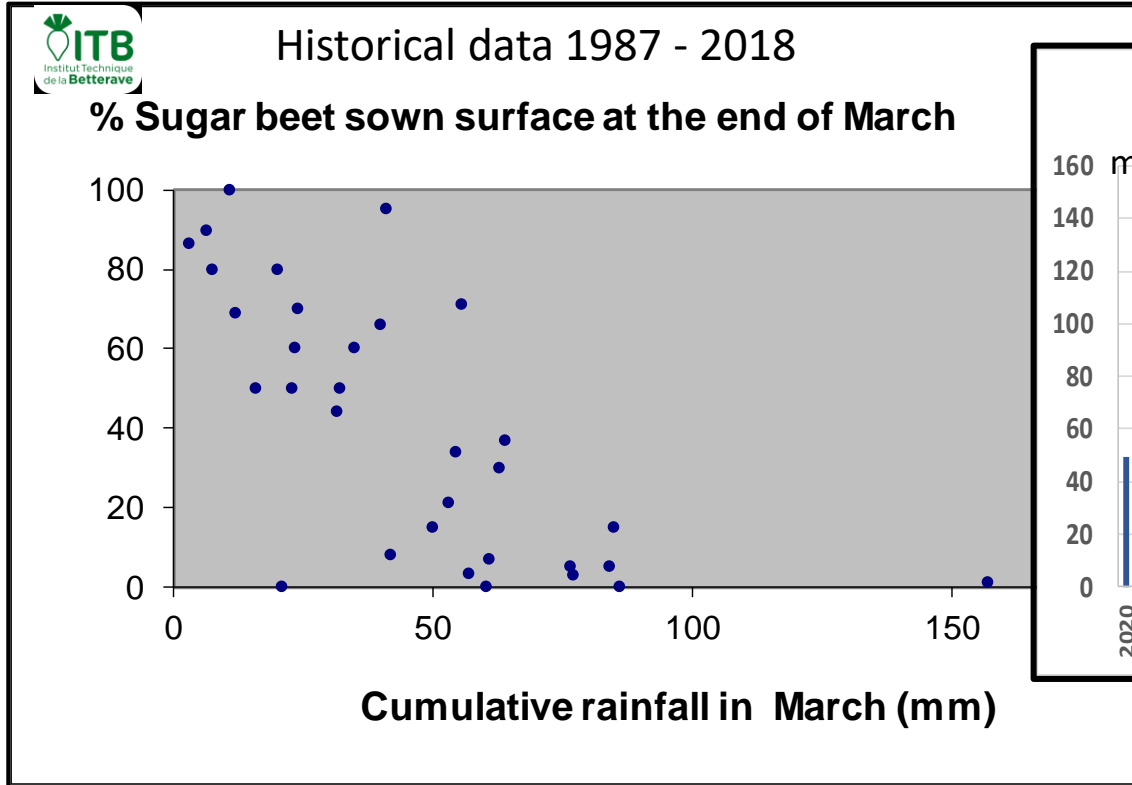
Probability of devernalization



Bolting rate = $f(T < 12^{\circ}\text{C}$ after sowing;
and $T_{\text{max}} > 25^{\circ}\text{C}$ 60-120 days after sowing over 7 days)

Longden et al, 1975; Fauchère et al, 2003

Field access during the sowing period



Conclusions

An insight into the future has been possible with the help of

- Precise geolocalized climatic scenario
- Detailed crop models for simulation

Main results

- Main changes will occur **after 2060**
- An **increase in temperatures** will favor **crop establishment** and **decrease bolting risk**
- **Rainfalls will be a main limit preventing field access**

Limits

- Quality of models and hypothesis
- Biotic stresses

Acknowledgements



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Thank you for your attention