OURANOS

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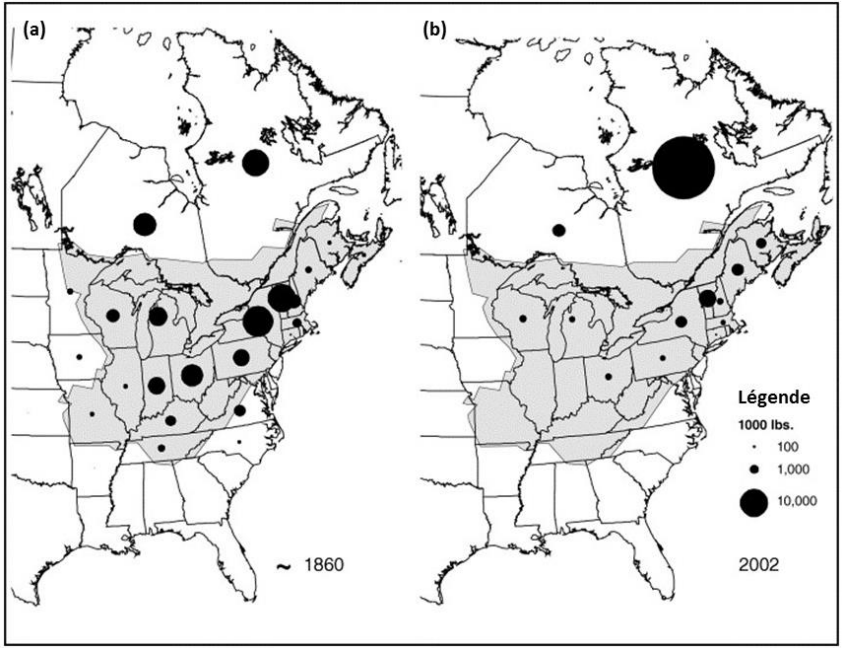
Entre l'arbre et l'écorce : l'érable à sucre et la production de sirop d'érable dans un climat en changement

Fédération des producteurs acéricoles du Québec

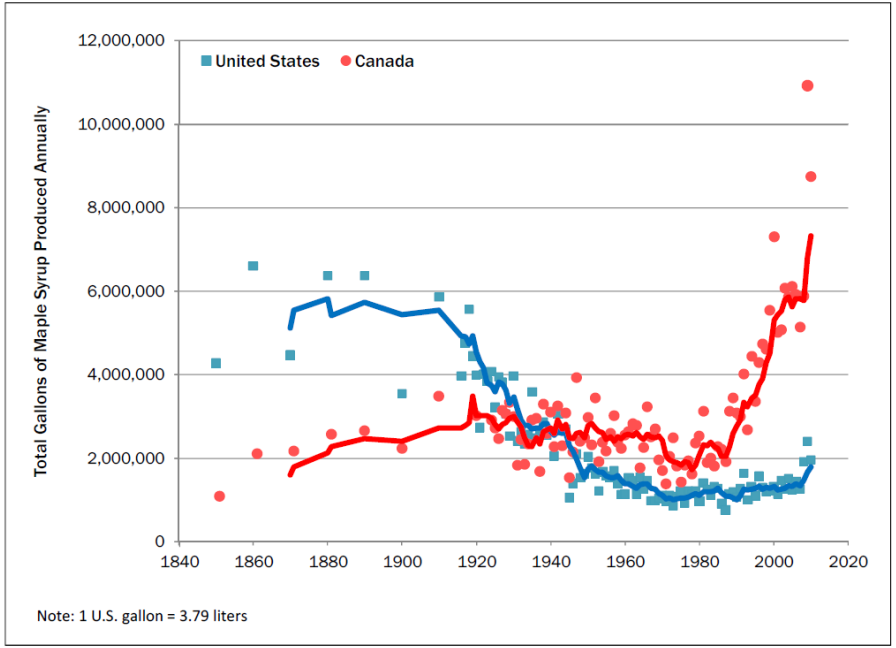
Ressources naturelles et Faune
Québec

Acériculture : Une industrie en changements

~1860: Canada << États-Unis
2002: Canada >> États-Unis



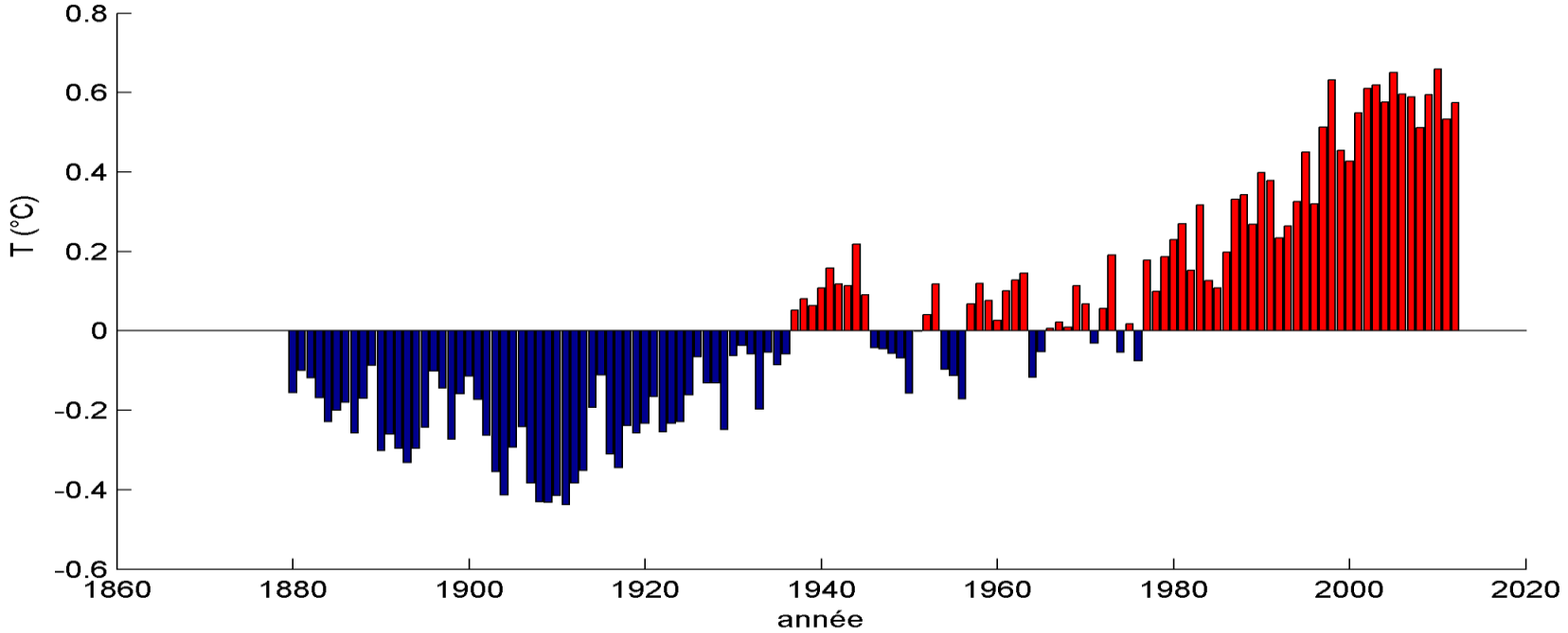
Whitney et Upmeyer 2004



Farrell et al. 2012

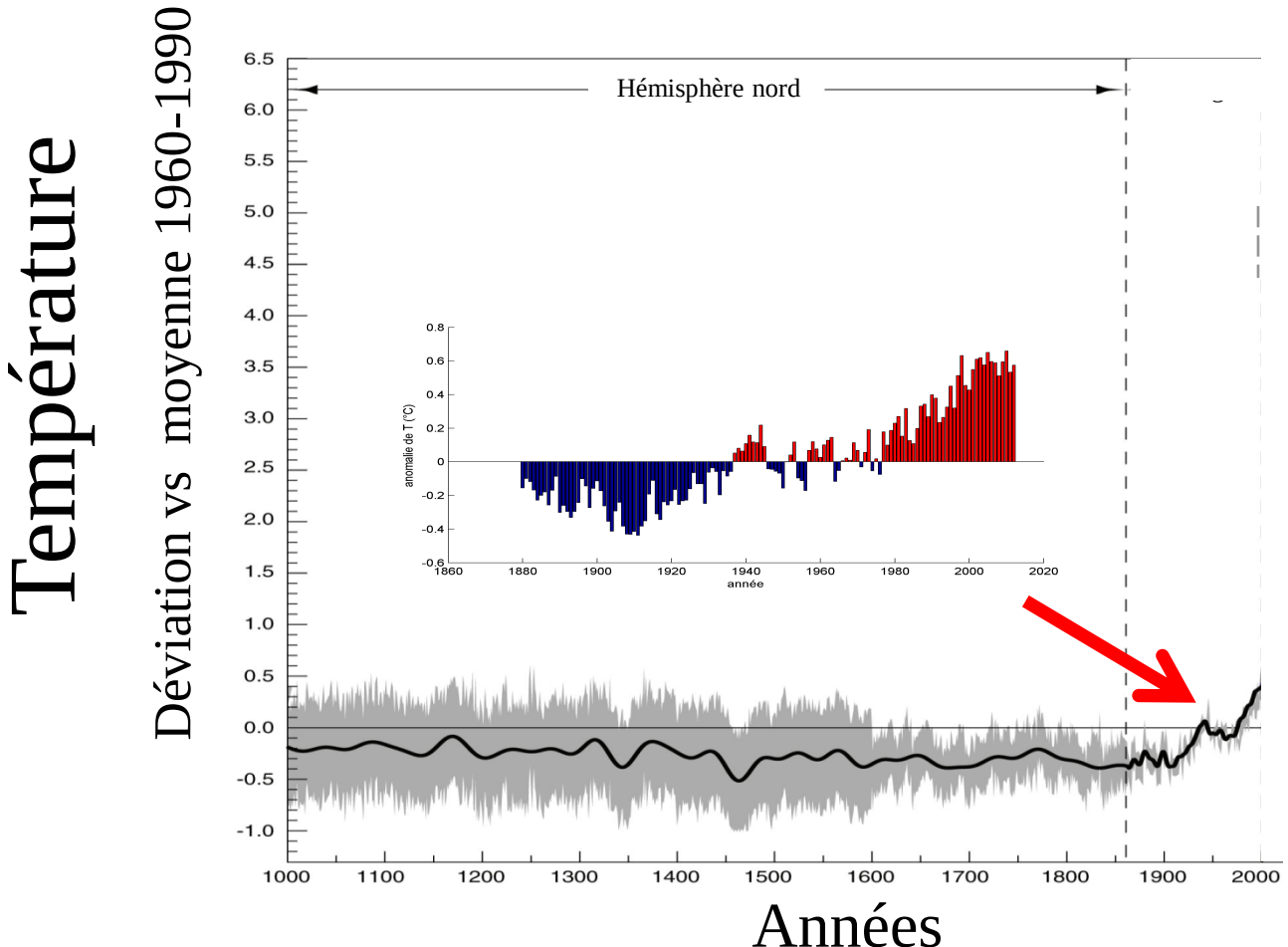
Évolution des températures globales depuis 1880

Déviations de la température annuelle par rapport à la moyenne de 1901-2000

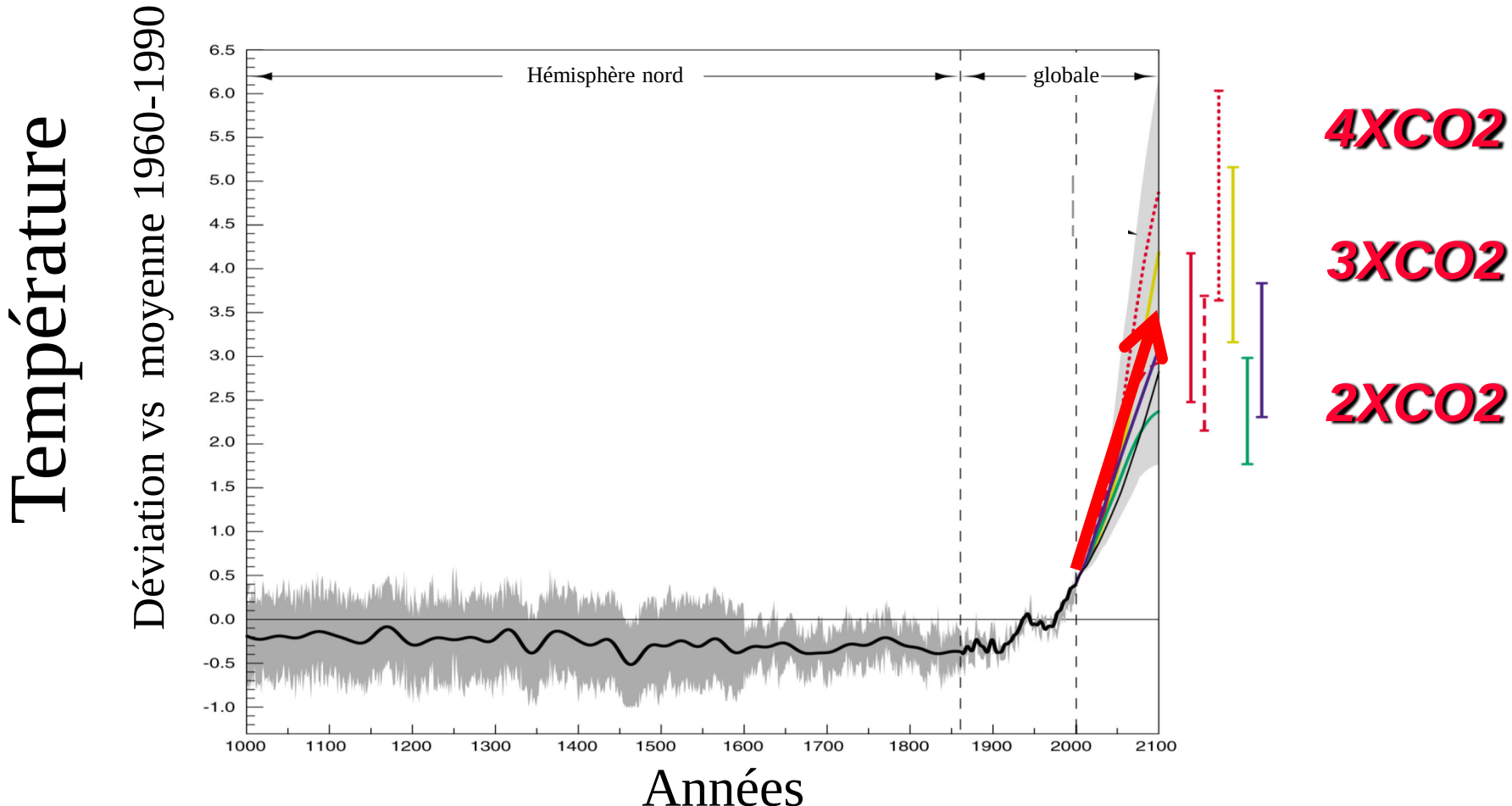


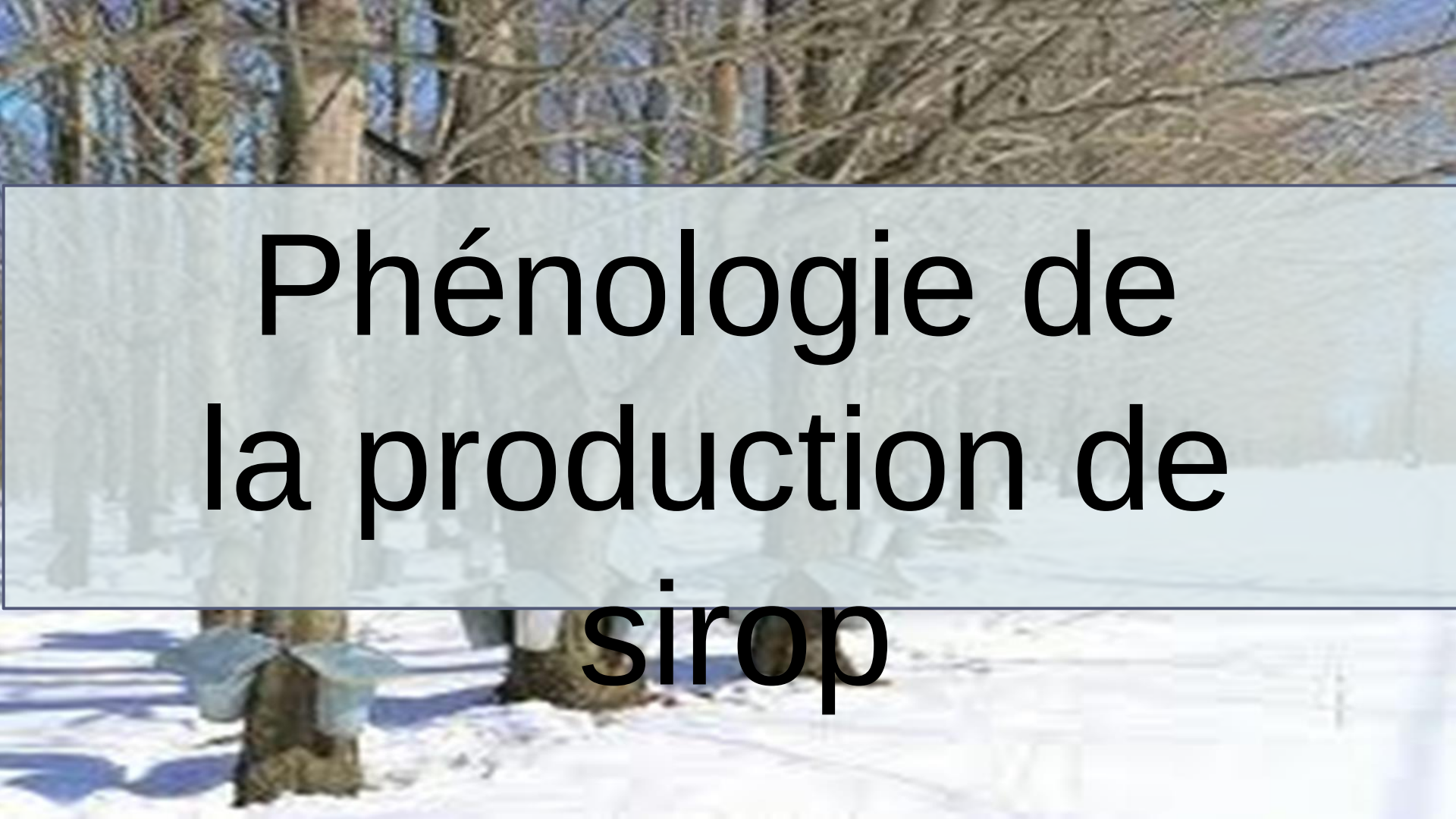
Source des données: NOAA

Tendance récente



Scénarios envisagés

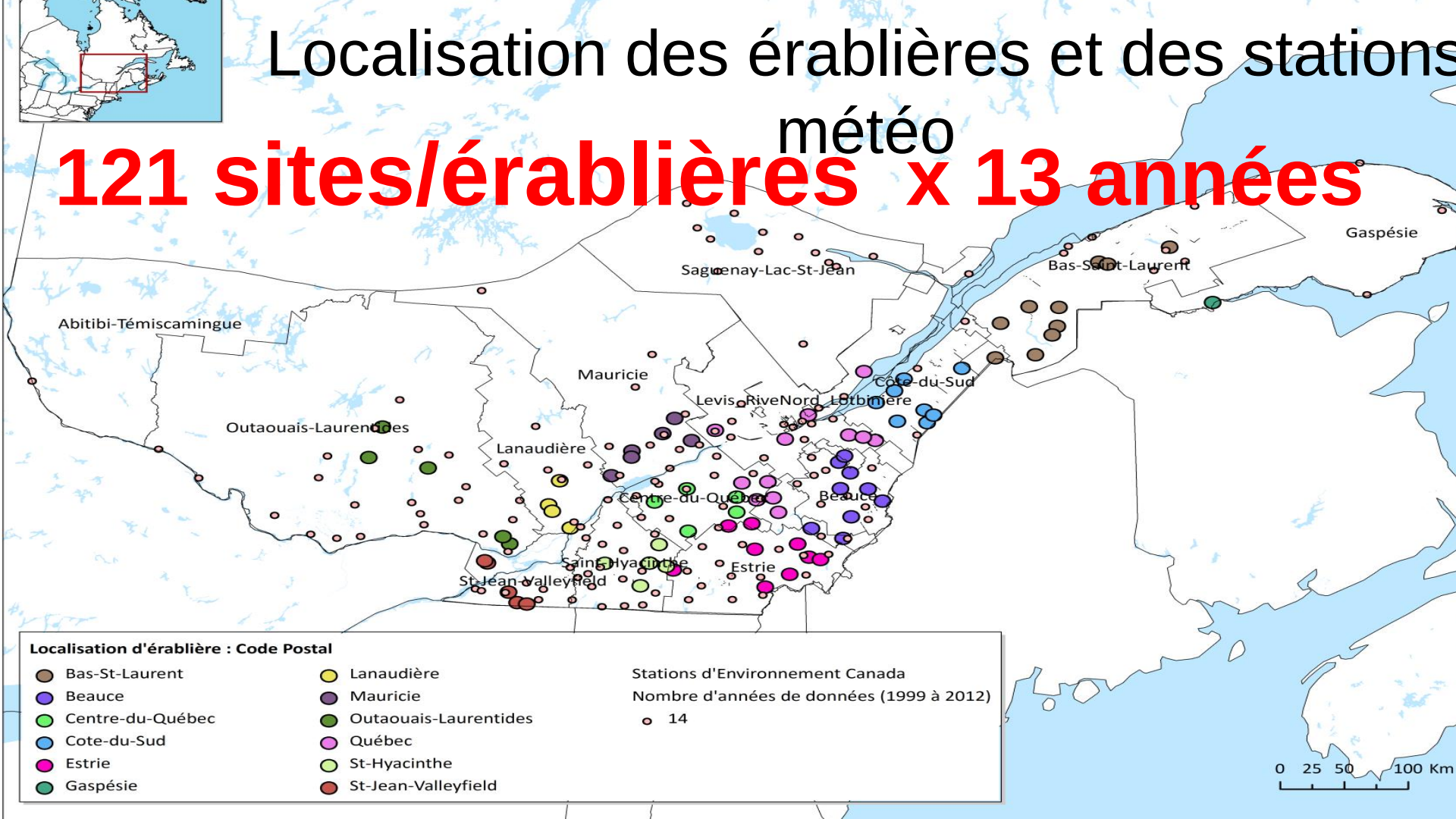




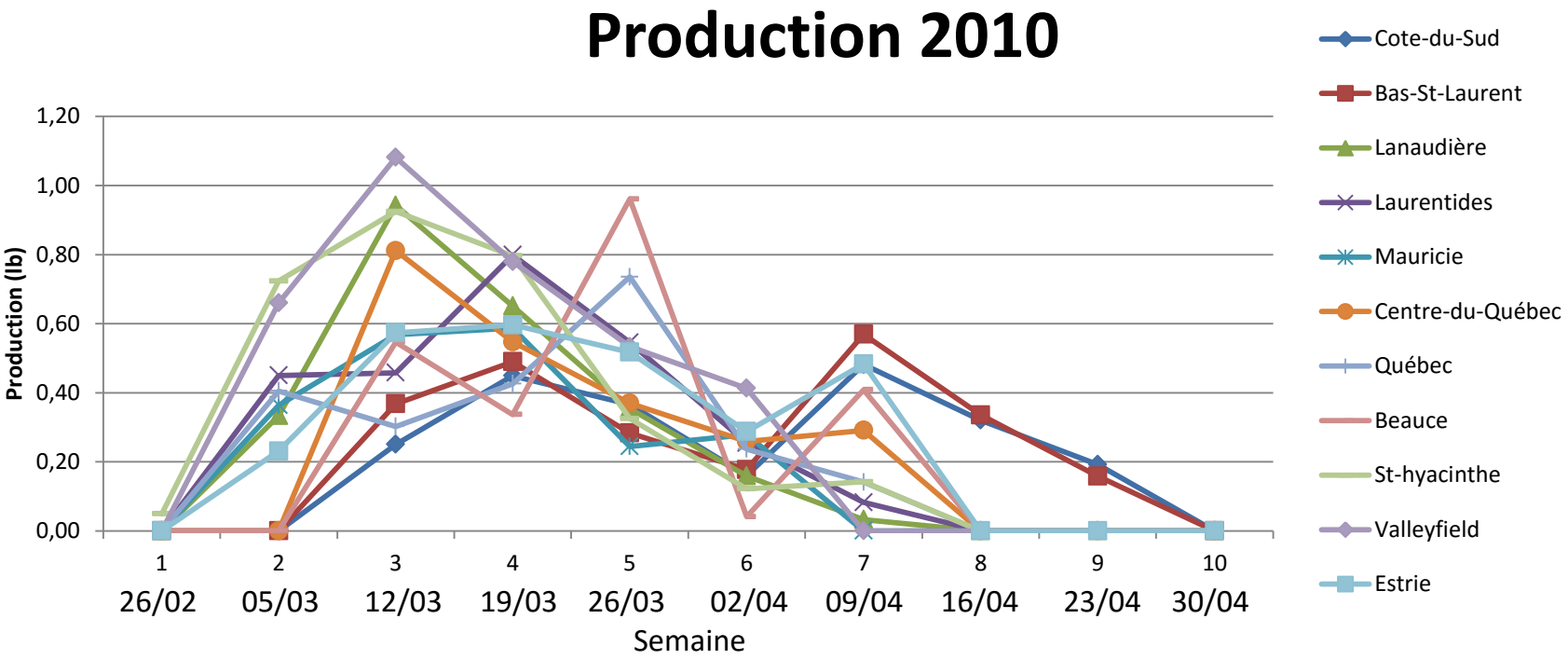
Phénologie de la production de sirop

Phénologie. Désigne la science des influences climatiques sur le développement saisonnier des plantes (floraison, feuillaison ou débourrement, coloration des feuilles, fructification) et des animaux (hibernation, migration, nidification).


Sondages téléphoniques hebdomadaires faits par la FPAQ auprès de producteurs de différentes régions
V S D L M M J V

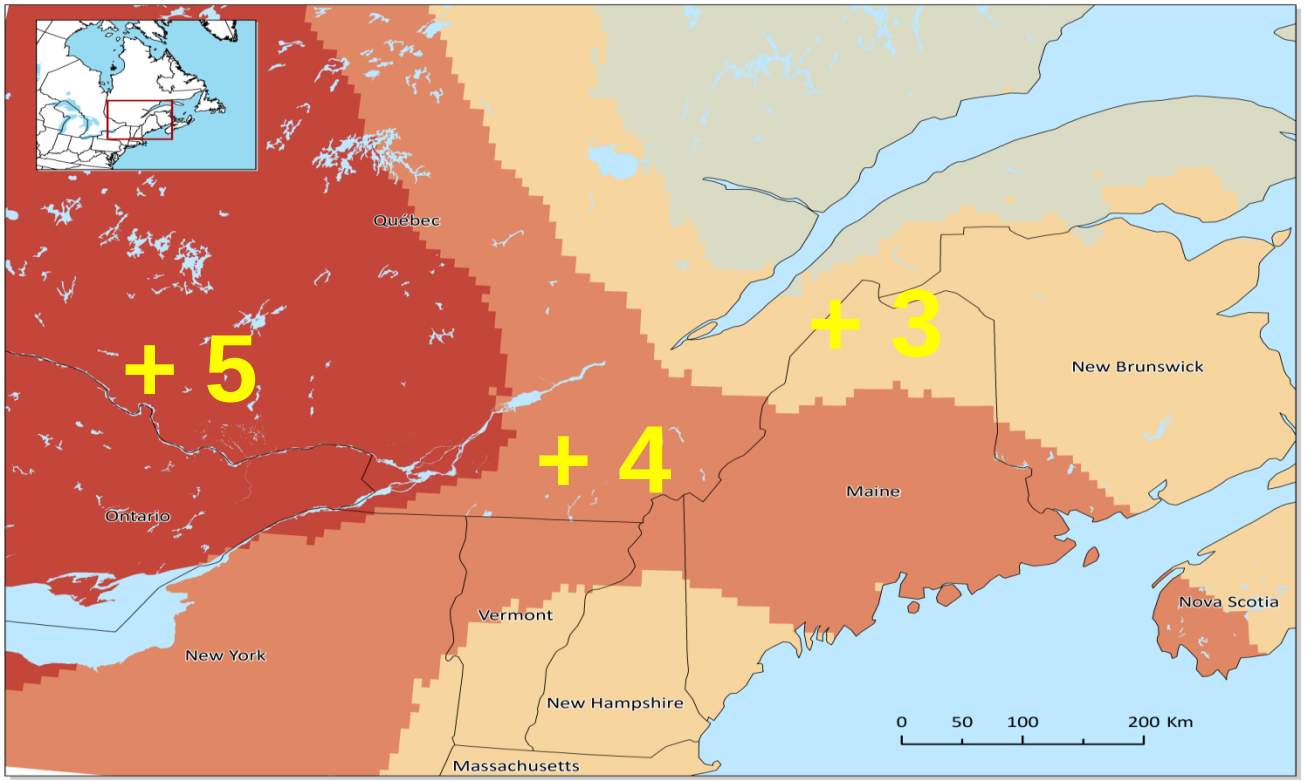

Localisation des érablières et des stations météo
121 sites/érablières x 13 années
Saguenay-Lac-St-Jean
Bas-Saint-Laurent
Gaspésie
Abitibi-Témiscamingue
Mauricie
Côte-du-Sud
Levis_RiveNord_Lotbinière
Outaouais-Laurentides
Lanaudière
Centre-du-Québec
Beauce
Saint-Hyacinthe
Estrie
St-Jean-Valleyfield
Localisation d'érablière : Code Postal
Bas-St-Laurent
Beauce
Centre-du-Québec
Cote-du-Sud
Estrie
Gaspésie
Lanaudière
Mauricie
Outaouais-Laurentides
Québec
St-Hyacinthe
St-Jean-Valleyfield
Stations d'Environnement Canada
Nombre d'années de données (1999 à 2012)
14
0 25 50 100 Km

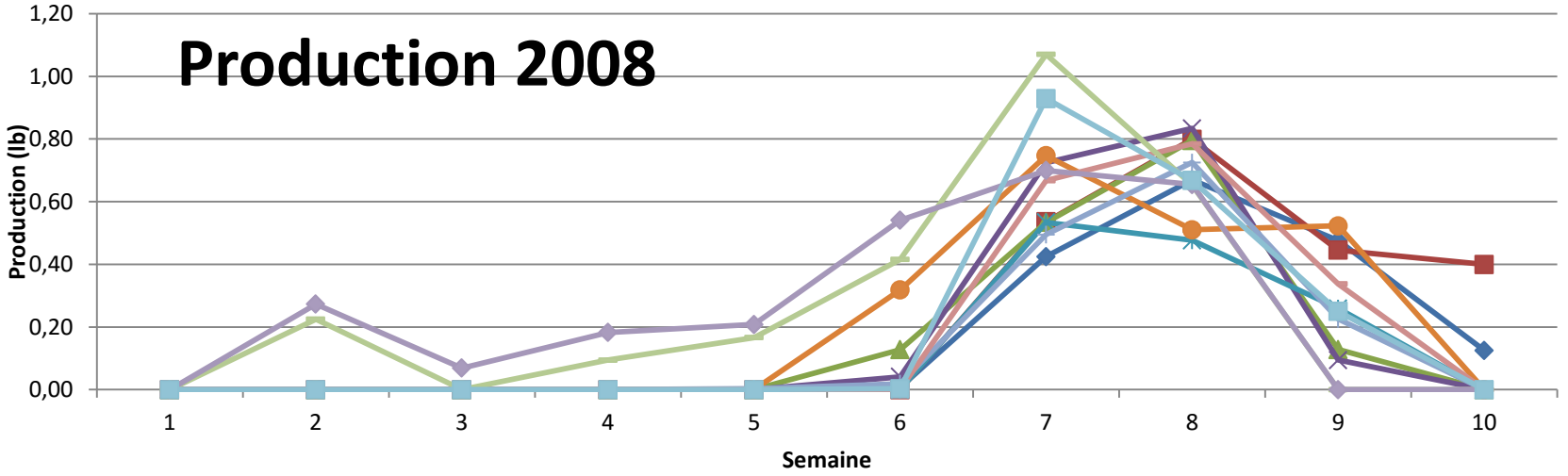
Production hebdomadaire par région

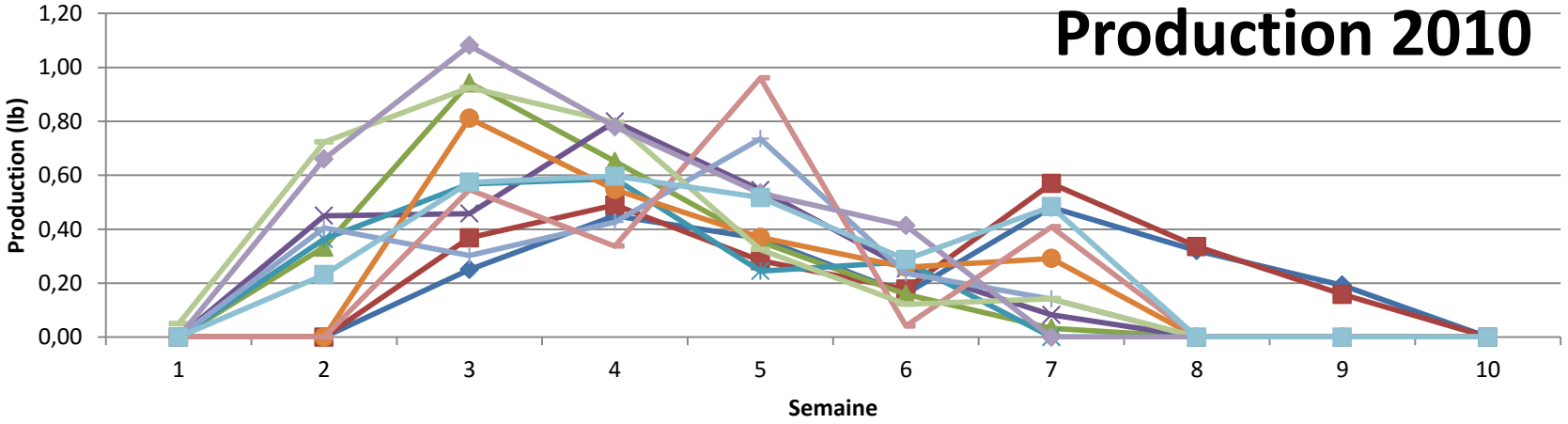


Mars 2010

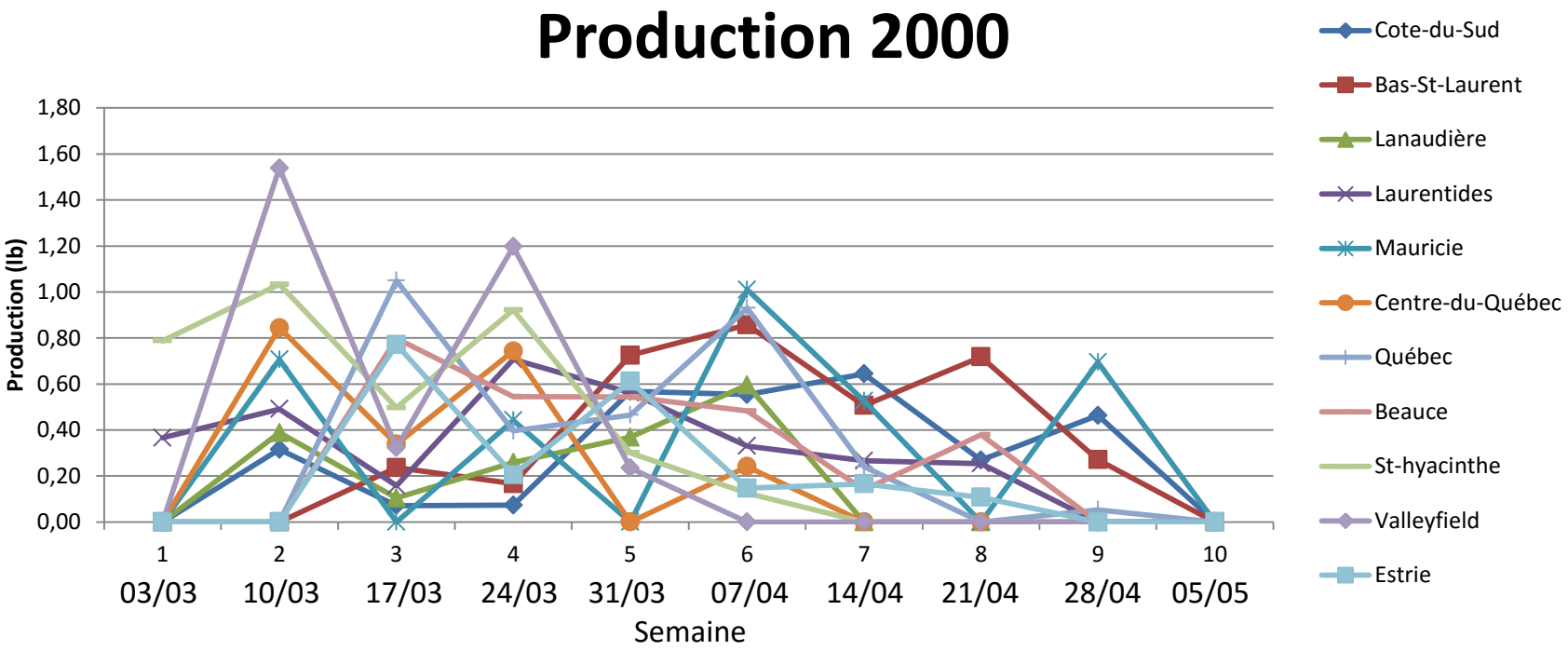
Anomalies de la température moyenne pour mars 2010 par rapport à la normale 1971 à 2000

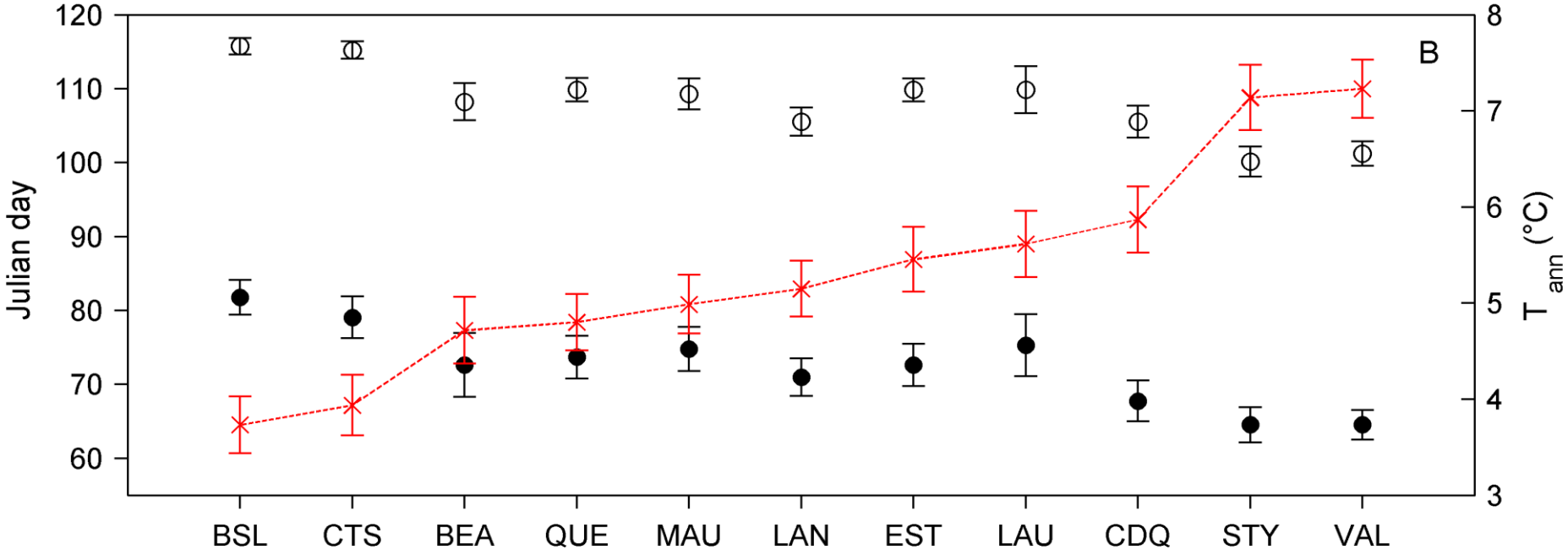



Production 2008
Production (lb)
1,20
1,00
0,80
0,60
0,40
0,20
0,00
1
2
3
4
5
6
7
8
9
10
Semaine

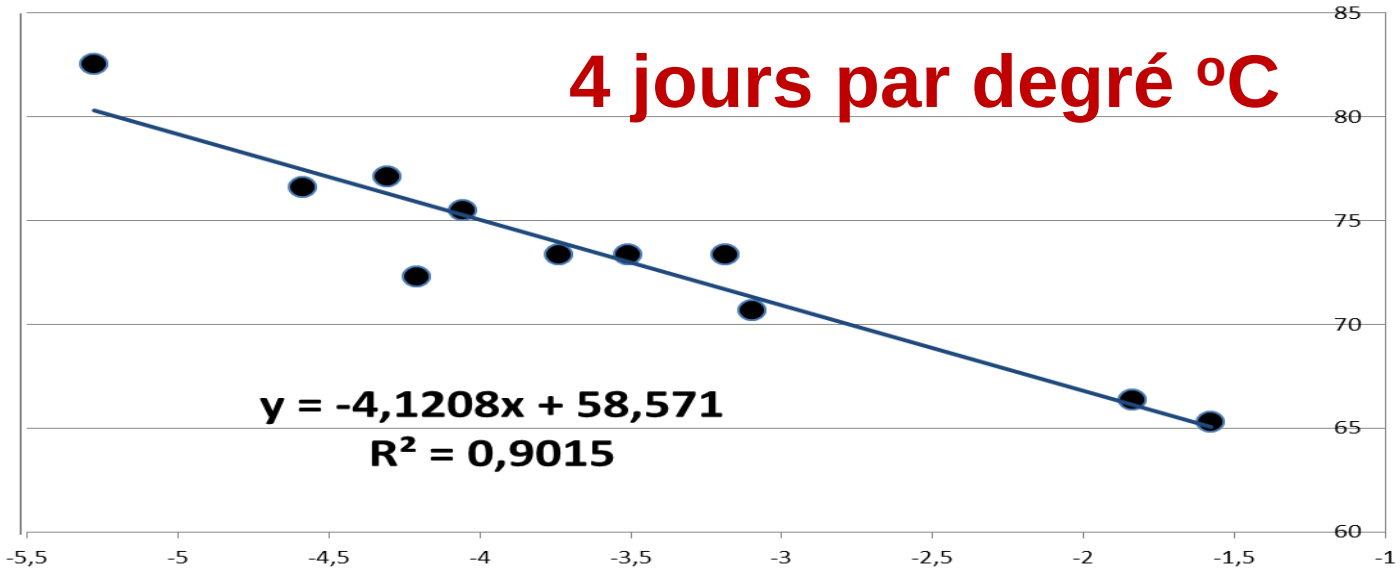

Production 2010
Production (lb)
1,20
1,00
0,80
0,60
0,40
0,20
0,00
1
2
3
4
5
6
7
8
9
10
Semaine

Production hebdomadaire par région




B
Julian day
120
110
100
90
80
70
60
8
7
6
5
4
3
T ann (°C)
BSL
CTS
BEA
QUE
MAU
LAN
EST
LAU
CDQ
STY
VAL

Modèle simple de début



Jour Julien

Température février-avril

Modèle “compliqué” de début

Modèle logistique : prédit la **présence** ou l’**absence** de production pendant la semaine x

Production =

$$- 5.09 + 0.722\ \text{FrThw3:NbCum} - 0.014\ (\text{FrThw3:NbCum})^2 - 0.07\ \text{GDDCum}$$

Efficacité : présence : 83-91%

absence : 88-97%

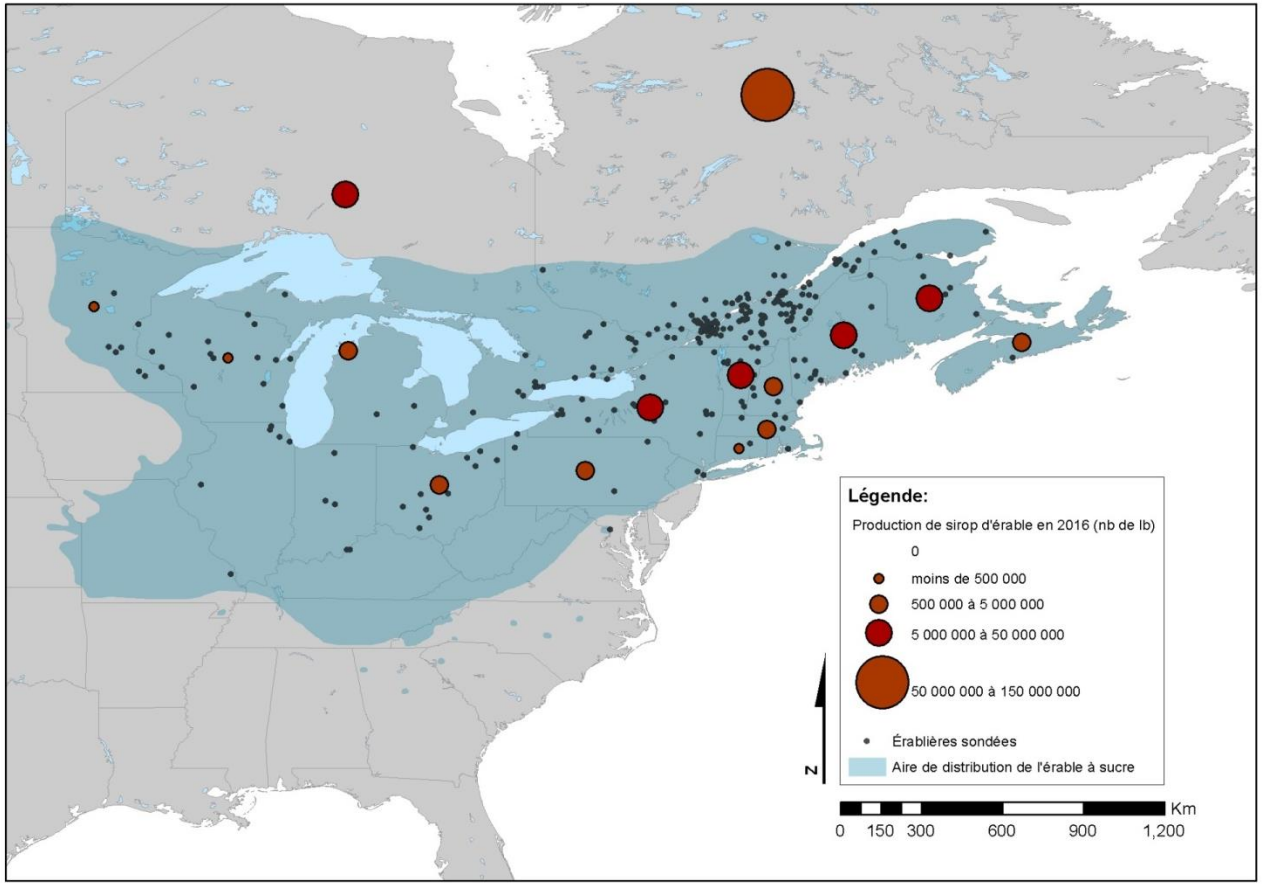
Comment les changements climatiques affecteront l'industrie du sirop d'érable?

Objectifs

1. Diffuser les plus récentes connaissances scientifiques (impacts et adaptation)
2. Documenter les perceptions et préoccupations de producteurs acéricoles

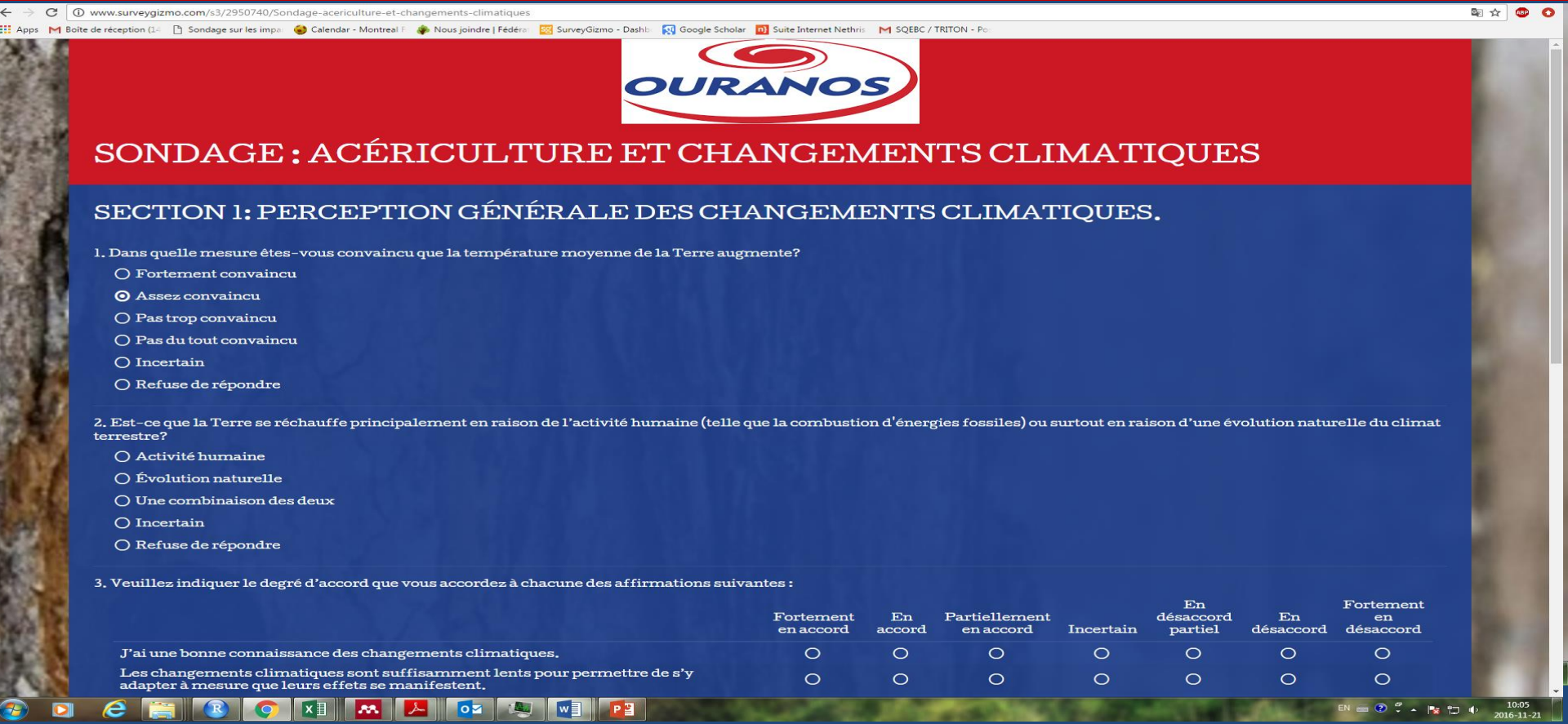
Sondage auprès de producteurs

- **2016**
- **354 répondants**
- **34 questions sur les CC**

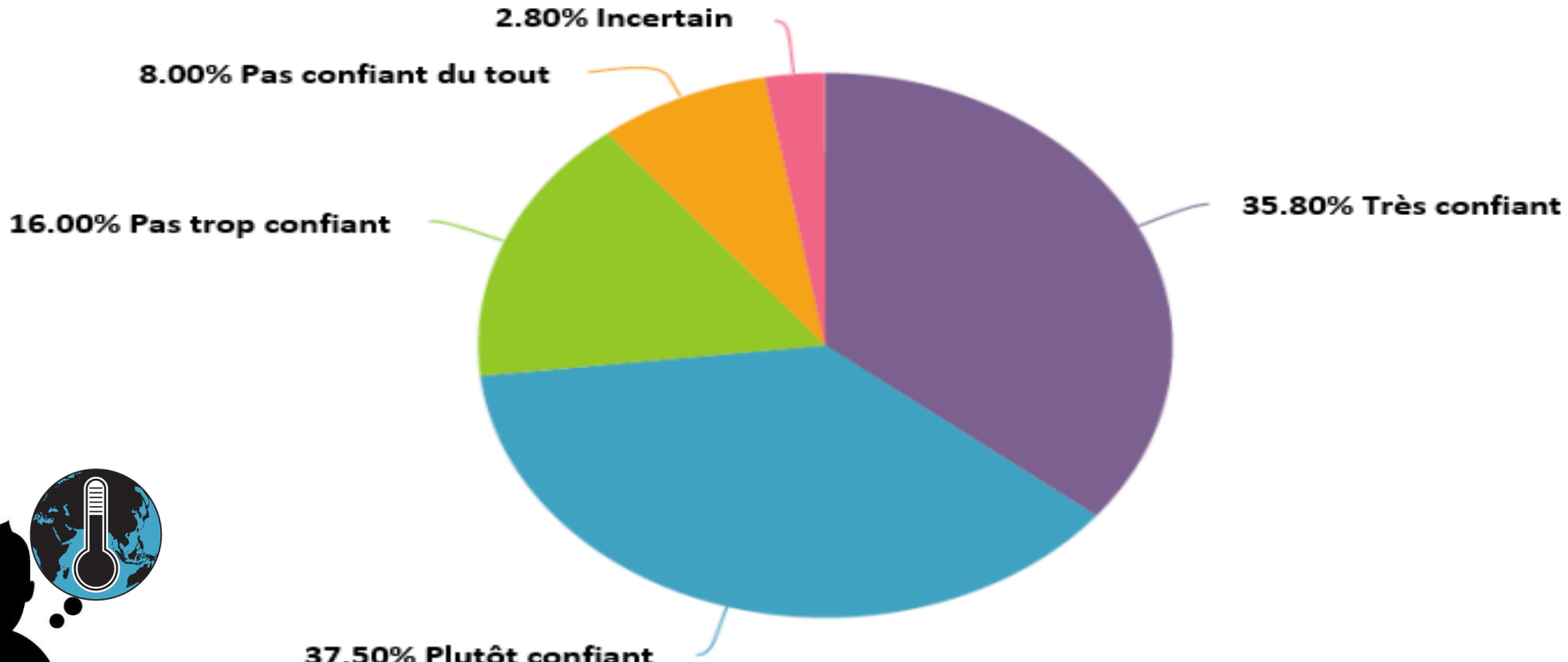


surveygizmo

1. Construction d'un sondage avec processus de relecture (SurveyGizmo).



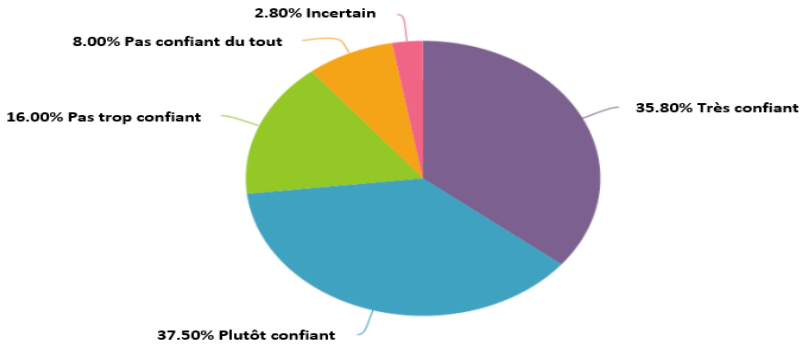
Dans quelle mesure êtes-vous convaincu que la température moyenne de la Terre augmente?

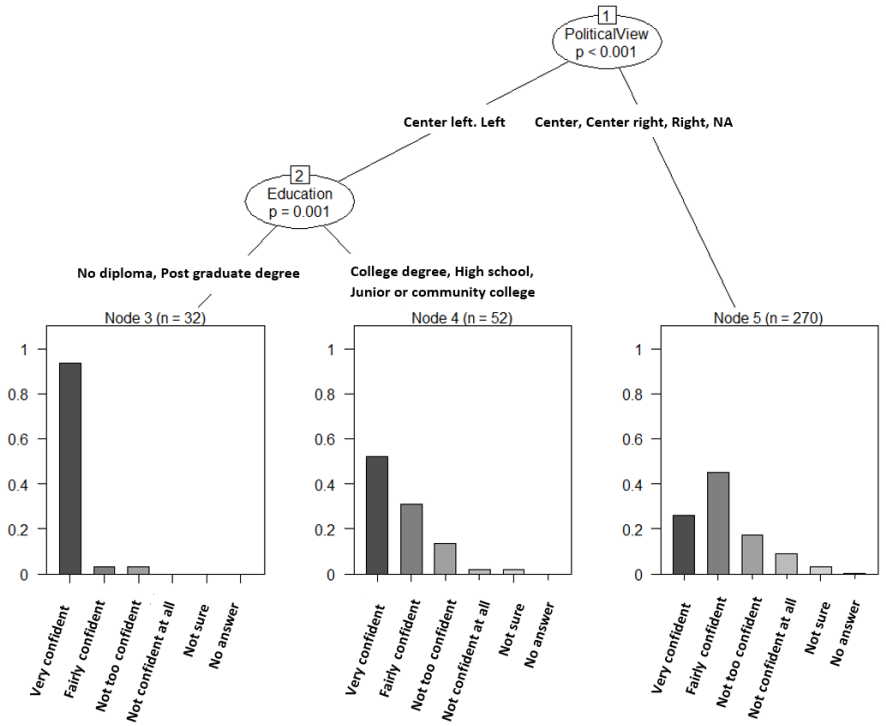


convaincu que la température moyenne de la Terre augmente?

Caractéristiques des répondants qui influencent cette perception

Explanatory variables	Importance	Model improvement ratio (MIR)
Latitude	1.77E-03	0.065877015
Longitude	3.74E-04	0.013938282
Country	4.69E-04	0.017494551
NbTAP	3.95E-04	0.01471263
MaplesAge	5.99E-04	0.022341402
Harv_Method	2.73E-03	0.101812536
Experience	-7.38E-04	-0.027532405
Releve	-5.59E-04	-0.020850063
Pourc_Income	-1.58E-04	-0.005879316
Yield2016	3.54E-05	0.001319261
SylviculturalInvest	-5.87E-04	-0.021882528
EquipmentInvest	-6.83E-04	-0.025467475
InfrastructureInvest	7.48E-04	0.027876561
Restaurant	-2.40E-04	-0.008948032
Gender	-9.48E-04	-0.035333255
Age	-1.19E-03	-0.044195262
Education	9.60E-03	0.357892612
PoliticalView	2.68E-02	1

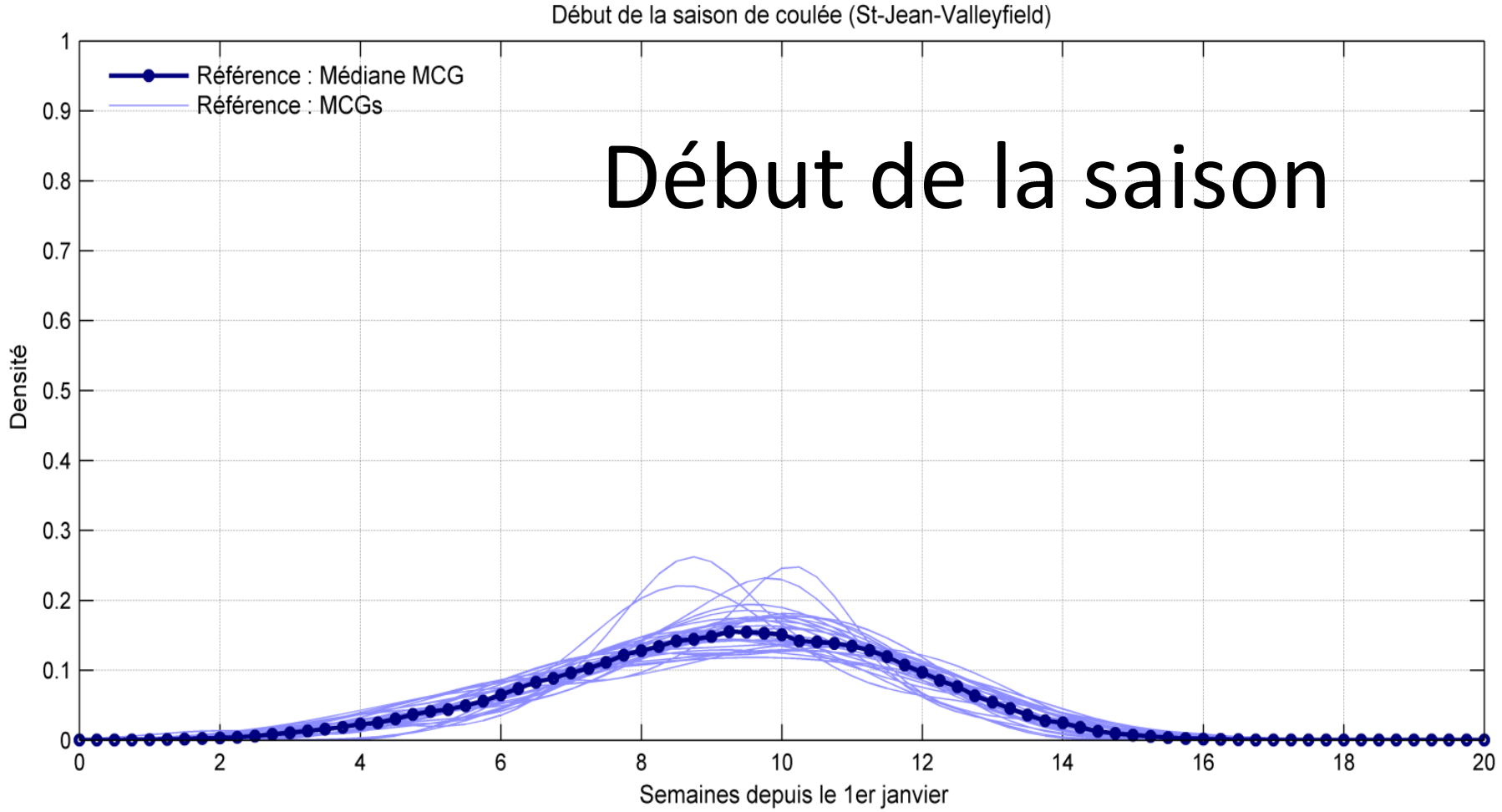


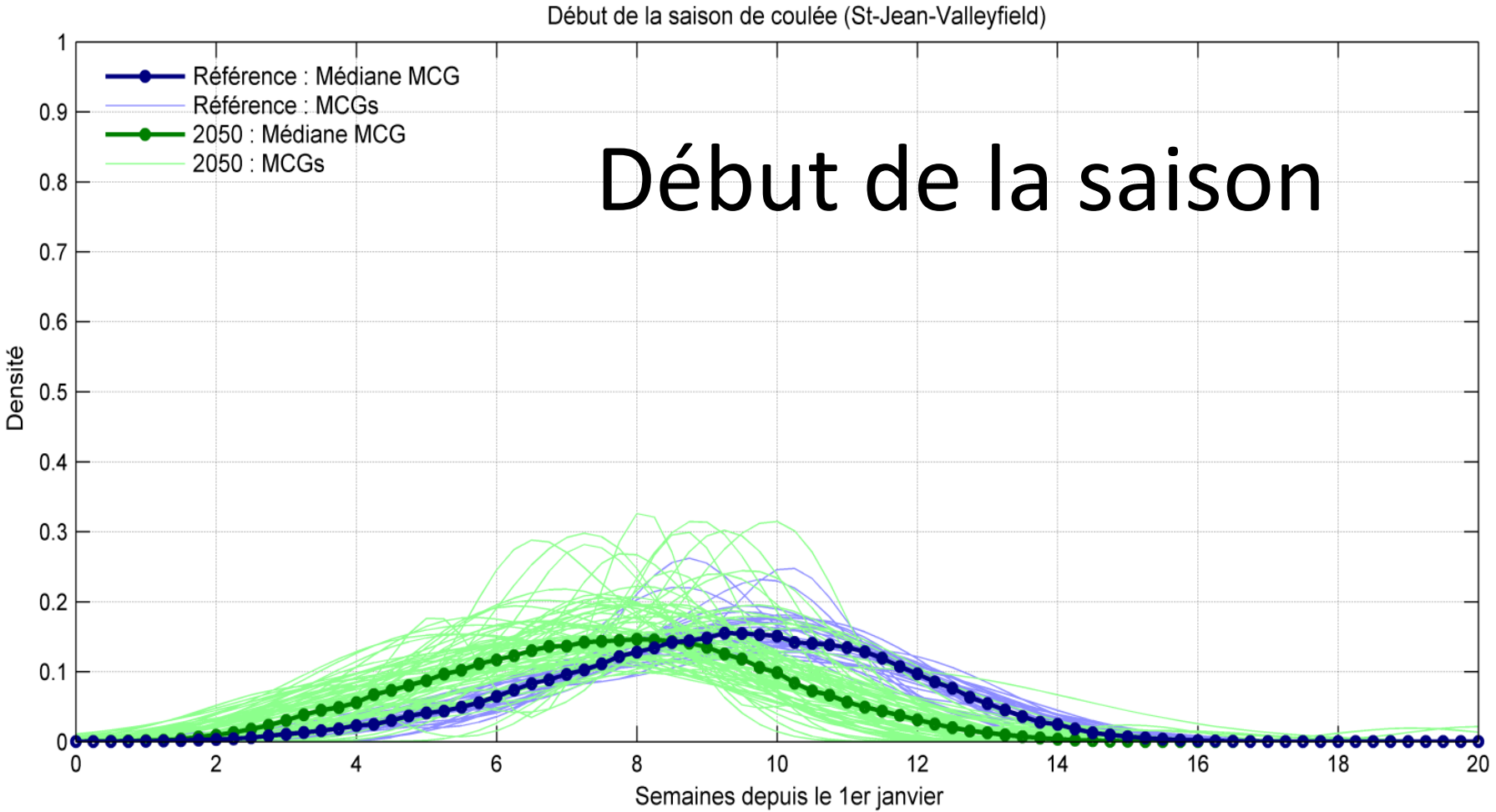


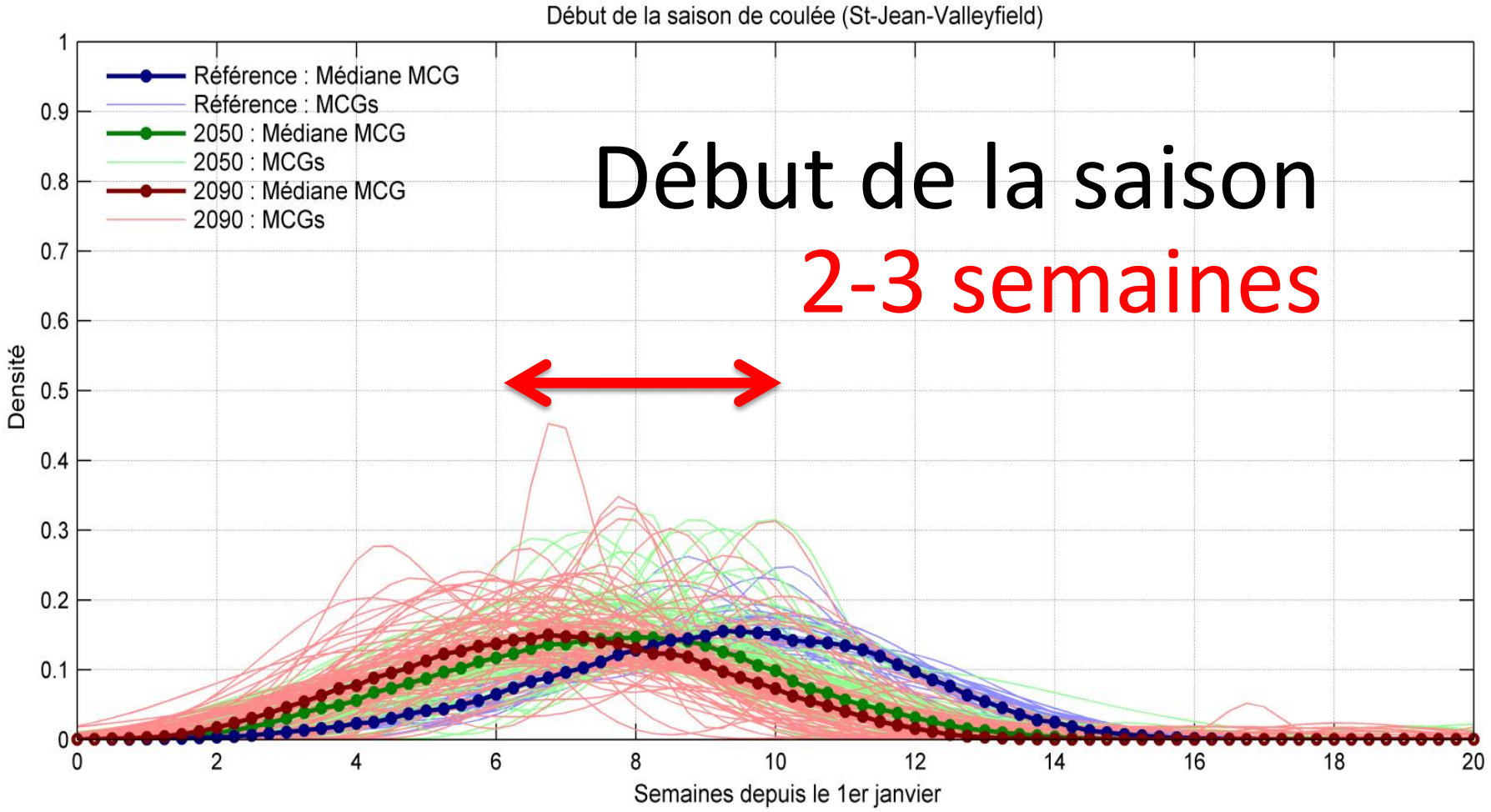
Impacts futurs des changements climatiques sur le moment de la coulée:

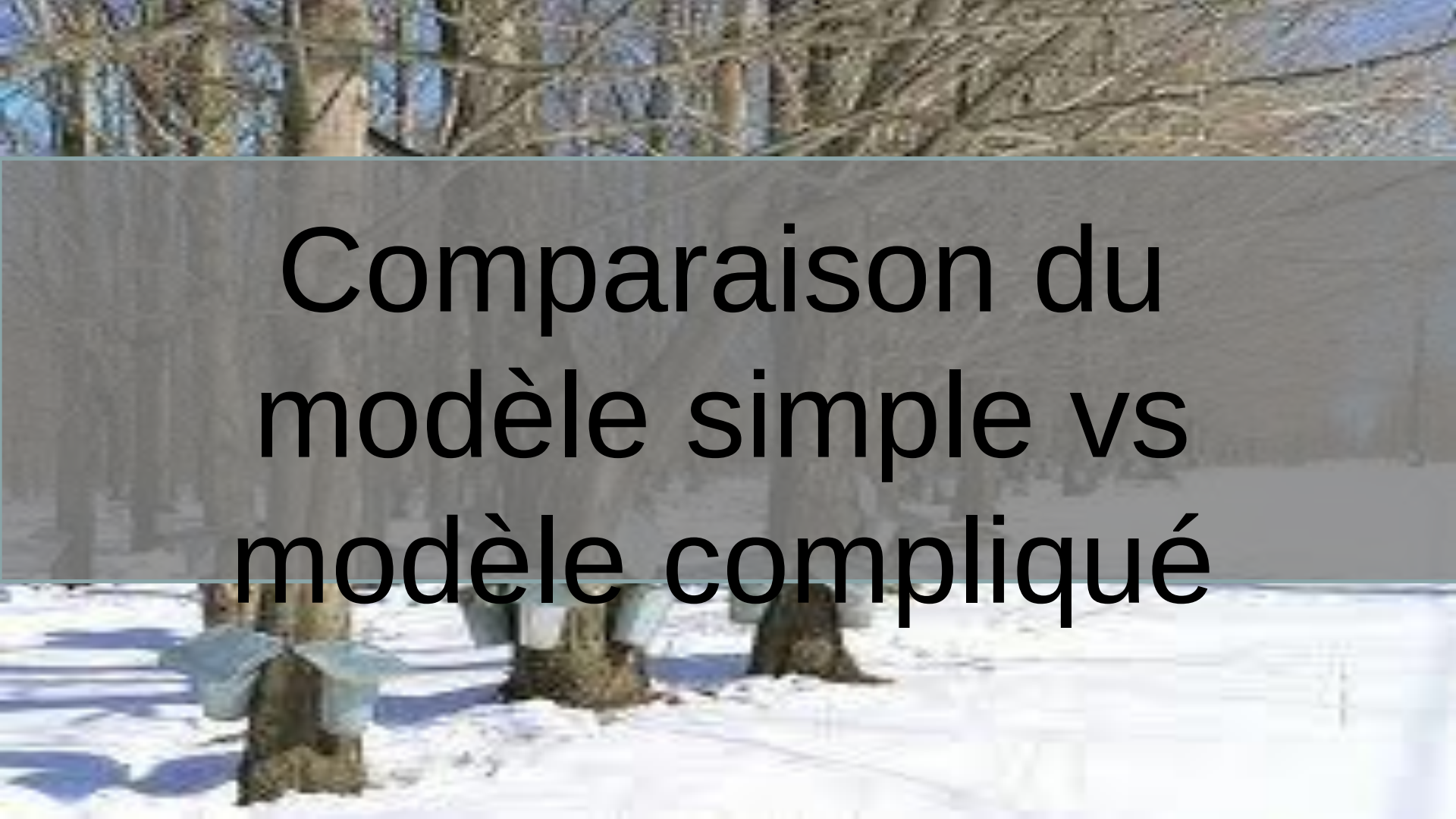
	Fortement en désaccord	En désaccord	En désaccord partiel	Incertain	Partiellement en accord	En accord	Fortement en accord
Au cours des 30 prochaines années, le début de la saison de coulée de la sève d'érable sera devancé par les changements climatiques.	3.1%	6.0%	6.8%	18.5%	21.7%	32.5%	11.4%


Modélisation
- Début, fin, durée et production totale annuelle
- 77 simulations avec des modèle
globaux pour toutes les régions


Début de la saison de coulée (St-Jean-Valleyfield)
Référence : Médiane MCG
Référence : MCGs
Début de la saison
Densité
Semaines depuis le 1er janvier
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
2
4
6
8
10
12
14
16
18
20

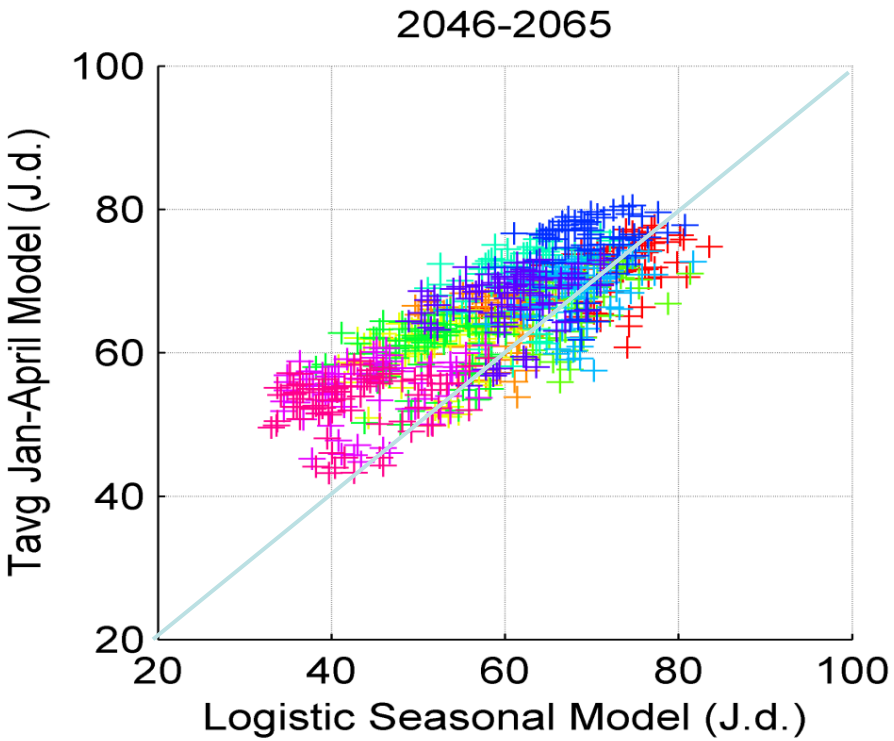

Début de la saison de coulée (St-Jean-Valleyfield)
Référence : Médiane MCG
Référence : MCGs
2050 : Médiane MCG
2050 : MCGs
Début de la saison
Densité
Semaines depuis le 1er janvier
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
2
4
6
8
10
12
14
16
18
20

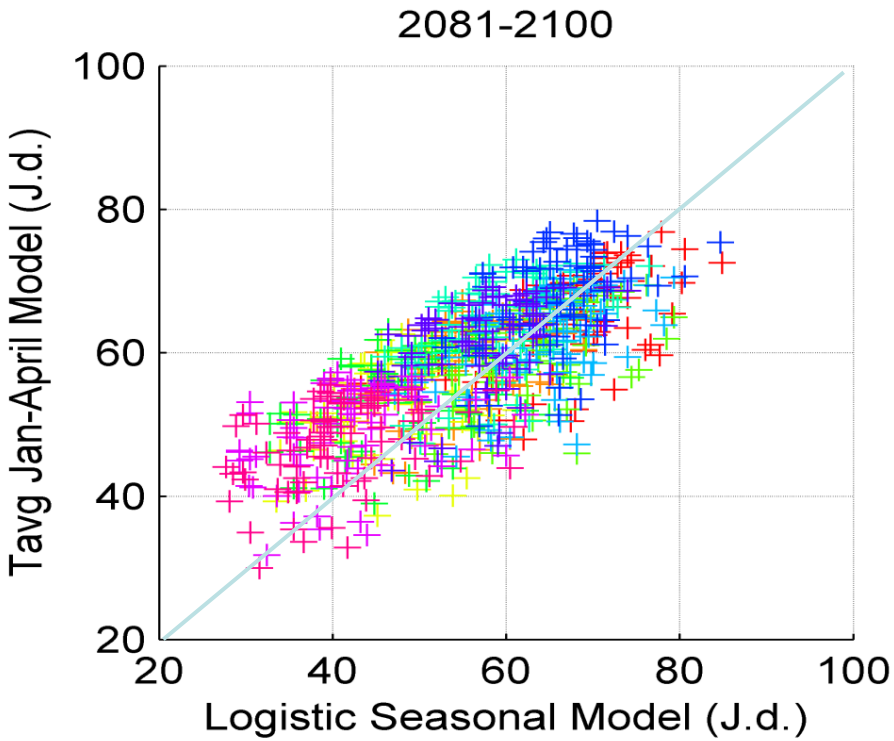

Début de la saison de coulée (St-Jean-Valleyfield)
Référence : Médiane MCG
Référence : MCGs
2050 : Médiane MCG
2050 : MCGs
2090 : Médiane MCG
2090 : MCGs
Début de la saison
2-3 semaines
Densité
Semaines depuis le 1er janvier
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
2
4
6
8
10
12
14
16
18
20



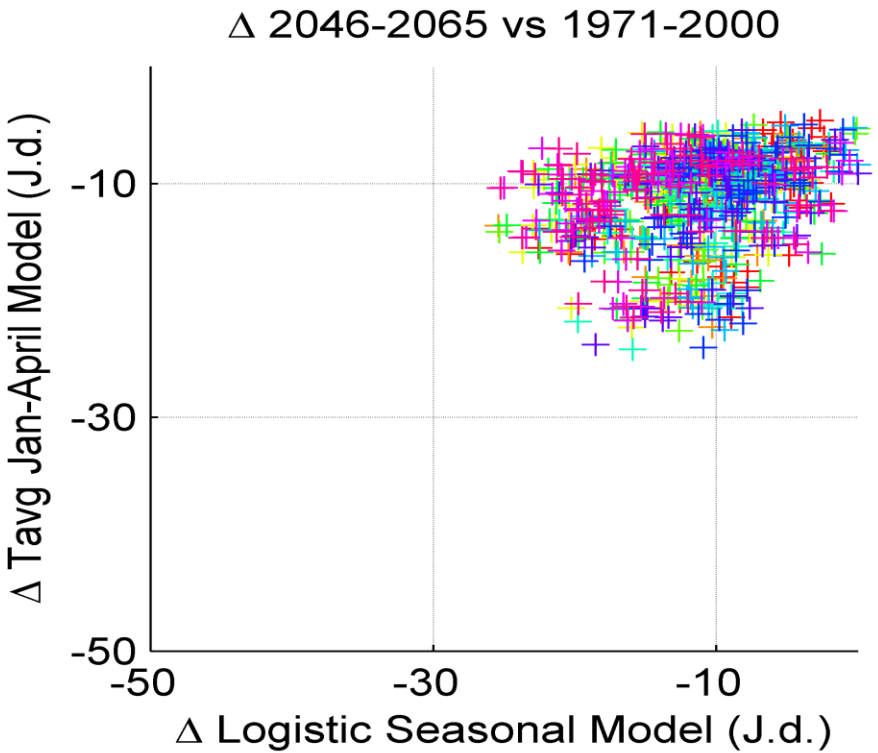
Comparaison du modèle simple vs modèle compliqué

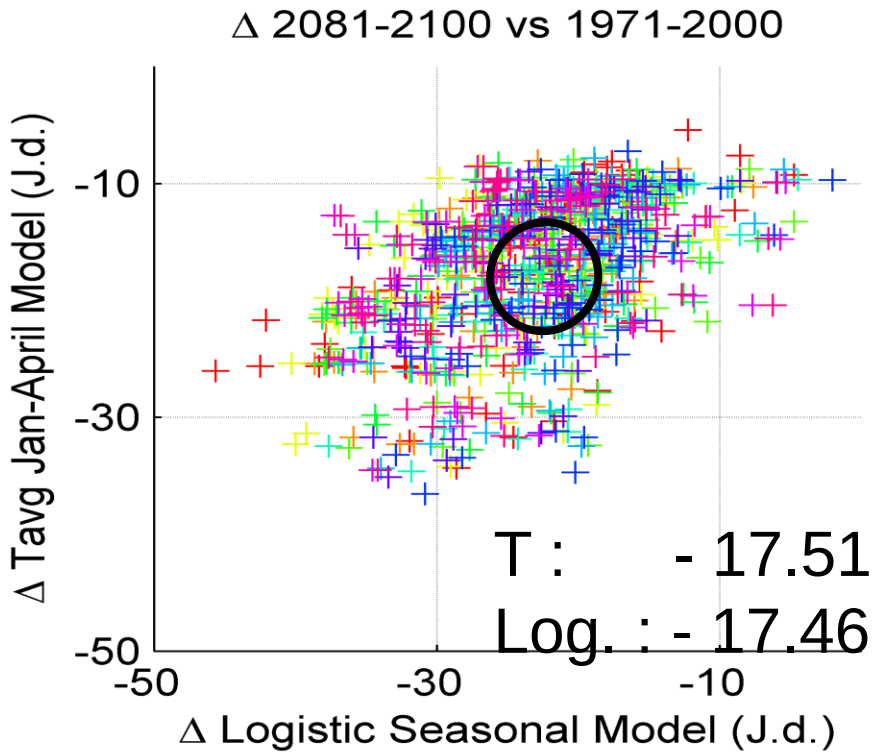
Jours de début de saison





Delta déplacements

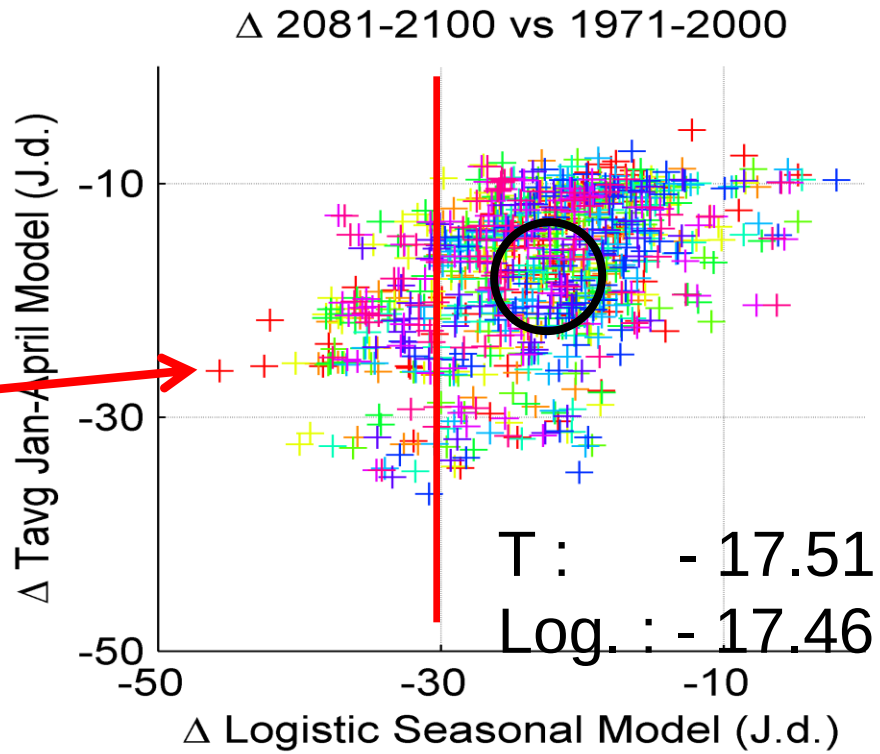




Delta déplacements

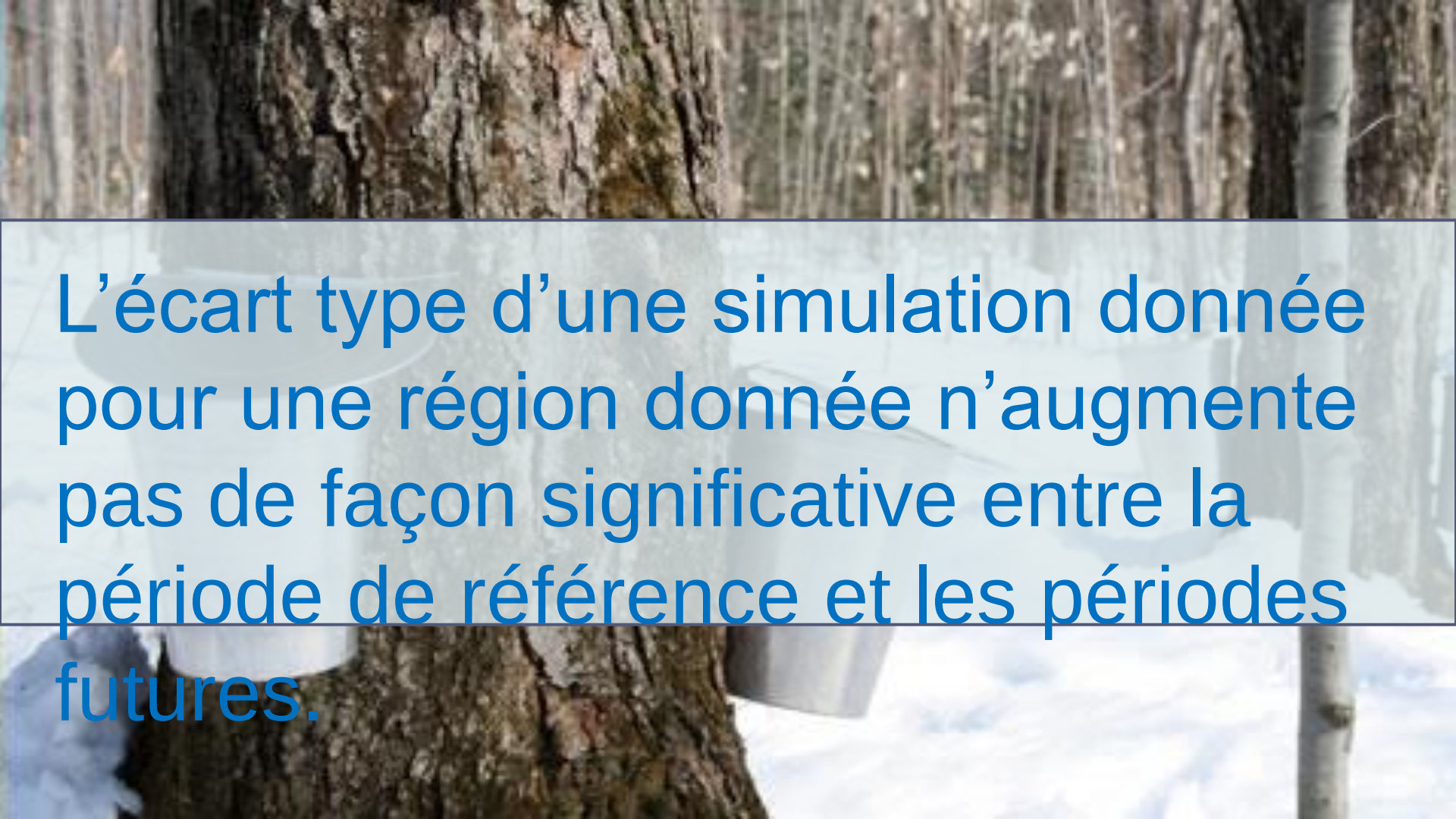
Delta 30 jours = 4 février

Moyenne de 20 ans



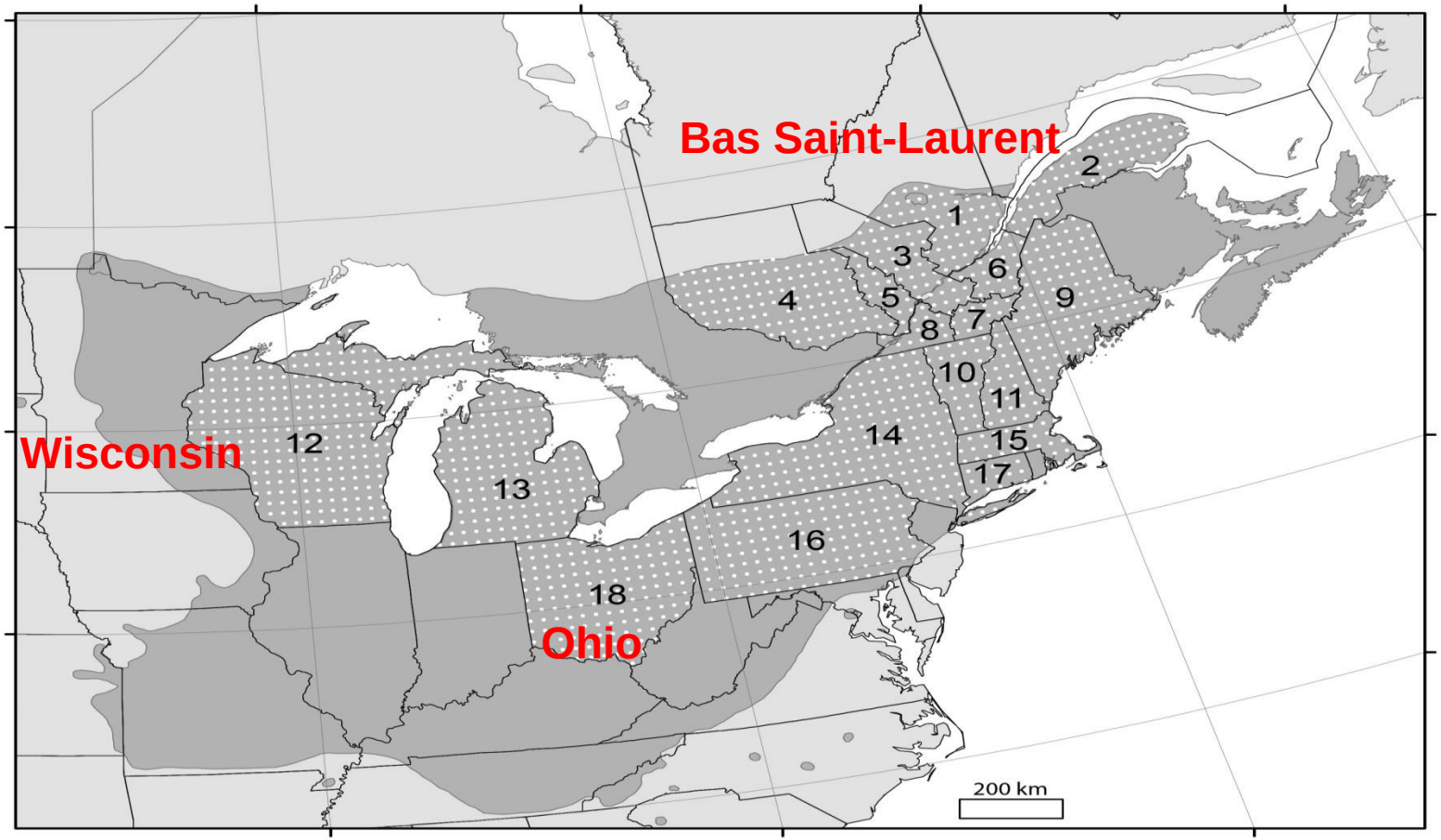
Impacts futurs des changements climatiques sur le moment de la coulée:

	Fortement en désaccord	En désaccord	En désaccord partiel	Incertain	Partiellement en accord	En accord	Fortement en accord
Au cours des 30 prochaines années, le début de la saison de coulée de la sève d'érable sera devancé par les changements climatiques.	3.1%	6.0%	6.8%	18.5%	21.7%	32.5%	11.4%
Au cours des 30 prochaines années, les changements climatiques entraineront une plus grande variabilité d'une année à l'autre du début de la coulée.	2.5%	5.9%	6.5%	17.3%	22.9%	34.8%	9.9%
Dans le futur, il sera de moins en moins facile de déterminer le meilleur moment d'entailler les érables.	5.4%	11.6%	9.4%	22.4%	19.3%	23.9%	8.0%



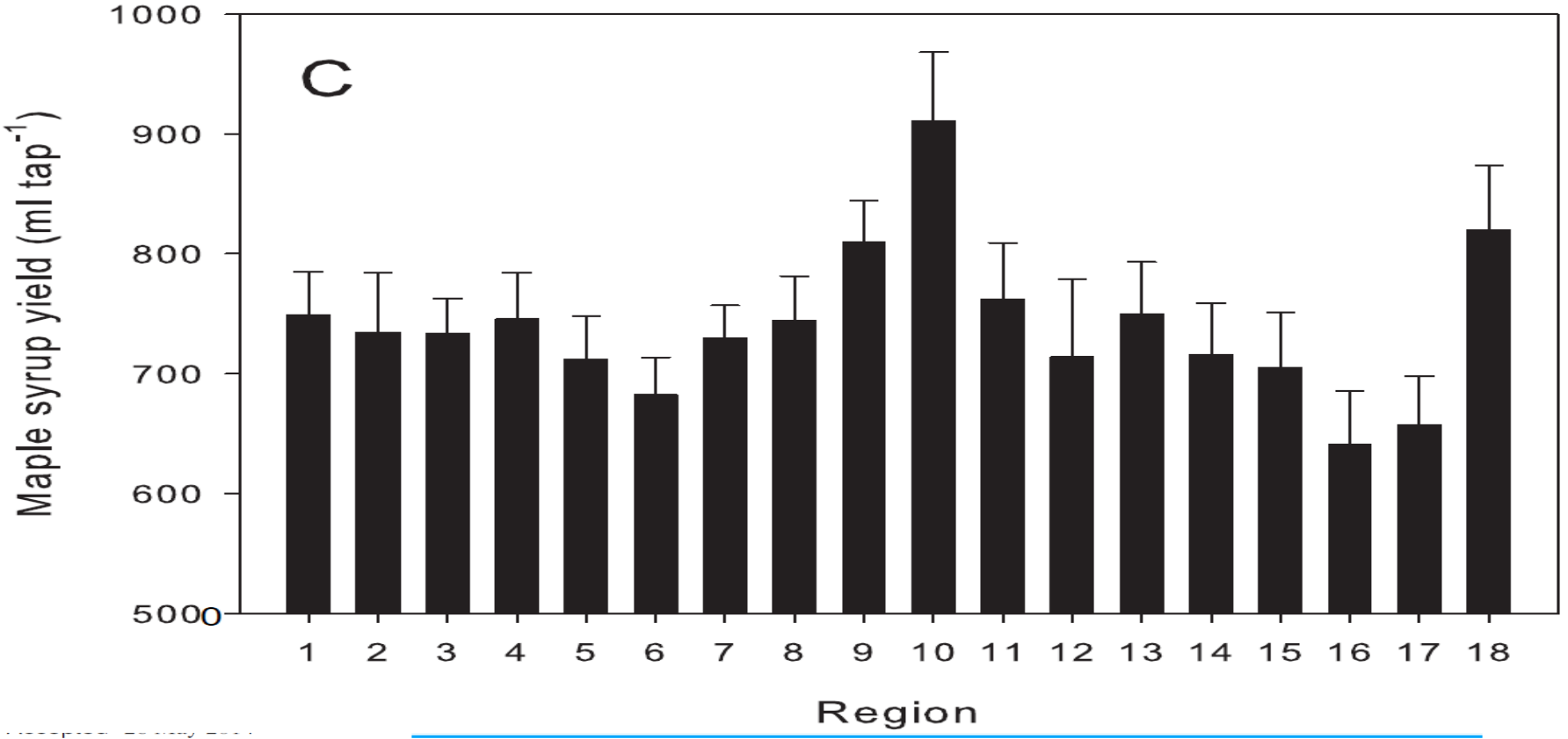
L’écart type d’une simulation donnée pour une région donnée n’augmente pas de façon significative entre la période de référence et les périodes futures.

Rendement à l’entaille

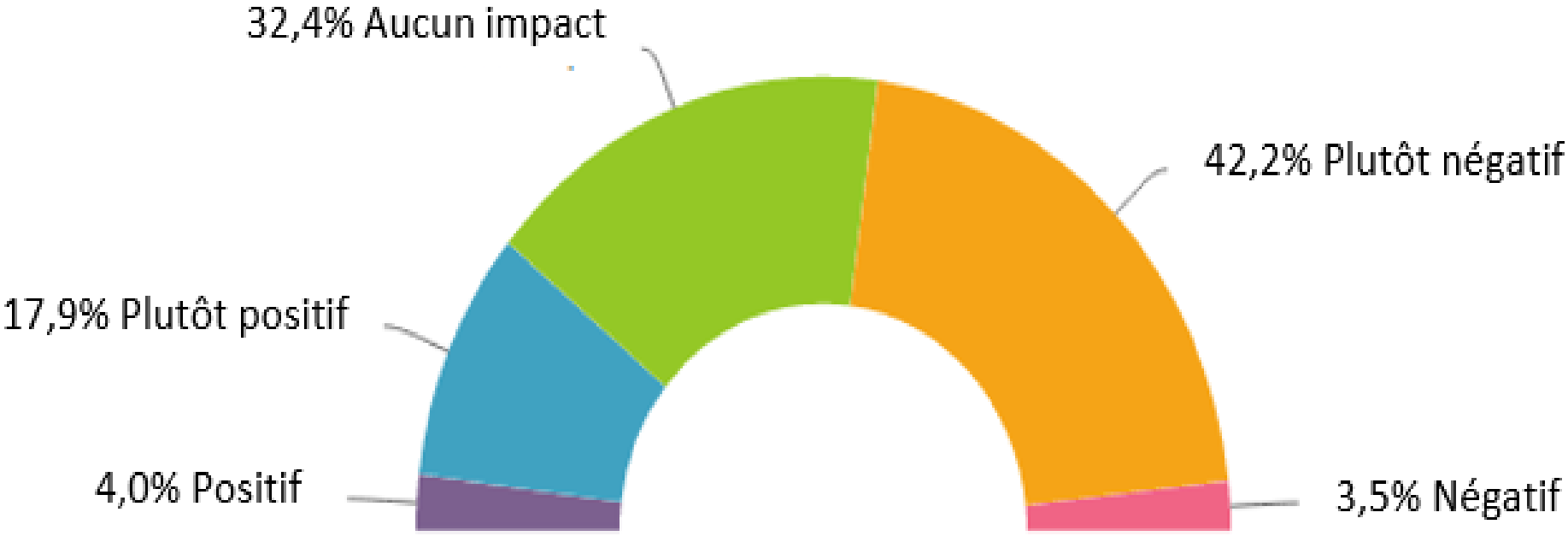

Bas Saint-Laurent
Wisconsin
Ohio
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
200 km

PeerJ

Interannual and spatial variability of maple syrup yield as related to climatic factors



Au cours des 30 prochaines années, quel sera l'impact des changements climatiques sur le rendement à l'entaille?



Variables prédictives

Nb cycles gel-dégel

Tmax Janvier

Cumul de degrés entre 0 et 8 oC

TJO-1

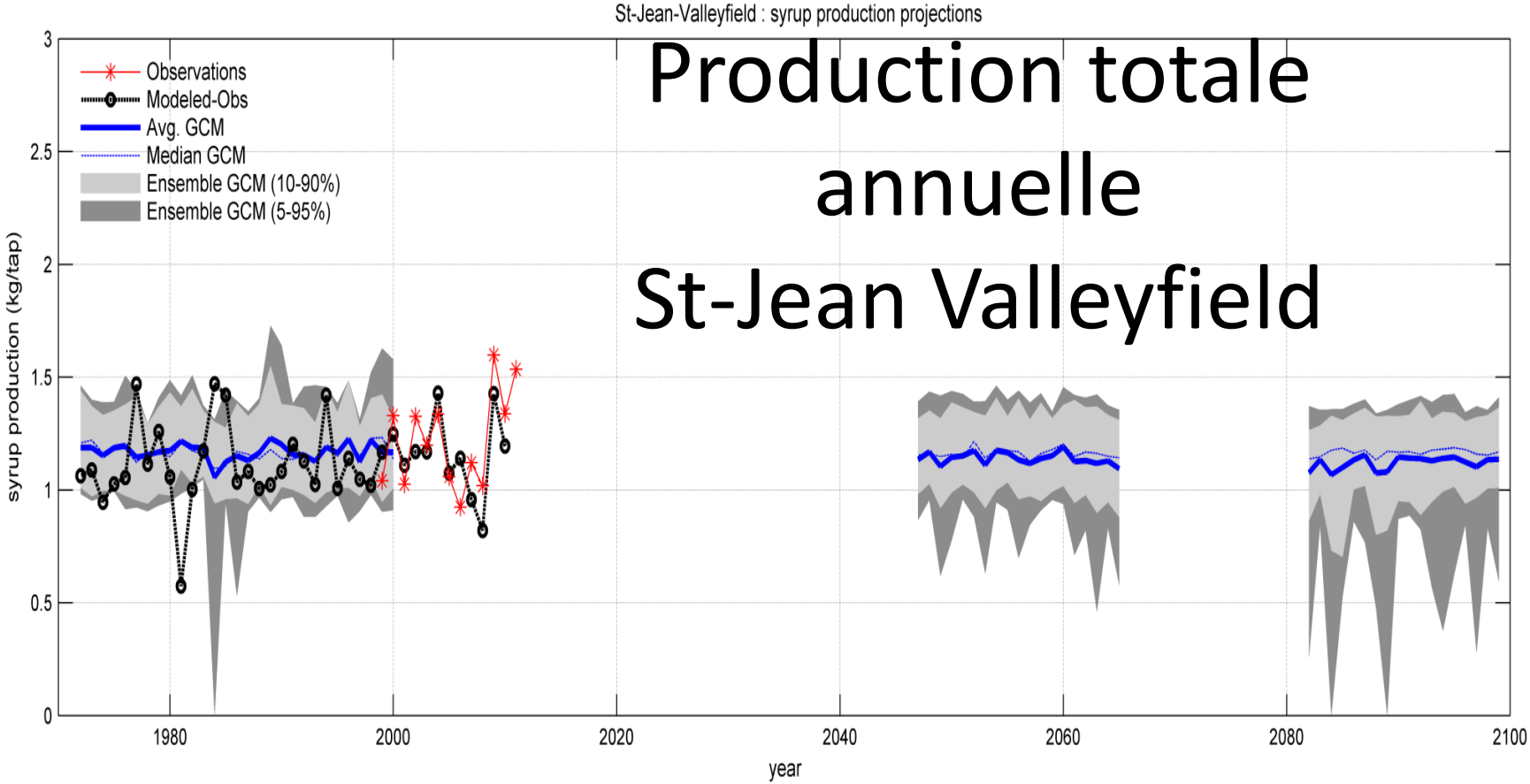
Variables prédictives

Nb cycles gel-dégel

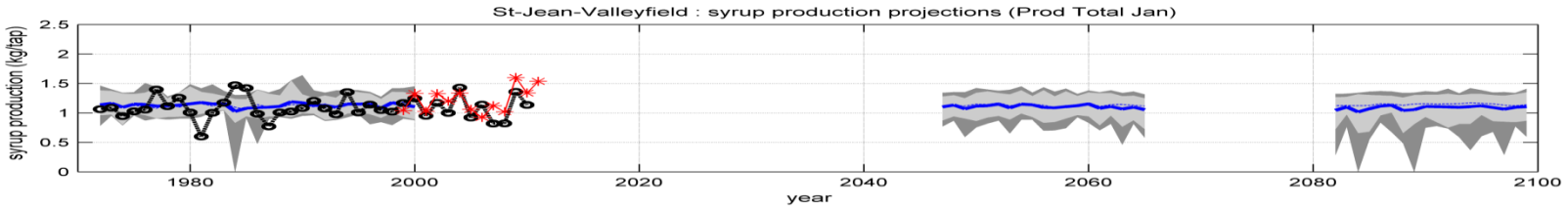
Tmax Janvier

Cumul de degrés entre 0 et 8 oC

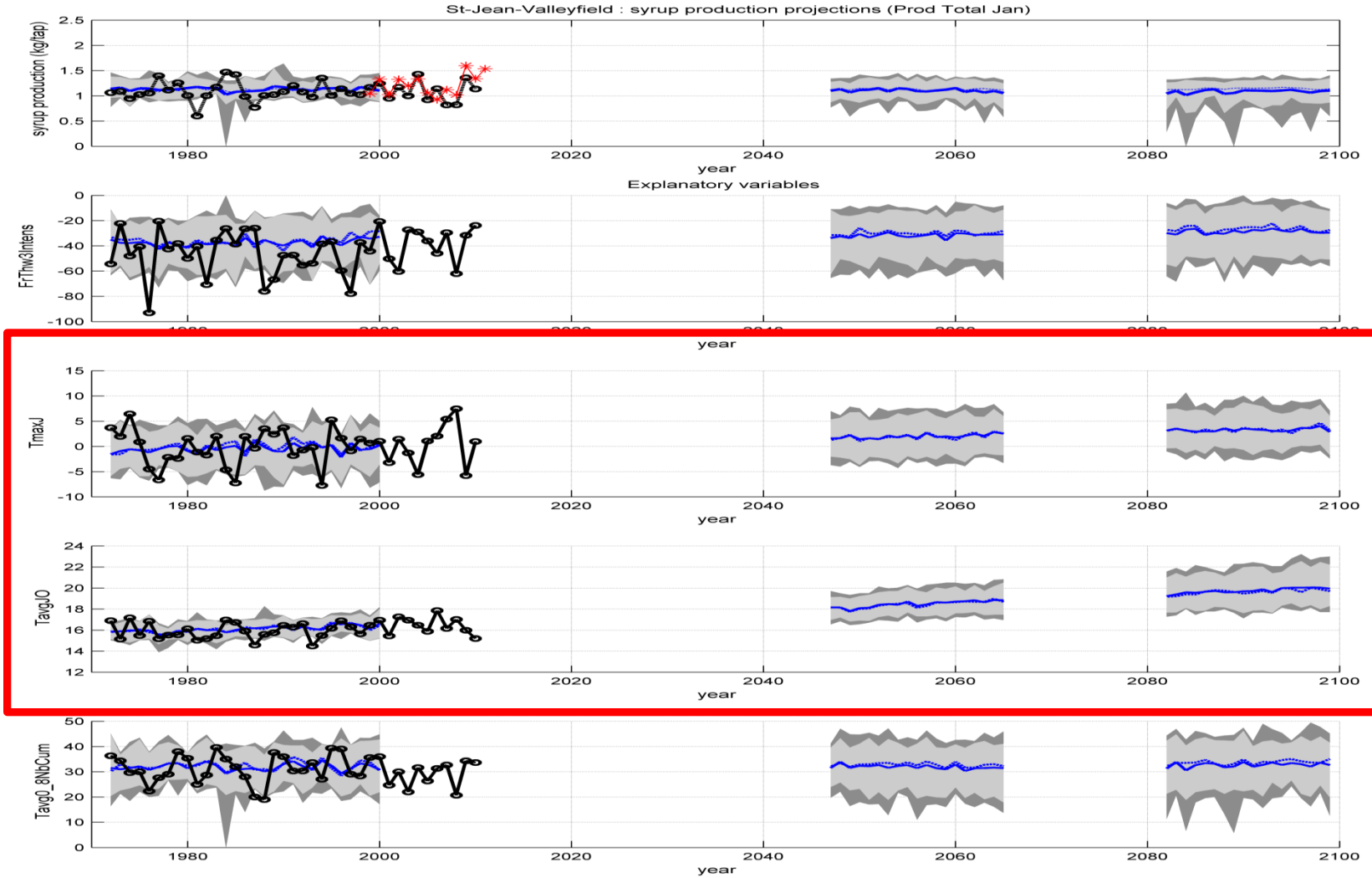
TJO-1



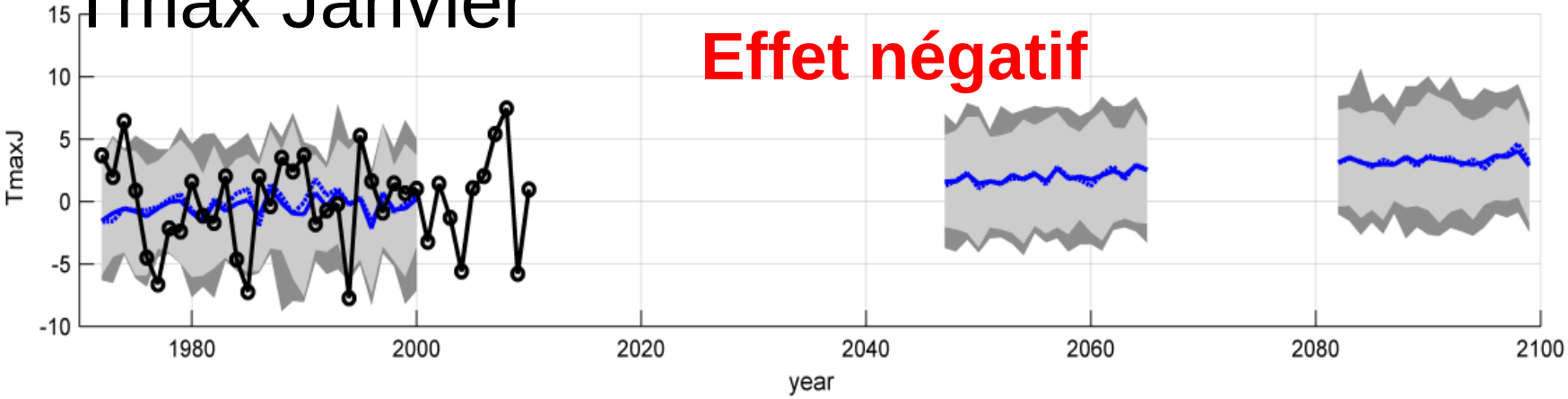
Production totale annuelle St-Jean Valleyfield



Que se passe-t-il sous la surface apparemment tranquille du lac ?

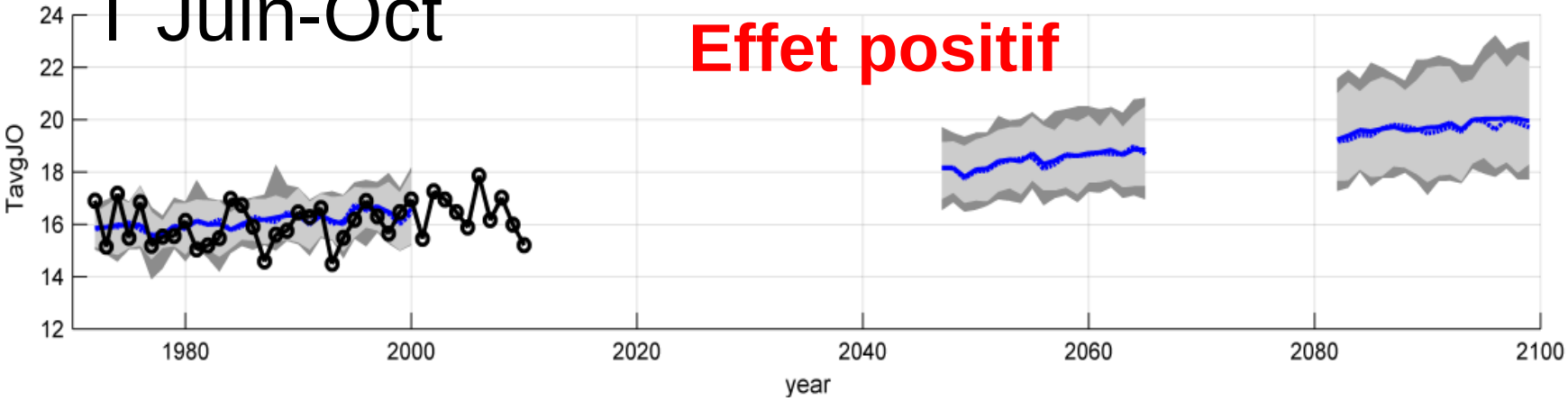

St-Jean-Valleyfield : syrup production projections (Prod Total Jan)
syrup production (kg/tap)
year
Explanatory variables
FrThw3Intens
TmaxJ
TavgJO
Tavg0_8NbCum
1980
2000
2020
2040
2060
2080
2100

Tmax Janvier



Effet négatif

T Juin-Oct



Effet positif

PeerJ

Interannual and spatial variability of maple syrup yield as related to climatic factors

Louis Duchesne[1] and Daniel Houle[1,2]

[1] Direction de la recherche forestière, Ministère des Forêts, de la Faune et des Parcs, Québec, Canada
[2] Consortium sur la climatologie régionale et l'adaptation aux changements climatiques (Ouranos), Montréal, Québec, Canada

ABSTRACT

Sugar maple syrup production is an important economic activity for eastern Canada and the northeastern United States. Since annual variations in syrup yield have been related to climate, there are concerns about the impacts of climatic change on the industry in the upcoming decades. Although the temporal variability of syrup yield has been studied for specific sites on different time scales or for large regions, a model capable of accounting for both temporal and regional differences in yield is still lacking. In the present study, we studied the factors responsible for interregional and interannual variability in maple syrup yield over the 2001–2012 period, by combining the data from 8 Quebec regions (Canada) and 10 U.S. states. The resulting model explained 44.5% of the variability in yield. It includes the effect of climatic conditions that precede the sapflow season (variables from the previous growing season and winter), the effect of climatic conditions during the current sapflow season, and terms accounting for intercountry and temporal variability. Optimal conditions for maple syrup production appear to be spatially restricted by less favourable climate conditions occurring during the growing season in the north, and in the south, by the warmer winter and earlier spring conditions. This suggests that climate change may favor maple syrup production northwards, while southern regions are more likely to be negatively affected by adverse spring conditions.

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Maple syrup production declines following masting

Joshua M. Rapp, Elizabeth E. Crone *

Department of Biology, Tufts University, 163 Packard Ave., Medford, MA 02155, USA

ARTICLE INFO

Article history:
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Keywords:
Acer saccharum
Masting
Non-timber forest product
Endogenous dynamics
Resource budget model
Nonstructural carbohydrates

ABSTRACT

Maple syrup is a non-timber forest resource, for which yield depends strongly on natural processes. Past research has heavily emphasized the role of weather and climate in determining sap flow, and the relationship between sap flow and syrup yield. However, syrup yield depends on sap sugar content, as well as sap flow. Although sap sugar content varies widely among years, less is known about the causes of this variation. Drawing on ecological theories for causes of mast-seeding in trees, we hypothesized that a trees' carbohydrate stores would fluctuate through time in concert with seed production, and that this fluctuation would affect sap sugar and syrup yield. We evaluated weather variables and past seed production as possible causes of inter-annual variation in maple syrup yield in Vermont, USA. Past seed production was strongly correlated with current syrup yield, suggesting that carbohydrate costs of reproduction affect stores. Climate variables were also important for syrup yield, but were only statistically significant predictors after accounting for variation in seed production. Seed production occurs several months before syrup production, and can be used as a way to forecast expected syrup yields, and prepare harvest plans accordingly.

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Maple syrup production declines following masting

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Depa

Le « masting » est un meilleur prédicteur du rendement que le climat

On peut prédire le rendement avant la saison

A R

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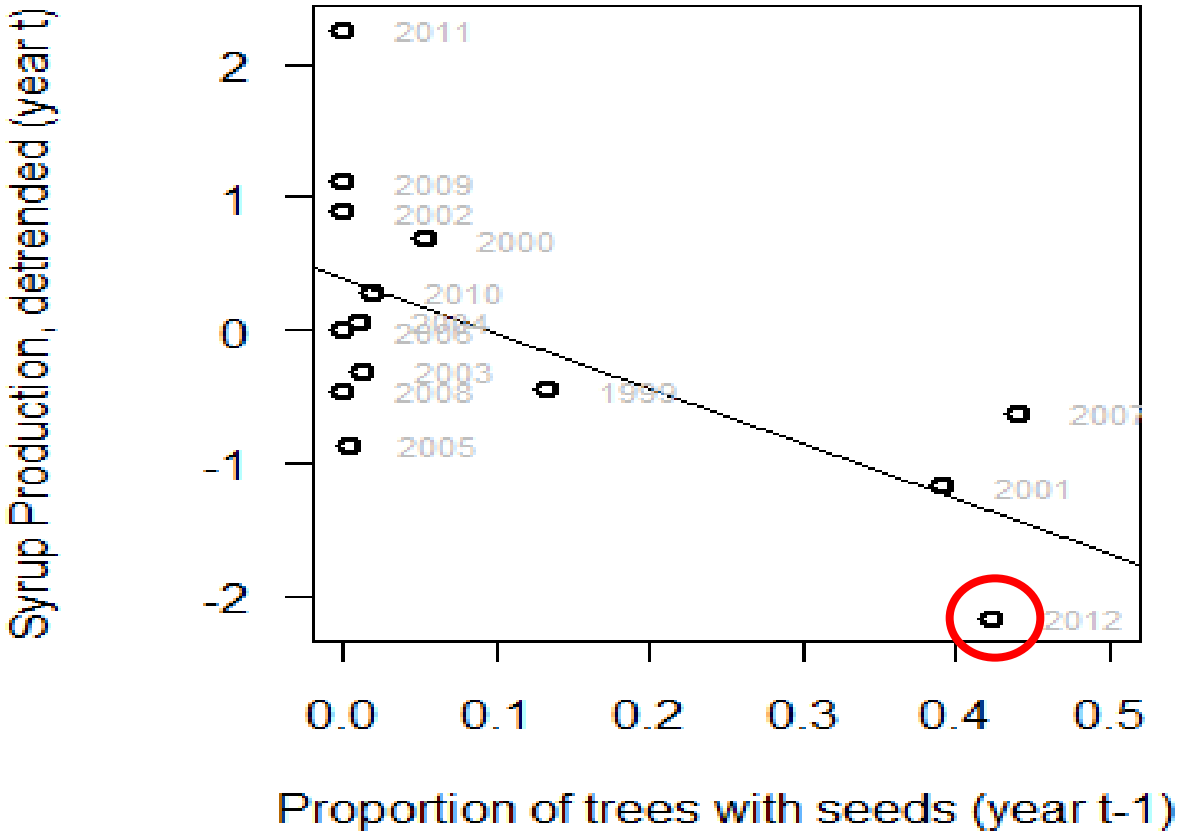
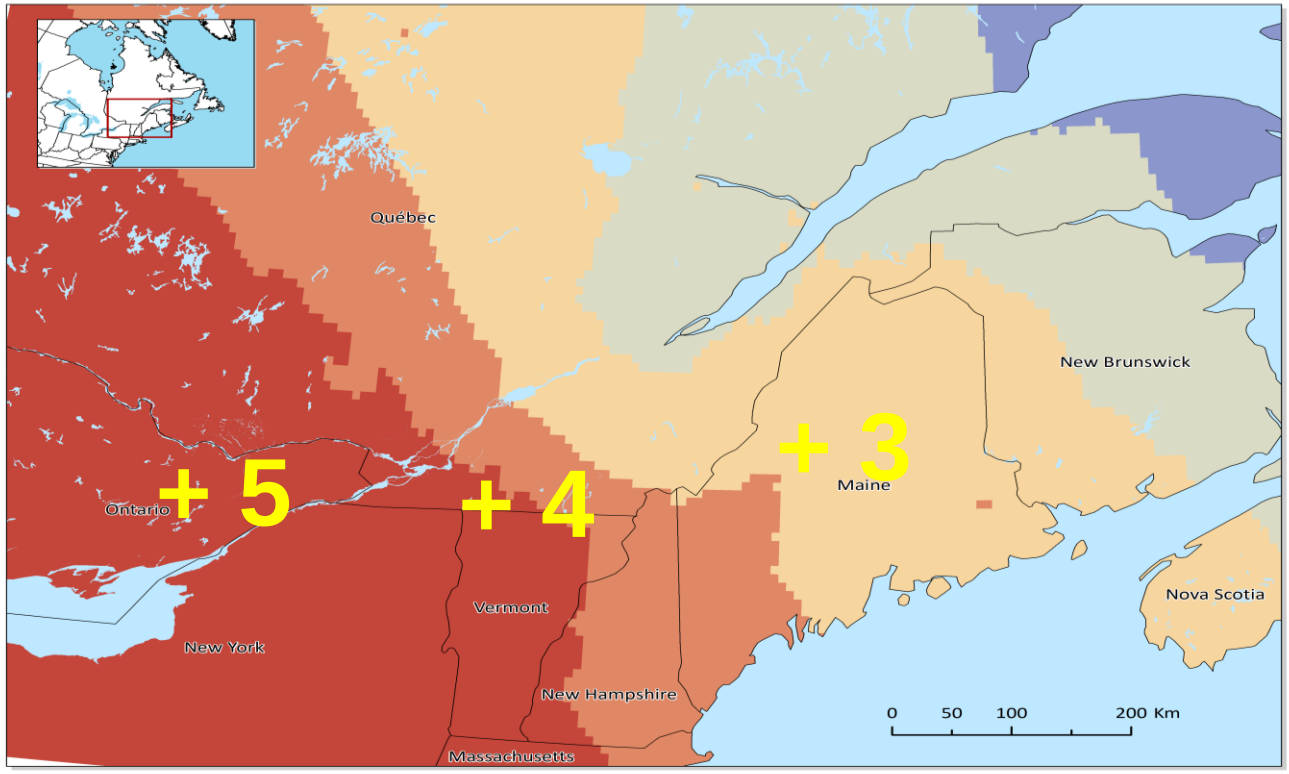
“Masting” et production de sirop



Mars 2012


Québec
New Brunswick
Maine
Ontario
+ 5
+ 4
+ 3
Vermont
New York
New Hampshire
Massachusetts
Nova Scotia
0 50 100 200 Km
°C
0 1 2 3 4 5 >6

Maple Syrup 2012

June 13, 2012

United States Department of Agriculture
National Agricultural Statistics Service
New England Field Office

NEW ENGLAND
Agricultural
Statistics
53 Pleasant Street
Room 2100
Concord, NH 03301

Gary R. Keough , Director | Phone: 603-224-9639 | Fax: 603-225-1434 | www.nass.usda.gov/nh | nass-nh@nass.usda.gov

A special "Thank you" goes to New England producers and agri-businesses who have helped us by completing the annual Maple Syrup survey during April and May.

2012 MAPLE SEASON TOO WARM

New England (excluding Rhode Island): New England's maple syrup production in 2012 totaled 1.24 million gallons, down 27 percent from 2011's near record production of 1.70 million gallons. Vermont remained the top maple State in New England and the Nation, producing 39 percent of the United States' maple syrup. Taps in New England totaled 5.76 million, up 5 percent from last year and accounted for 59 percent of the Nation's maple taps.

The 2012 maple syrup season in New England was considered too warm. A series of heat waves in March ended the season for many, and resulted in a significant drop in maple syrup production. An exception was Maine, where temperatures were cool enough in top producing

per gallon for maple syrup varies widely across New England depending on the percentage sold retail, wholesale, or bulk. The 2011 all sales equivalent price per gallon in Connecticut averaged $73.00, up $3.00; Maine averaged $34.00, up $0.50; Massachusetts averaged $57.00, up $0.50; New Hampshire averaged $49.00, down $6.40; and Vermont averaged $35.00, up $1.00. The high percentage of bulk sales in Vermont and Maine keep average prices below the other States. New Hampshire's 2011 price fell below the previous year due to an increase in bulk sales. New England's 2011 gallon equivalent price across all types of sales averaged $36.96, an increase of $0.94 from the 2010 price of $36.02.

Journal of Biogeography (J. Biogeogr.) (2013)

ORIGINAL ARTICLE

Geographical variation in reproductive capacity of sugar maple (*Acer saccharum* Marshall) northern peripheral populations

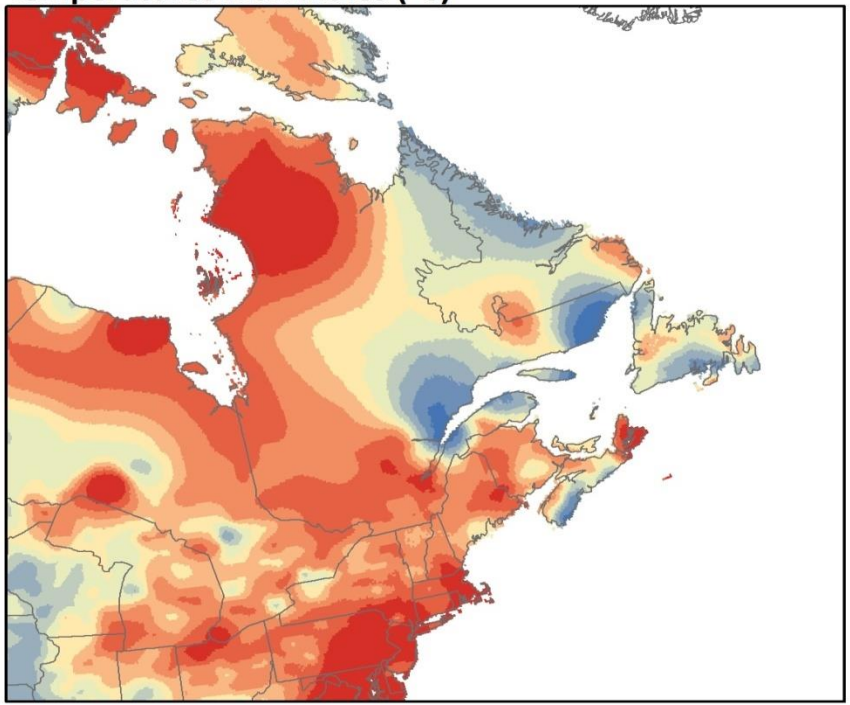
Noémie Graignic*, Francine Tremblay and Yves Bergeron

Peut-on quantifier l'impact du Masting au Québec?

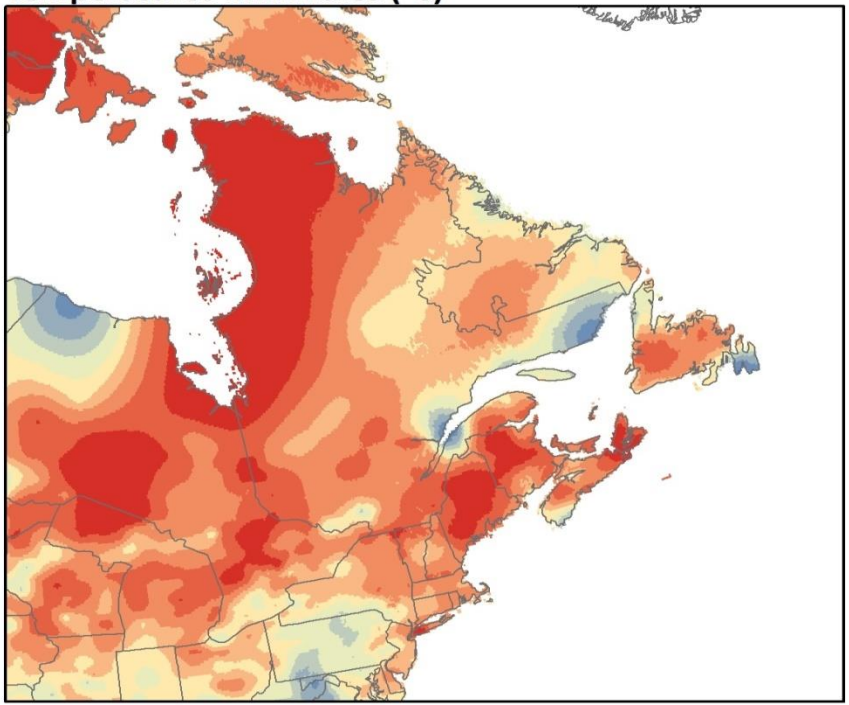
"Masting" : 2006 et 2011

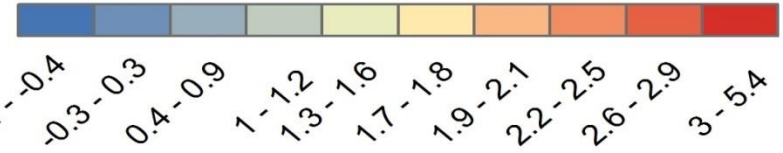
Anomalies juillet 2010 p/r 1960 - 2000

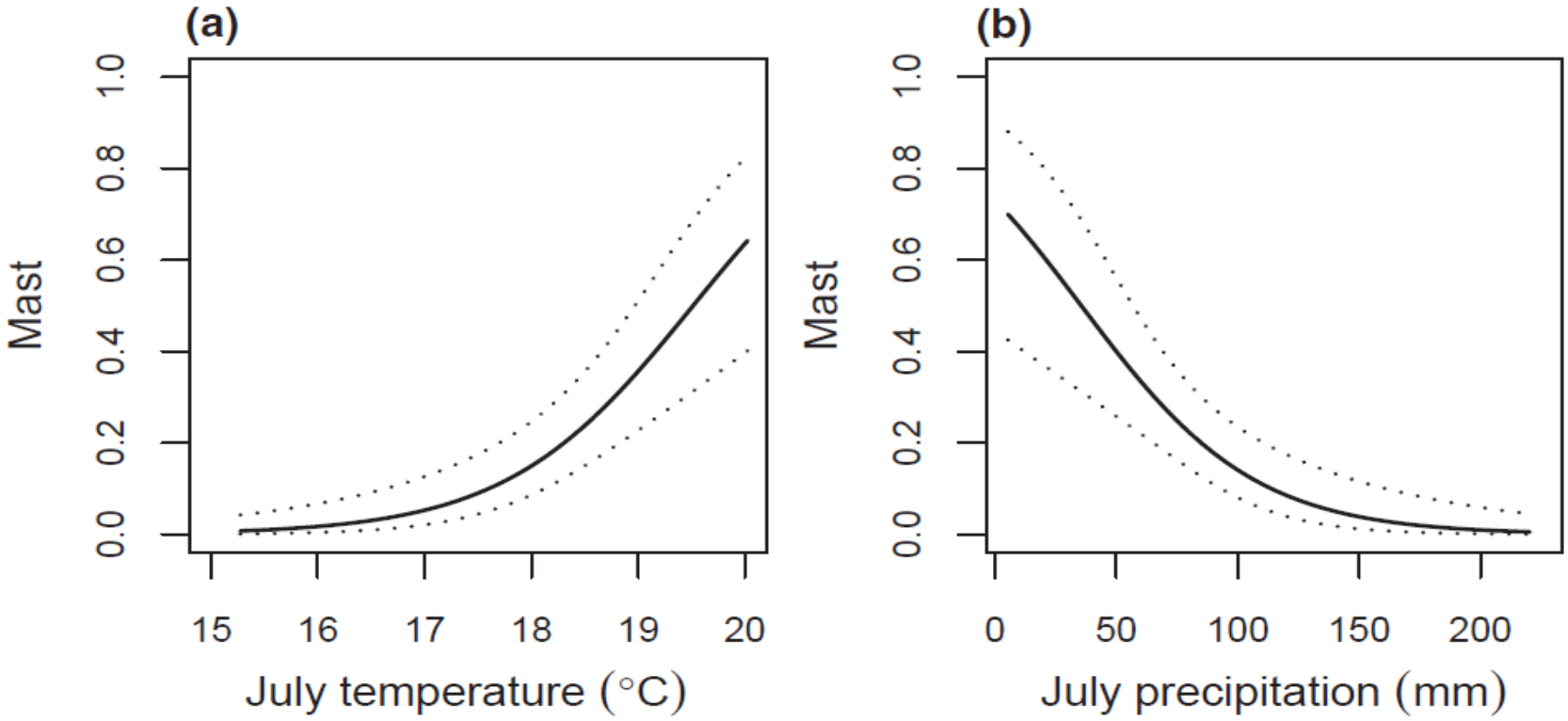
Températures maximales (°C)



Températures minimales (°C)






(a)
Mast
0.0
0.2
0.4
0.6
0.8
1.0
15
16
17
18
19
20
July temperature (°C)
(b)
Mast
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
July precipitation (mm)

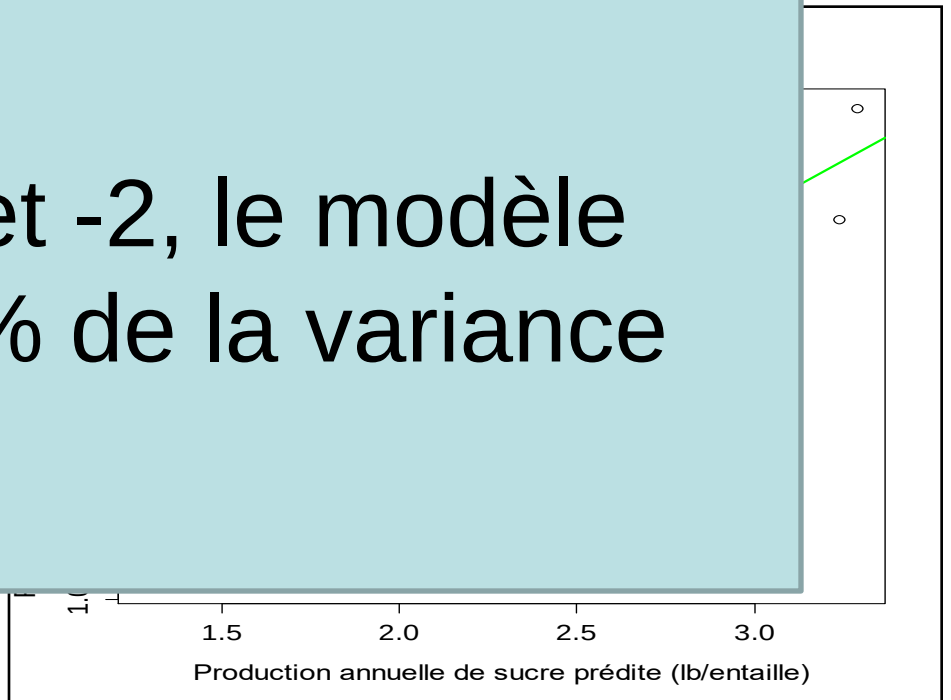

2010
2011
2012
Stress climatique
Masting
Mauvais rendement

Modèle de production totale

y=-1.228+0.017Tavg0_8:NbCum-0.131TmaxJanv+0.190TavgJuinOct-

0.03 JuinOct

Avec T juillet -2, le modèle explique 64% de la variance



New Phytologist

Research

Rapid report

How fresh is maple syrup? Sugar maple trees mobilize carbon stored several years previously during early springtime sap-ascent

Authors for correspondence:
Jan Muhr
Tel: +49 3641 576140
Email: jmuhr@bgc-jena.mpg.de

Henrik Hartmann
Tel: +49 3641 576294
Email: hhart@bgc-jena.mpg.de

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Jan Muhr[1], Christian Messier[2,3], Sylvain Delagrange[3], Susan Trumbore[1,4], Xiaomei Xu[4] and Henrik Hartmann[1]

[1]Max-Planck-Institute for Biogeochemistry, Hans-Knöll-Str. 10, 07745 Jena, Germany; [2]Institut des Sciences de la Forêt Tempéré (ISFORT), Université du Québec en Outaouais (UQO), 58 Rue Principale, Ripon, QC, JOV 1V0, Canada; [3]Center for Forest Research (CEF), Université du Québec à Montréal, PO Box 8888, Centre-ville Station, Montréal, QC H3C 3P8, Canada; [4]Department of Earth System Science, University of California, Irvine, CA 92697-3100, USA

New Phytologist (2015)
doi: 10.1111/nph.13782

Key words: bomb-radiocarbon approach, nonstructural carbon (NSC) pool, reserve carbon (C) mobilization, springtime sap production, sugar maple (*Acer saccharum*).

Summary

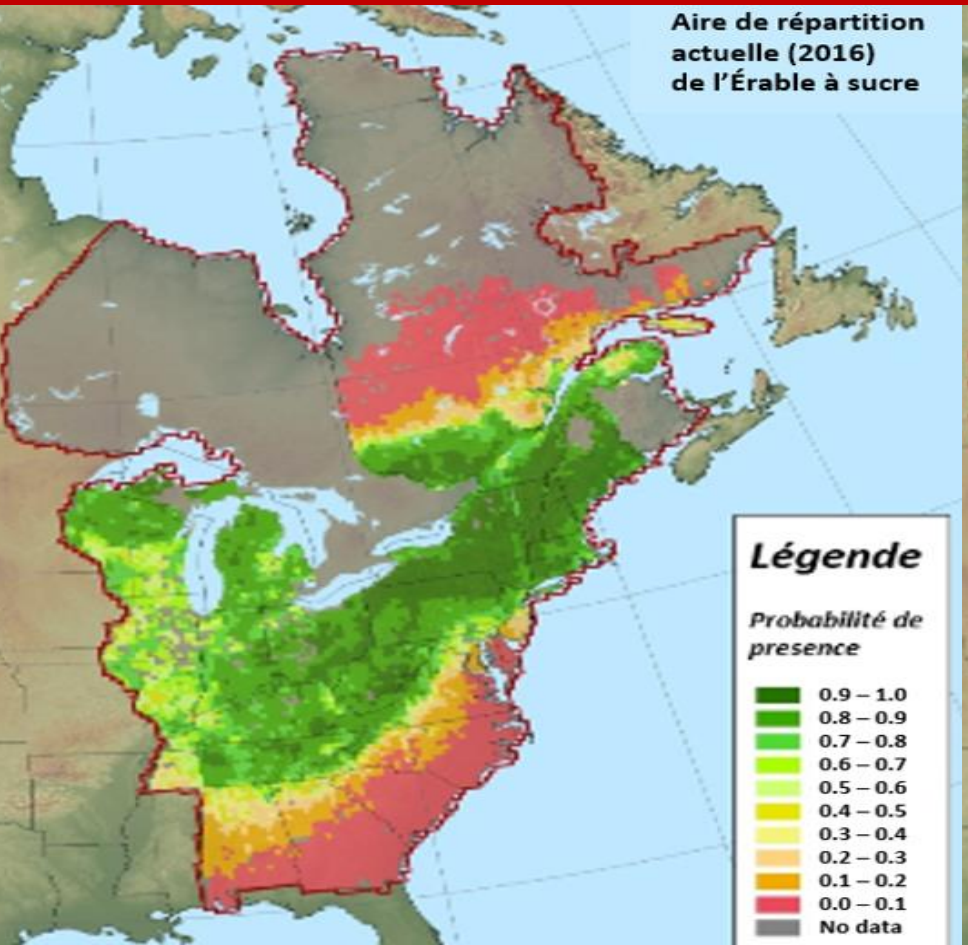
- While trees store substantial amounts of nonstructural carbon (NSC) for later use, storage regulation and mobilization of stored NSC in long-lived organisms like trees are still not well understood.
- At two different sites with sugar maple (*Acer saccharum*), we investigated ascending sap (sugar concentration, $\delta^{13}C$, $\Delta^{14}C$) as the mobilized component of stored stem NSC during early springtime. Using the bomb-spike radiocarbon approach we were able to estimate the average time elapsed since the mobilized carbon (C) was originally fixed from the atmosphere and to infer the turnover time of stem storage.
- Sites differed in concentration dynamics and overall $\delta^{13}C$, indicating different growing conditions. The absence of temporal trends for $\delta^{13}C$ and $\Delta^{14}C$ indicated sugar mobilization from a well-mixed pool with average $\Delta^{14}C$ consistent with a mean turnover time (TT) of three to five years for this pool, with only minor differences between the sites.
- Sugar maple trees hence appear well buffered against single or even several years of negative plant C balance from environmental stress such as drought or repeated defoliation by insects. Manipulative investigations (e.g. starvation via girdling) combined with $\Delta^{14}C$ measurements of this mobilized storage pool will provide further new insights into tree storage regulation and functioning.

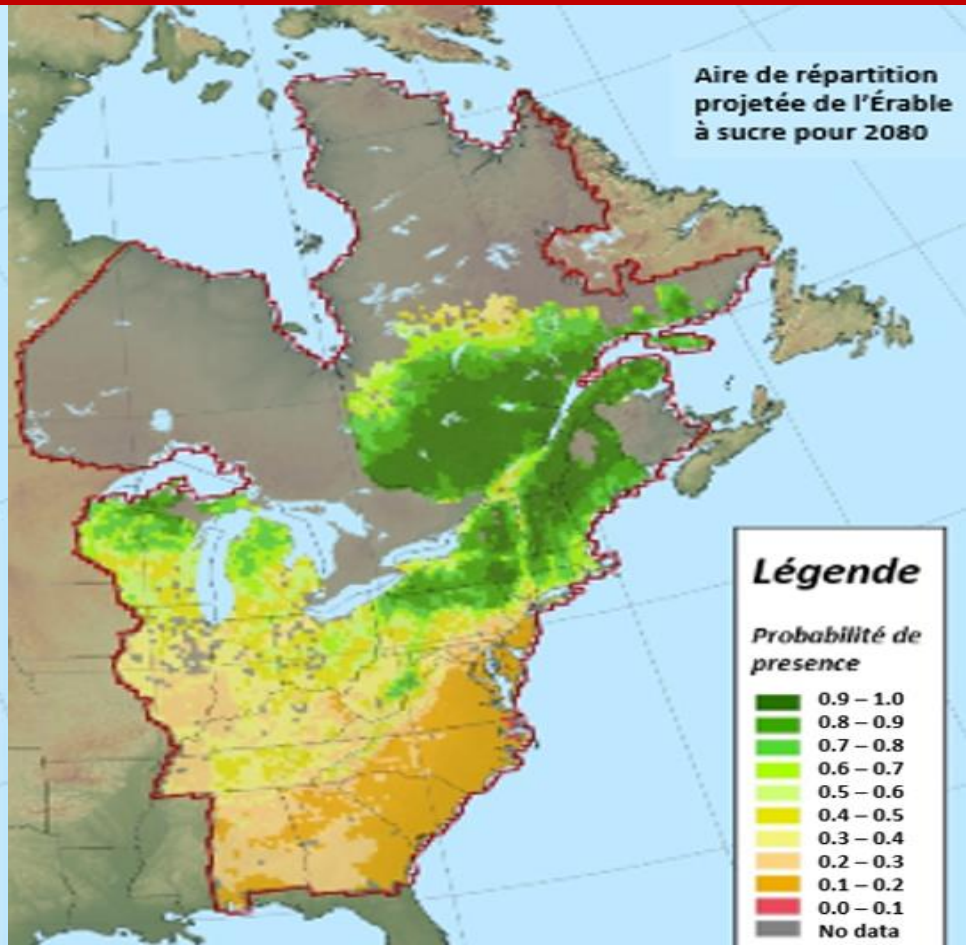
Autre impacts climatiques

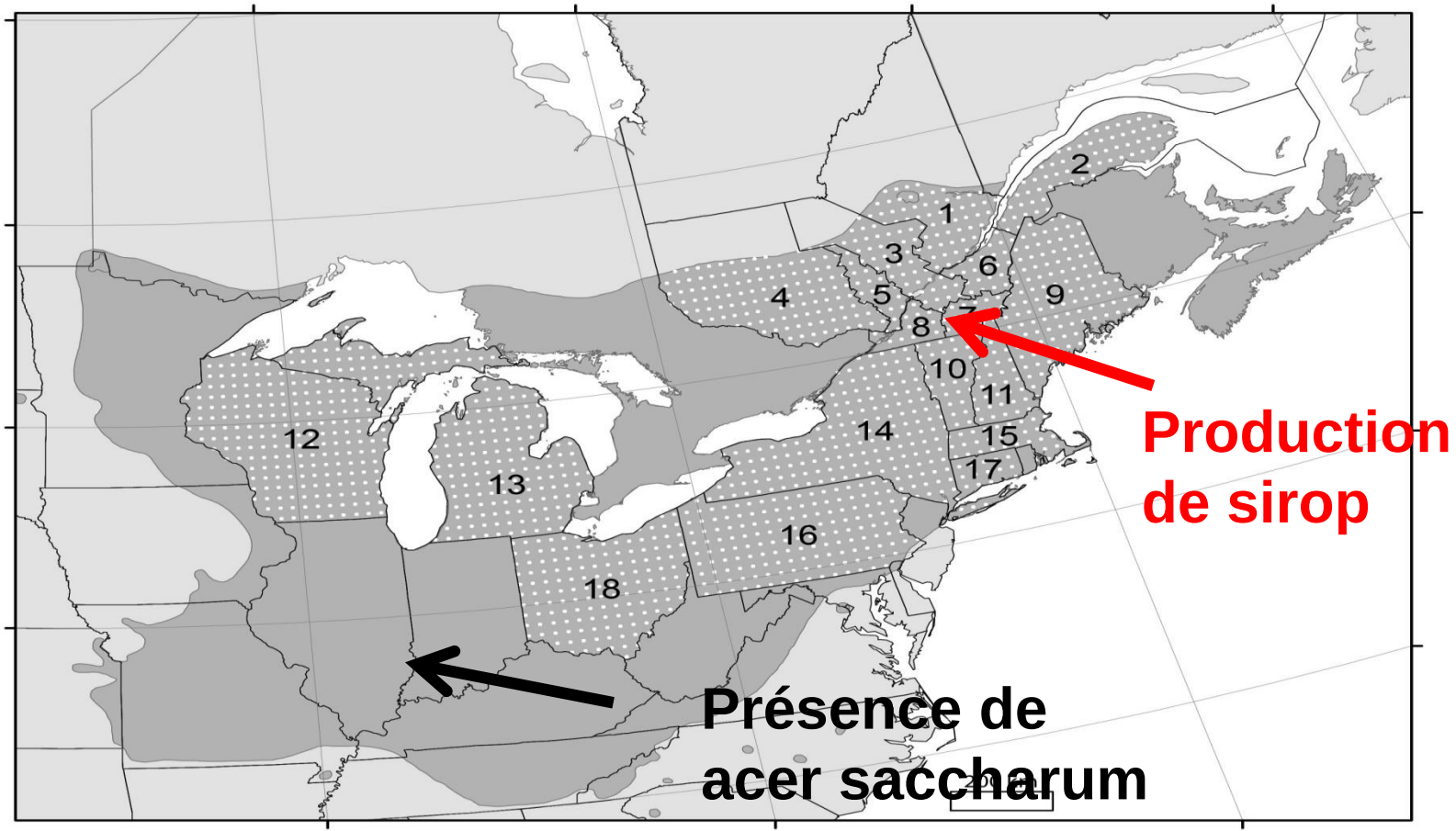
Selon vous, au cours des 30 prochaines années, quelle est la probabilité que les aléas suivants surviennent plus souvent qu'auparavant?

	Très faible	Faible	Moyenne	Élevée	Très Élevée	Je ne sais pas
Des températures annuelles moyennes élevées	2.4%	11.3%	31.6%	29.0%	23.3%	2.4%
Des épisodes de fortes pluies	2.1%	10.4%	29.0%	36.7%	17.0%	4.8%
Des tempêtes de neiges ou de verglas	1.2%	8.1%	37.3%	32.5%	15.5%	5.4%
Des sécheresses	3.6%	17.0%	30.1%	30.4%	14.3%	4.5%
Des feux de forêt	1.5%	18.2%	33.1%	29.3%	13.7%	4.2%
Des épidémies d'insectes	2.7%	8.4%	37.6%	31.0%	15.2%	5.1%
Des hivers particulièrement doux	2.1%	8.7%	33.3%	34.5%	18.3%	3.0%
Devancement dans le temps de la période printanière d'alternance gel-dégel	2.1%	9.9%	27.5%	36.4%	21.2%	3.0%
Davantage d'épisodes de dégel en hiver	2.1%	7.5%	27.6%	37.8%	21.0%	3.9%
Des tempêtes de vents violents	1.8%	12.5%	35.2%	30.4%	13.7%	6.3%
Des canicules en été	1.2%	7.5%	35.5%	34.9%	16.1%	4.8%
Des tempêtes de grêle	3.0%	16.4%	37.7%	26.1%	8.8%	7.9%
Des événements de chaleur extrême au printemps qui déclencheraient prématurément la fin de la saison de coulée	2.4%	14.7%	30.6%	32.4%	14.4%	5.4%

Migration vers le nord de l'érable à sucre






1
2
3
4
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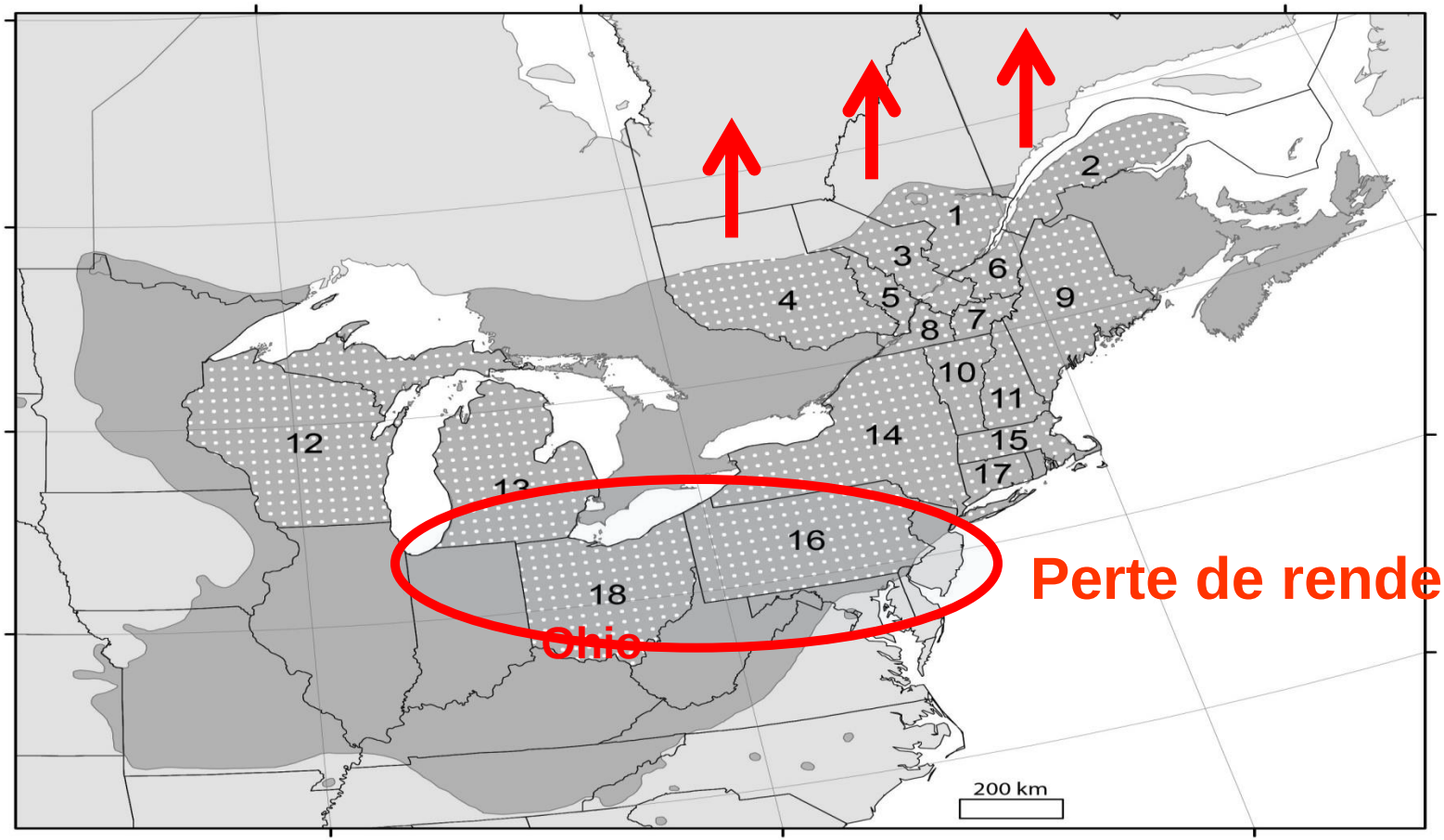
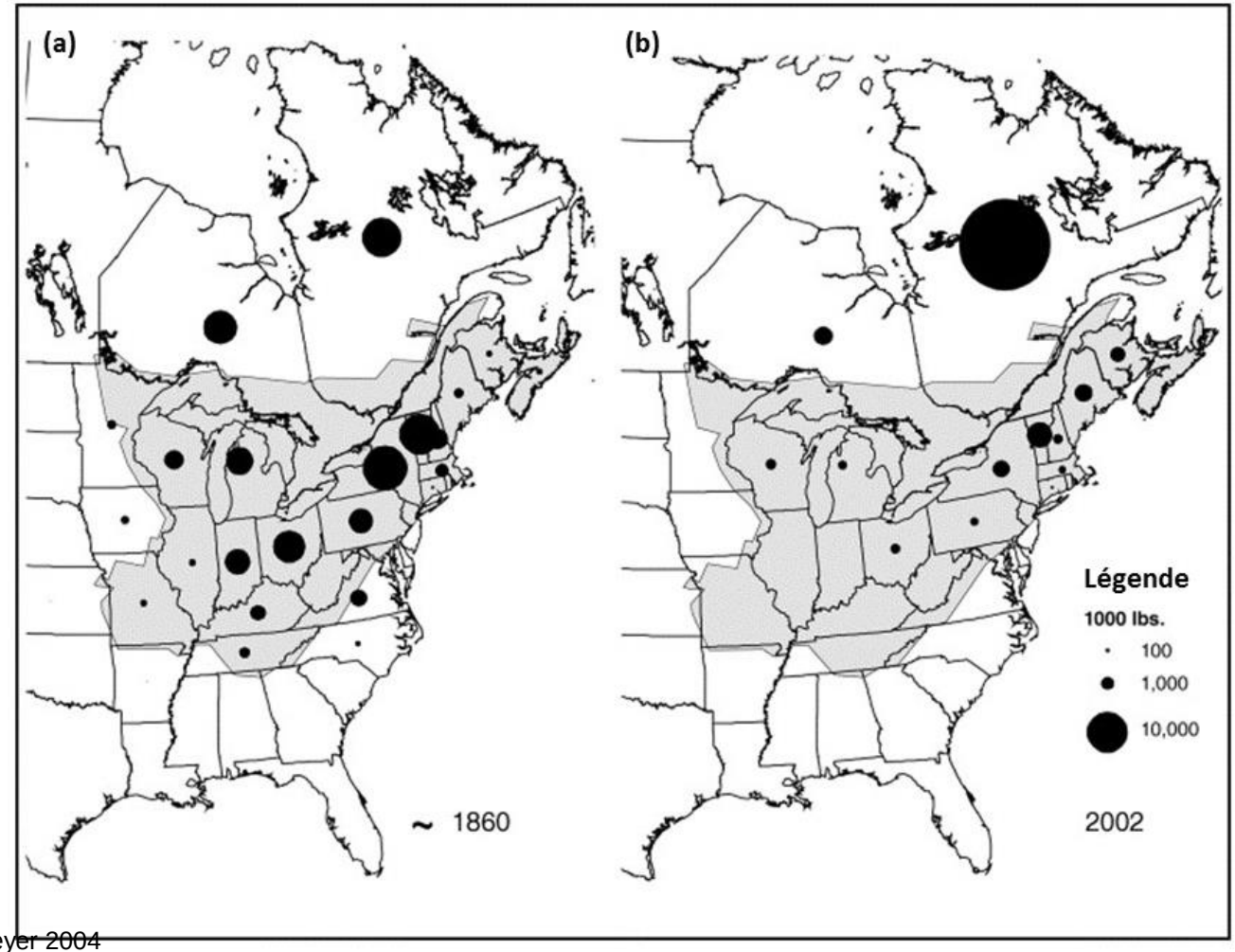
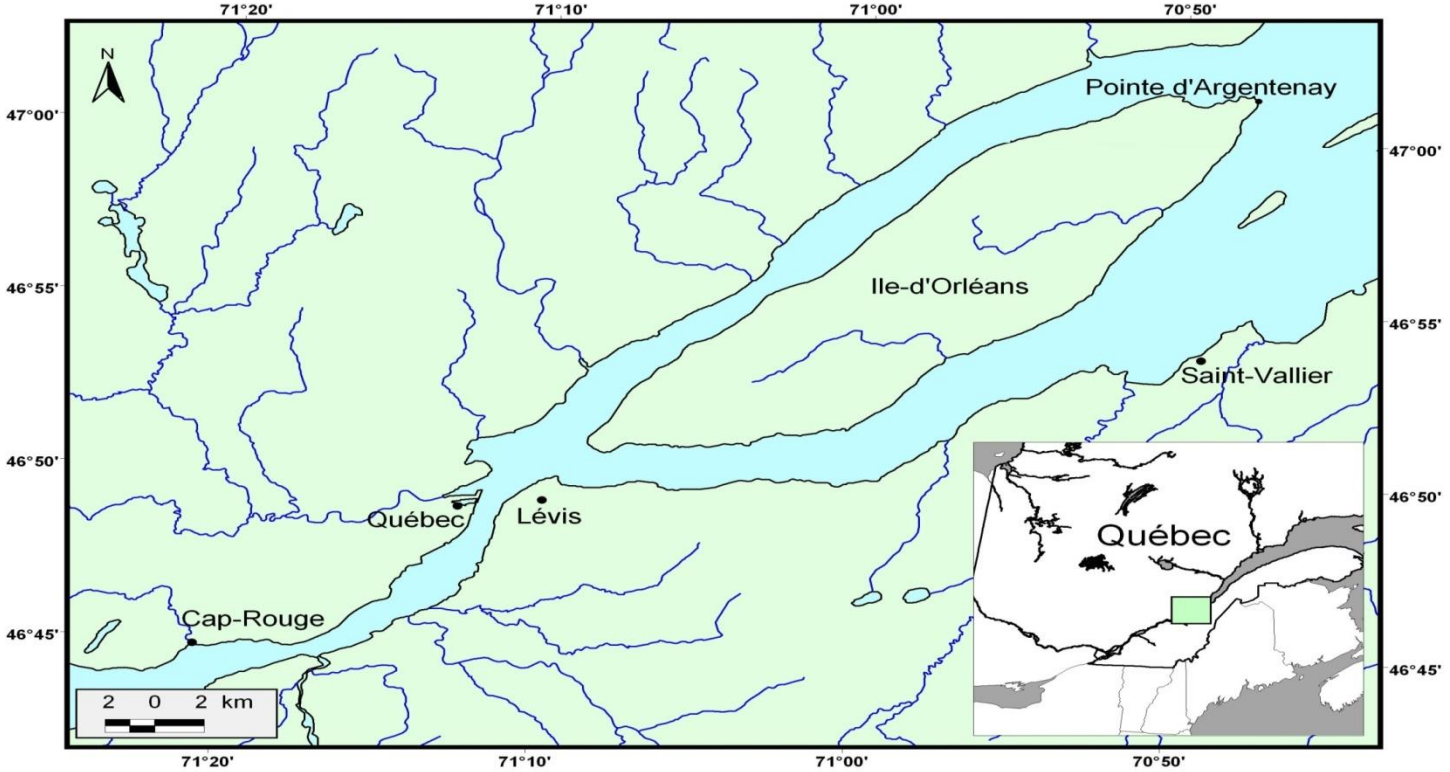
6
8
9
10
11
12
13
14
15
16
17
18
Production
de sirop
Présence de
acer saccharum


1
2
3
4
5
6
7
8
9
10
11
12
14
15
16
17
18
Ohio
200 km
Perte de rendement



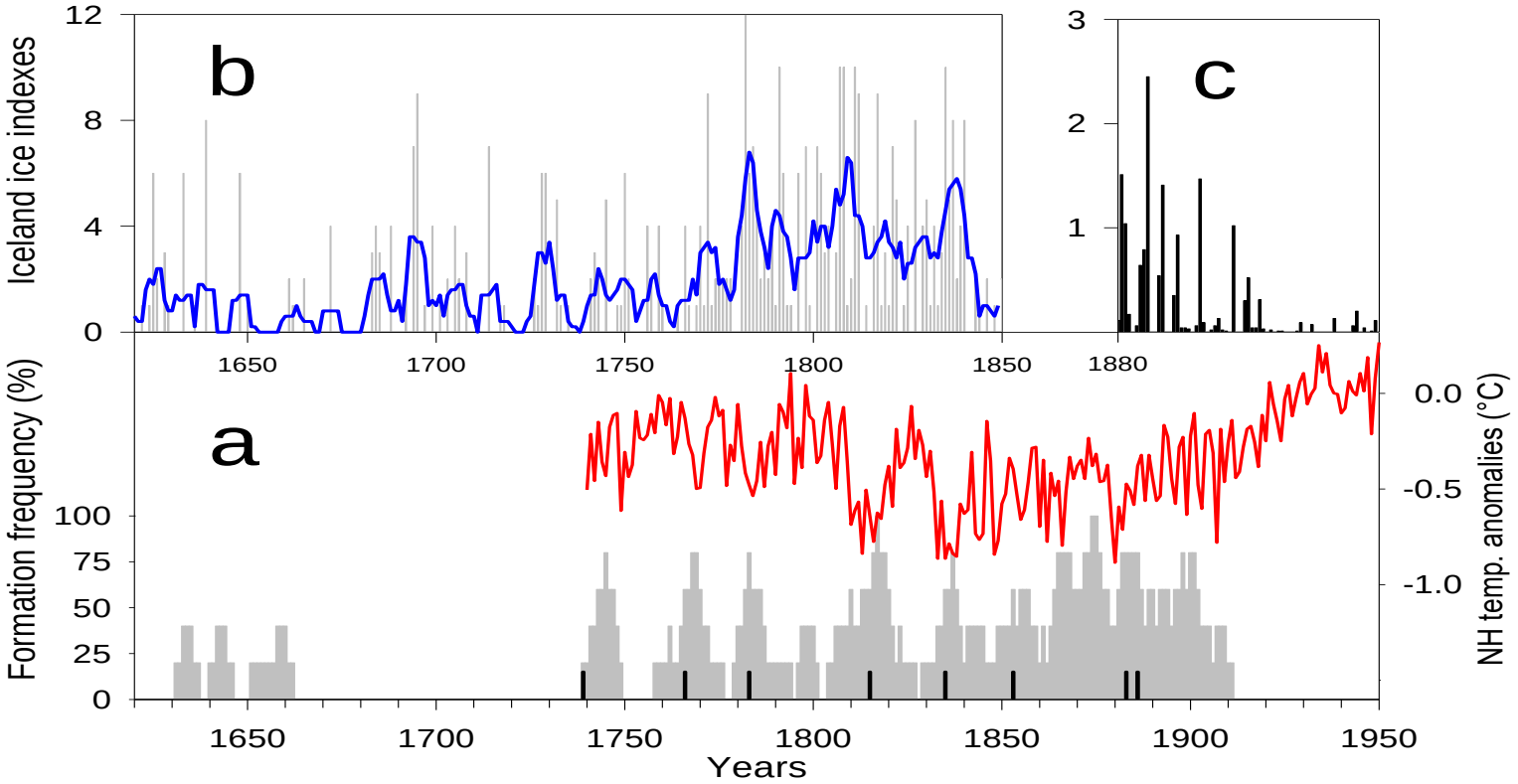
Whitney et Upmeyer 2004

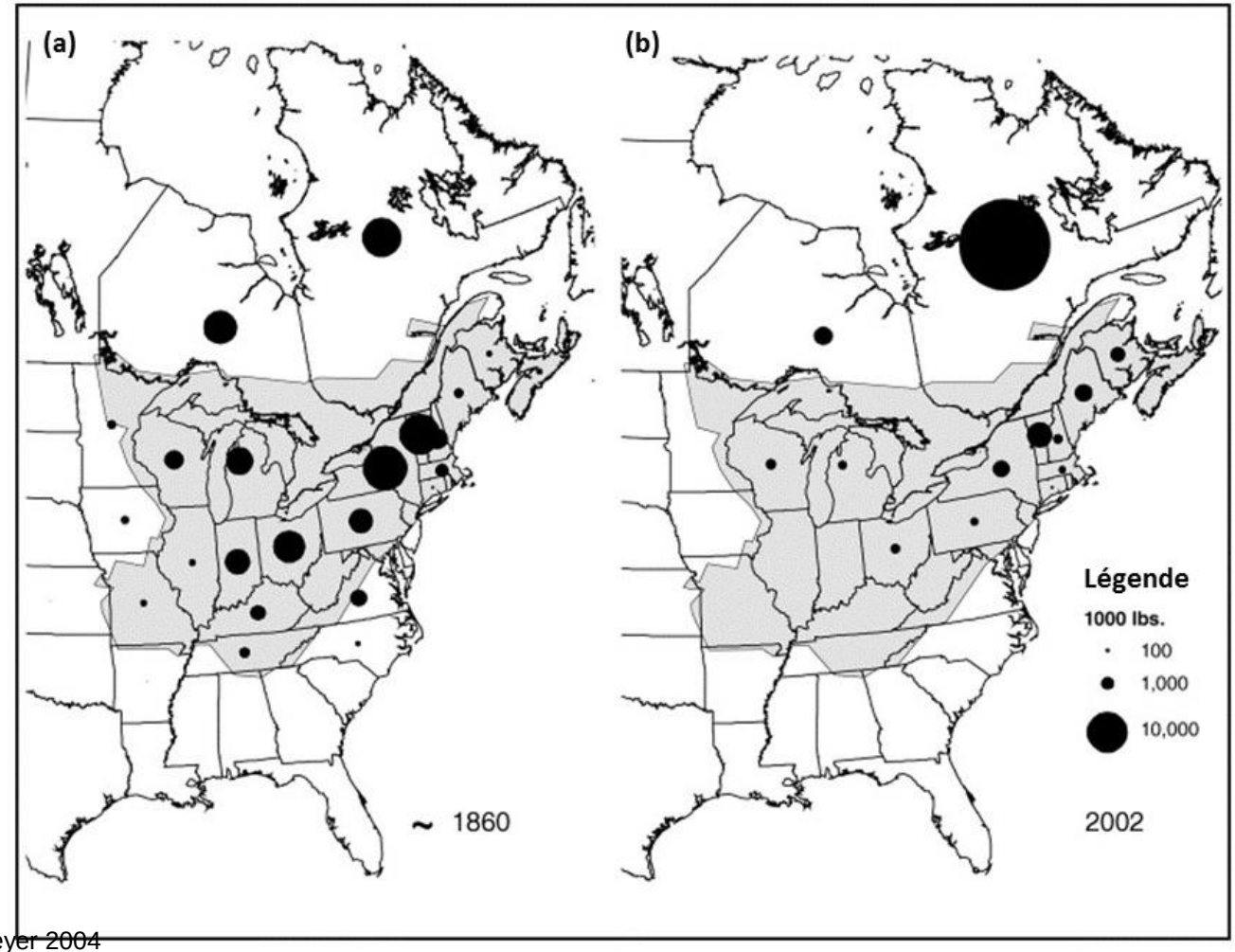
Variations des températures hivernales



Variations des températures hivernales

Variations des températures hivernales





Whitney et Upmeyer 2004


Merci !