

DIFFICULT MIGRATION OF TEMPERATE TREE SPECIES IN THE BOREAL FOREST UNDER CLIMATE CHANGE?

Steve Vissault, Matthew Talluto,
Isabelle Boulangéat and Dominique Gravel



Quantifying and mapping the impact of climate change
on forest productivity in Eastern Canada



CONTEXT THE BOREAL-TEMPERATE ECOTONE

The surface of the boreal-temperate forests ecotone is **expected to shift over the next 100 years**.



CONTEXT THE BOREAL-TEMPERATE ECOTONE

1. The location of this ecotone is responsive to climate.



CONTEXT PREDICTED FUTURE SPECIES DISTRIBUTION

2. Several temperate forest species are predicted to **shift northward** under climate change



Sugar maple

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Sugar maple



Yellow birch

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Red oak



Yellow birch

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Red oak



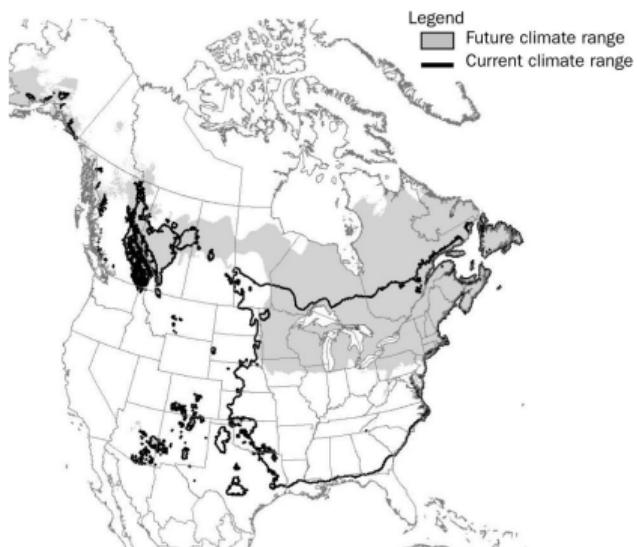
Yellow birch



American ash

CONTEXT PREDICTED FUTURE SPECIES DISTRIBUTION

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Future climate enveloppe of Sugar maple (2071-2100)

CONTEXT LIMITS AND DIFFICULTIES IN THIS STUDY CONTEXT

Forest have:

1. Limited dispersions
2. Slow population dynamics
3. Successional stages (dynamic communities)

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- Spatial interactions (e.g. competition)
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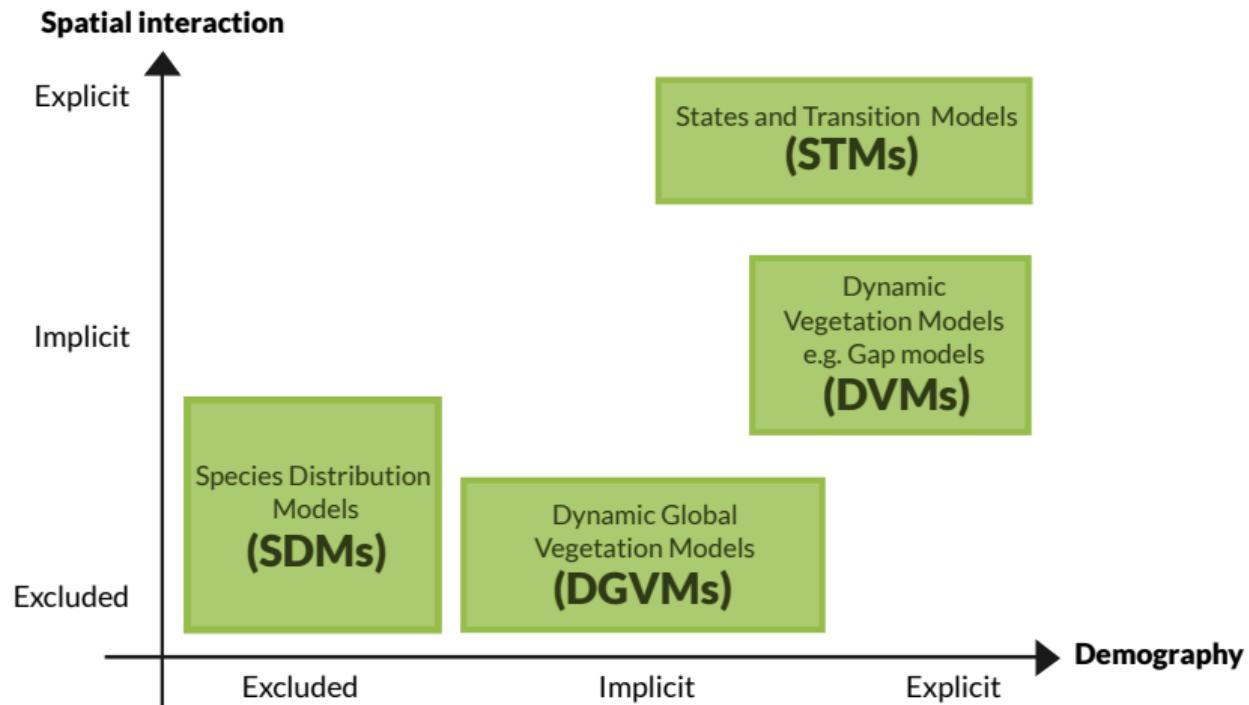
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To predict species or communities range shift we need to include:

- Spatial interactions (e.g. competition)
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These components will be effected by future climate

CONTEXT MODELLING COMPROMISE



STUDY OBJECTIVE

Main objective: Assess range shift and migration rates of the temperate forest community toward boreal forest under climate change.

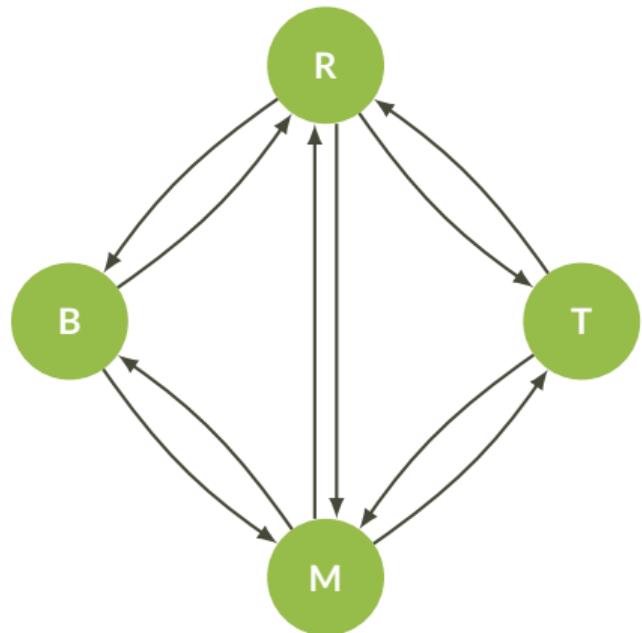
STUDY OBJECTIVE

Main objective: Assess range shift and migration rates of the temperate forest community toward boreal forest under climate change.

Why ?

- Predict the future distribution of temperate species community in Quebec
- Improve and adapt our forests management practices under climate change

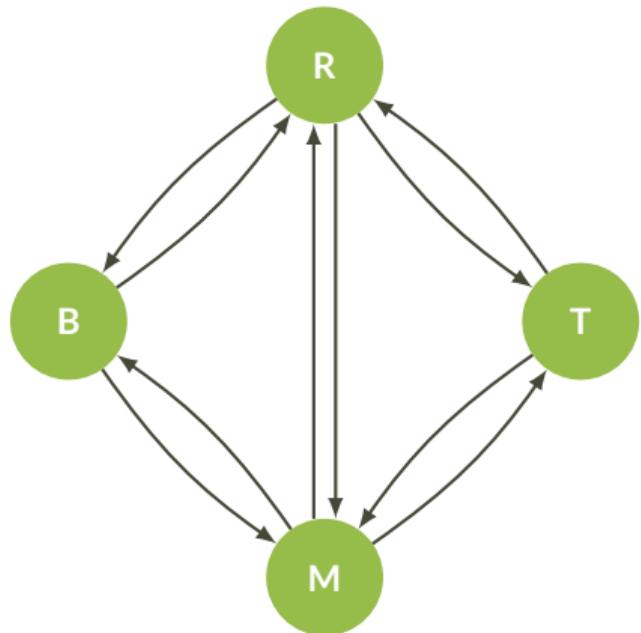
NEW APPROACH STATES AND TRANSITIONS MODEL



Model Description

- Landscape scale
- 4 States:
 - **B** Boreal forest
 - **M** Mixed forest
 - **T** Temperate forest
- **R** corresponds to a post-disturbance patch
- Spatially explicit and stochastic model

NEW APPROACH STATES AND TRANSITIONS MODEL



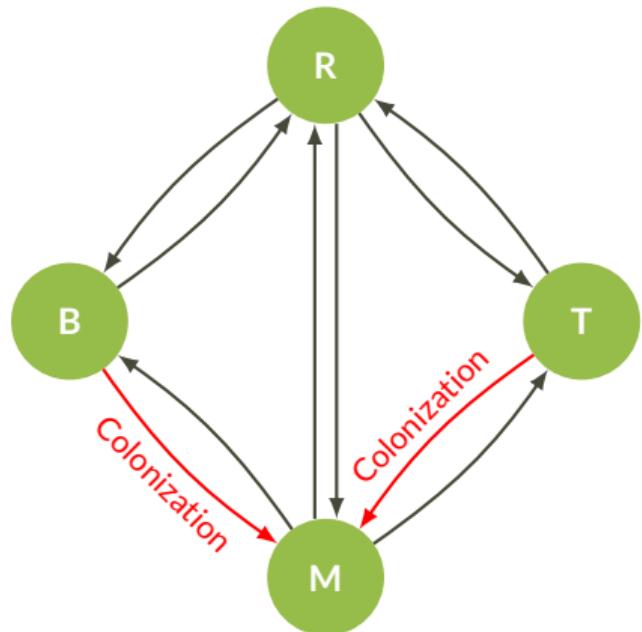
States	Classification
T	$Ba_t \geq 75\%$
M	$Ba_b \geq 25\% \text{ and } Ba_t \geq 25\%$
B	$Ba_b \geq 75\%$
R	$Ba \leq 10m_2/\text{ha}$

*Ba means basal area (m_2/ha)

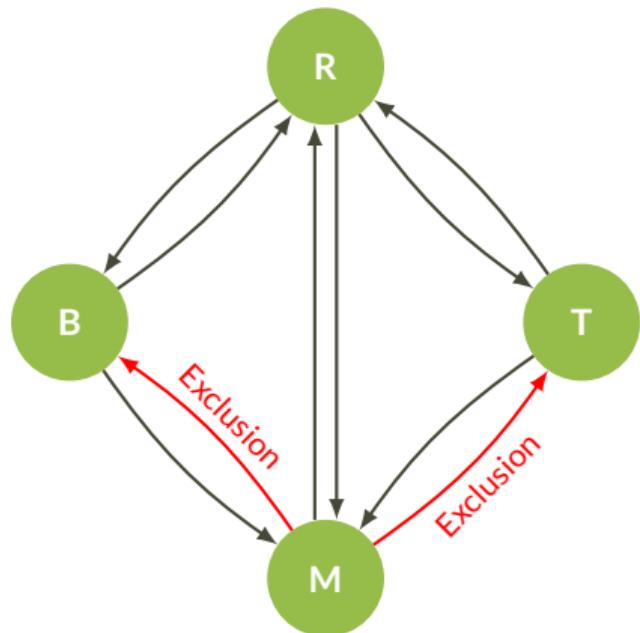
NEW APPROACH STATES AND TRANSITIONS MODEL

Ecological processes:

- Colonization



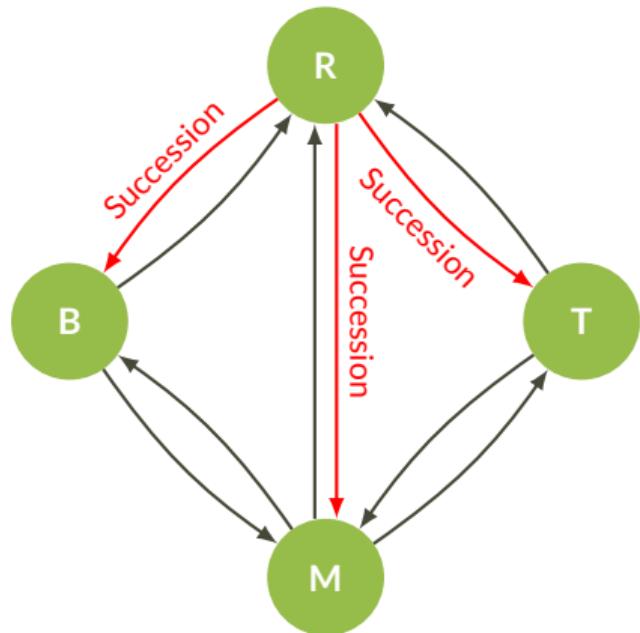
NEW APPROACH STATES AND TRANSITIONS MODEL



Ecological processes:

- Colonization
- Competitive exclusion

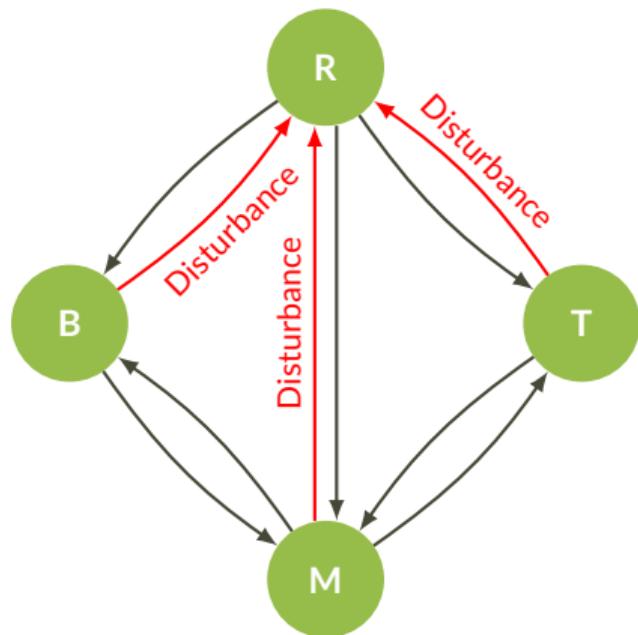
NEW APPROACH STATES AND TRANSITIONS MODEL



Ecological processes:

- Colonization
- Competitive exclusion
- Succession

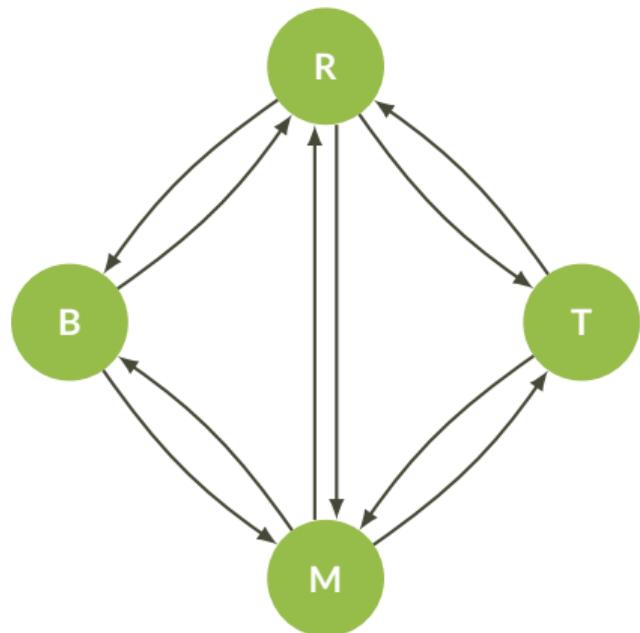
NEW APPROACH STATES AND TRANSITIONS MODEL



Ecological processes:

- Colonization
- Competitive exclusion
- Succession
- Disturbance

NEW APPROACH STATES AND TRANSITIONS MODEL



Ecological processes:

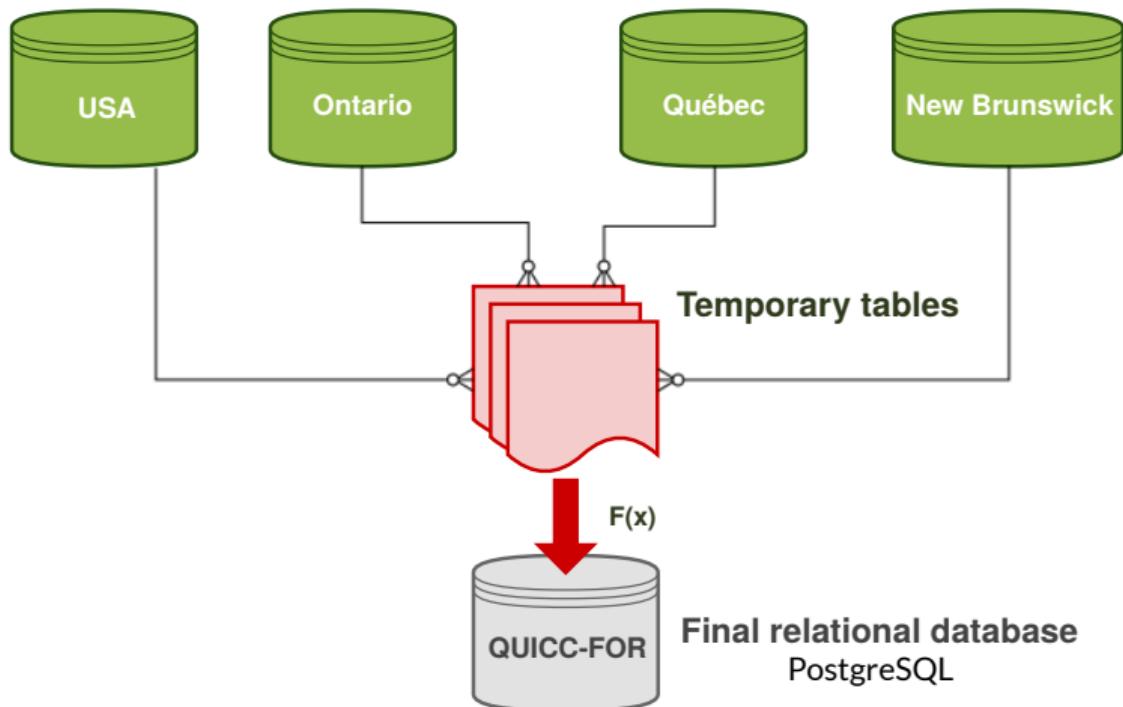
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- Competitive exclusion
- Succession
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Each probability depends on:

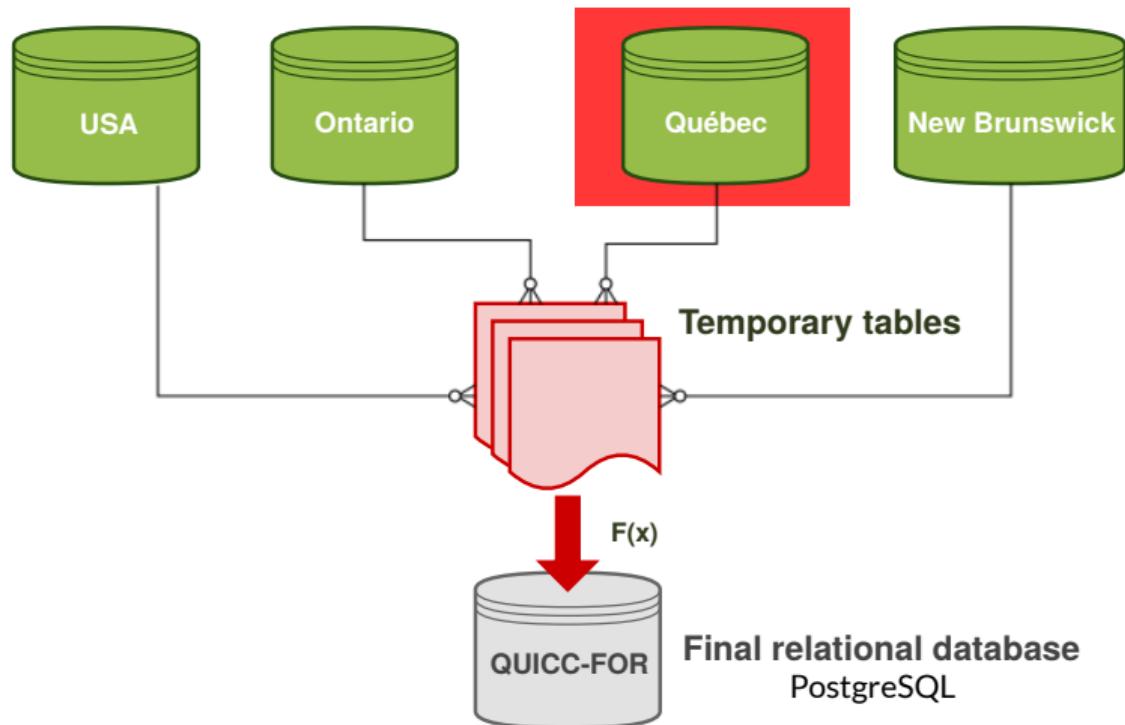
- Proportion of states available in the neighborhood
- Local climatic conditions (Precipitation, Temperature)

DATA THE QUICC-FOR DATABASE

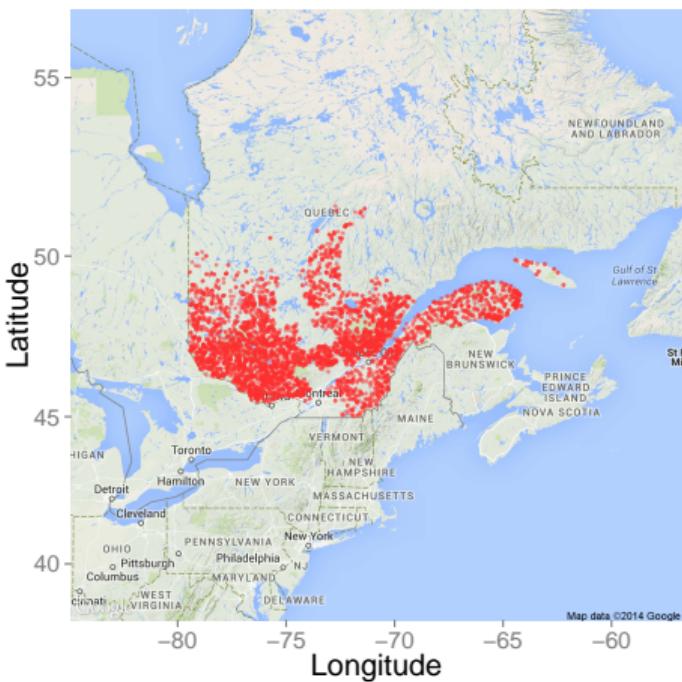
Merge several databases of forest permanent plots survey



Preliminary results include only the Quebec database

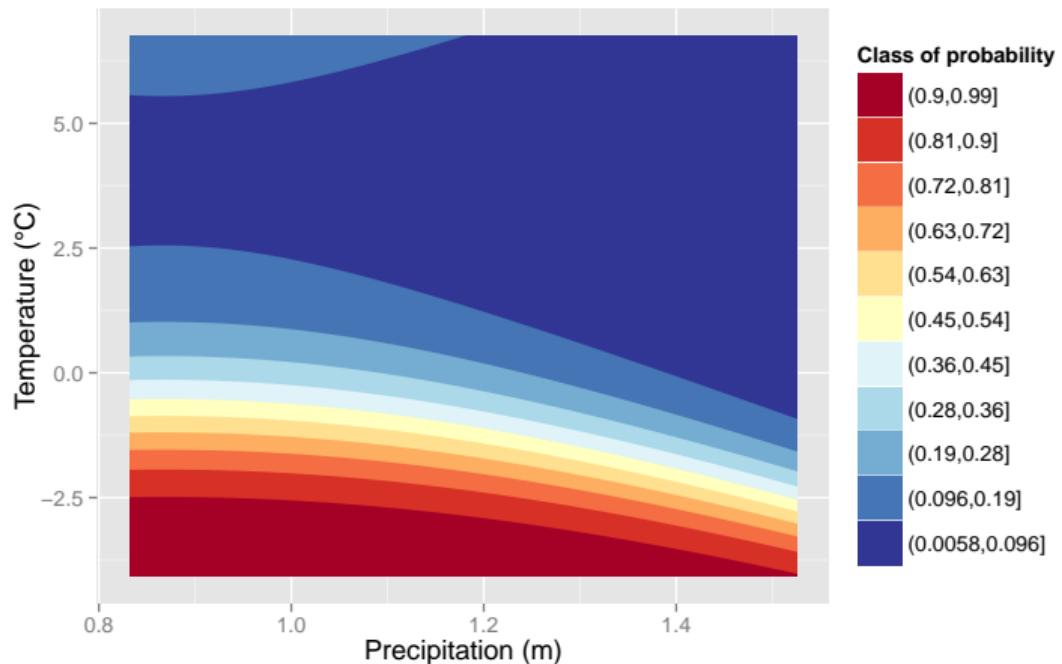
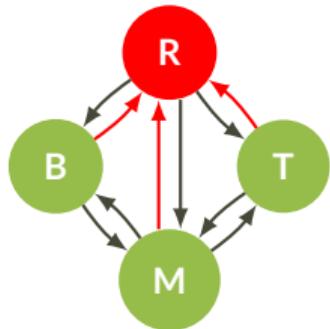


CALIBRATION DATA USED

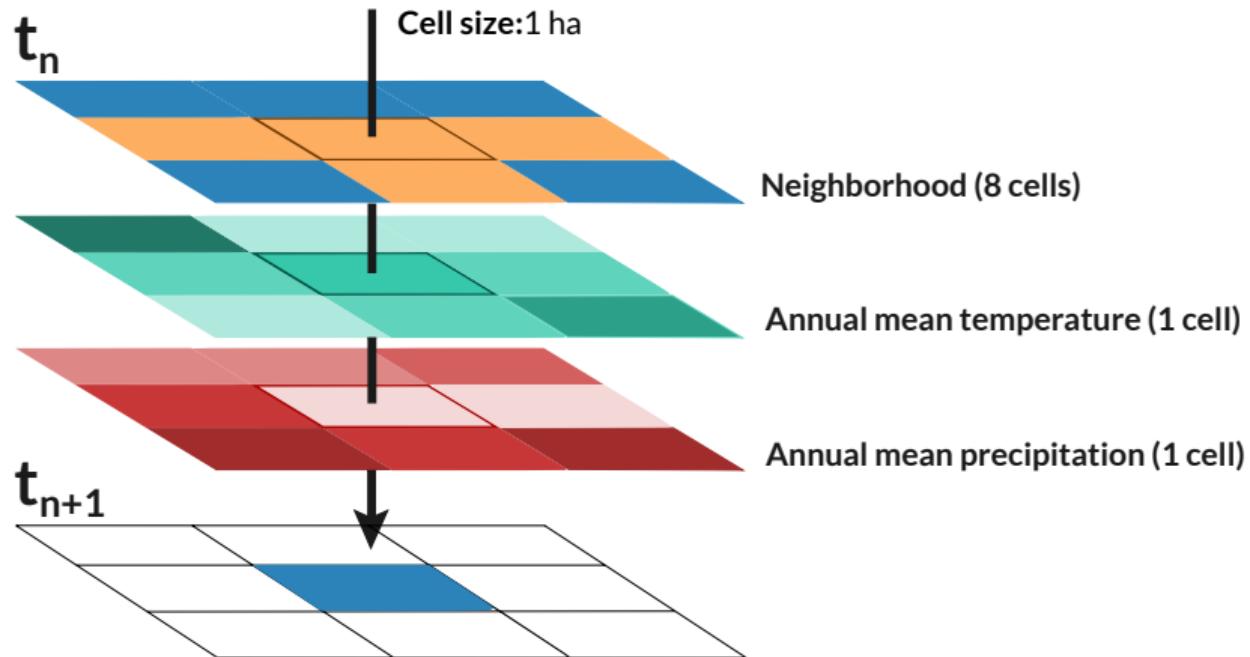


- 1. Classify state of each plot**
 - Plot remeasured (10 years)
 - Transition observed between remeasurements
 - Past-climate of the plot over 15 years
- 2. Compute state transition probabilities**
based on the past climate and neighbors plot states.

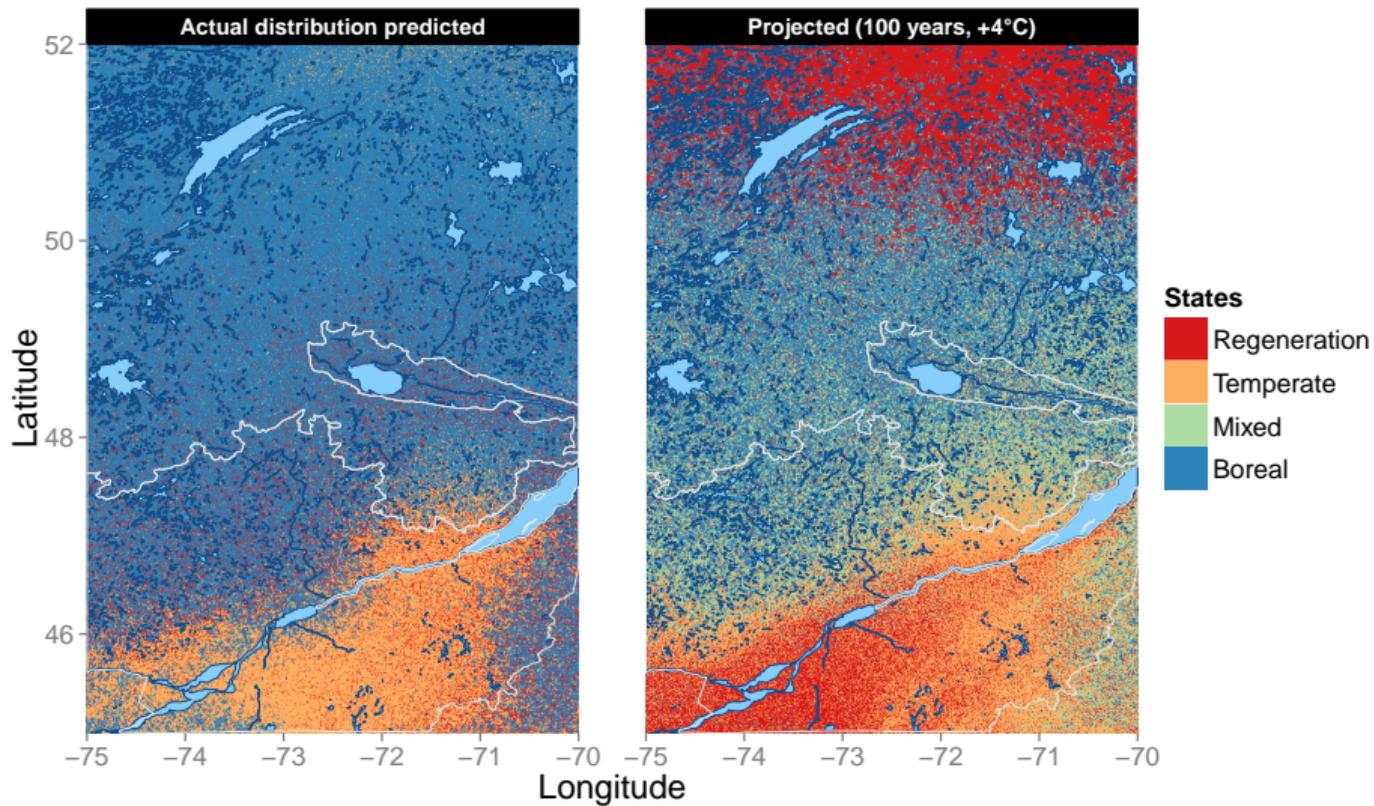
CALIBRATION TRANSITION PROBABILITIES OVER CLIMATIC GRADIENTS



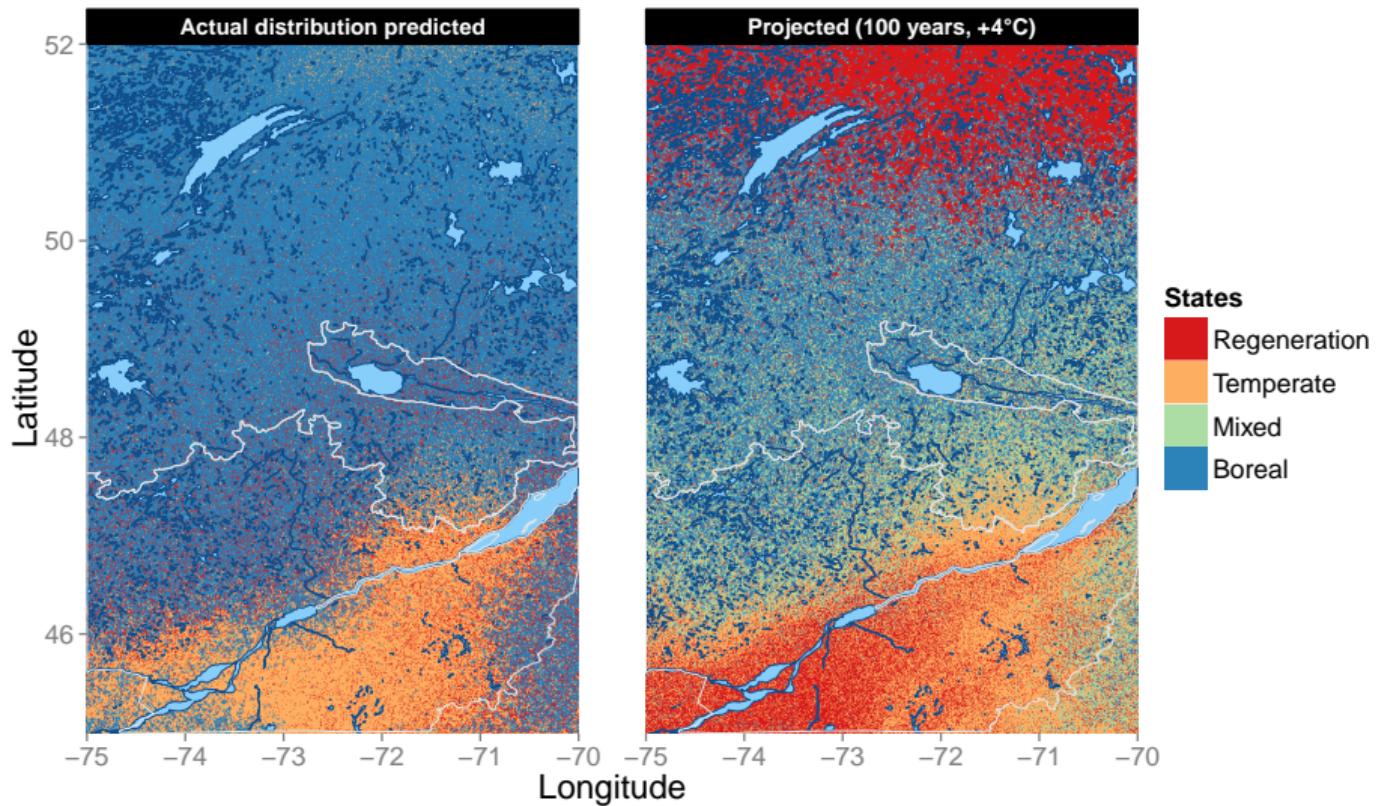
RESULTS SIMULATIONS



RESULTS ACTUAL PREDICTED LANDSCAPE



RESULTS FUTUR PREDICTED LANDSCAPE



INCOMINGS

Next steps:

1. Add all data from the QUICC-FOR database
2. Improve the calibration
3. Process validation
4. Perform simulations using Regional Climate Models (RCM)

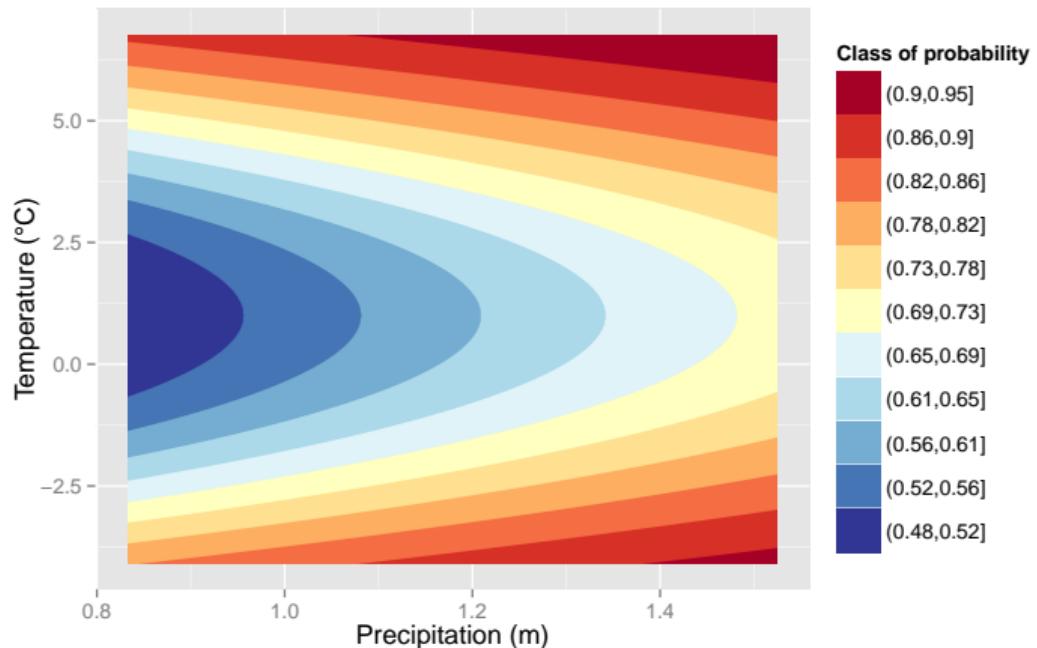
QUESTIONS

Thanks for your attention.
Any Questions ?

CALIBRATION EXTRA SLIDES

$$P(D_{t1} | M_{t0}, \text{Climate}) = f(\underbrace{\text{Climate},}_{\text{Step 1. RandomForest}} \underbrace{\hat{D}, \hat{M}}_{\text{Step 2. Multinomial regression}}) \quad (1)$$

Boreal succession probability



Temperate succession probability

