

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

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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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Yellow birch

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Red oak



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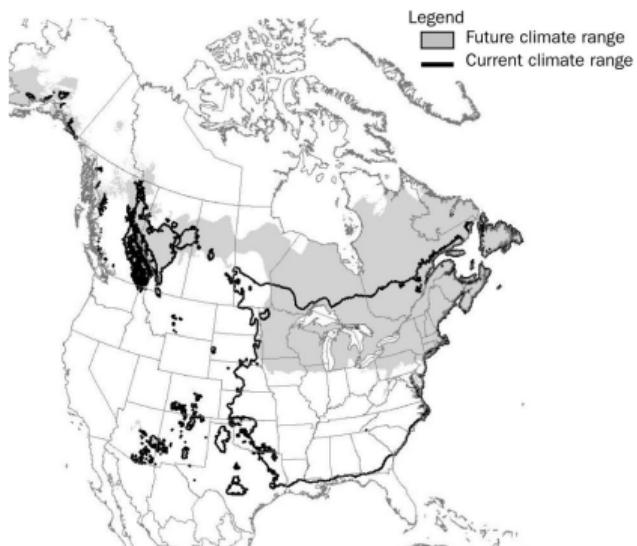


American ash

McKenney *et al.* 2007; Woodall *et al.* 2008; Iverson and Prasad, 2002. Web illustrations

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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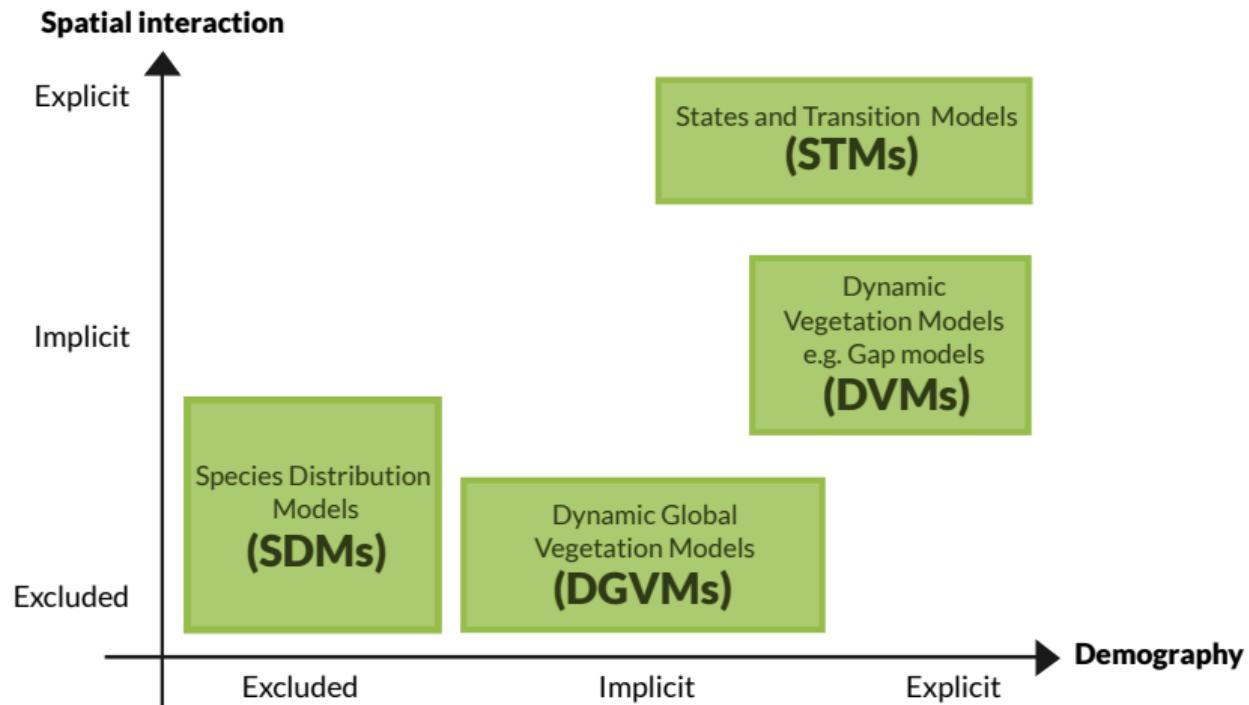
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These components will be effected by future climate

CONTEXT MODELLING COMPROMISE



STUDY OBJECTIVE

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

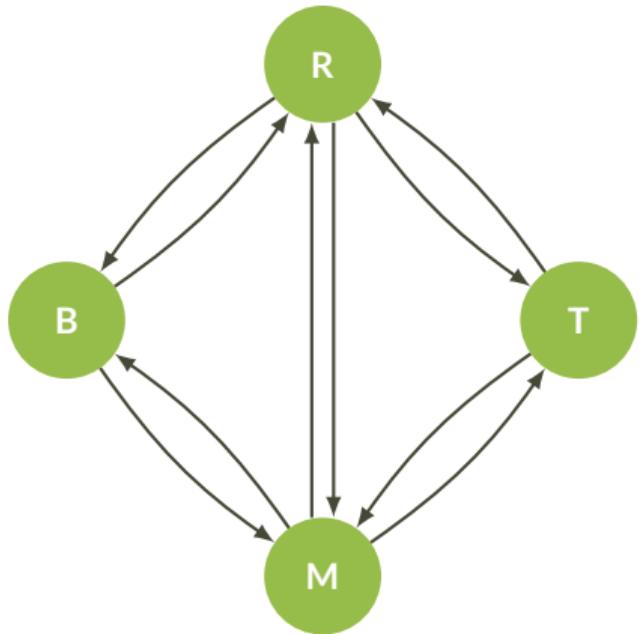
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Why ?

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

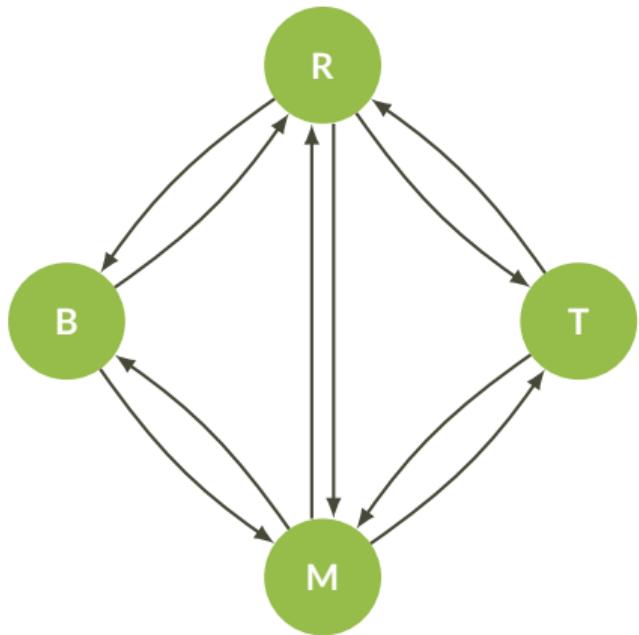
NEW APPROACH STATES AND TRANSITIONS MODEL



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

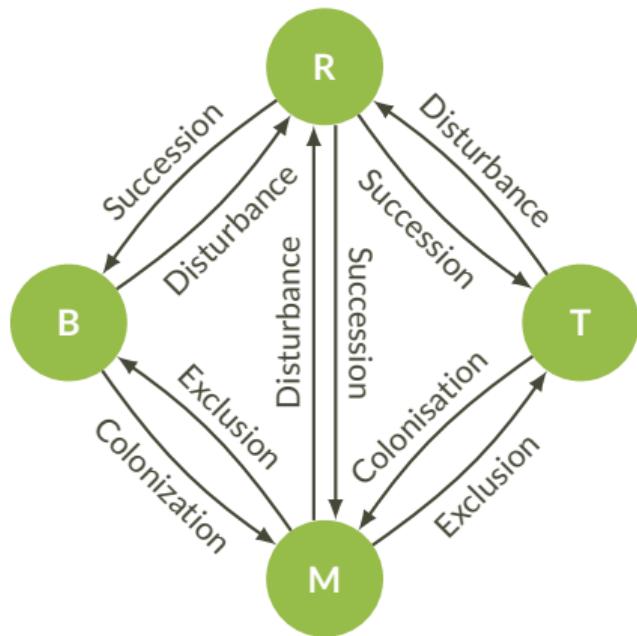
NEW APPROACH STATES AND TRANSITIONS MODEL



| 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)

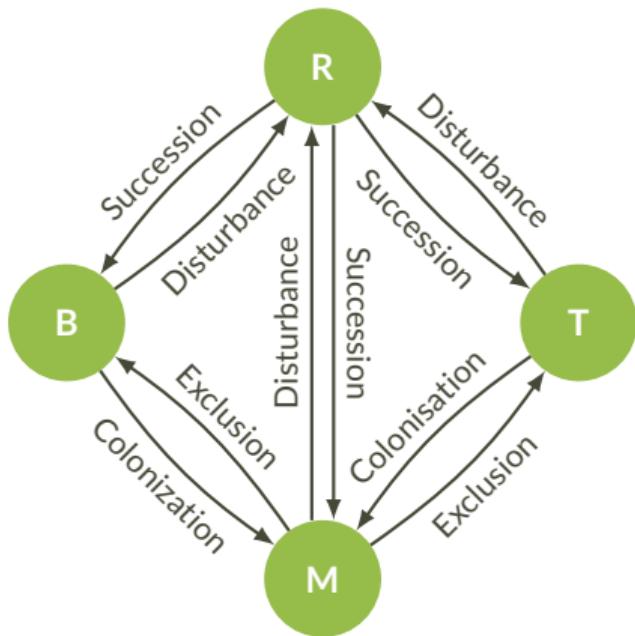
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Ecological processes:

- **Colonization**
- Competitive exclusion
- Succession
- Disturbance

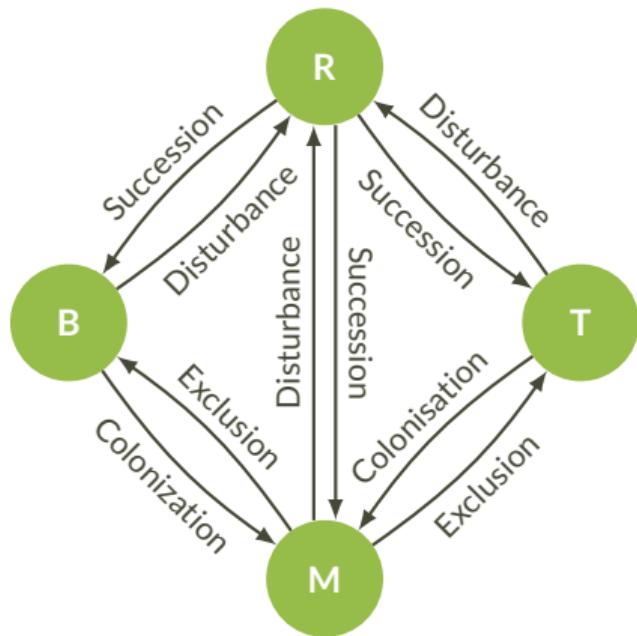
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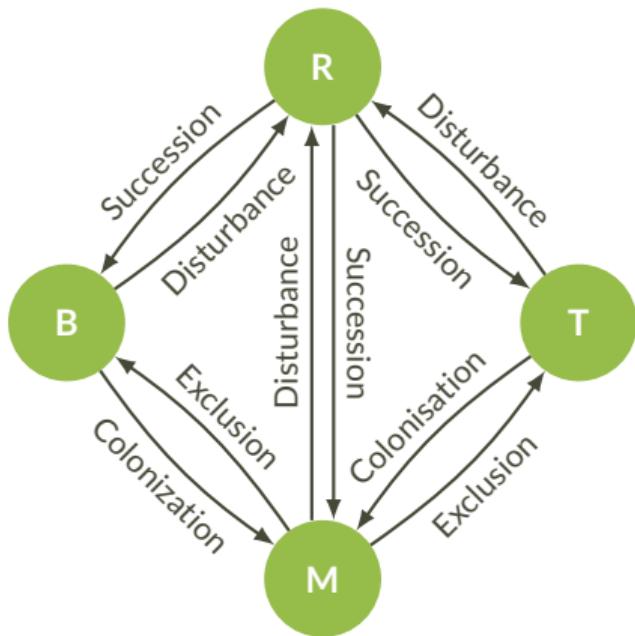
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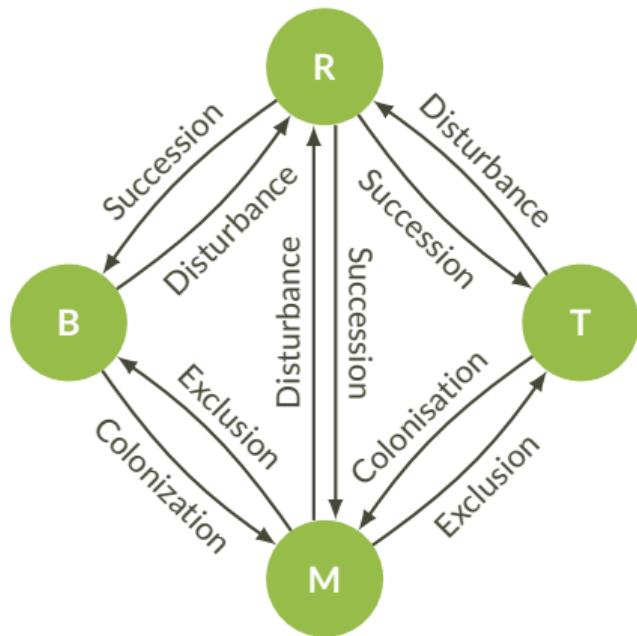
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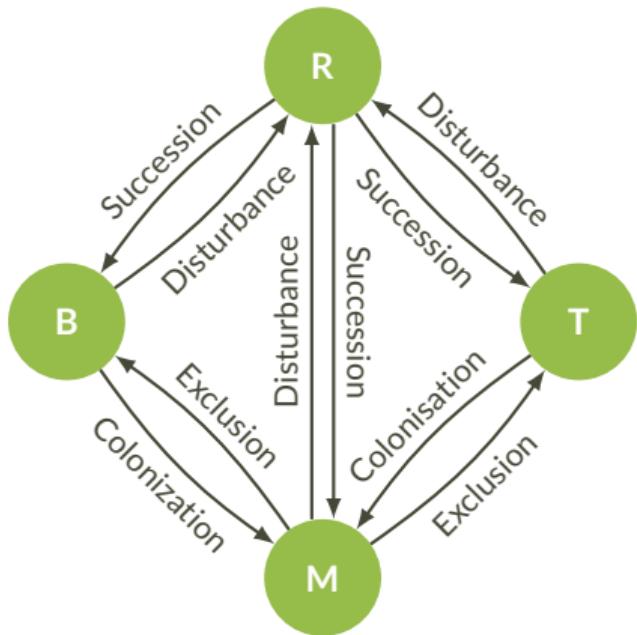
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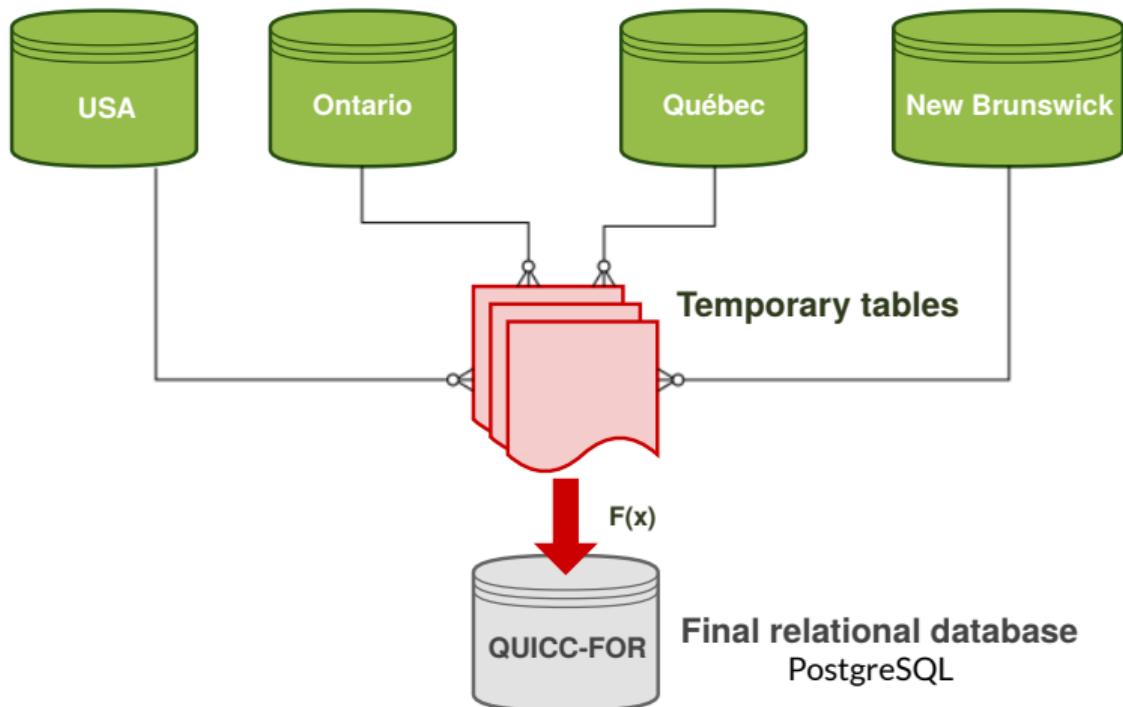
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Each probability depends on:

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

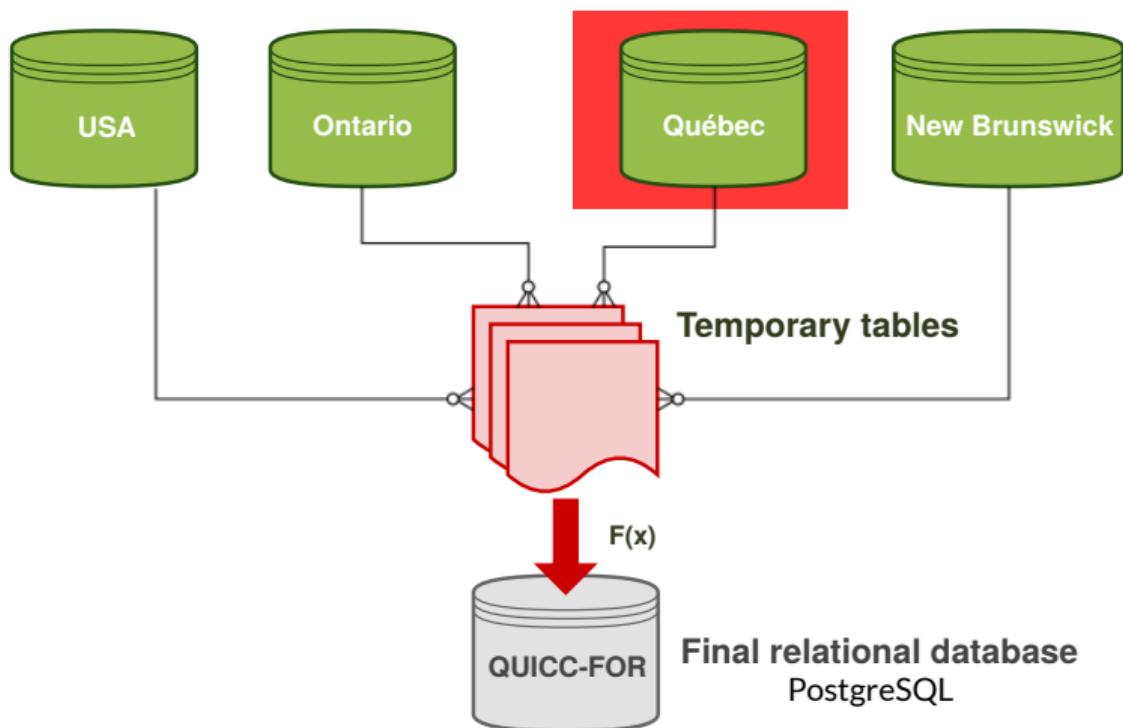
DATA USED THE QUICC-FOR DATABASE

Merge several databases of forest permanent plots survey



DATA USED CALIBRATION

Preliminary results include only the Quebec database



Plots distribution map

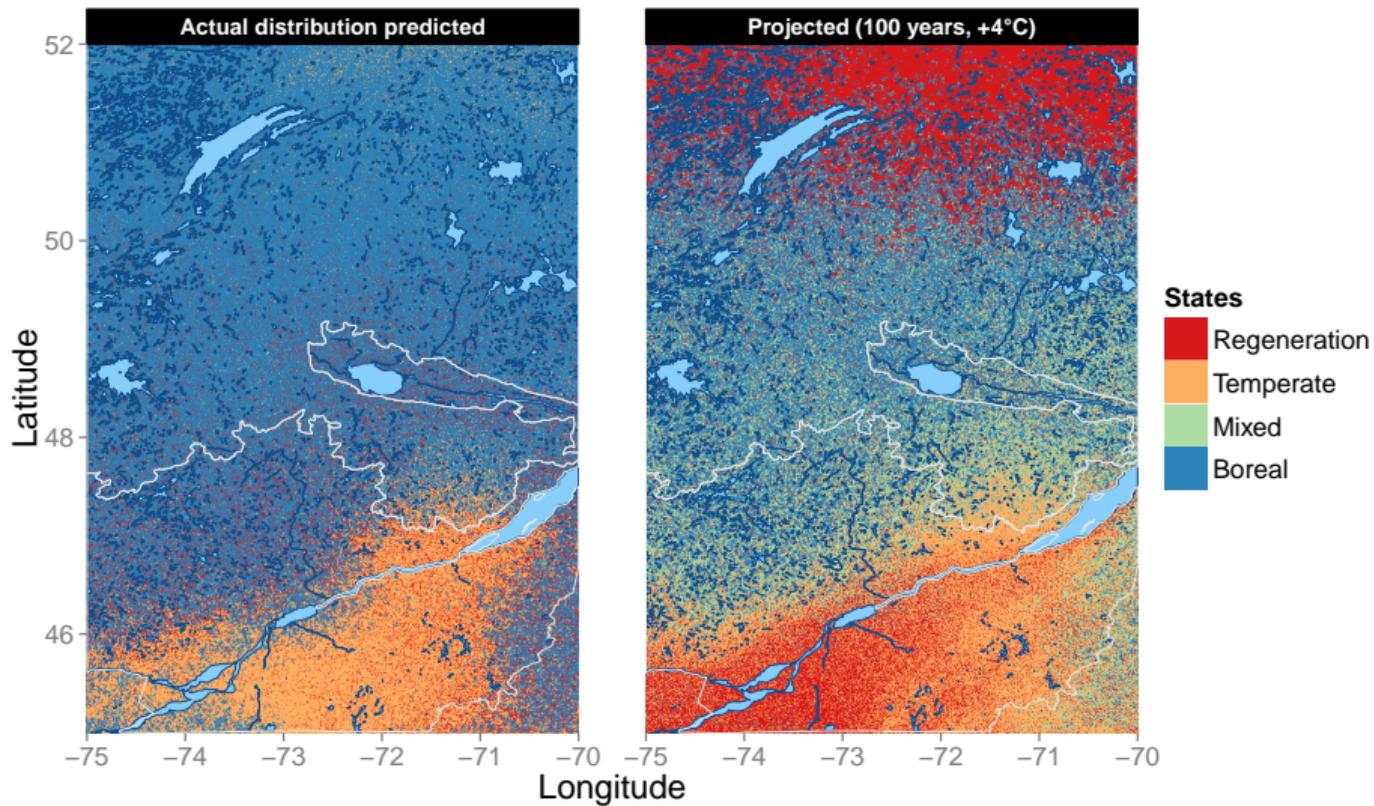
- 1. Classify state of each plot**
 - Plot remeasured (10 years)
 - Transition observed between remeasurements
 - Past-climate of the plot over 15 years
- 2. Compute state transition probabilities**
based on the past climate and neighbors plot states.

CALIBRATION TRANSITION PROBABILITIES

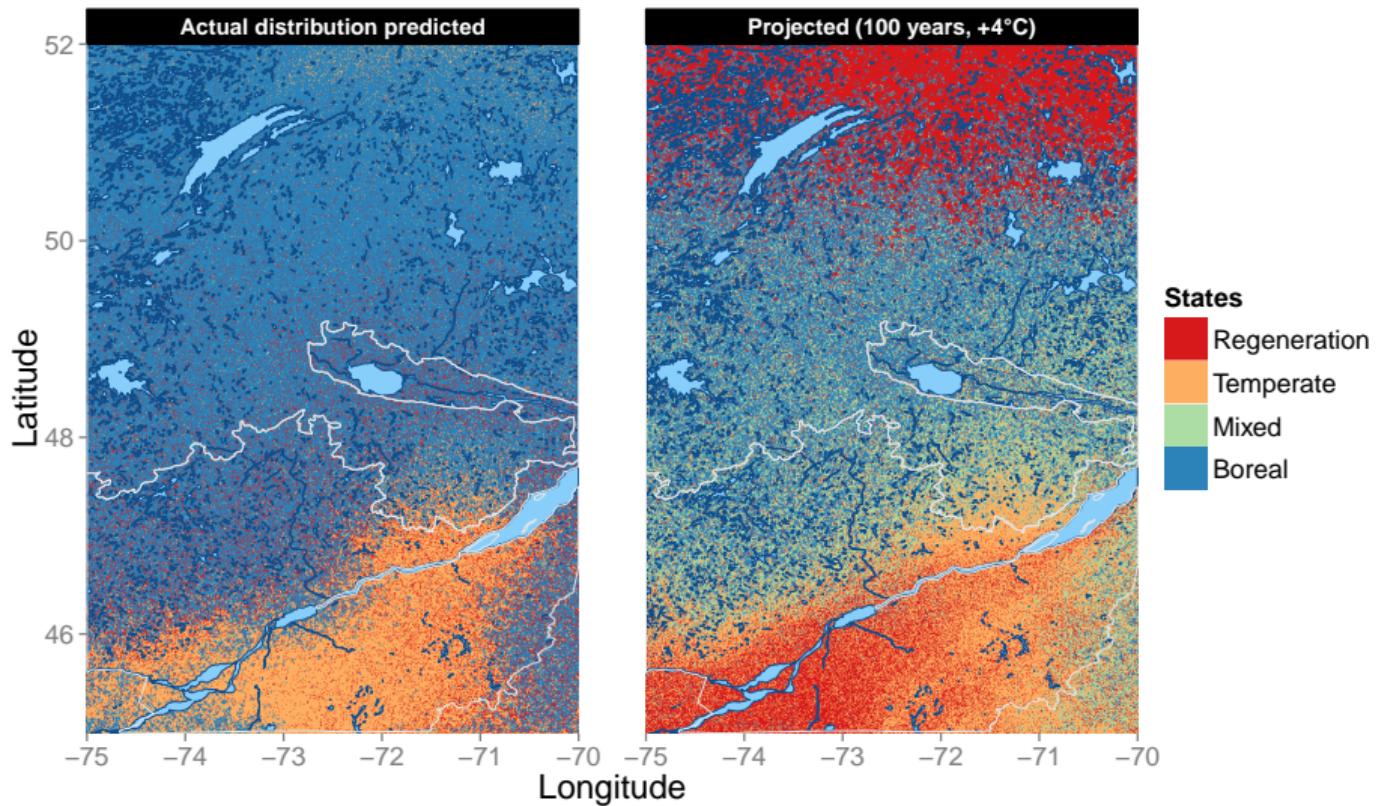
Figure: State transition probability
function

STM spatial explicit version

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 ?