

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

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



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## CONTEXT THE BOREAL-TEMPERATE ECOTONE

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



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## CONTEXT THE BOREAL-TEMPERATE ECOTONE

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



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## CONTEXT PREDICTED FUTURE SPECIES DISTRIBUTION

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



Sugar maple



Red oak



Yellow birch

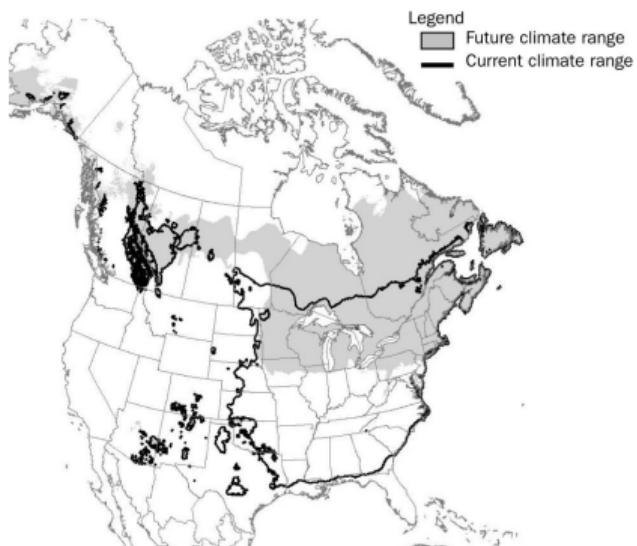


American ash

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## CONTEXT PREDICTED FUTURE SPECIES DISTRIBUTION

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Future climate enveloppe of Sugar maple (2071-2100)

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## 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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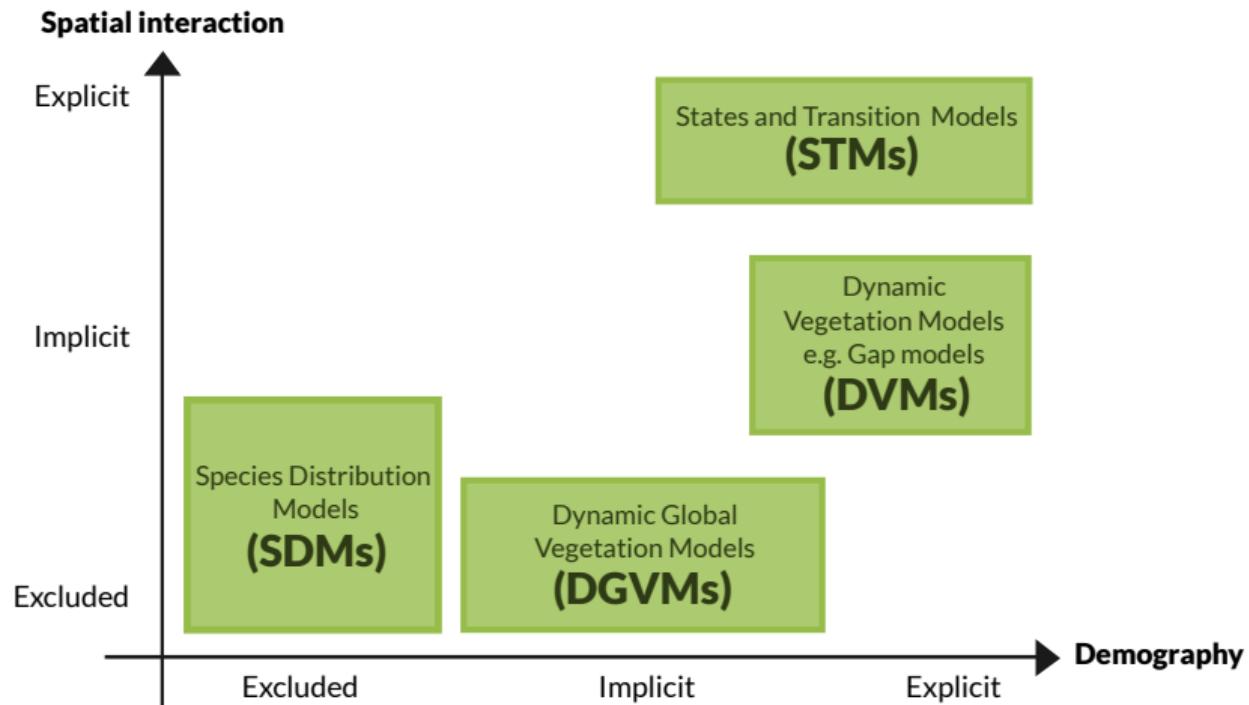
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To predict species or communities range shift we need to include:

- Spatial interactions (e.g. competition)
- Population demography

These components will be effected by future climate

## CONTEXT MODELLING COMPROMISE



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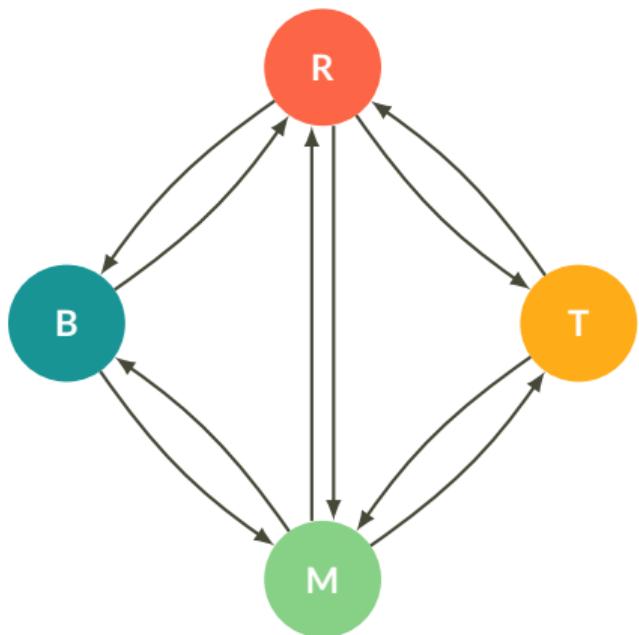
**Main objective:** Assess range shift and migration rates of the temperate forest community toward boreal forest under climate change.

### Why ?

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

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## NEW APPROACH STATES AND TRANSITIONS MODEL



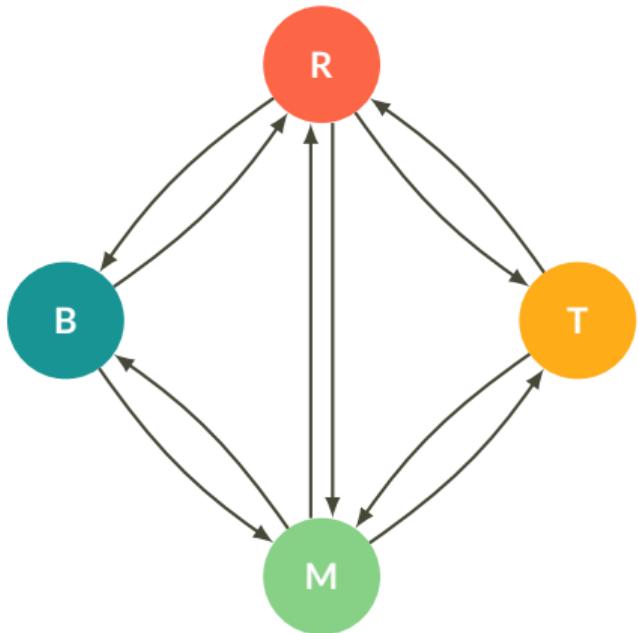
### Model Description

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

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## NEW APPROACH CLASSIFICATION

Criteria: Presence/absence



State	Species
B	White spruce
B	Black spruce
B	Hemlock
B	Balsam fir etc.
T	White ash
T	Red maple
T	Sugar maple
T	American beech etc.
M	Presence of both species (T and B)
R	$Ba \leq 10m_2/ha$

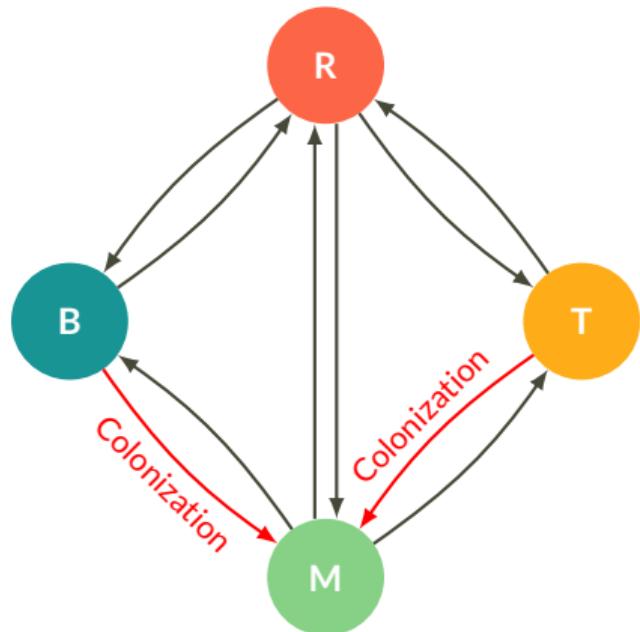
\* $Ba$  means basal area ( $m_2/ha$ )

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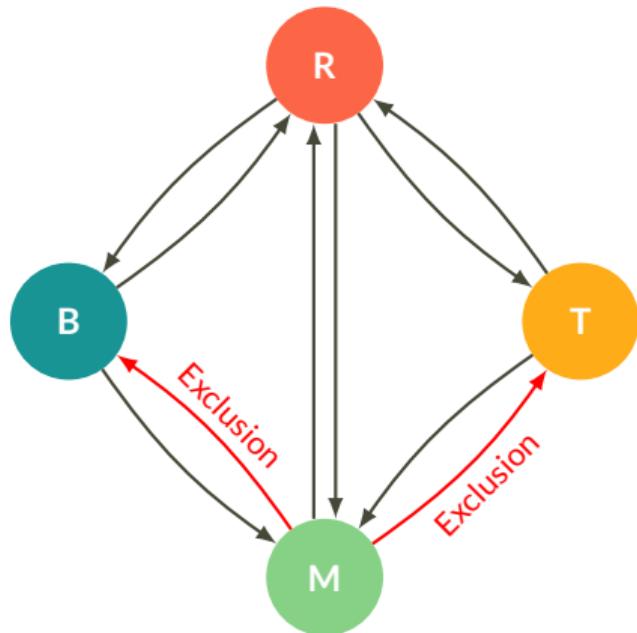
Ecological processes:

- Colonization



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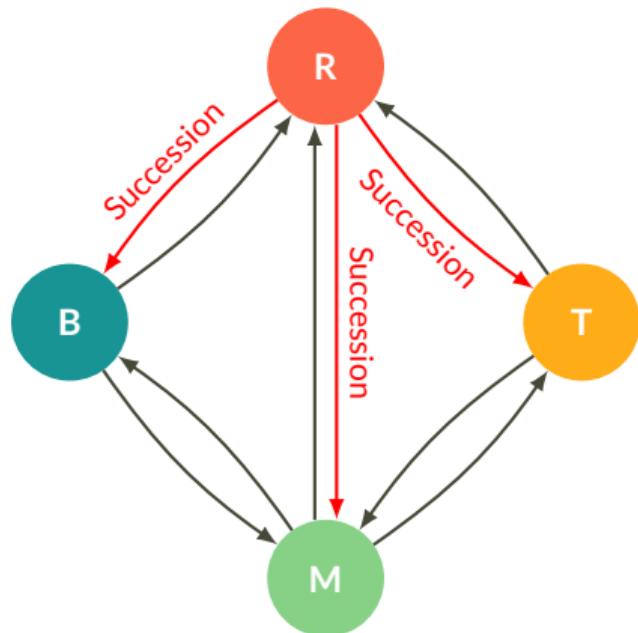


**Ecological processes:**

- Colonization
- Competitive exclusion

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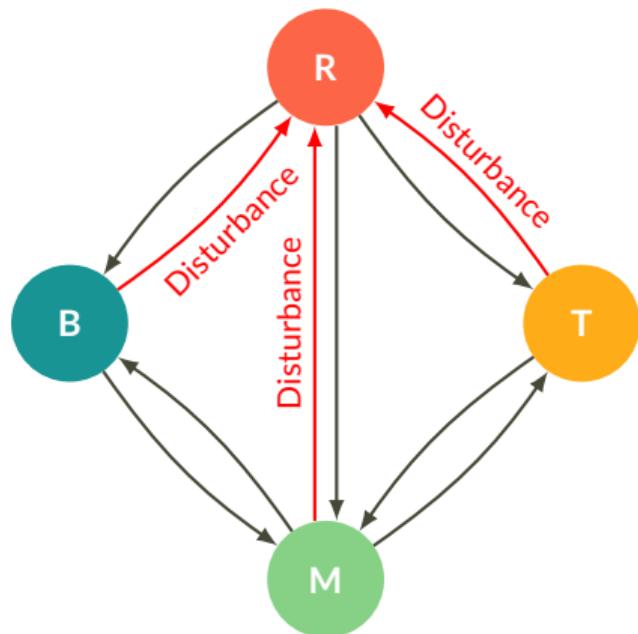


### Ecological processes:

- Colonization
- Competitive exclusion
- Succession

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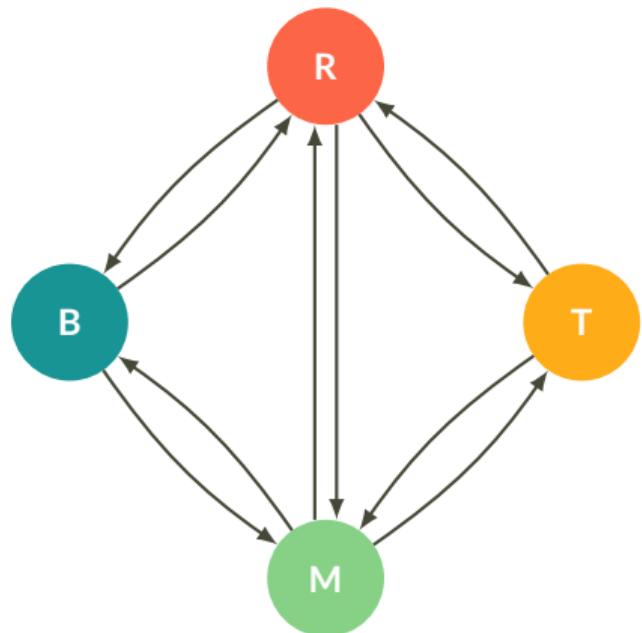


### Ecological processes:

- Colonization
- Competitive exclusion
- Succession
- Disturbance

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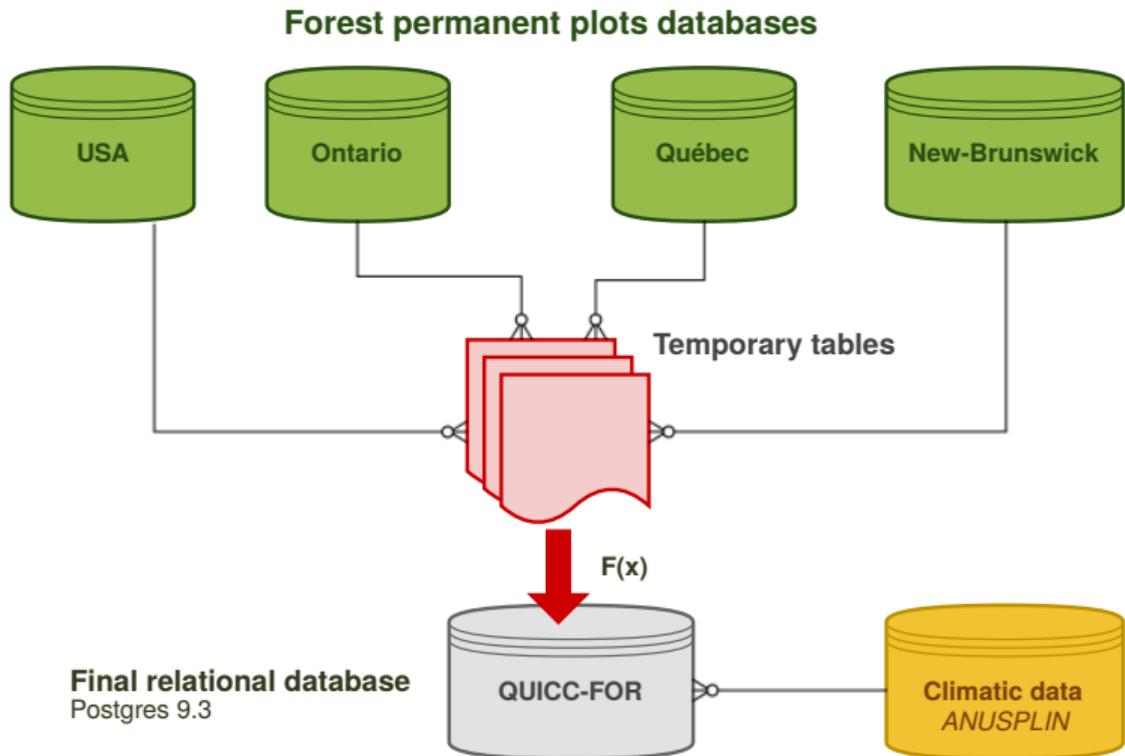
### Ecological processes:

- Colonization
- Competitive exclusion
- Succession
- Disturbance

### Each probability depends on:

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

## DATA THE QUICC-FOR DATABASE



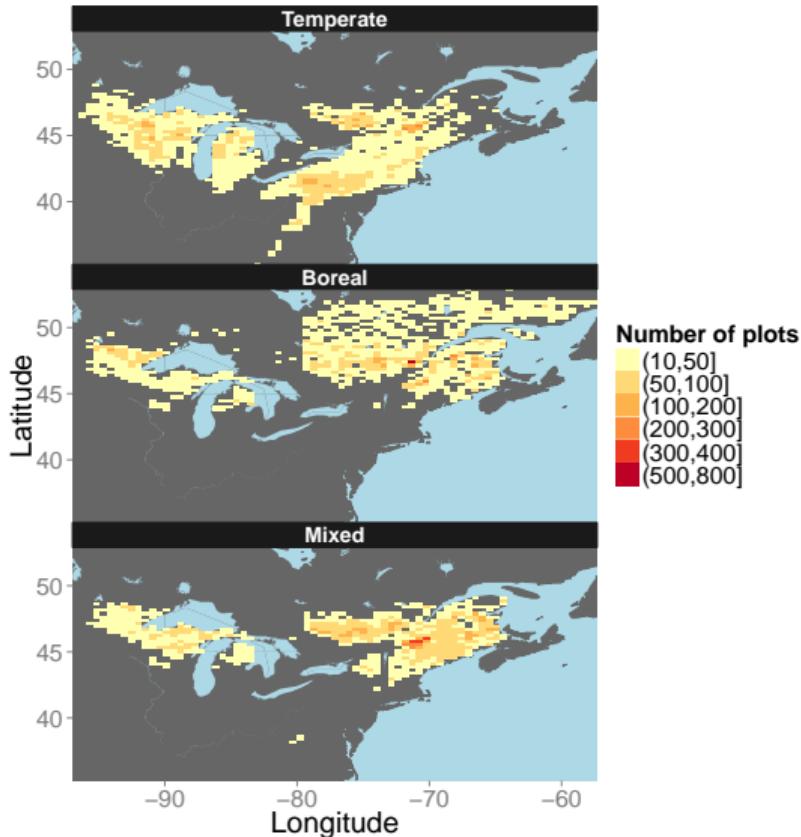
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## CALIBRATION    DATA USED

### 1. Classify state of each plot

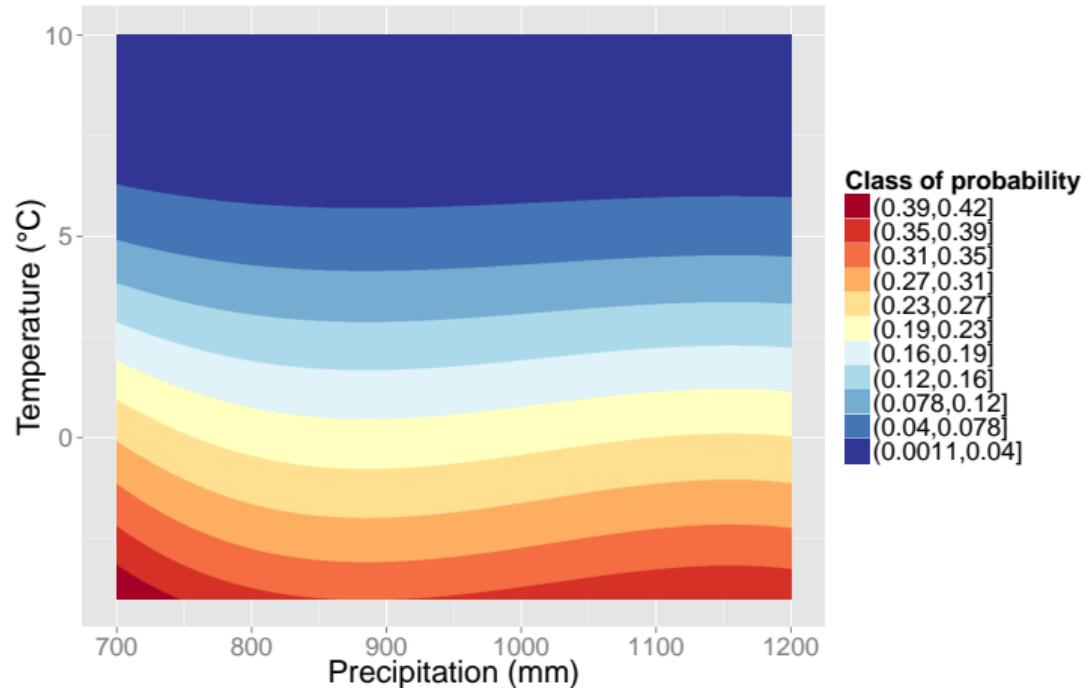
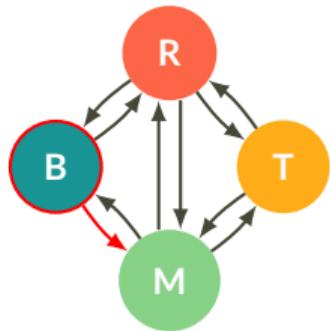
- Plot remeasured
- Transition observed between remeasurements
- Past-climate of the plot over 15 years

### 2. Compute state transition probabilities based on the actual climate and neighbors plot states.



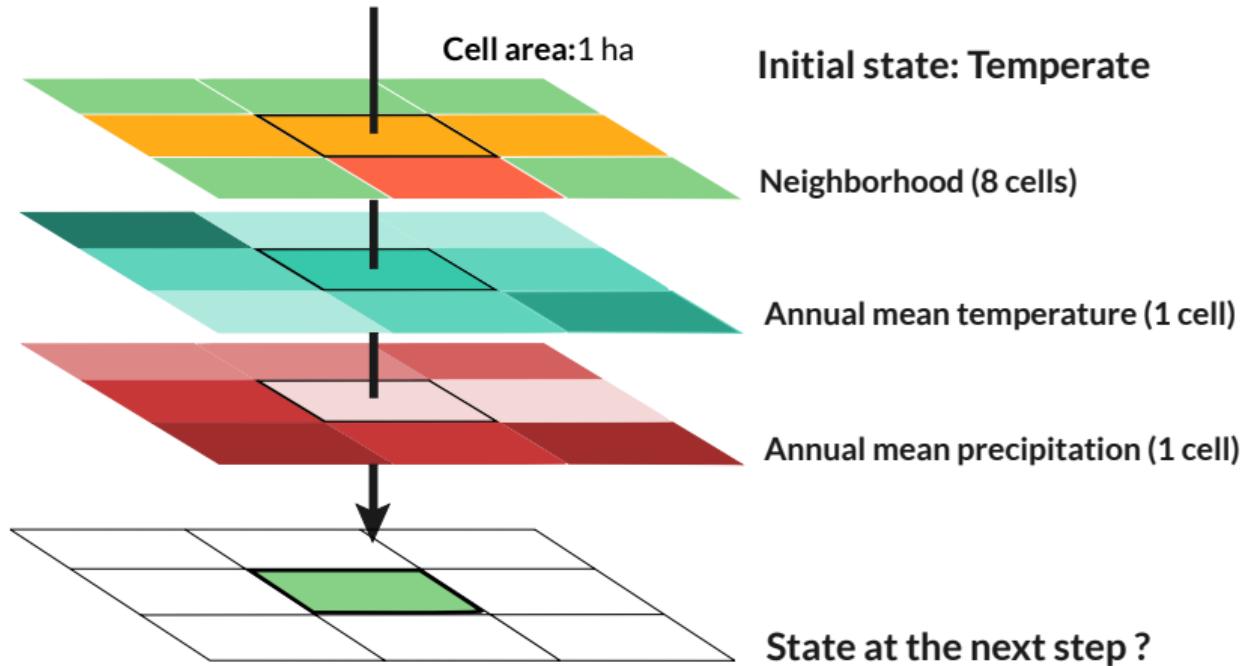
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## CALIBRATION    TRANSITION PROBABILITIES OVER CLIMATIC GRADIENTS



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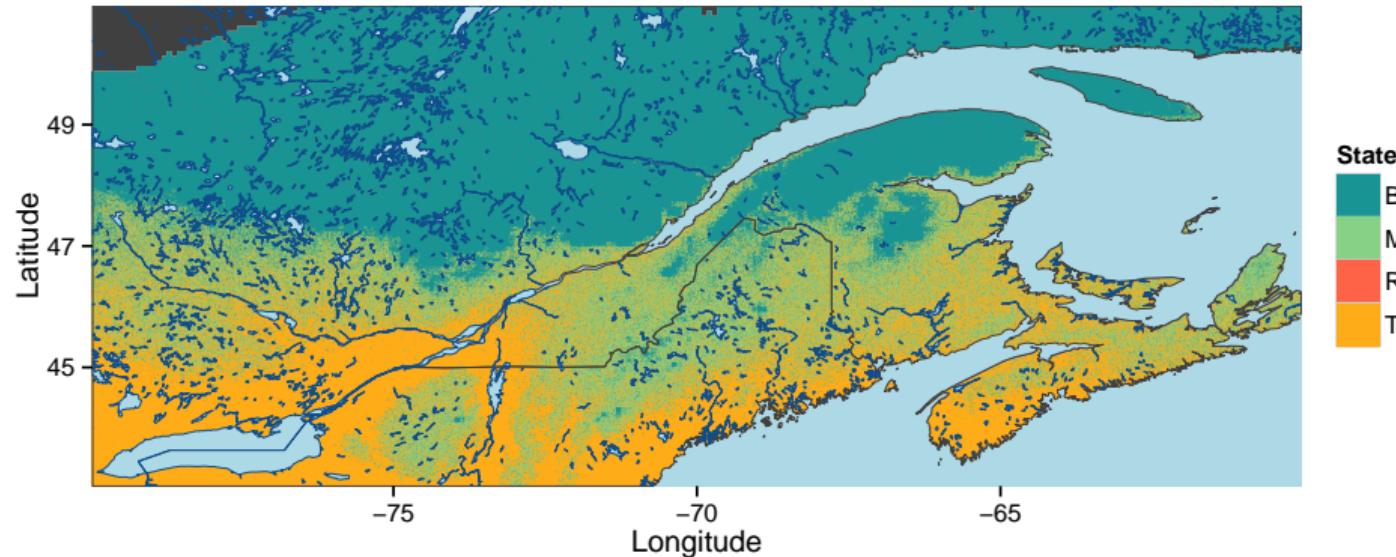
## SIMULATIONS PREDICT THE NEXT TIMESTEP



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## RESULTS PREDICT THE ACTUAL LANDSCAPE

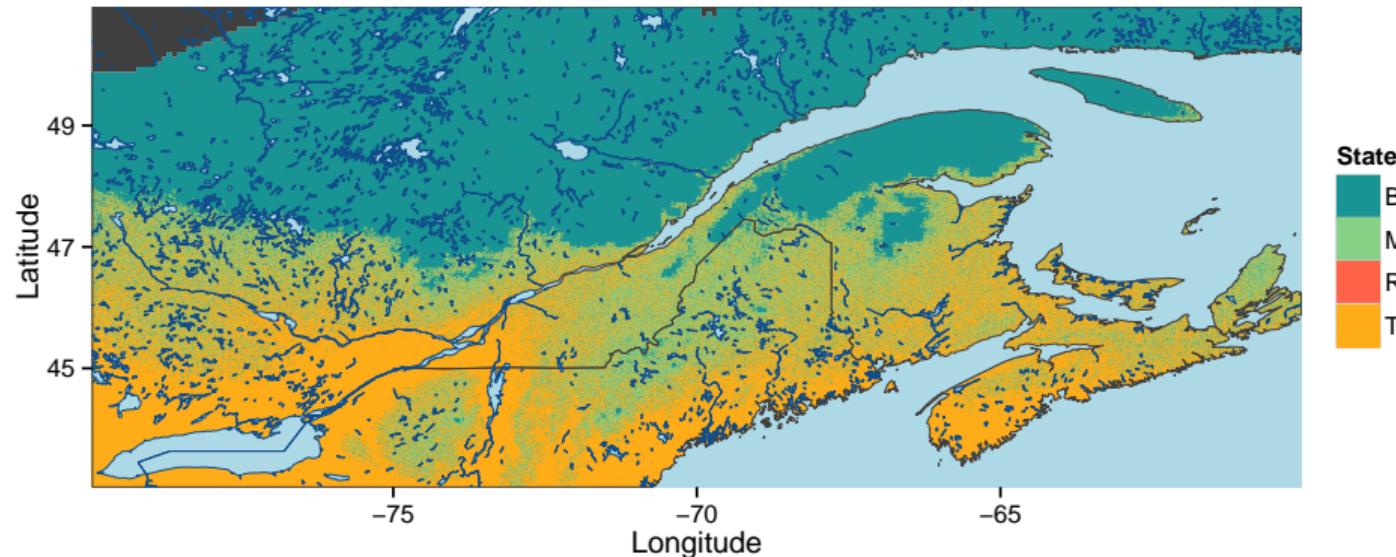
Actual states distributions predicted by the STM on climatology: 1970-2000



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## RESULTS FUTUR PREDICTED LANDSCAPE

Temperature increase linearly ( $2^{\circ}\text{C}$ ): 2100



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## ACKNOWLEDGEMENTS



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Funded by



Thanks to my supervisors and contributors

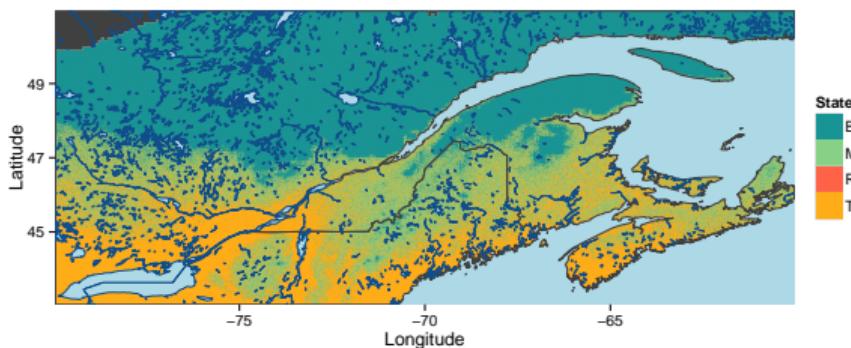
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## CALIBRATION EXTRA SLIDES

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

Landscape predicted by the STM



Bioclimatic domains in Quebec

