

A state transition model to investigate what constrains the northward migration of the temperate forest

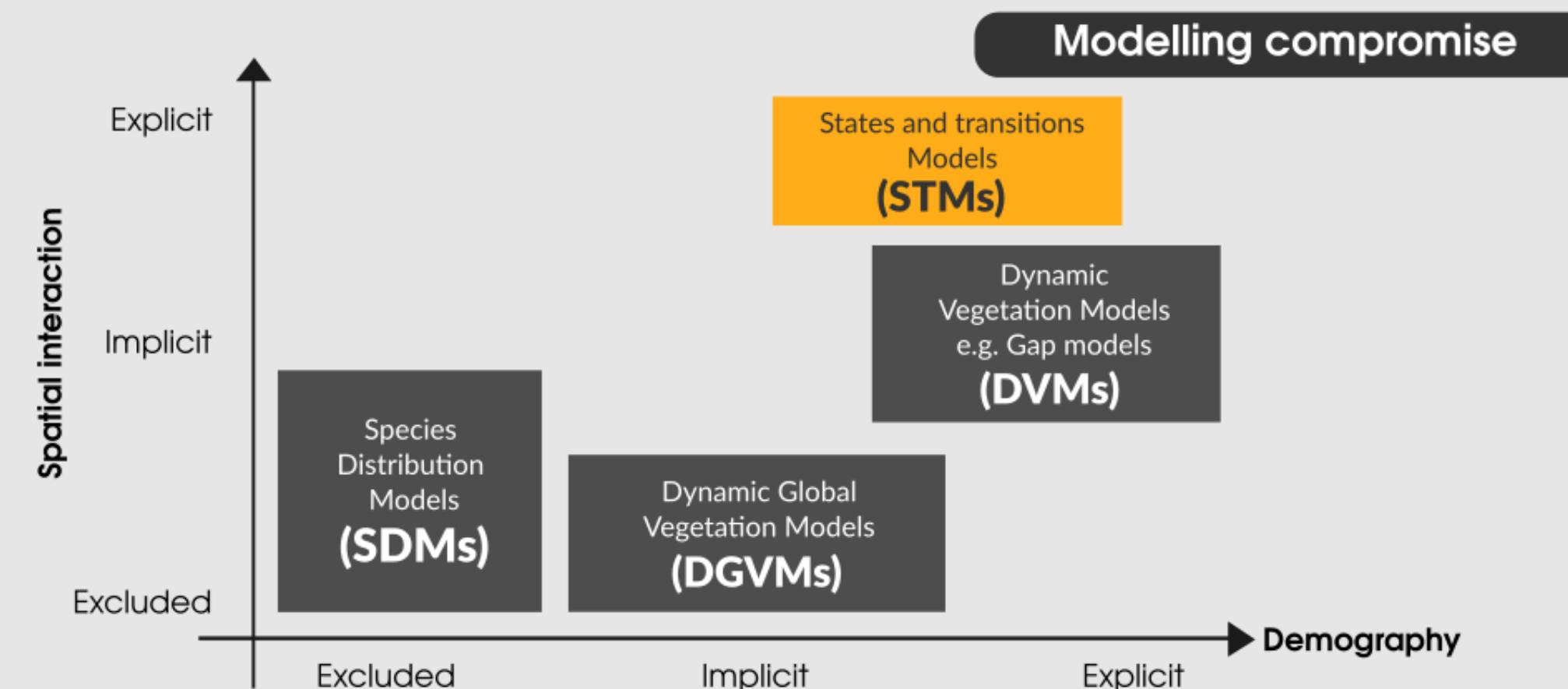
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Overview

- Species distribution models (SDMs) predict that several temperate species will shift northward under climate change (Iverson et Prasad 2002).
- SDMs are limited in their ability to incorporate ecological processes such as biotic interactions, dispersal limitation and slow vegetation dynamic (Thuiller et al., 2008).
- These processes may impact the migration rate of temperate species under climate change.

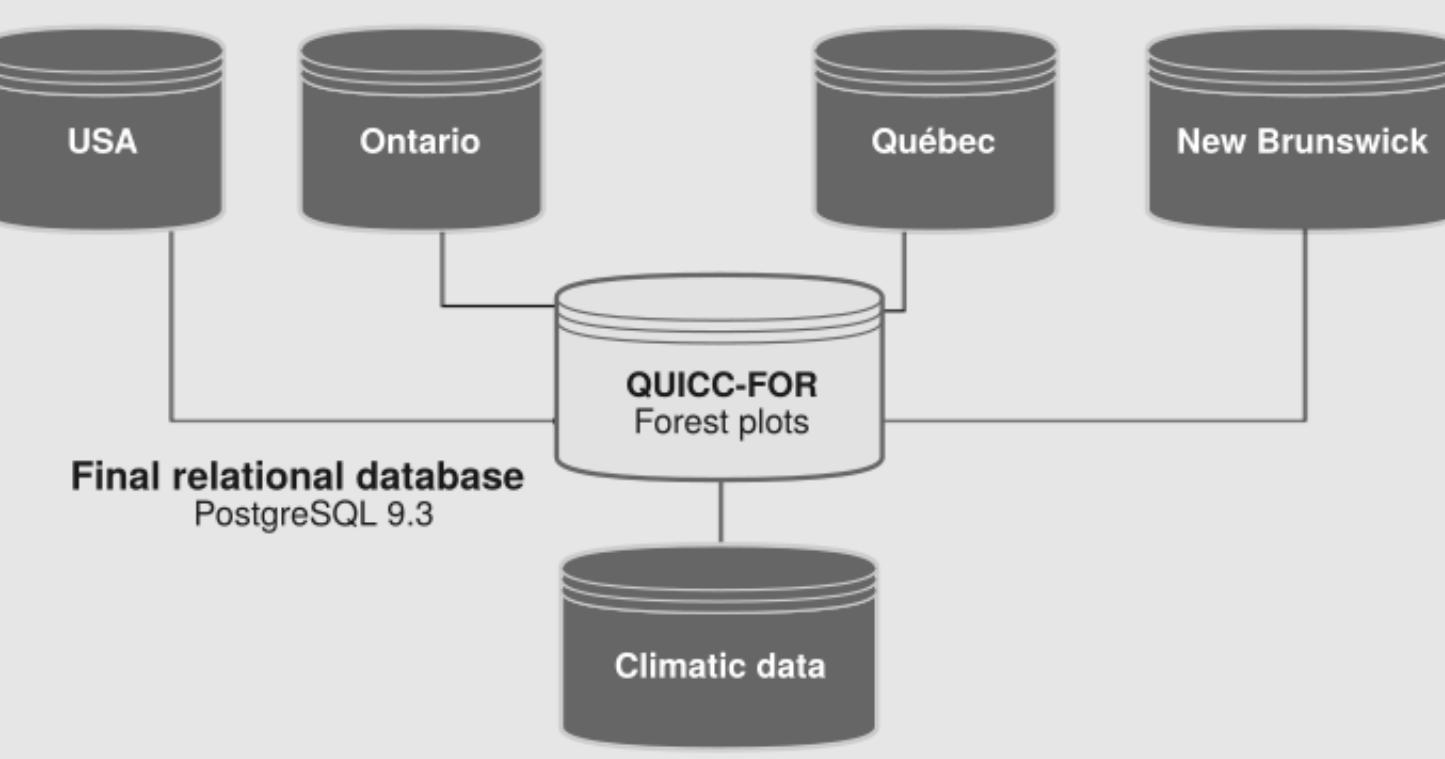


Objectives

- Improve the prediction for the future distribution of the temperate forest by integrating ecological processes in a states and transitions model (STM).
- Investigate the migration rate of the temperate forest under climate change.
- Identify which ecological mechanism constrains the migration rate.

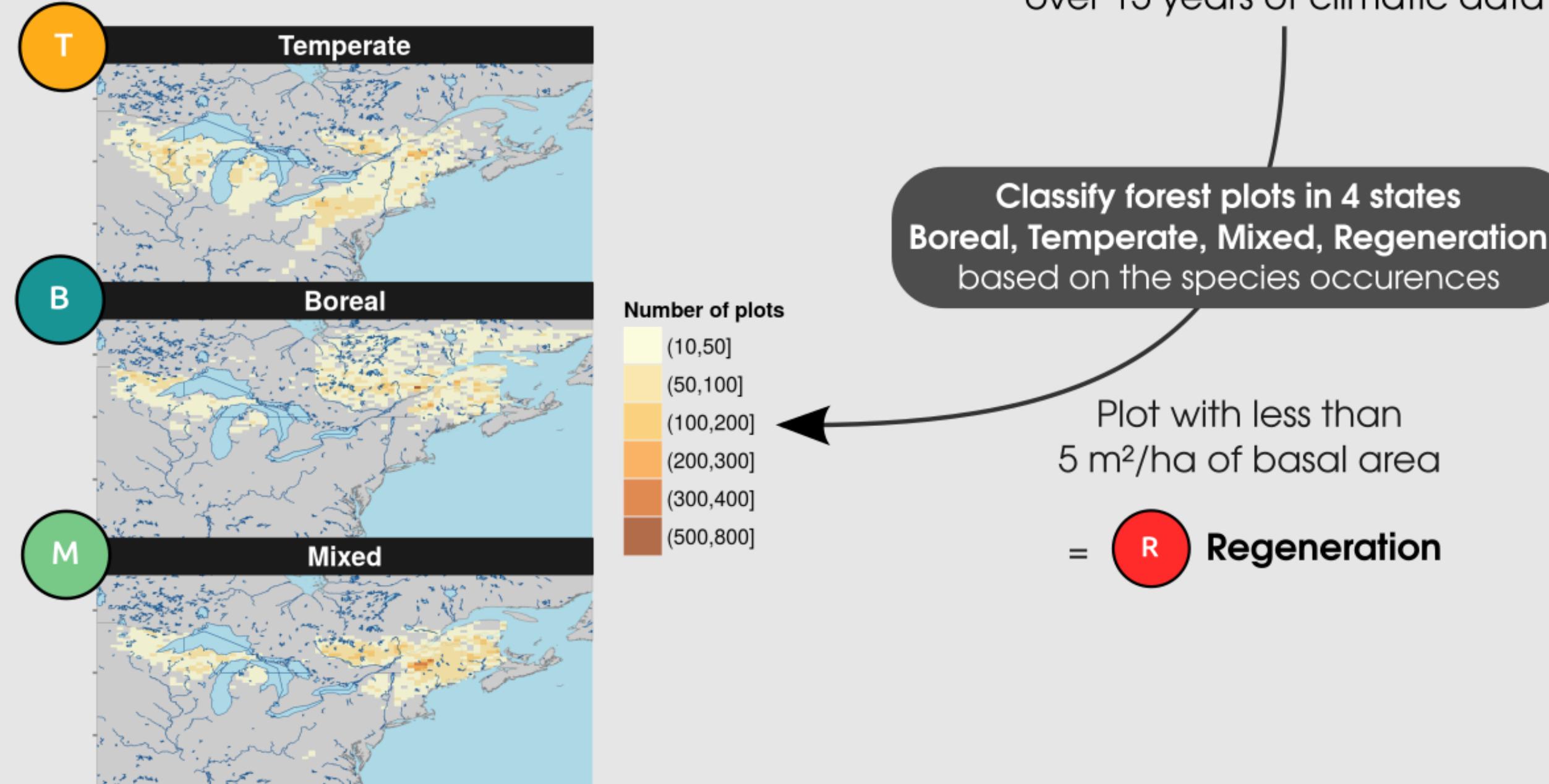
Databases

Merging several forest permanent plots and climatic databases into one



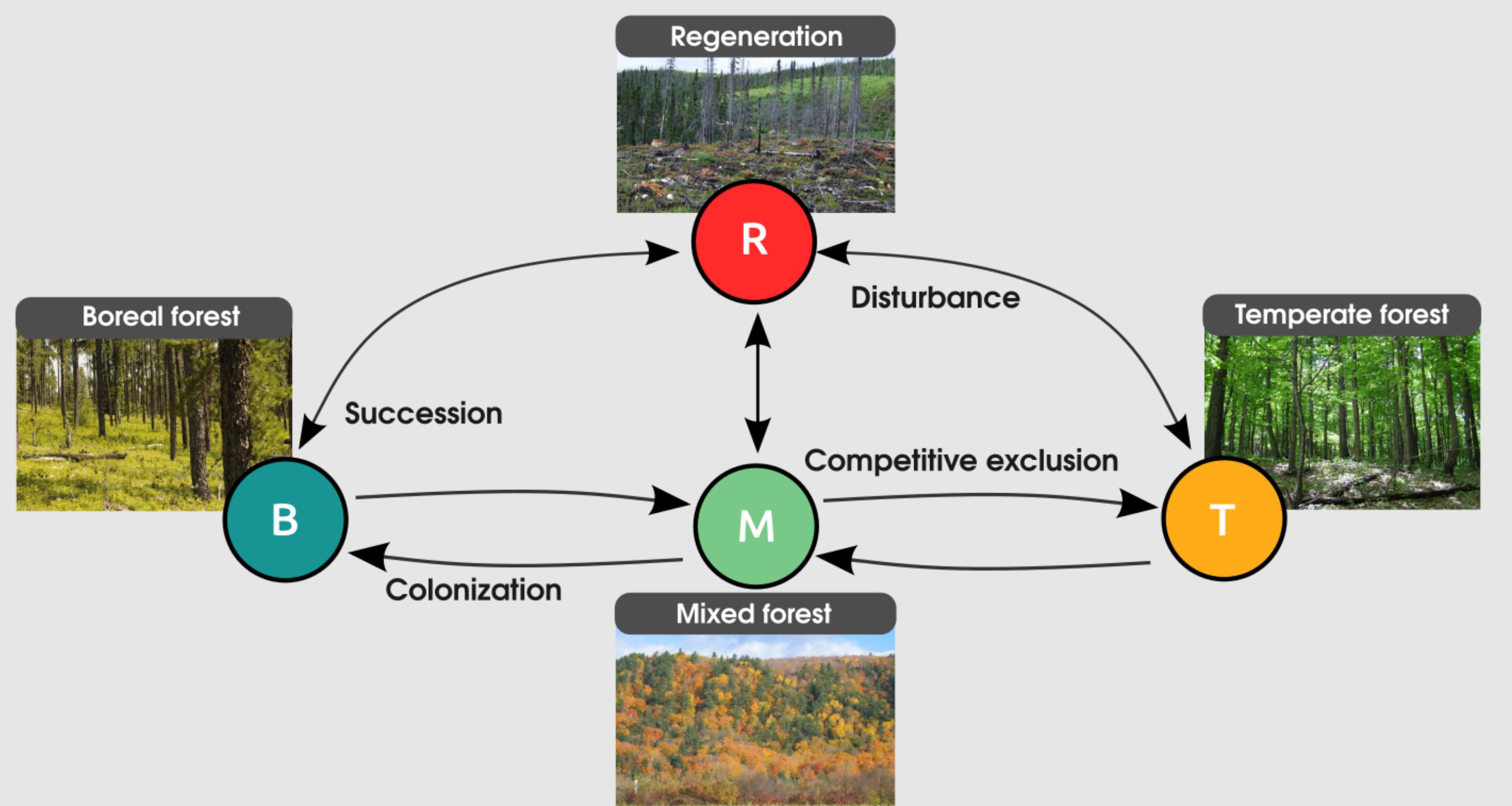
Data used:

- 68 700 forest plots widely distributed in Eastern North-America
- Plot surveys start in 1970 until 2012
- Between 1 and 6 measures
- 138 000 total measurements
- For each plot and measure: over 15 years of climatic data

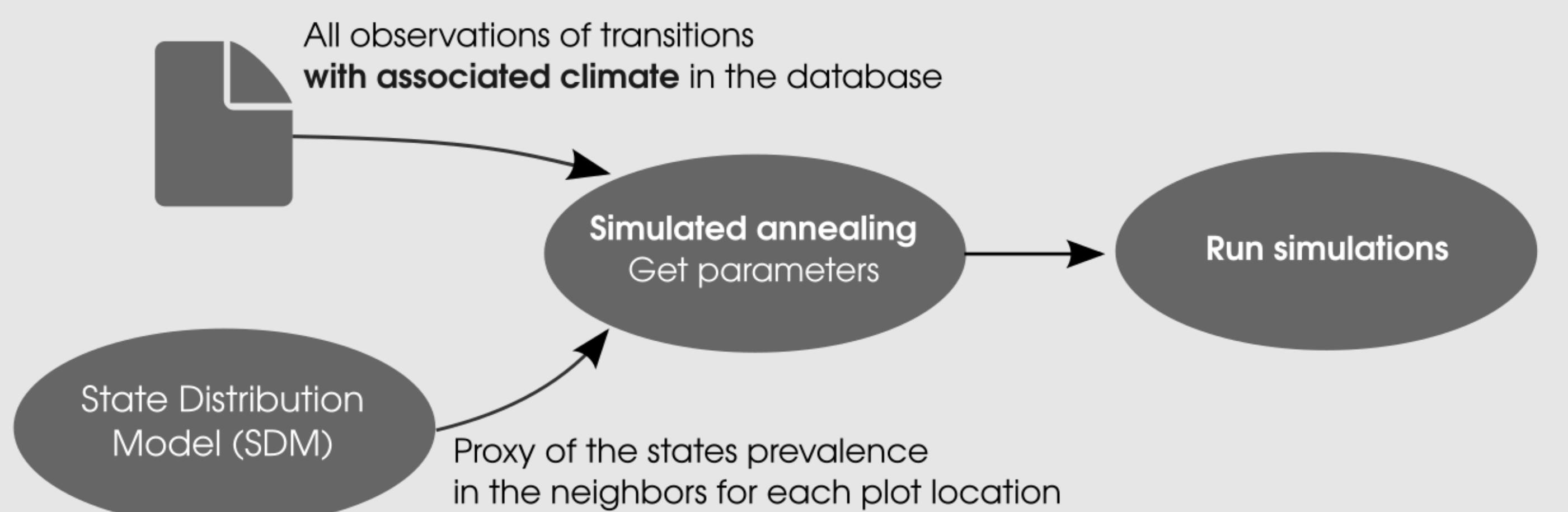


State and transition model

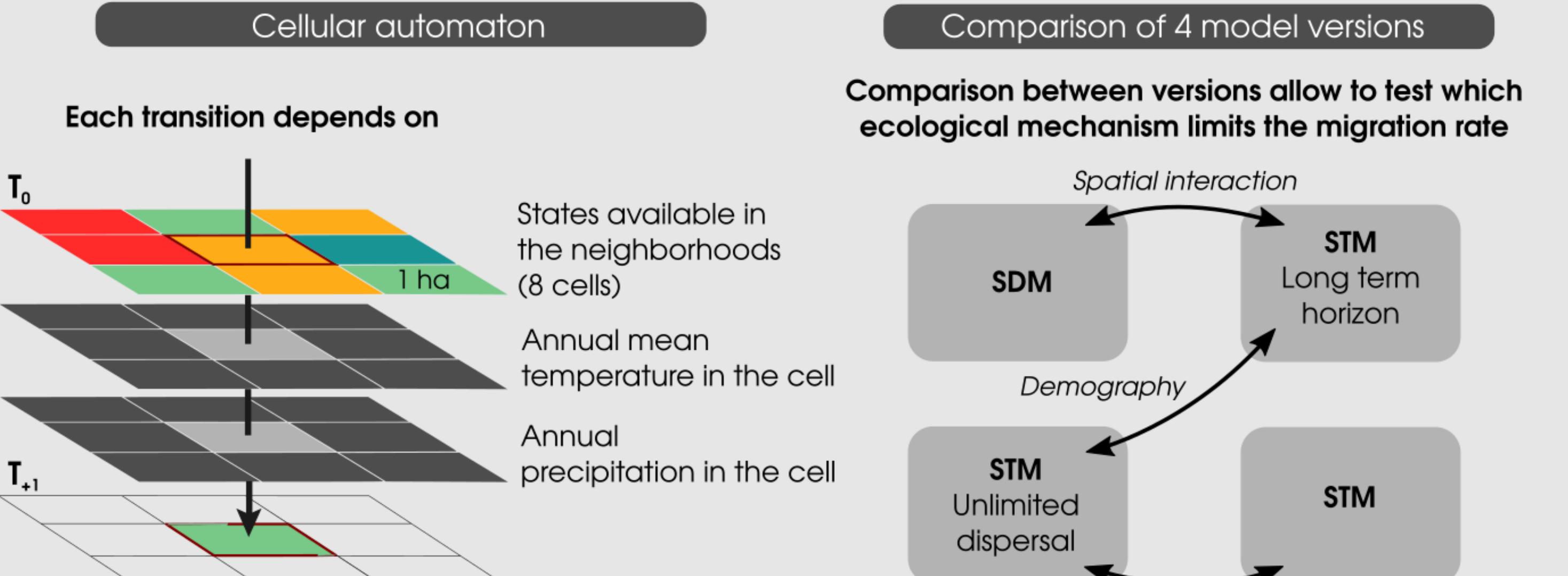
1. Model conceptualization



2. Calibrate transition probabilities (flows between states)

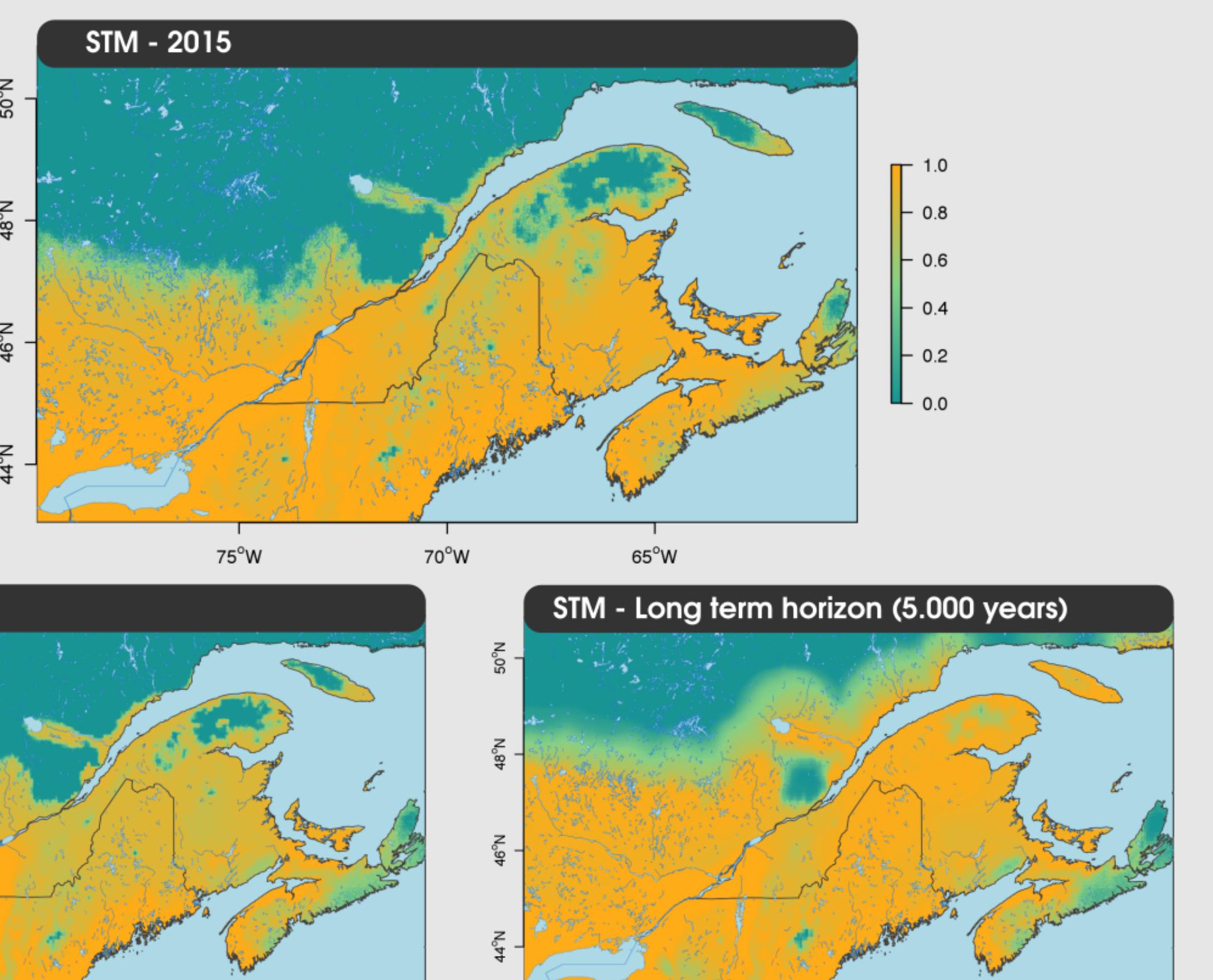


3. Run STM simulations on landscapes



Results

Figure 1. Predicted landscapes of the temperate forest distribution at the ecotone
Results from the best set of parameters and
23 General Circulation Models (Scenario RCP 8.5, AR5, IPCC 2014)



- Replacements of mixed forests by temperate forests.
- Long term simulations suggest a further but extremely slow colonization of the temperate forest northward.

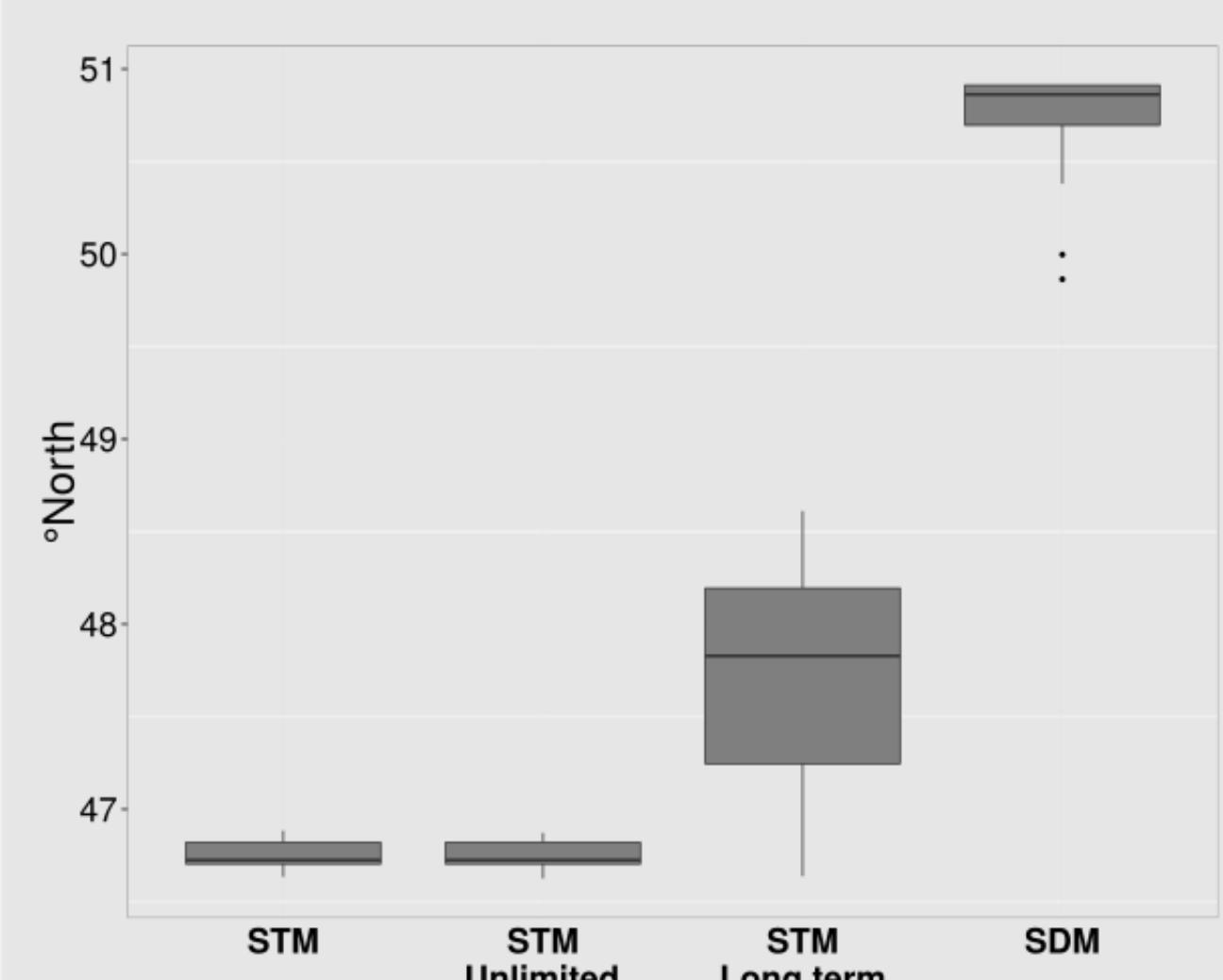


Figure 2. Median latitude predicted by the 4 model versions within a landscape subset in response to climate change.

- Slow temperate forest demography constrains migration rate more than dispersal limitation.
- Spatial interaction prevents the temperate forest to fulfill its predicted niche (SDM) within an ecological timescale.

Implications

- According to our simulations, the northern limit of the temperate forest is expected to barely move northward within the next century.
- The tension between the actual landscape and its equilibrium state with the climate is expected to increase.

References

- Iverson, L. R., & Prasad, A. M. (2002). Potential redistribution of tree species habitat under five climate change scenarios in the eastern US. *Forest Ecology and Management*, 155(1-3), 205-222.
- Thuiller, W., Albert, C., Araújo, M. B., Berry, P. M., Cabeza, M., Guisan, A., Zimmermann, N. E. (2008). Predicting global change impacts on plant species' distributions: Future challenges. *Perspectives in Plant Ecology, Evolution and Systematics*, 9(3-4), 137-152.