Biotic interactions, demography and dispersion limited constraints temperate forest migration rate under Climate Change.

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Background

- Most studies use correlative approaches to predict impact of CC on future distribution range (lead to instantaneous vegetation responses)
- Integrate ecological processes are primordial to evaluate migration rate and predict future range shift.
  - Vegetation = Slow demography, limited dispersion.
  - Biotic interaction could lead to local extinction (e.g strong competitive exclusion at distribution edges).
- Process-based models models enhance abilities to understand and predict future range shift (Snell 2011).

Objectives

1. We want to predict the future distribution of the temperate forest communities at the end of this century with CC.
2. We want to illustrate that the migration rate is slow, generating a time lag between the potential and the realized distribution of the temperate communities (both are at the equilibrium with the climate).
3. According to point 2, we want to highlight which ecological processes (limited dispersion, demography or/and biotic interaction) are slowing down this migration.

Methods

4 models versions:

1. STM with local prevalence (full version) (8 neighbors cells)
2. STM with global prevalence (w/o limited dispersion) (8 neighbors cells pickup randomly accross the landscape)

3. STM at equilibrium (w/o dispersion and demography)
4. SDM (w/o demography, spatial interaction and limited dispersion)

Take Home

Ecological take home (for the worst scenario: RCP 8.5):

- The temperate forest distribution will change slightly at the end of this century (migrate northward - 5 km).
- Temperate forest migration rate is slow (40-50 m per year) and will create an important time lag at the end of this century between his potential distribution and his realized. (**Note:** At which rate the temperate forest needs to migrate to follow his climatic envelope ?)
- Limited dispersion, spatial interaction and slow demography constraint migration rate of the temperate forest community at his northward edge.
- Spatial interaction explains the mosaic landscape structured observed at the biomes transitions.

Methodological take home

- The STM is not only able to predict future range shift and migration rate (with the uncertainties) but also investigate the mechanisms behind communities distribution shift.

Figures

Figures 1: Actual and future geographic distribution of the temperate forest communities (2050 and 2100) under CC scenario (RCP 8.5).

Desc: Panels with 2 isoclines by panel (red and blue). red isoline: distribution predicted at the equilibrium with the climatic horizon (1970-2000). blue isoline: distribution predicted at the equilibrium with the future climatic conditions (2100 or 2050). The isoline corresponds to the maximum of latitude recorded (T+M).

Keys:

- Insignificant range shift (T+M)
- Signicant amount of transition M->T, where the mixed state was already present (exp. Facilitation,competitive exclusion).

Figure 2: Proportion of (T+M) accross a geo/climatic gradient illustrating the slow migration rate.

See the figure here. Add the SDM lines to show the time lag.

Table 1: Gain in cells/area over the time depends of the model version (which corresponds to ecological proccessa)

Years	STM-local	STM-global	SDM	STM-eq
1970-2000	5625	5625	6500	6000
2050	+526	+800	+2000	+1000
2100	+1252	+1600	+4000	+2000

+ = expansion - = contraction

Notes: - *The number of cells can be translated to a rate: number of km/years - Maps are a better representation ?*

Annexe 1: Variance analysis. Is the uncertainty explain by the initial landscape, the set of parameters, or the type of model (STM-g, STM-l) ? We expect the type of model.