



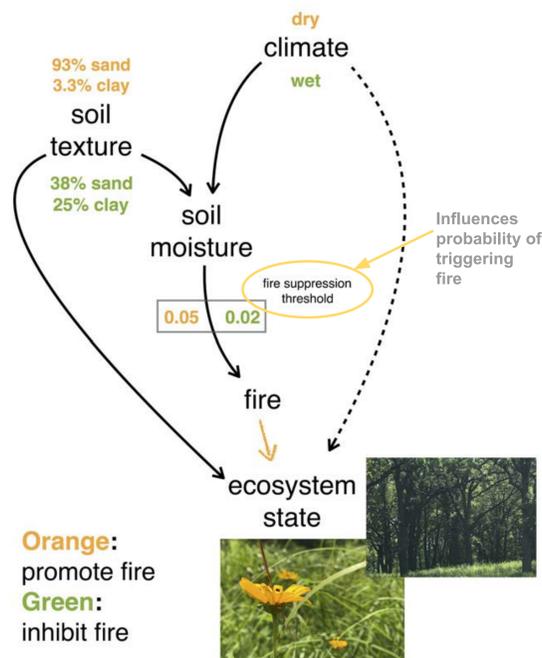
## The Prairie-Forest Boundary



- Forests and prairies exist side-by-side in the Midwest.<sup>1</sup>
- Climate change may have large-scale effects on this boundary. We ask what the small-scale effects will be.
- Fire and soil may control the prairie-forest boundary:
  - Fire kills tree saplings, promoting grass growth.<sup>2</sup>
  - Dry soils increase the likelihood of fire occurrence.<sup>3</sup>

## Methodology

- We used the ED2 ecosystem model to understand influences on the prairie-forest boundary.
- We tested twelve different climate, soil, and fire scenarios (Figure 1).
- We allowed each ecosystem to self-assemble for 500 years in a simplified grass-oak system.
- We used fractional tree cover to classify the results as prairie, forest, or savanna ecosystems (Figure 2).



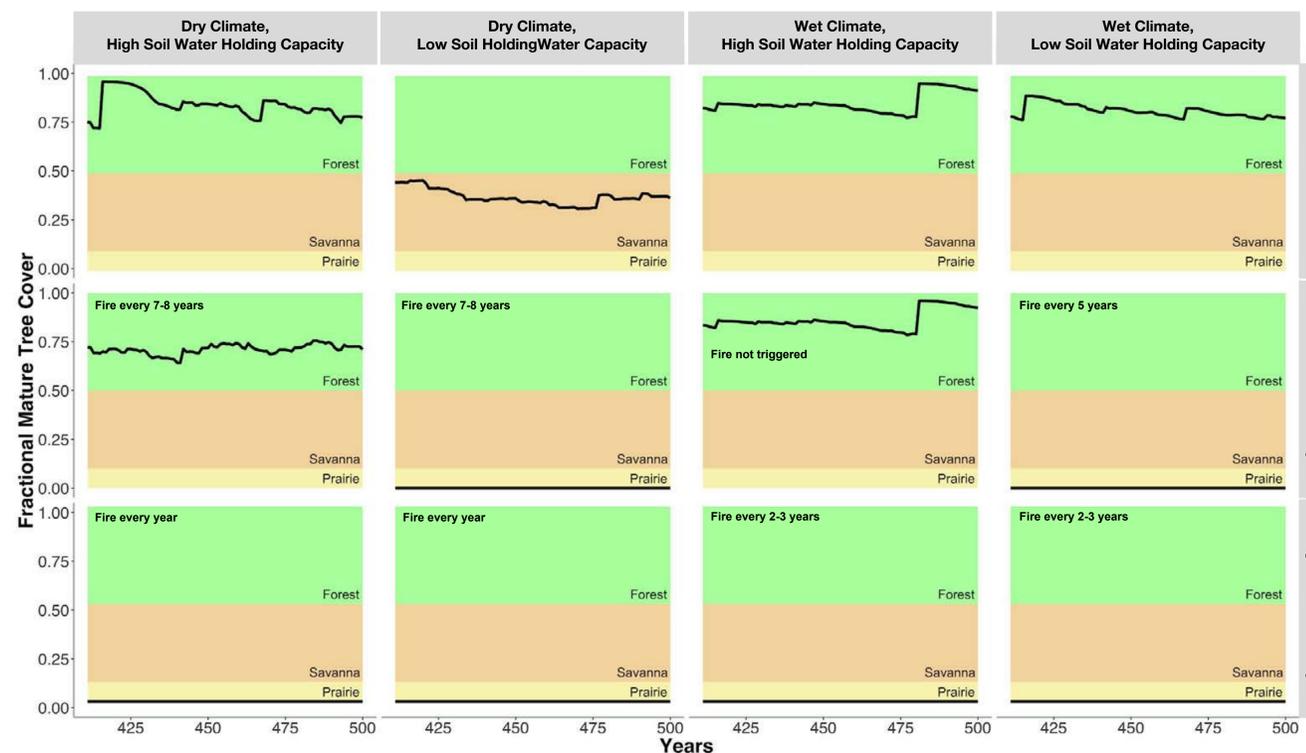
**Figure 1.** This flowchart demonstrates how drivers and parameters influence each other in the model ED2. Each driver and parameter is labeled with the settings we used.

## What makes a prairie or a forest?

Forest and prairie ecosystems historically exist side-by-side with sharp transitions between the two<sup>1</sup>. On a global scale, climate best explains these transitions. **But on a local scale, what environmental factor determines whether a landscape becomes a forest or a prairie?**

We hypothesized that prairies and forests are likely two alternative stable states maintained by fire regimes, which are ultimately controlled by climate and soil moisture.

## Fire Makes the Difference



**Figure 2.** The above figure shows the last 90 years of the simulation and the ecosystem state. Each colored region represents a different ecosystem state. If the line falls within a specific region, it is considered to be that ecosystem state.

- Without fire most ecosystems were forested (Figure 2, top row).
- No fire scenario created a savanna system (10-50% fractional tree cover<sup>4,5</sup>).
- The same fire return interval could generate different ecosystem states (Figure 2, see columns).
- Ecosystems with a fire return interval of 1-3 years (Figure 2, bottom row) consistently went to prairie.

## Conclusions

- Climate and soil water holding capacity are not enough to tip an ecosystem into a prairie.
- Whether a landscape becomes a prairie or a forest depends on both fire return interval and soil water holding capacity.
- Fire may create a feedback loop:
  - Fire kills competitive trees, helping grass.<sup>2</sup>
  - Grasses serve as a fuel and spread fire.<sup>6</sup>
 This feedback loop could drive the sharp prairie-forest transition.



## Further Questions

- What exact fire return interval triggers the development of prairie over forest ecosystems?
- Does an increased fire return interval induce a gradual or dramatic change from forest to prairie ecosystems?

## References

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