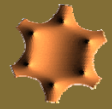


Savanna-Fire Model: Combined effects of tree-tree establishment competition and spatially explicit fire on the spatial pattern of trees in savannas



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Introduction

Savannas are open formations (not forested) dominated by grasses where woody species, such as, shrubs, trees and palm trees never form continuous cover that parallels the grass one.

"savanna problem": What is unique about savannas that allows the continual coexistence of trees and grasses where in other biomes one or the other growth form dominates?
Sarmiento1984

1. There tree-tree competition
2. The role of fire

Calabrese's Model Savanna's Model (SM)

- Two states:
• Grass occupied (G)
• Tree occupied (T)
- Rules:
• Death (T → G); with probability α
• Birth/Dispersal; T sends out offspring at constant rate b .
• Establishment: $P_e = PcPf$

$$P_c = e^{-\delta S}$$

Competition (S is the number of neighbors) and δ is the competition coefficient

$$P_f = \frac{\sigma}{\sigma + 1 - \beta}$$

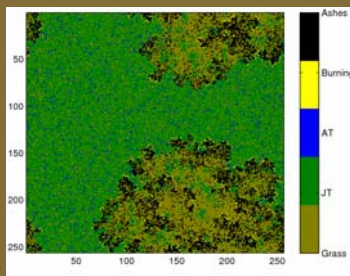
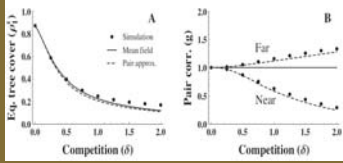
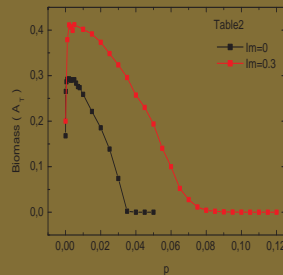
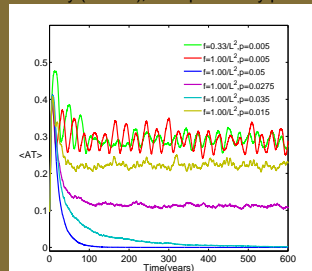
Stochastic fire - probability of surviving fire

Combined model SM + Forest Fire Model (SM-FFM)

- Five States:
• Grass (G)
• Juvenile Tree (JT)
• Adult Tree (AT)
• Burning (B)
• Ashes (A)

- Rules:
• Death (AT → G); α rate
• Growth (JT → AT); g rate
• Ashes (B → A)
• Birth (G → JT);

- Dispersal: near and far neighborhood at β
Establishment: $P_e = P_e = e^{-\delta S}$. (Competition)
• Burn (G and JT → B);
With probability (1-Im), if at least one nearest neighbor is burning; (Im= Immunity)
With probability f, if no nearest neighbor is burning. (f = sparkingling)
• Recovery (A → G); With probability p

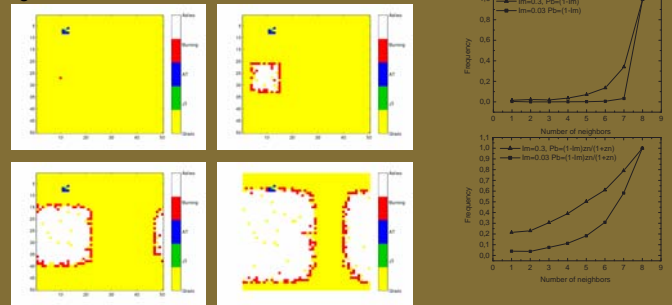


Results

The positive and negative effects due adult trees in the neighbourhood of juveniles ones

Protection

What is the effect of surrounding adult trees on the surviving of a juvenile tree against fire?

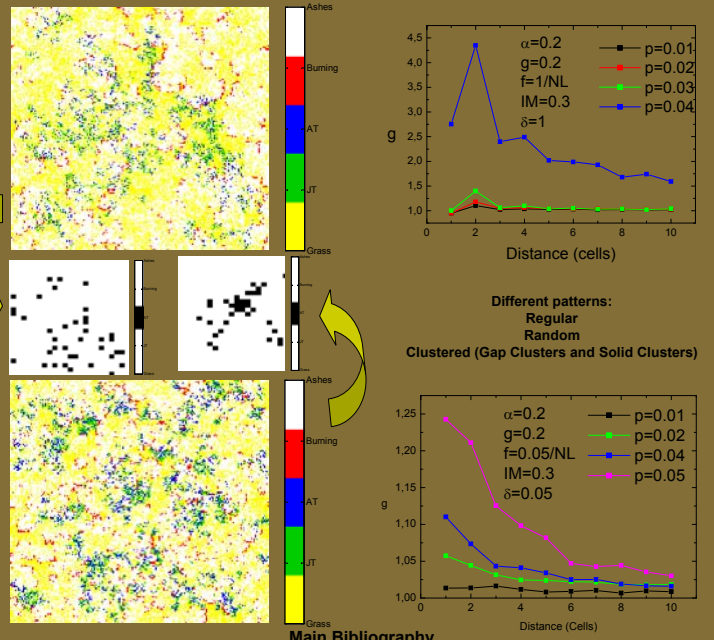


Competition

Competition is mediated by roots that extend laterally beyond the canopy (lattice site) of adult trees. The spatial scale of establishment competition is defined by the competition near neighborhood (More neighborhood)

Spatial pattern under different fire scenarios

SM-FFM



Main Bibliography

- Justin M. Calabrese, Federico Vázquez, Cristóbal López, Maxi San Miguel, and Volker Grimm. The individual and interactive effects of tree-tree establishment competition and fire on savanna structure and dynamics. *The American Naturalist* (accepted), (2009).
- B. Drossel and F. Schwab, Self-organized critical forest-fire model. *Physical Review Letters*, 69(11):1629(1632), 1992