**Dynamic ecosystem assembly and escaping the "fire-trap" in the tropics: Insights from FATES_15.0.0**

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**Response to Review**

Thank you for the comments on our manuscript. We appreciate the review and positive feedback. Specific comments are addressed in the manuscript and below with text shown in blue.

On behalf of the authors,
Jacquelyn Shuman

Huilin Huang, 19 Jan 2024

The manuscript titled "Dynamic ecosystem assembly and escaping the "fire-trap" in the tropics: Insights from FATES_15.0.0" explores the influence of climate, fire regime, and plant traits related to fire tolerance on the biogeography of tropical forests and grasslands. The authors employ simulations with the vegetation demographic model FATES-SPITFIRE, incorporating three vegetation types with varying levels of fire tolerance. The manuscript is well-written, with a clear presentation of methods, a thorough discussion of results, and a consideration of uncertainties. I have a few specific comments regarding the methodology and explanations.

L133: Please provide an explanation for $moist_{ext,\ fc}$, moisture of extinction

This explanation has been added to the text in section 2.1.2.2: "…the moisture content at which fuel no longer burns."

Line 325: Can you clarify the origin of the value 66,000 °C$^{-2}$? It appears to be derived from Eq. 6 in Thonicke et al. (2010) but in their paper, 1.0*10^(-3) is adopted.

The value of 1.0*10^(-3) is the drying ratio parameter used in Thonicke et al (2010). For this work we created an equation to split out the calculation for the relative rate of fuel drying ($rel\_fm_{fc}$) as it relates to the SAV (surface area to volume) of the fuel classes) and an empirical value (Eq. 4). This allows the user to modify the parameter for the "drying ratio" without modifying the SAV of the fuel class. In Thonicke et al 2010 their Eq. 6 the values for the rate of fuel class drying are taken from the relationship between the SAV (surface area to volume) and an empirical value set to $6.6x10^4$ in Thonicke et al (2010) and $1.3x10^4$ in Lasslop et al 2014. This can be verified by calculating the ratio for Thonicke et al 2010 given the SAV values. For example, in this work and Thonicke et al 2010, the 10 hr small branch fuels have a SAV of 3.58 $cm^{-1}$, so using the ratio of the 3.58 $cm^{-1}$ SAV to the empirical value of $6.6x10^4$ gives a drying parameter (degrees $C^{-2}$) of 5.42 x $10^{-5}$ consistent with that reported in Thonicke et al 2010 in the section below their Eq. 6. This same calculation can be used to confirm the value for the other fuel classes; so for the 100 hr large branch fuels, SAV of 0.98 to the empirical value of $6.6x10^4$ yields the value of 1.49 $x10^5$ as reported in Thonicke et al 2010. The drying ratio value of $6.6x10^4$ for Thonicke et al 2010 is also reported in Lasslop et al 2014 on page 743 in the sections above Eq. 3.

Fig. 3a shows a region of decrease in maximum temperature, whereas the surrounding regions show an increase. Can you explain the reason for the decrease?

We did not investigate this area of small decrease in maximum temperature located in the area that is dominated by a shift from trees to grasses. This region would be a good target for further investigation.

Figure 9/10 and Section 3.2: It seems the experimental design resembles sensitivity tests, as they all represent potential vegetation cases. A justification for choosing the medium drying case for validation against observations would be helpful.

Based on the histogram distribution for biomass from observations and CLM-FATES, all drying scenarios have a high bias for biomass, but the medium drying scenario captures the bimodal distribution of low and high biomass without the overprediction of low biomass found in the high drying scenario. The medium drying scenario was then used for the tropical simulation to represent this mid-range of potential vegetation for a situation without land use. The areas of high biomass within the moist tropics coincide with areas of low fire disturbance, and would expect to show high bias with the high drying scenario as well.

Fig S13. Suggest exchanging the positions of a) GPP and b) LAI to align with the color bar.

The figure was correctly laid out, but the caption was switched for the observations. This has been fixed for both S13 and S14.

Line 467-468: How does FATES determine the overcompetition of fire-vulnerable trees over fire-tolerant trees in regions where fire was absent?

In areas where fire was absent, over competition of fire-vulnerable trees would be attributed to the growth of trees in response to site and climate conditions. The fire-vulnerable trees have a lower wood density, and so are able to allocate more resources to growth than the higher wood density fire-tolerant trees. This increased growth allows the fire-vulnerable trees to out compete the fire-tolerant trees through faster biomass and height accumulation.

Line 535-536: How does FATES describe the large savanna region in Western Africa and Southern Africa, where tropical rainforest and grassland co-exist?

Similar to the results for South America, the model does not adequately capture this co-existence of trees and grasses in Africa.