Reviewer #2

The authors modified the DGVM model in order to evaluate carbon emissions, vegetation and flux changes by fire in south Africa.

The simulation design, and the results are very clear and understandable, and the manuscript is basically well written. I little bit concern about description of the improved model.

We greatly appreciate the reviewer's positive and constructive comments to improve the paper writing. Below we provide a point-by-point response to reviewer's comments. In the following paragraphs, the reviewer's comments are in black font and our responses are in blue.

1. The authors should describe parameterizations and modification of model more concretely. Especially, following the parts:

"we have calibrated the parameters of fire spread, fuel combustibility, 180 and carbon combustion to reproduce the observed magnitude and temporal variations of burned area and carbon emission in satellite data."

How did the authors calibrate?

R: In the latest version, we used the crop fraction from LUH2, which is updated annually from 1948-2014, to exclude fire in the croplands. The crop fraction in LUH2 is much smaller than the crop data GLC2000 (a constant crop fraction at the year 2000) used in Huang et al. (2020).

With a smaller crop fraction data, we have reduced the fire spread rate and fuel combustibility to produce a similar burned area as before. Besides, the carbon emission per burned area fraction ($\frac{carbon\ emission}{Burned\ area\ fraction}$) in Southern Africa (Huang et al. 2020) is larger than the observed value from GFED4s. We have decreased the leaf combustion completeness accordingly. The above description is added in Lines 185-188.

"we optimize photosynthesis-related parameters according to the observed GPP magnitude in both wet seasons and dry seasons as follows."

How did the authors optimize?

R: The previous version SSiB4/TRIFFID-Fire overestimates vegetation productivity (GPP) in the dry season and fails to capture its seasonal variations. In the updated version, we have decreased the root-zone soil moisture potential factor ($f(\theta)$) in dry months which reflects the impacts of soil water deficit on transpiration. The whole process of calibration is discussed in the following paragraph. We have revised the last sentence to avoid confusion: "To reduce GPP magnitude in dry seasons, we optimized root-zone soil moisture potential factor f(θ), a parameter that determines transpiration in SSiB4/TRIFFID-Fire, to constrain photosynthesis activities. The procedure is introduced as follows."

"Therefore, we adjusted the 205 coefficients c1 and c2 for C4 grasses to reflect the effects of soil water deficit on transpiration in a wider range of soil moisture between 0.3 – 0.6 (Fig. 2a). ð□□□(ð□□□) for C3 grasses is also adjusted but is designed to be less sensitive to low moisture conditions (compared to C4 grasses) to make it more adaptive in the dry area (Fig. 2b)."

How did the authors adjust?

R: In the equation, c1 represents the wilting point at which stomates close completely, and c2 is a slope factor controlling how sensitive the vegetation responds to soil water deficit. For both C3 and C4 grasses, we have decreased c2 to reduce the slope so that the vegetation responds to water deficit at relatively wetter conditions (Fig. 2 original and calibrated lines). The c1 for C3 grasses is set to be smaller than that for C4 grasses so that its stomates close at a drier condition and it is more sustainable to drought than C4 grasses. The above description is added in Lines 213-218

2. I think it is better to compare the results of improved model and those of previous model and show how the new model became better.

R: We agree that it is necessary to compare the updated model with the previous one to show the improvements. As shown in Fig. R1 (also added to supplementary material Fig. S1), the previous SSiB4/TRIFFID-Fire overestimates GPP in the dry season compared to observations and does not capture its seasonal cycle well. The improved version has largely decreased GPP in dry months with the temporal correlation coefficient increased to 0.91. The reduction in GPP also decelerates vegetation recovery in the dry season, making it more consistent with field observations. Therefore, the improvement is vital to study fire effects on vegetation and surface energy.

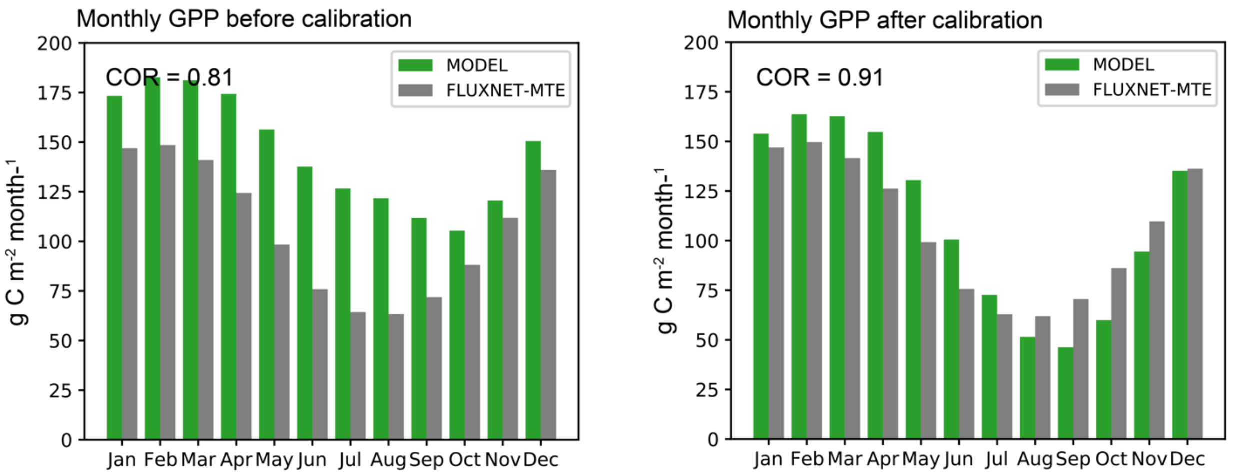
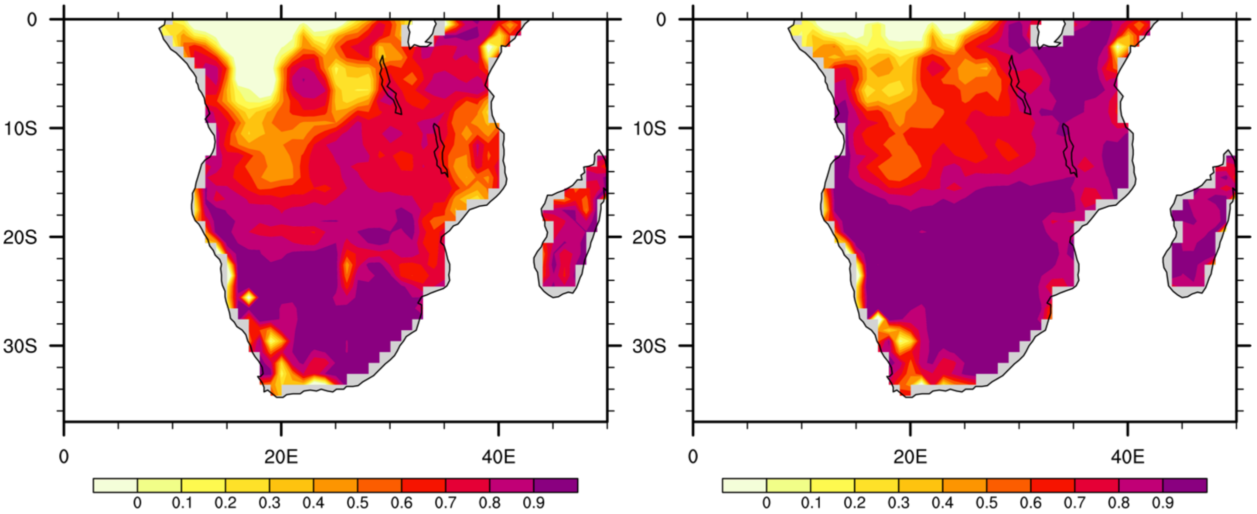


Fig. R1 Monthly GPP (g C m-2 mon-1) in model and observation (a) before calibration and (b) after calibration

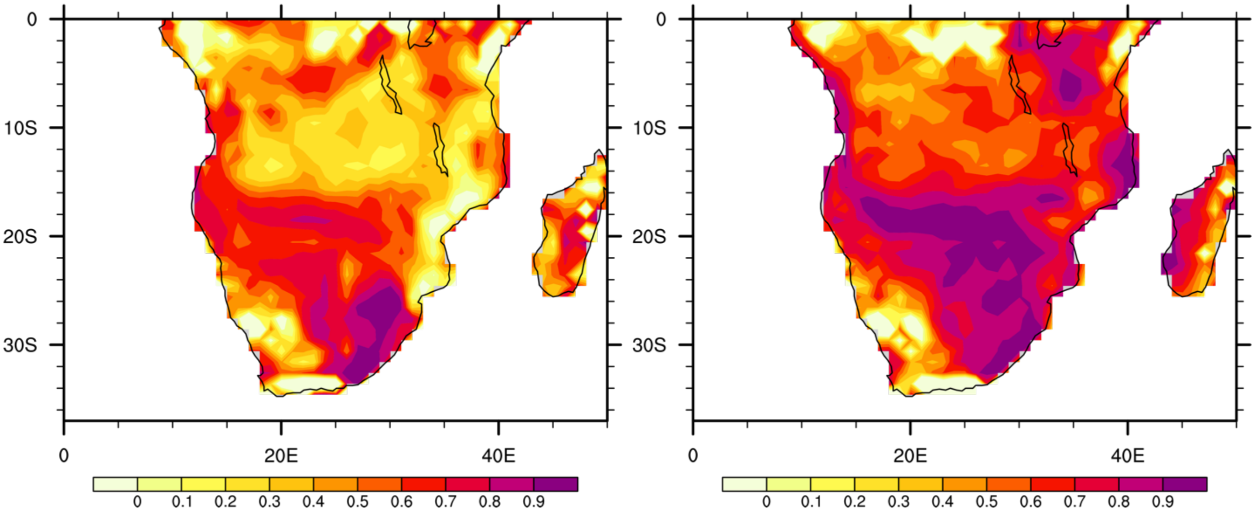
The point-by-point monthly correlations are improved in both GPP and LAI (Fig. R2). In previous model results, most C3 and C4 dominant areas (5-20 °S) have a temporal correlation of 0.4-0.6 between modeled GPP and observed GPP from FLUXNET-MTE

(Figs. R2a). With model improvement, the seasonal variations in these regions have been largely improved with a correlation coefficient between 0.5-0.7 (Figs. R2b). A similar conclusion can be drawn from LAI, which has even larger improvements compared to GPP. We add Figs. R1 and R2 to supplementary material and the above discussion to Lines 323 to 329.



(a) GPPCOR before calibration

(b) GPP COR after calibration



(c) LAI COR before calibration

(d) LAI COR after calibration

Figure R2 (a-b) Point-by-point climatology monthly correlation between FLUXNET-MTE and SSiB4/TRIFFID-Fire GPP (a) before calibration and (b) after calibration. (c-d) Point-by-point monthly correlation between GLASS and SSiB4/TRIFFID-Fire LAI (c) before calibration and (d) after calibration.