(Reviewer comments in *italics;* Responses in **bold**)

Response to Anonymous Referee #2 Received and published: 23 July 2017

This work uses the vegetation model INLAND to evaluate the individual and combined effects of the climate variability, the fire and the Phosphorus (P) limitation on the Brazilian ecosystem. The changes on the NPP,] and AGB were evaluated in relation to 12 climate simulations. The AGB was also evaluated in function of observed data. In addition to climate variability, this work shows the importance of considering the soil nutrient limitation as well as the disturbances caused by the biomass burning in the study of vegetation dynamics. It is also presented some deficiencies of the DGVMs and the databases used to feed the INLAND model. Understanding the mechanisms that affect the vegetation and the efforts to improve numerical models in order to simulate such effects is of paramount important to the scientific progress. Therefore, this study is of great relevance and, in my opinion, it is suitable for publication in the
BG. However, I have some recommendations and doubts that I would like to see being clarified before publication.

Specific comments

1. *L55-L60: observing the Figure 6d (CV+PC), all the Amazon region became "very robust", so we* can assume that the simulation that considers only the climatic effect *didn't indicate the "savannization of the Amazon", in other words, the results obtained in this study don't agree with the mentioned works. Can you comment on this?*

Response: The "savannization of the Amazon" have been appointed by studies that use future climate scenarios (Oyama and Nobre, 2003; Betts et al., 2004; Cox et al., 2000; Cox et al., 2004; Salazar et al., 2007 Pereira et al., 2012) or climate scenarios associated to changes on vegetation in the deforestation case (Shukla et al., 1990; Malhi et al., 2009; Pires and Costa, 2013). Our results do not indicate the "savannization of the Amazon" because they are based on past climate.

2. *L140: "values smaller than 0.8 m^2m-^2 characterize a grassland vegetation type" – Grassland can have LAI values much higher than 0.8 m^2m-^2. Darvishzadeh et al., 2008 found out grassland's average values of 2.76 m^2m-^{2} and maximum value of 7.34 m^2m-^2. Please check if the INLAND really utilizes this threshold of LAI to define grassland.*

Response: We agree with the reviewer, although we think the reviewer misunderstood the text. The total LAI for grasslands can definitely be much higher than 0.8 m^2m^{-2}. In this sentence, we refer to the LAI upper (tree LAI). That means that grassland vegetation type cannot have trees with LAI greater than 0.8 m^2m^{-2} while the LAI lower (grasses) is not limited.

3. *3. L85-L87: According to Oliveira et al. (in press), the weather also has influence in the nutrients. Then, the climate change's effect cannot be higher due to the indirect effects in the nutrients? Can you comment on this?*

Response: Certainly, there is influence between weather and nutrients. For example, a very intense rain can leach nutrients, such as nitrogen, as well as strong winds can carry clay particles where numerous nutrients are adsorbed. However, in this work the nutritional conditions are prescribed and fixed. In this way, we cannot assert that the climate change's effect is higher due to the indirect effects in the nutrients. Oliveira et al (in press) has also been updated to Oliveira et al. (2017).

4. *L157-L158: How are the other PFTs affected by the availability of P?*

Response: Tropical evergreen and deciduous trees are affected by availability of P in INLAND while other PFTs are unaffected. The lack of scientific reports about the influence of phosphorus on shrub and grass vegetation along the Amazon basin justify why only these two PFTs are affected. The phosphorus limitation in INLAND is based on regression equation developed by Castanho et al. (2013), which use results of Fyllas et al. (2009) and Mercado et al. (2009). Fyllas et al. (2009) show that soil fertility is one of the most important predictors for observed higher nutrient concentration in Amazon tree leaves, while Mercado et al. (2009) report that the correlation between observed V_{max} and P concentration in Amazon tree leaves. Thus, Castanho et al. (2013) developed a similar regression equation to that of Mercado et al. (2009, 2011) between V_{max} and total P concentration in soil, instead of P concentration in leaves, allowing estimate V_{max} for the whole Amazon.

5. *L262: I didn't understand where the 8.7% came from. Could you make it clearer?*

Response: We calculated the average biomass values for each biome area (Amazon and Cerrado) using the biomes delimitation from IBGE showed in Figure 1. This average biomass value was calculated for all simulations (Table 1), to compare the difference in the average value of each simulation. In Cerrado, average biomass is 8.7% lower in the simulation with inter-annual climate variability (CV) than with average climate (CA).

6. *L339-L344: It can be seen in Figure 6 large differences between CA + F (Line3) and CV + F (Line 4). However, the differences between CA (Line 1) and CA + F (Line 3) and the ones between PC (Column 1), PR (Column 2) and PG (Column 3) are not very significant. Thus, the climatic variability is dominant when considering the three effects. Probably, if a fifth map showing CA + PG +F − CA+PG is constructed in Figure 4, it will be quite distinct from Figure 4d. Therefore, it should be exposed more clearly how it came up to the conclusion described in L513-515.*

Response: In Figure 6, we evaluate only the robustness of the simulations. Although there is little difference between the vegetation types along the central Cerrado domain in CA (Line 1) and CA + F (Line 3), the most part of these changes is very robust when fire is considered. We do not use the vegetation types to infer which are the main determinant drivers on the transition, we use the Figure 6 only to show how these drives affect the distribution of vegetation. It is clear, however, that the CV+F

combinations yield the best vegetation patterns, with minor differences associated with soil P.
The difference between CA + PG +F − CA+PG shows similar behavior that on CV simulations, but we did not plot this difference because in our statistical analyses only the interannual climate variability showed significant influence on AGB and LAI. Finally, to write the sentence in L513-515 ("fire is in the main determinant factor of the vegetation changes along the transition. The nutrient limitation is second in magnitude, stronger than the effect of inter-annual climate variability"), we use F-statistics in Tables 3, 4 and 5, which permits infer the magnitude of fire, phosphorus limitation, and climate on AGB and LAI. To clarify this, we rewrote this sentence to "Based on the F-statistic in Tables 3, 4 and 5, this work shows that fire is in the main determinant factor of the changes in vegetation structure (LAI, AGB) changes along the transition. The nutrient limitation is second in magnitude, stronger than the effect of inter-annual climate variability."

7. *L342: I think it is unlikely that an area with "deciduous forest" will turn into "evergreen forest" after being consumed by fire. Please comment if this is possible or if it is a model deficiency.*

Response: In INLAND simulation, the "deciduous forest" is turning into "evergreen forest" after being consumed by fire happens in only 5 pixels and in average climate condition only, in a clay soil with large water retention capacity (Figure 6G-I) In this situation, where there is little water stress in the CA simulation, both evergreen and drought deciduous PFTS have each one very high LAI, and the PFT that dominates can be defined by minor effects. Fire, although active, is probably too small to be relevant in a non-stressed ecosystem. However, when the interannual climate variability is considered, INLAND replaces the "evergreen forest" in Figures 6G-I to "Savanna and Grasslands" (Figure 6J-L). These results show the limitations of CA and the importance to consider the interannual climate variability on simulations to improve the vegetation simulated.

Technical corrections

1. *L22: "1960 – 1990" → "1961 – 1990", as described in L204.*
   Response: This has been changed in the revised manuscript.

2. *L23: "two regional datasets" → "two datasets".*
   Response: This has been changed in the revised manuscript.

3. *L62: "particularly the P limitation." → "particularly the Phosphorus (P) limitation."*
   Response: This has been changed in the revised manuscript.

4. L72: "Phosphorus (P) is a" → "P is a" or "Phosphorus is a".
   Response: This has been changed in the revised manuscript.

5. *L103: Transects 1 and 2 are more related to "Cerrado" than "Amazon", as shown in Figures 1, 2 and 5. Please rewrite this sentence.*
   Response: We do not agree with this technical correction. The transects were located 50% in Amazon domain and 50% in Cerrado domain, as we described.

6. L105: "Transect 1 (T1, 43 °-49 °W; 5 °-7 °S)" → "Transect 1 (T1, 44 °-50 °W; 5°-7°S)".
   Response: This has been changed in the revised manuscript.

7. L107: "Transect 5 (T5, 53 °-61 ° W; 13 °-15 ° S)" → "Transect 5 (T5, 52 °-60°W;13°-15 ° S)".
   Response: This has been changed in the revised manuscript.

8. L138: "annual mean LAI_{upper} above" → "annual mean LAI_{upper} below".
   Response: We do not agree with this technical correction. The annual average of "LAI upper" in INLAND needs to be above 0.8 m^2 m^{-2}. This value is prescribed by the model.

9. L173: "We used the P-mehlich-1" → "We used the Pmehlich-1".
   Response: This has been changed in the revised manuscript.

10. L176: "resulting in 12 additional pixels" – Wouldn't it be 6?
    Response: There are 12 pixels, as described in Suplementary Materials.

11. L176: "pixels with observed total P content" → "pixels without observed total P content"
    Response: These additional pixels with the observed total P content are described in Suplementary Materials.

12. L186: "Above-Ground AGB (AGB) database" → "Above-Ground Biomass (AGB database"
    Response: This has been changed in the revised manuscript.

13. L194-L196: There are two pixels for each longitude in each transects. Do the Figures 3 and 5 show the mean of the two pixels, or only the upper or the lower one?
    Response: The Figures 3 and 5 show the average of two pixels. This information was added to the caption of both figures.

14. L212: Remove the phrase: "The model simulations were run for the time period 1582-2008, a total of 427 years." – The boundary condition begins in 1948, so it can't be said that the model began in 1582. This was only an artifice used to simulate the same period for seven times.
    Response: This has been changed in the revised manuscript.

15. L224: "the simulations (CV +PC) − (CA+PC) = (CV −CA)|PC" → "the simulations (CV +PC) and (CA+PC)" - The notation "(CV −CA)|PC" is interesting, but it wasn't used. Then it can be removed.
    Response: This has been changed in the revised manuscript.

16. L228: "and CA+PC, so that (CA+PC+F)−(CA+PC) = F|CA,PC. Similarly,"→ "and CA + PC. Similarly,".
    Response: This has been changed in the revised manuscript.

17. L230: "between CV +PC+F and CV +PC, so that (CV +PC+F)−(CV +PC) =F|CV,PC. The different" → "between CV +PC +F and CV +PC. The different".
    Response: This has been changed in the revised manuscript.

18. L273: "TB declined by 2% for PR", - In Figure 4b it looks positive, so it would be an increase instead of a decrease. Please check it.
    Response: This 2% refers to the area average of Cerrado domain.

19. L393: "compared to CV + PC" → "compared to CV + PC − CA + PC".
    Response: In this sentence, we are comparing CV+PG – CV+PC.

20. Figure 4d: "CV + PG + F − CV + PC" → "CV + PG + F − CV + PG".
    Response: This has been changed in the revised manuscript. Although this is not a regionally relevant event, we modified the text to include this discussion.

References:

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