Reply to comments from Referee #2

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1.**"This paper is interesting and it addresses the well-known, and widely studied, problem of savanna dynamics and tree-grass coexistence. It is very interesting the distinction between horizontal and vertical structure."**
A: Thanks for your interest and positive comments on our work.

2.**"On the other hand, other works (eg, Baudena et al 2009) find bimodality (in that case, associated with bistability) without the need for disturbances, and introducing the distinction between adult trees and seedlings, taking into account the differences in competition with grass. How do these results relate to the other mechanisms which have been proposed? How can one distinguish between the different mechanisms?"**
A: Indeed it is true that there is a large body of ecological literature explaining co-existence and bistability in savanna systems. However, we provide several new aspects to understand the modeled bistability and observed bimodality. New aspects are first that we analyze and model both woody cover and biomass. Second, we discuss the need and effect of disturbances by fire to understand bimodality and third we focus on the different approaches of age class modeling.
In the Discussion Section, we will add: "A large number of experimental and modelling studies have focused on the tree-grass co-existence from an ecological perspective (eg. Higgins et al. [2000], Baudena et al. [2010] and Sankaran et al. [2005]) thereby mainly focusing on cover and far less on biomass. In our paper we have demonstrated bimodality in both observed woody cover and biomass. It is interesting to see that for high cover fractions both high and low above ground biomass occurs. With our coupled energy-water-biomass model that distinguishes horizontal and vertical structures of woody vegetation we are for the first time able to fit observed bimodality in woody cover and biomass (Fig. 11).
Modelling bimodalities in tree cover is generally done with a fire-vegetation feedback mechanism, in which fire limits tree establishment and induces tree mortality (e.g. Staver and Levin [2012]). As it is also thought that the majority of the fuel for the fire is provided by the grass biomass (e.g. Higgins et al. [2000]), the outcome is that fire frequency is reduced by an increase in tree cover. In general, without disturbance the models will simulate full tree cover due to the competitive exclusion mechanism [Tilman, 1982], also in the wet regimes, where our analysis is focused owing to the availability of above ground biomass observations in these regions.
Our approach of age class modeling, in which the vegetation increases its biomass, while

keeping the same structure is similar to models using tree seedlings and adult trees (e.g Baudena et al. [2010], Scheiter and Higgins [2009]). Baudena et al. [2010] found that tree seedlings compete for the same water as grasses, while adult trees can outcompete grass as it has deeper roots. A similar mechanism is found in our model: young species compete against bare soil processes, while more adult trees have higher root depths having more water resources."
We will thank Mara Baudena for her contribution to this discussion in the acknowledgement.

3.**"Finally, the paper is plagued with a continued use of too many acronyms which make it very difficult to read. Streamlining the presentation and reducing the jargon/acronums would help."**
A: We have defined a group of mathematical symbols instead of acronyms (e.g. B for AGB, P for MAP, etc).

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