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Interactive comment on "The climatic imprint of bimodal distributions in vegetation cover for West Africa" *by* Z. Yin et al.

Anonymous Referee #2

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Recently, some influential studies (e.g., Hirota et al. 2011; Staver et al. 2011; Scheffer et al. 2013) suggested that multi-modality in the frequency distribution of remotely-sensed tree cover (other ecosystem state variables as well) can be evidence of alternative ecosystem states at large spatial scales. These studies have important implications on ecological consequences of global climate change and so forth. In this article, Yin et al. present sub-continental analyses on the relationships between climatic conditions and relevant ecosystem state variables in West Africa. I find the most interesting argument is that detection of multi-modality of tree cover is largely dependent on solar radiation and aboveground biomass (as a central message conveyed by the title). This would imply -though the authors did not make such corollary explicitly- that the distinct ecosystem states (i.e., treeless, savanna and forest) could be simply caused

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by the discontinuously distributed environmental/ecological factors, and therefore the alternative stable states theory is not necessarily invoked to explain the observed pattern in the tropics. In this sense, this paper has merits that call attention to a more comprehensive set of environmental/ecological variables when it comes to analysing frequency distribution of ecosystem states. However, the basic logic here is questionable: for their analyses the authors merely consider radiation and biomass as potential 'drivers' or 'conditions' of existence of bi-stable tree cover (e.g. Table 2. "woody cover states determined by radiation and biomass states"). However, the bimodal distribution of these variables is plausibly dependent on bimodal tree cover as well. In fact, there are important feedbacks between these state variables (the authors mentioned such kind of feedbacks in the Introduction as well). For instance, rainforests having high tree cover can substantially modify regional radiation regime (e.g., through producing more clouds), compared with savanna and treeless states. In this sense, we may expect bimodality of radiation is (at least partly) a result of bimodality of tree cover. Indeed, there are complex feedbacks between these factors that make it difficult to disentangle their relationships, but the authors need to explicitly acknowledge the feedbacks, and elaborate their logic in the Introduction and other relevant places. In the meantime, the Discussion part needs to be improved to accommodate implications on the core findings (conditional bimodality of tree cover), especially a clear link to the previous explanation of alternative stable state theory on tropical tree cover patterns.

Specific comments: Introduction and Discussion: To facilitate broader readership, it would be better to give a brief introduction on the context of the link between frequency distribution and alternative stable states, multimodality of tree cover in the tropics, theoretical and/or practical significance, etc. Also the niche (and aim) of this study need to be elaborated: what is the general importance of this work, apart from that more climatic variables are included for detecting bistability?

Data: It has been suggested that the inference of multimodality from the MODIS VCF data has some caveats. A very recent paper (Xu et al. 2015. A Changing Number

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of Alternative States in the Boreal Biome: Reproducibility Risks of Replacing Remote Sensing Products. Plos ONE) shows that the update of this remote sensing product could have a substantial impact on the detection of multi-modality. It would be ideal if the authors can re-do the analyses based on the updated version (Collection 5) of MODIS VCF data. They should at least acknowledge this caveat, if they are not able to re-do them.

Fig. 1: the bimodality of radiation (Fig. 1e) looks not clear from the histogram (more like a unimodal distribution), can you provide results from the latent class analysis that can justify bimodal distribution as the best fit?

P6, lines 4-5: It is probably not a sufficient sampling size of 50 data points (<1%) for the bimodality test. Why not just use all the data points (not very heavy for computation)?

P7, lines 20-23: Why consider bimodal distributions as unimodal if one of the modes has less than 20% of the points? Why not just follow the test? In these ways you underestimate bimodality, so it shouldn't be surprising to find little climatic overlap of the different states.

Interactive comment on Biogeosciences Discuss., 12, 18213, 2015.