

Interactive comment on “African biomes are most sensitive to changes in CO₂ under recent and near-future CO₂ conditions” by Simon Scheiter et al.

Anonymous Referee #1

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Schieter et al. provide a detailed assessment of the predictions of the aDGVM model in Africa focus on the question of timelags between transient and equilibrium climate states. They clearly illustrate the dependance of time lags and so-called carbon and tree cover ‘debt’ to the rates of change, the absolute values of CO₂ and the presence or absence of fire. They link these findings back to applications in terms of assessing global carbon budgets, and implications for model benchmarking.

In general the paper is well written and the experimental design and results are both comprehensive and clearly depicted. I have few comments on these except for mostly minor grammatical points. On the discussion points I think there is a little room for

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improvement. The notion of carbon debt needs a little more by way of explanation, specifically of why it is a debt and to whom the debt is owed, etc. The specific recommendation that the authors make to the land surface modeling community regarding forcing data, initialization strategies etc. are also a little vaguely worded and could do with some expansion.

Aside from that I think this manuscript provides a very solid illustration of the likely impact of lags on carbon cycle dynamics, and should provide a firm justification for further research into this topic.

Specific Comments

Line 12: Lag effects imply. (as opposed to implicate) Line 18: During Earth’s history. . .
Line 25: Needs a reference for RCP8.5. Line 49: Is ‘mismatch’ the right word? (given there’s no real reason they should be matched in the first place. What about ‘The substantial differences between the rate of change in environmental forcing and . . .’?
Line 52: Delete ‘in’ before ‘constant’ Line 63: Not sure I’d use ‘oscillate’ either. I’m not sure what I would use though, because isn’t all vegetation to some extent in a transient successional state? Line 65: Influences ‘whether’, as opposed to ‘if’. Line 90: I don’t really understand this sentence. . . Line 100: I’m not sure that I totall ybuy that temperature increases are too heterogeneous to be interesting here? Maybe say that CO₂ can be used as an illustration of the general principle which is likely extensible to shifts in other drivers? Line 103: What does ‘typically’ mean in this context? Line 112: Splitting hairs, but isn’t it a contradiction to have a ‘G’ in aDGVM and then also say that it’s outright only for savannas? ‘Optimise for use in savannas’ maybe? Line 121: In this era of ‘trait-based’ modeling, how is the shade tolerance implemented exactly? As an environmental limit on recruitment? Line 126: Should that be kJ/m²/s? Line 173: I don’t quite understand here why you used all these different CO₂ scenarios, or why you’d expect the vegetation to -not- be at equilibrium with constant forcing? Is it about cycling or oscillations in the intrinsic dynamics of the model? L178: Why was a smoothing algorithm needed? To smooth over stochastic outputs? L218: Were

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there 200 replicates for all runs, or just for the study site in SA? (and if so, why?) L250: I really like this figure....Can you make it so that the text doesn't overlap the orange lines? L275: Why does fire slow down the transition? Is it because systems are stuck in stable equilibria one way or another? L285: The terminology of 'debt' is slightly confusing to me, especially as the quantities of 'debt' are negative. Does that mean there is negative debt? And to whom is the debt owed? The atmosphere or the ecosystem? I guess a negative carbon debt is a promise that the system will take up more CO₂ in the future? L315: I'm tripped up again by the use of 'typically'... Do you mean in the transient simulations? By implication in the real world? Also technically I guess this is a prediction, rather than an illustration, so many change 'show' to something less forceful. L320: Also change 'previous findings' to 'previous model results' or suchlike. L325: I feel like this section is missing a statement on what, if any, other studies have had to say on this topic, for Africa or elsewhere. Or indeed, is this type of analysis totally novel? L328: This justification for why the fire runs have greater lags should perhaps come earlier in the manuscript. L358: This needs a little more clarification. I.e. "(the strong CO₂ effect) can compensate for other predicted changes in climate drivers, e.g. reduced rainfall" L357: Maybe expand on what a high CO₂ sensitivity might mean for the results of this paper? L385: change to :prevents both savanna and forest trees recruitment" L398: Need a reference for 'as is currently often the case'. L420: Would it make sense to frame the carbon debt here in terms of the overall carbon budgets of the different RCPs? For example, if emissions stabilises at the end of RCPxx, then the ecosystems would continue to keep absorbing carbon to get to their equilibrium ecosystem state and re-absorb xx PgC from the system? L439: I don't really understand this part. How can modifications to the initial climate conditions have an impact on the successional stage? Also, I think it's fairly standard to do pre-industrial spin-up and then transient simulations to the present day. Are you proposing an alternative approach to climate drivers here? L444: Further, given that we need to run transient simulations with ramping CO₂, that is slightly at odds with initializing with contemporary observations. L474: Maybe cite Julia Nabels work with

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TREEMIG as illustrative of the complexities of the implementation of seed dispersal? L500: Again, I'd argue that it 'predicts' or 'projects' or 'indicates', but perhaps not that it 'shows'.

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