

# Assessing impacts of selective logging on water, energy, and carbon budgets and ecosystem dynamics in Amazon forests using the Functionally Assembled Terrestrial Ecosystem Simulator [MS No.: bg-2019-129]

## Responses to review comments

### Anonymous Referee #2:

*The authors parameterized two PFTs in FATES for a tropical forest site and embedded a selective logging module. As a model description paper, the manuscript appears fairly complete and informative for others interested in understanding the model design better. The authors present results of a calibration exercise at the two sites by comparing simulated and observed responses to logging at one site, and comparing it to undisturbed dynamics at the second site. The results show that the model is modestly successful in capturing some facets of the forest/ecosystem dynamics, but performs poorly at others.*

#### Response:

Thanks for the nice summary. We agree with the referee that the model can be improved in many aspects.

*As a biogeoscience paper, we think the manuscript falls disappointingly short of reaching some interesting potential for insight. Specifically, there is a substantial mismatch between data and the model for some very basic forest/ecosystem characteristics. There are large errors in LAI, GPP, RH, and age structure, as conceded by the authors. Even for the control site, GPP shows an almost opposite seasonality between model and data. The errors caused by calibration are much greater than the variation due to disturbance levels (Table 5). While it would have been preferable to have a more successful calibration, falling short of that, the authors should present a coherent and robust explanation of what the fundamental structural problems were, with figures specifically illustrating the insights. That would elevate the significance of the paper, and increase its utility for those seeking to do similar work.*

#### Response:

The low LAI bias is a characteristics of the version of FATES in the original manuscript. The authors have attempted to improve it by alleviating the penalty of establishing leaf biomass through additional model development and testing. In the revision, we have updated the model to a new version of FATES in which the penalty for establishing leaf biomass is greatly reduced. We also performed ensemble simulations to evaluate potential ways to improve the low LAI bias by perturbing key physiological parameters. We will revise the manuscript to incorporate the new results and more discussions along this line.

**Comments for each section Introduction:** *The authors lay out pertinent background information but the text does not explicitly articulate a cogent and compelling argument for why this study is needed. I think the introduction would be more effective if text were added to make the connection between the background information and the aims of the paper.*

**Response:**

Thanks for pointing this out. We have revised the introduction section to explicitly articulate the need to better represent wood harvest in next generation Earth system models, in which FATES will be a component in the revised manuscript.

**Methods:** *They report that FATES is very sensitive to parameter values, to a point that with some combinations the two PFTs cannot coexist. That is somewhat worrisome. There is a fair amount of detail given on how a logging activity is applied to a patch, but it's a bit unclear which patches are selected for logging.*

**Response:**

In the revised manuscript, we acknowledge that ensuring co-existence continues to be an issue in FATES and we will try to improve it in newer versions. Nevertheless, parameterizations in the logging module do not require co-existence. Currently, we assumed that for a site such as km83, once logging is activated, trees will be harvested from all patches. We have added this information to the revised manuscript. We also added information on new developments in FATES where the time since disturbances is added prognostic variables to track the history of land use, key for applications of the model at regional to global scales.

**Results:** *Given that SH mismatch happens at the seasonal scale it would be useful to have some analysis results at that time scale. For example, the results in Fig 4 could be replotted at the seasonal scale (average across years). Low SH is attributed to attributed to low LAI, but what's causing LAI? It seems a fairly straight forward question to answer (or at least speculate). It appears they did not go far enough with the most interesting/instructive part of the exploration. Similarly with soil moisture, the authors present a cursory analysis of soil water uptake. What about SWC of the deeper layer(s)? What is their relation to simulated ET?*

**Response:**

We have added more analyses and discussion on the water and energy budgets at the seasonable scale as suggested in the revised manuscript.

***Line-by-line comments***

56: *“suggested a net tropical forest land-use source of 1.3 : :” is grammatically incorrect. I suggest something like, “suggested tropical forests can be a net source of 1.3... from land-use change.”*

**Response:** done.

63: *The authors defined degradation as widespread damage to remaining trees, subcanopy*

*vegetation and soils, and that it could cause as much as 40% carbon loss of clearcut deforestation. In your simulation, how did you define the effect of degradation?*

**Response:** The selective logging numerical experiments are meant to represent different levels of degradation. We will make this point clear in the revised manuscript.

66: *delete "as".*

**Response:** done.

67: *hyphenate one-eighth.*

**Response:** done.

70: *Extraneous parenthesis.*

**Response:** We have removed it.

78: *couple terrestrial and atmospheric: : :*

**Response:** done.

78-80: *Perhaps list some examples of those models?*

**Response:** Will do

79: *comma after "change"*

**Response:** done.

81: *representation of wood harvest: : :*

**Response:** done.

83: *Is that in LM3V? It's unclear.*

**Response:** Yes, we will clarify it.

86-89: *It would be better to define selective logging earlier, since it is referred to many times prior to this point in the text.*

**Response:** Yes, will have moved the definition to the first paragraph.

90: *Not just simplified but absent*

**Response:** will add that point.

91: *did not*

**Response:** done.

98: *"tremendous" is overly dramatic*

**Response:** modified to be “a lot”

108: *“assess the simulated recovery of Tapajos National Forest: : :”*

**Response:** done.

109: *summary of*

**Response:** done.

113: *simulated forest trajectory*

**Response:** done.

120: *The authors describe FATES model as a further developed model based on CLM(ED), which can be viewed as an early version of FATES. Then, which version is what you used in this study? Is there any paper that formerly published FATES model?*

**Response:** The model version used has been and will be provided in the Code and data availability section. A number of manuscripts are currently in various stages of review. We will list published/accepted ones in the revised manuscript.

152: *Specific should be lowercase. But lines 150-155 is a run-on sentence. They need to at least insert a conjunction.*

**Response:** done.

162: *Delete hyphen in co-existence*

**Response:** done.

164: *Delete hyphen in co-existence*

**Response:** done.

176-7: *“transports off-site by adding: : :” should be “transports off-site by reducing site carbon pools. Remaining necromass : : : are added to coarse woody debris and litter pools.”*

**Response:** done.

181: *“are represented” should be “are conceptually represented.” Because this paragraph just talks about the various concepts, and not specific implementation of logging regimes & effects.*

**Response:** done.

189: *It's unclear if FATES implements these two types of logging practices.*

**Response:** Yes, FATES is now able to represent these two practices by changing parameters in the logging module. We have clarified this in the revised manuscript.

221-4: *Parentheses seem unnecessary.*

**Response:** we have removed them.

227: “: : :whose: : :” *is grammatically incorrect.*

**Response:** changed to the. Thanks.

250: *Delete respectively.*

**Response:** done.

273: *Awkward phrasing. I recommend, “To ... conservation, we calculate,”. And then say how del-B is used to ensure mass conservation. (Just calculating del-B doesn't ensure mass conservation).*

**Response:** done.

315: *Equation should be plural. Or, if singular, use an article.*

**Response:** changed to plural.