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Biogeosciences Discussions

Interactive comment on "Fire-regime variability impacts forest carbon dynamics for centuries to millennia" *by* Tara W. Hudiburg et al.

M. W. I. Schmidt

michael.schmidt@geo.uzh.ch

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A note upfront from the submitting person: This review was prepared by two master students (Lena Weiss and Fatemeh Ajallooeian) in geography or earth system science at the University of Zurich. The review was part of an exercise during a second semester master level seminar on "the biogeochemistry of plant-soil systems in a changing world", which I organize. We would like to highlight that the depth of scientific knowledge and technical understanding of these reviewers represents that of master students. We have enjoyed discussing the manuscript in the seminar, and hope that our comments will be helpful for the authors.

In this paper, the authors investigate how fire-regime variability impacts soil C and net ecosystem carbon balance. These events are of importance in biogeochemical

processes including net carbon (C) balance. In long-term studies and monitoring of forests, biogeochemical cycles represent a great resilience against long lasting stand-replacing fire events. On the contrary, the aftermath of such repeated fires or temporal fluctuations in a fire regime (e.g., the characteristic timing or severity of fire) are not known very well. In theory, such fire events and variabilities can influence carbon balance for centuries to millennia. The authors found that C range in a paleo-informed scenario is significantly different from an equilibrium scenario (with a constant fire return interval), likely because of the difference in fire severity and timing variabilities. Paleo-informed scenarios consisted of multi-century periods of positive and negative net ecosystem C balance, with the amount of net C balance being largely greater than the equilibrium scenario. In addition, these fluctuations produced long lasting effects on the C balance for millennia. This implies that fire-regime variability is a major driver of C trajectories in stand-replacing fire regimes. Thus, anticipating carbon stability in these systems, will depend strongly on the ability of ecosystem models to represent a realistic range of fire-regime variability over the past several centuries to millennia.

Overall the paper is well structured and easy to follow. The importance of the theme is highlighted in several occasions. Methods, material, applications are well explained. Some things might need a more accurate definition for a better understanding. Using a three-pool model makes it more valuable and leads to more accurate results. Main positive point is the declaration of uncertainties and suggestions for future projects.

Two minor errors in grammar were found:

- Page 2, line 48: we suggest changing the word "great" to "greater" since it is followed by the word "than" and in comparison, certain adjectives such as great should get an "er" or "est" at the end.

- Page 4, line 83: we would change "significance influence of fire" to significant influence since it makes more sense

For a better understanding and conception, we suggest the following: - Page 2, line 40:

we would find a definition of “C trajectories” helpful

- Page 3, line 61: it is somewhat unclear what the authors mean by pool sizes, we suggest that they indicate which elements pool sizes they specifically mean (e.g. carbon or nitrogen or etc.,)

- Page 3, line 71: it is not clear what is meant by Net Ecosystem Carbon Balance (NECB)

- Page 4, line 86: the term “spin up” is confusing. We suggest that the authors try to explain and clarify this term in a more understandable wording perhaps by defining this term with a simple example before using it.

- Page 5, line 139-141: “Day Cent” Is well described but already mentioned in section 2.1, therefore we suggest the description should come earlier

- Page 6, line 151-152: is L:N and lignin to nitrogen the same? It is not mentioned in the text

- Page 7, line 182: from our point of view, the “key difference” between the two fire types should come at the beginning of the paragraph

- Page 8, line 208: timeframe CE, is that defined as common era?

- Page 8, lines 211-219: we think the explanation of different scenarios can be expressed in a more precise and separated way. The description of additional scenarios make it difficult to understand and follow the subject since they’re told altogether. Perhaps by separating the scenarios and explaining each of them on an independent paragraph, the concept can be easier to follow. The use of that many brackets makes it more confusing than helping anything.

- Page 9, line 248: isn’t the data fitted? Not surprising that it is “broadly in agreement”

- Page 13, line 360-365: very long and complicated sentence. We would suggest making more than one sentence out of it for a better understanding

- Page 13, line 369: the word “woody pool” should be clarified

- Page 14, line 383 & 388: are “ecosystem states” and “biogeochemical states” the same? Here we would need simplification or a better definition

Concerning the figures: - Implement results in Table 1

- Figure 1: For a better visual understanding, it would be nice to have at least two different colors for the different types of fire. Also, different symbols could be used. The spacing between the line is very big and could be better used. It would be sufficient to have only one legend as it is the same, and we can read the word “high severity fire” four times in a small figure. That could be simplified.

- Figure 2: It is too confusing that the grey Equilibrium line and the yellow Equilibrium + 2 degrees have the same value on the y-axis but it’s not shown.

- Figure 1, 2 and 4: In the text the time data is in CE. In the Figures time data Cal BP is used. We would suggest to only use one time specification.

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