

## ***Interactive comment on “Forest stand age information improves an inverse North American carbon flux estimate” by F. Deng et al.***

**Anonymous Referee #4**

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Comments on the manuscript by Deng et al. “Forest stand age information improves an inverse North American carbon flux estimate” submitted to Biogeosciences Discussions.

### **Overall Evaluation**

This manuscript represents a very useful exploration of the use of forest stand age information into an atmospheric CO<sub>2</sub> inversion methodology applied to North America. Although there are minor differences between the inversion with and without the use of stand age information, the comparison does suggest some qualitative improvements in the spatial distribution of flux estimates. Also, in comparison with the inversion estimates without forest stand information, there is also better agreement between the inversion estimates with forest stand information and an independent estimate of

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carbon exchange from an empirical model that uses satellite-based information. The manuscript is well organized and well written. Most of my specific comments below are minor. In summary, I think this is a good first exploration of how one might use stand age distribution in an atmospheric CO<sub>2</sub> inversion, and this study should provide a good basis for others to explore different ways of using stand age information in inversions.

### **Specific Comments**

1. Title: I'm not sure this is the best title, as it is not clear that the “carbon flux estimate” was improved. Also, it is not clear to me if anything was necessarily improved. The value of this study is a demonstration of how forest age information might be used. I would suggest a title like “The use of forest stand age information in an atmospheric CO<sub>2</sub> inversion applied to North America”.
2. Introduction: Although the Introduction is written in a scholarly fashion, it is a bit long. If other reviewers suggest that it be shortened, I would concur with that recommendation.
3. Lines 16 and 20 of page 4787: Should “reanalyzed” be changed to “reanalysis”?
4. Line 17 of page 4787: Change “taken” to “implemented”?
5. Line 18 of page 4787: Change “at each grid” to “at each grid point”?
6. Line 3 of page 4788: “shows greater seasonal and diurnal variation” than what? Do you mean “is characterized by substantial seasonal and diurnal variation”? or do you mean “greater than over the ocean”?
7. Line 16 of page 4789: Note that you haven't defined the “50 regions” yet, and the reader doesn't find out about these until they read the caption for Figure 1, which isn't cited until section 3.1.
8. Line 28 of page 4789: Change “as a weight in modifying” to “in a weighted fashion to modify”?

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9. Line 1 of page 4790: Change “same weight was also used” to “same weighting approach was also used”.
10. Lines 2 and 3 of page 4790: Change to “respectively, as used in Eq. (2) below”?
11. Lines 24 and 25 of page 4793: I was really confused by the use of “regional” in this sentence. At first I thought it was equivalent to “North America region”, but then I realized that it was referring to regions within North America. Here is my suggestion for improving the sentence: “The ratio was then scaled to a quantity ( $f_{ri}$ ) for each region  $i$  within North America as an area-weighted average of  $f_s$ , and for each region we defined an age factor as  $f(\text{age})_i = f_{ri} - f_c$  (6) where  $f_c$  is the mean of the  $f_r$  for all North America regions”. I think adding in the subscript  $i$  helps the reader.
12. Line 20 on page 4795: Change “were solved with” to “resulted in”?
13. Line 22 on page 4795: Change “aged” to “old growth”?
14. Line 23 on page 4795: Change “by the a priori that could” to “by the a priori fluxes that could”?
15. Line 14 on page 4796: Change “aged forests” to “old growth forests” or “old forests”?
16. Line 16 on page 4797: Change “conducted in a higher” to “conducted at a higher”?
17. Line 19 of page 4797: Change “from CO<sub>2</sub> alone” to “from CO<sub>2</sub> concentrations alone”?
18. Line 22 of page 4798: Change “9 to 30” to “9 to 28”.
19. Sentence spanning lines 7-9 of page 4799: I would suggest rewriting the sentence as follows: “In other words, the EC-MOD product likely has included some age effects with respect to above-ground productivity, and this makes it worthwhile for comparison with an atmospheric inversion that implements an age constraint.”

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20. Line 11 of page 4799: It is not clear what you mean by “better” in this sentence. I think you should add the following text to the end of the sentence: “than the inversion without age constraints”.
21. Lines 13 and 14 of page 4799: Change “the unity and decrease” to “unity and the decrease”. Note that I’m not convinced that this is necessarily a “sign” of improvement, as we don’t fully understand the biases in the EC-MOD product. It is a model-model comparison, and this is why I suggest removing “improves” from the title. I would suggest changing “are signs of . . .” to “may indicate improvements achieved through using age information in the atmospheric inversion”.
22. Line 15 of page 4799: Change “of the complicated” to “of a complicated”?
23. Line 16 of page 4799: Change “at age around” to “at an age around”?
24. Line 12 of page 4800: Change “the implication of the positive effect is that” to “our study suggest that”.
25. Line 13 of page 4800: Change “adding the forest stand age” to “adding forest stand age”?
26. Line 21 of page 4800: Change “have influence” to “have an influence”.
27. Lines 23 and 24 of page 4800: Change “a major . . .” to “the dominant association among regions, and a general NEP function . . .”.
28. Line 25 of page 4800: Change “along novel ways” to “along with novel ways”.
29. Line 2 of page 4801: Change “Before that” to “In the meantime”?
30. Line 17 of page 4801: Change “atmospheric constraint” to “atmospheric constraints”.
31. Line 19 of page 4801: Change “old” to “old growth”?