

***Interactive comment on* “The carbon budget of terrestrial ecosystems at country-scale – a European case study” by I. A. Janssens et al.**

Anonymous Referee #2

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This manuscript describes an analysis of the net carbon flux of Europe on a per country basis. The methods are based primarily on model estimates and local harvest and measurement inventories, most of which appear to have come from literature reviews. The paper breaks down the analysis into grasslands, forests, agricultural lands, and peatlands. This paper represents a significant contribution to the important goal of assessing country- and continent-scale carbon budgets, and may have a substantial impact on scientific, economic and political agendas. I see no major concerns, however, I do see numerous points that could be improved to help this paper have a greater impact on the readership. These points follow.

Major points:

1) The methods are the weakest portion of this manuscript. In particular, the paper lacks sufficient detail for the reader to understand what was done to estimate the carbon budgets. Significantly more detail is needed. Specific comments on this subject follow below.

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2) A sensitivity analysis of the error around the estimates (per country) would be highly valuable. This paper will serve as a textbook for future research to emulate. Further, this paper may be used by the IPCC and other scientific and political organizations. Therefore, a detailed sensitivity analysis is essential so future researchers can understand at least one approach to understanding how to calculate error bars on the net carbon flux estimates (per country), and also, so users of these results will know just how accurate the estimates may be. For example, if a country's net carbon flux indicates it is a source, yet the estimate is not statistically different than zero, this is essential to show. I recommend a figure that shows the net carbon flux of each country, with error bars on the flux, and a detailed methods section on how the error bars are calculated, and a paragraph in the discussion on the implications of this error analysis.

3) The writing is hard to follow in numerous locations, particularly in the abstract and introduction. This drastically lessens the impact of the paper, and should be improved prior to publication.

Details:*Abstract*

Third line down, “Sinking” is not a verb, nor is it a word. This is used throughout the manuscript. It is poor grammar, and hurts the impact of the paper. It should be replaced with “Forests and grasslands were a net sink for carbon. . .” in place of “Forests and grasslands were sinking carbon. . .”

Third and fourth line, “. . .whereas arable soils were carbon sources. . .” replace soils with ecosystems if that is what you mean.

Last line in first paragraph, “. . .were much lower than expected. . .” what do you mean by expected? You never state in the paragraph what you expected. This is out of place and confusing. You might replace with something like “Draining and extraction of peatlands caused substantial reductions in country-specific net carbon balances.”

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The second paragraph of the abstract is very confusing, and it takes the reader numerous efforts to fully grasp your meaning. The first sentence directly contradicts the third sentence. First you say that net carbon fluxes were small relative to fossil fuel emissions, then you say the small net balance is composed of two very large but opposing fluxes. This is confusing. To make it more confusing, your second sentence uses vague terms, such as “. . . did terrestrial carbon fluxes matter. . .” What does “matter” mean? I understand what it means as a stand-alone word, but in this context its meaning is confusing. Further complicating this section is the phrase in parentheses of the second paragraph “(ranged between uptake of 70% of fossil fuel fluxes and increase of emissions with 25%)”? That makes absolutely no sense. Please re-write the entire second paragraph more clearly, otherwise many readers will give up at that point and put the paper down in preference of one that is easier to understand.

Third paragraph, the words “Firstly” and “Secondly” should simply be “First” and “Second”.

Introduction

Last paragraph, “. . . alternatives for post-Kyoto regimes. . .” What does regime mean in this context?

Materials and Methods:

Section 2.1 You say “Inventories also give proper weight to all areas and vegetation types. . .”. Can you back up this statement with a citation? This is a very important point, and I’m skeptical that you can make such a strong statement.

Section 2.1, you say “All other C stocks. . . are usually simulated. . .” I really think this needs more description. “Usually” is such a vague word, please tell us how often, with what models, and provide citations. It is very important that you clearly describe the methods and models and provide the citations.

Section 2.1, last line, you should examine the literature of Mark Harmon on wood

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products. He found that wood products have a surprisingly fast turnover back to the atmosphere.

Section 2.2 You say that “Agricultural (arable soils and grasslands) C fluxes were assumed to be limited to soil C stock changes.” Please describe what the potential errors are of this assumption, given that it is certainly a false assumption.

Same paragraph, you say that “. . .harvested products are respired within the same year.” How is the amount of C in harvested products estimated? Also, why do you estimate the amount of respiration from harvested products since above you stated that “Agricultural (arable soils and grasslands) C fluxes were assumed to be limited to soil C stock changes.”

Section 2.2, second paragraph. Was this approach also used for forests and peatlands? Same paragraph: Yugoslavia has not existed for over a decade. You should describe the countries separately, especially since you do specifically estimate fluxes for some of them (e.g. Slovenia).

Section 2.2 Exactly what countries are considered “European” for this manuscript should be stated somewhere in the methods in a highlighted spot so that we can see exactly what countries the estimates are for. This is important, because many people from many different countries will read this paper, and they will be keenly interested how their own country fared in the estimates.

Section 2.2. Somewhere can you provide a box-arrow model figure that shows all of the C fluxes and stores that you considered along with the methods employed for each? This would simplify the methods substantially.

Results and Discussion

Section 3.1. line 23. You say “As expected. . .” Why? Please provide an explanation of why this was expected. What is the mechanism underlying your expectation? Although the scientist experienced with terrestrial carbon budgets will probably accurately guess

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why you expected this, you should not make them guess. I imagine your reasoning is that GPP is correlated with leaf area index, LAI is higher in forests, forests intrinsically store more carbon as wood and soil OM than grasslands, and lastly, countries with more forest cover are also more likely to practice aggressive silvicultural management and hence grow wood faster. But this is just my theory. . .what is yours?

Section 3.1, in general, why don't you discuss country specific variation in decomposition and soil carbon storage? It seems likely this is an important aspect of variation in net carbon fluxes, and should be addressed. Even if your methods found it did not differ greatly between countries, this deserves a short discussion because many scientists expect soil carbon storage to be critically important and they will wonder why it was not addressed.

Section 3.2 What is the underlying reason for a negative relationship in figure 3? I can imagine that countries that do more agriculture are also more proficient and aggressive with tilling practices, and hence get more harvested product out but also stimulate more decomposition. But what is your theory?

Section 3.2 You say "The main reason for this is that the CESAR model was developed to predict the effects of management changes on soil C sequestration and not to predict baseline fluxes." Please explain what you mean by baseline fluxes. Further, you then say "Hence, many of the assumptions and simplifications may not be valid for the prediction of the current situation." If this is so, then why did you use this model?

Section 3.3 line 4, you say ". . .almost twice as high as the forest soil sink. . ." You never presented the forest soil sink! Please refer to my earlier comment on forest soil carbon storage.

Section 3.3, line 5, "As expected. . ." again, please explain why you expected this, do not make the reader guess.

Section 3.3, second paragraph, it seems that to be consistent with the rest of the paper

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you should start a new section here “Because both forests and grasslands. . .”

Section 3.4, line 21, “Peat disturbance strongly confounds. . .” Confounds is the wrong word here. I suggest you change to “Peat disturbance strongly changes. . .”

Section 3.5, first line, “In most countries, the net terrestrial C balance estimate is thus very small.” What do you mean by very small? Very small compared to what? I think this is too vague of a term.

Section 3.6.1 This is poorly written. First of all, “stimulatieve” is not a real word. You need to find another word to use in its place that accurately represents what you are trying to say. Second, you contradict yourself by saying “However, in the absence of protective or stimulative measures, the forest C sink will revert within a couple of decades as a result of the progressing age structure, and then more. . .countries will stop sinking C in their forests. . .”. Then you contradict that with “If economic stimuli would change forest management towards shorter rotations, this process would even be accelerated.” This is a direct contradiction. Harmon (Science, 1990, and others) showed that cutting old-growth and replacing with young forests results in a long-term net flux to the atmosphere (source), not a sink. This is because old-growth stores huge amounts of carbon. Please account for this in your statement, otherwise politicians and managers may get the wrong impression. Also, please re-write this paragraph to more clearly depict your results.

Section 3.6.1, Paragraph starting with “Two articles in the Kyoto Protocol. . .” This is a nice review paragraph, but it is poorly linked back to the main objective of the manuscript. Please link this back to the focus of the paper.

Section 3.7.1, you say “(this estimate is smaller than that cited above because IT excludes Russia)”. Which estimate does IT refer to?

Section 3.7.1, last paragraph, remove parentheses from the word “economical”.

Figure 4. Perhaps try using country codes (e.g. SI) rather than dots. This would provide

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much more information to the reader interested in how their favorite country fared. If this is too messy then disregard my suggestion.

Also, try the following figure to demonstrate the importance of forest AREA to carbon storage. X-axis % forest area, y-axis “relative importance” (from figure 7). This might be a very nice correlation.

Interactive comment on Biogeosciences Discussions, 1, 167, 2004.

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