

Interactive comment on “Environmental change impacts on the C- and N-cycle of European forests: a model comparison study” by D. R. Cameron et al.

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We thank the reviewer for their constructive comments. In the following, we outline how the paper will be improved in response.

General comments

Cameron and co-authors compared the performance of four biogeochemical models in their capacity to estimate the CO₂ and N₂O balance of pine and beech over Europe.

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In addition to species differences, decadal differences, spatial patterns and model differences were studied. The presentation of the models and results is systematic. This, however, resulted in a wordy presentation that is extremely hard to digest. The manuscript would gain a lot by preparing a table that describes the main characteristics of the four models and at the same time presents the relevant processes that were not included in the models i.e. reduction of heterotrophic respiration under enhanced N deposition (Janssens et al 2010, Nature Geoscience). This table should also include information on initial model conditions. So basically the table should summarize the entire section 2 and subsequently the text of section 2 should be substantially reduced (avoid repetition between the table and the text). Such a table would help the readers to understand the differences and similarities between the models at a glance

We would like to thank the reviewer for their constructive criticism of our presentation of the Methods section and for their suggestion to make greater use of tables to summarise and compare information presented. Our concern was to give all the information that would be required to make the work reproducible. However, we recognise that the current presentation is too lengthy and dense and would benefit from a rewrite making greater use of tables and reducing the length of the text as has been suggested. We agree that this will make the presentation much more readable.

Specifically we will

- shorten the model descriptions making them more concise
- we will create a table as suggested by the reviewer that gives the key information about each model such as
 - approach taken to calculate GPP
 - number of soil levels
 - timestep

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- processes not considered by the model
- initial conditions/model spinup etc.

The result section is well structured but there is simply too much information to be digested. Again table(s) comparing the results for the four models would be useful and allow to reduce the text substantially. The current results section is a complete listing of the observations with little differentiation between minor and major results. The table(s) could contain all results the authors would like to share but the text should only contain the major findings that will be discussed in the discussion section.

In this study we were concerned to present a full description of the main responses of the four models and how they differed. However we recognise that the reviewer found our manuscript difficult to digest suggesting that we need to improve our presentation.

Therefore following the suggestion of the reviewer, we will

- create tables summarising results
 - lists of geographical areas with low high NEE/NPP and N₂O for beech/pine and disagreement between models rather than a text description of the spatial variation.
 - tables of R² results from linear regressions summarising the strongest relationships for each model, replacing a text description of these results.
- substantially shorten the text in our Results section concentrating on results that are revisited in the Discussion section and summarised in the Conclusions.

Figures 3, 4, 6, 7, 8 and 9 can now be classified as ‘color pattern comparison’. Most of these maps bear little information as most of the patterns seems reasonable. These

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data should be post-processed to the point that they support the objectives of the paper: comparing four models. The authors could consider to prepare summary graphs i.e. rather than showing four maps (one for each model), show a similarity map for all four models. Such a map will support the text better than the current series of maps.

We decided to show the maps in this manuscript without much further processing because this provides the reader with the most detailed information and makes direct comparison between the results of the models clearly visible. After reading the comment of the reviewer, we understand their point that of wider interest is where models in general agree and disagree giving a direct measure of model uncertainty rather than a presentation showing differences between specific models. A presentation showing model agreement/disagreement will show more clearly where models are strongest and weakest. Therefore we plan to replace figures 3, 4, 6, 7, 8 and 9 with figures that show the model average field for each of NEE, NPP and N₂O and also the model standard deviation to show where model agreement is greatest and smallest. This will reduce the number of panels presented in each figure and will allow a greater focus on geographical areas where modelling is stronger/weaker and more/less certain and less on a detailed comparison of the individual models. The current text relates to the old figures comparing the results of the four models. We propose rewriting the text to reflect the new emphasis and the new figures.

Minor comments

- Use the same units for C and N. C is now expressed per m², N per ha. This obscures the claim that the C flux is larger than the N flux.

The same units for C and N fluxes are already used in those figures where the fluxes are compared (Fig 1 and 2). For the maps since the focus is not on a comparison in

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magnitude between C and N fluxes we think that it is more appropriate to keep the units as they are.

We use different units for C and N in Tables 1 and 2. This is largely for the comparison against literature that we make in the Discussion section. This could be changed to be consistent with the Figures and with the reviewers suggestion but will obscure direct comparison with data in the literature. We therefore suggest to keep the units as they are.

- *EU25+5 is not an official terminology. One can check which countries are part of the EU25 but the +5 is untraceable.*

This will be changed to EU25 plus Norway, Switzerland and the Balkan countries in our revised version.

- *Fig1, the claim that all the models have larger N₂O emissions for beech than pine is not clear from the figure. Use different scales for C and N.*

It is important for C and N to be on the same scales in Fig 1 since they are being compared directly. This comment from the reviewer seems counter to the point they made above. We don't agree that it is unclear that N₂O emissions are greater from beech than pine except for the model INTEGRATOR which does not model different species. A caveat to this effect will be added to the manuscript.

- *It is often stated that 'the model is in closer balance in XX than in YY' (i.e. p 11062, lines 4-5) it is not clear what is in balance and what is expected to be in balance and whether this balance is a numerical or ecological prerequisite.*

C and N cycles will in general be in quasi-equilibrium since otherwise there will be large net losses/gains in C and N from the trees/soil which are not often observed

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over decadal timescales. Such large imbalances if present in model predictions are therefore interesting and important and we think should be understood in terms of plant mechanisms and processes. Text will be added to clarify that imbalance refers to the difference between incoming and outgoing fluxes of C and N from the trees or the soil and thus a change to the stock of C and N in the same.

- *Several paragraphs start with none informative sentences such as 'Before looking at how ...' or 'Before moving on ...'. If the text is well structured you can delete these sentences they don't add anything to the manuscript.*

We will remove none informative sentences from the next version.

- *Page 11076, line 24 e.f. Have a look at for example Dieleman et al 2010, Cell, Plant and Environment for a recent meta-analysis on the topic.*

We thank the reviewer for this useful reference that we shall add to the text.

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