

Interactive comment on “Greenhouse gas balance of cropland conversion to bioenergy poplar short rotation coppice” by S. Sabbatini et al.

Anonymous Referee #1

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General remarks:

Sabbatini and colleagues present a greenhouse gas balance of a Mediterranean site planted with bioenergy poplar short rotation coppice (SRC) measured over two years and compare results to a reference site under agricultural use. They conclude that the reference site is a small greenhouse gas (GHG) source, while the poplar short rotation coppice is a considerable GHG sink of 2.2 kg CO₂ eq m⁻² over the two years of investigation taking into account CO₂, CH₄, and N₂O fluxes, management activities, soil organic carbon losses, GHG offset in terms of natural gas savings in the process of heat production, and biomass exports with regard to reemissions as CO₂ after burning. The topic is within the scope of the journal and of high environmental and political relevance as the production of bioenergy in Europe is a possible strategy to reduce

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GHG emissions. General design and approach are valid and mostly well presented; methods are thoroughly described.

However, the current version of the manuscript has quite a number of shortcomings – most of them are minor – so that revisions are needed in order to bring it into an acceptable form. If the below-mentioned points are considered – mainly by putting some clarifications into the text – I feel that this will be a nice and much appreciated contribution to the scientific community.

Major points:

- This paper offers comprehensive details at some points, but lacks transparency at others. For example, the presented GHG budget is based on two years of measurements, i.e. one poplar rotation. It should be clearly pointed out in the Abstract and Discussion that this budget does not represent the period right after conversion from arable land to poplar coppice as one would expect much higher GHG release from the ecosystem to the atmosphere immediately after conversion. This fact needs to be discussed in the right context and conclusions should be verified with regard to a possibly changing budget of the newly established SRC site over time.

- CO₂ fluxes are identified to be the major contributor to the full budget. However, their presentation is poor. Please provide an additional figure showing the seasonal development of CO₂ exchange so that the reader gets an idea of possible controlling factors and an illustration of periods when discrepancies occur between sites and years.

- Discussion is missing on sustainability of the presented conversion method, particularly on field operations such as irrigation. With regard to the GHG balance, this strategy seems to work out quite well, but what about other parts of the environment, e.g. the local water balance, etc.? Please add some thoughts on that.

- Manual chamber measurements: Using just three samples to calculate one flux rate is a bit dangerous. A huge additional uncertainty is induced. I know how challenging

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these measurements are and I appreciate their consideration in this study, but proper error estimations should be provided (see specific points).

- I'm a bit skeptical whether (such) a (comprehensive) presentation of the soil incubation studies is needed. Do they add any valuable insights with regard to the main aim, i.e. the GHG budget, of the paper?

- All in all, the paper reads well and I like it. Nevertheless, please avoid these terribly long sentences. Also, check for correct grammar (prepositions, etc.). It doesn't sound quite right at some points in the text. I guess it'll be quickly and easily fixed. There is not so much to change, but it will greatly improve readability and overall quality of the paper.

Specific comments and technical corrections required:

- P. 8037, l.8-9: At this point, the reader is puzzled why you need SOC content of an older poplar plantation to estimate SOC loss as a result of SRC 'establishment'. You want to determine possible SOC loss and recovery over time. For the latter you need the older site. Consider rephrasing.

- P. 8037, l.10-12: Unclear. Possibly split into two sentences. How does 'considering the C intensity of natural gas' fit to the rest of the sentence?

- P. 8037, l.13-14: Add 'by' between 'assessed' and 'comparing'.

- P. 8037, l.14: Start sentence with 'Cumulative FCO₂ was higher at SRC...'

- General comment on Abstract:

- Add brief information on type of crop at REF site, field management

- It is unclear whether the SRC site had been converted just before the start of the measurements at SRC. Also, is the land use history of the two sites (before conversion to SRC) identical?

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- P. 8038, I.2: Delete 'the'.
- P. 8038, I.8: Add reference after 'decades'.
- P. 8038, I.11: Switch 'both' and 'during'.
- P. 8038, I.11-12: '...by capturing CO₂ from the atmosphere and storing it into the soil...' – CO₂ is going to the above-ground biomass in the first place.
- P. 8038, I.4: Alter the equilibrium of the ecosystem in terms of what? Just GHG or maybe also of water?
- P.8039, I.24: Remove part in brackets. SRC has been defined earlier.
- P.8039, I.25: Despite? Maybe water limitation is the reason why there are so few studies due to the fact that poplar uses so much water that a conversion has not only expected positive effects on GHG exchange, but is on the other hand problematic with regard to local or regional water supply and balances, which in turn might also affect climatic conditions. Consider rephrasing.
- P.8040, I.4: What is an 'overall method' in this context? Consider using a subtitle like 'Assessment approach' or something more meaningful than 'overall method'.
- P.8040, I.6: 'second rotation cycle': Does that mean your measurements did not commence right after conversion from arable land to SRC? If so, this needs to be indicated earlier, otherwise Abstract and Introduction are misleading.
- P.8040, I.7: I understand what you mean, but the phrasing might be a little bit confusing to some readers. Please indicate your sign convention clearly and in a way that everybody understands that an 'uptake' is a 'negative' GHG contribution quantitatively, but not qualitatively.
- P.8040, I.10: Did you consider the possible role of nitrogen compounds in your estimation? Ammonia and aerosol NH₄NO₃ do also influence the GHG budget at local scale. Also, by substantially modifying the surface resistance through growing poplar trees, an

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increase in nitrogen deposition can be expected. However, it's tricky to include these aspects into CO₂ equivalents due to their reactivity, uncertain emission factors, etc. I'm not asking for an extra term in Equation (1), but since a GHG balance is investigated, the nitrogen part should be kept in mind and should at least be mentioned at some point in the paper.

- P.8041, l.21: Just to make sure: The land use history of REF and SRC were completely identical before 2010? Otherwise the whole approach wouldn't make much sense regarding the main aim of the study.
- P.8043, l.14: 'To this end...'. What end?
- P.8043, l.17: Add '(see Table 1 for models and manufacturers)'.
- P.8044, l.3: Please: The star in u-star is a subscript and not a superscript. Half of the micromet community is making this mistake.
- P.8044, l.13: What is the median value?
- P.8044, l.14: Check sentence, something is missing.
- P.8046, l.9: Change to 'all periods of observation' or 'the period of observation'.
- P.8046, l.10: Change to 'At the SRC site, three collars were distributed along...'
- P.8046, l.13-14: This means that only three samples were used to calculate one flux, right? In my opinion four samples are required to derive a somewhat robust flux estimate. A huge error is additionally induced, let alone the uncertainty of vial sampling with subsequent GC analysis itself. This needs to be discussed and the respective error estimates need to be included in the final numbers.
- P.8046, l.15: Add 'was' between 'CH₄' and 'measured'.
- P.8046, l.18-19: I understand the dependency on land management as it is described below. But what is meant by 'weather dependent'? Before, during, after rain? Are all

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important weather conditions covered by the measurements?

- P.8046, I.21: Low variability? I see from Figure 3 that no high fluxes occur (compared to values from other agricultural sites), however, the variability at SRC for N₂O and CH₄ seems to be quite considerable in both ways, i.e. seasonally and among chambers. Consider rephrasing.
- P.8047, I.8: Replace 'if' with 'whether'.
- P.8047, I.13: 'led'. What do you mean? Modified, transformed, prepared?
- P.8047, I.21: Replace 'so' with 'in order'.
- P.8047, I.22 to p.8048, I.2: No details are given on how nitrification and mineralization rates were calculated. Please add.
- P.8048, I.6: volumetric soil moisture
- P.8052, I.5-11: This is insufficient. FCO₂ is the major contributor to the GHG balance. More information on seasonal course and main reasons (players, controlling factors) for differences among sites and years ideally in a new figure are needed. This doesn't need to be extensive, but some above-mentioned key points will help to better illustrate the results.
- P.8053, I.2: What is the detection limit of the GC? What is the lower flux detection limit?
- P.8054, I.21: What is supposed to happen after 12 years? Keep in mind that this time span builds the frame for some of your calculations. How reliable is this number?
- P.8056, I.24: due to both
- P.8057, I.2: Why 4 years old? I thought SRC was harvested in January 2012 and the period you are looking at is from January 2012 to January 2014.
- P.8057, I.2: Isn't -293 within the range of -77 to -4756?

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- P.8057, l.1-6: In general, the discussion could be spiced up a bit. Instead of solely citing numbers from other studies, possible reasons could be discussed, e.g., Jassal et al. (2013) measured at a site with a much lower stem density, which is the likely reason for lower C sequestration compared to SRC in this study.

- P.8057, l.18-19: '...but was higher than results found by...'

- P.8058, l.10: Again, why 12 years? What happens then? If SRC will be used for other crops, etc., after let's say 6 years, your reasoning fails.

- P.8058, l.21: What species? Crop species? Microbial communities? Nitrogen content? Please clarify.

- P.8058, l.15 – p.8059, l.23: The authors do not take into account that N₂O and CH₄ were not measured immediately after conversion, which leads to a distorted image. An estimation (if possible) and discussion is needed on how the GHG balance would have changed, otherwise the numbers presented here remain a stand-alone two-year-window with limited force of expression.

- P.8061, l.24: At the study sites,...

Figure 1: Add a comment in the caption that these are the periods taken into account for budget calculation; however, harvest at SRC was postponed to Jan 2015.

Figure 3: Why only 14 months of measurements at REF site?

Figure 5: Needed?

References:

Jassal, R. S., Black, T. A., Arevalo, C., Jones, H., Bhatti, J. S., and Sidders, D.: Carbon sequestration and water use of a young hybrid poplar plantation in north-central Alberta, *Biomass Bioenerg.*, 56, 323–333, 2013.

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