

Interactive comment on “Spatial and temporal variation of CO₂ efflux along a disturbance gradient in a *miombo* woodland in Western Zambia” by L. Merbold et al.

Anonymous Referee #2

Received and published: 7 September 2010

General comment

The manuscript reports on the spatial and temporal variation of soil respiration along a disturbance gradient: from a protected forest in Western Zambia to a disturbed area outside a reserve. The spatial variability of soil chamber respiration measurement is related to various abiotic and biotic drivers and is compared to eddy covariance derived estimates of ecosystem respiration. Understanding the mechanisms driving spatial and temporal variability in soil respiration is currently an important research focus, and data from open woodlands in Africa are scarce. Moreover, this manuscript assesses the spatial variability within and among plots of different vegetation cover and disturbance

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regime; this is an important aspect which has not yet been investigated in depth. Thus, the manuscript addresses a timely question with potential interest for the readership of Biogeosciences. However, while the introduction and material and methods are well written, the results are partially poorly elaborated and somewhat messy in the current presentation. The manuscript also suffers from too many objectives and too many figures and tables and lacks a coherent and focused storyline. Hence, I believe that the manuscript can be substantially improved if the authors focus on their central aspects, i.e. on the spatial heterogeneity in soil respiration and its underlying causes and implications for eddy-covariance flux estimates which should be discussed in depth. I have added detailed suggestions below which may help to focus the manuscript.

Major comments:

The terminology for the subplot classification needs to be improved: I could not follow the assignment of categorical numbers (1...14) to the categories: for each plot, the numbers (e.g. 1) represent different categories, which makes a comparison in the subsequent figures very difficult. For example No 1 presents a different vegetation type in plots 1, 3, and 4 (being FHE, ECI and ABE). Indeed, the numbers could be fully omitted. Further I would suggest to stick to a more intuitive abbreviation, such as T – trees; G- grasses; L – litter etc. The current form of presentation does not allow a comparison of different vegetation types (e.g. tree cover versus grass cover) on soil respiration and I fully agree with reviewer 1 that this is an important aspect to investigate. The same applies to figure 3: identical vegetation types should receive the same color in all plots. It is not just an issue of data presentation: it should be analyzed to what extent the between-plot differences are due to changes in vegetation composition. Similarly, the data for similar vegetation types across plots should be compared.

The analysis of heterogeneity in soil respiration data and up-scaling to ecosystem fluxes could be better linked throughout the manuscript. Currently, it reads as if these are two different lines of investigation.

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The authors make a strong point that heterogeneity in soil respiration was significantly linked to soil carbon content. However, even though this relationship is significant in 3 plots (due to high number of replicates), the amount of variance explained by the correlation between R_{snom} and C is extremely low: only 3 and 8% of the variance can be explained by this correlation in plot 3 and 4, respectively. Thus there is little ecologically relevant information in this relationship. Therefore it should be interpreted more carefully and the results and discussion need to be modified accordingly.

Minor comments:

M&M:

Be more precise on the time which has elapsed between logging and measurements

How many soil collars were inserted per subplot?

Some information on the weather conditions (variability) within each of the sampling campaigns should be provided

Unclear if stem respiration was considered constant or scaled to temperature changes. The implications and potential errors during up-scaling should be shortly discussed

The interpretation of the eddy covariance data for the different plots could be biased if the predominate wind direction changes during seasons. Some additional information should be given.

There is some sort of discussion already in M&M (e.g. line 264 ff; or line 281ff), which would be better placed in the discussion

Results:

Many (complex) figures are only briefly described with one or two sentences. The number of figures should be reduced with those remaining being better described.

The effect of rain pulses on soil respiration is only briefly mentioned but I think this

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aspect needs a bit more consideration as it can be an important phenomenon in these systems. There is a lot of recent literature on the underlying courses (e.g. Inglima et al. 2009, *Global Change Biol.* 15, 1289-1301; Borken & Matzner 2009, *Global Change Biol.* 15, 808-824; Unger et al. 2010 *Soil Biol Biochem.* 42: 1800-1810).

Fig.2 is not strictly required as the results are mentioned in the text.

Line 373: should probably read "same categories" instead of "different categories". This sentence is unclear

Line 373-374: this is not visible from Figure 6: e.g. category 4 has the lowest efflux rate in plot 1 and the highest in plot 2. A different way of presentation should be chosen to allow direct comparison of vegetation classes (see comments above). Adjust the scale on the y-axis (currently 20 while the highest rates are below $14 \mu\text{mol m}^{-2}\text{s}^{-1}$) to facilitate the comparison

Information in Fig. 7 is given in Table 4 and can thus be omitted

Line 391ff – the trend along the disturbance gradient is not very clear and needs a better explanation

Line 421-423 – rephrase sentence, unclear

Line 429-430: it is difficult to judge the quality of the regressions ("best fit"), please indicate r^2 and p-levels

Discussion:

More care is needed in the interpretation of the effect of soil carbon content on soil respiration (see comments above). I do not find convincing arguments for "hot spots of soil carbon"

Discussion could be shortened by 10-20% and focused, taken the above mentioned comments into account

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Check format of citations in brackets

Interactive comment on Biogeosciences Discuss., 7, 5757, 2010.

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