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## ***Interactive comment on “Fluxes of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O from soil of burned grassland savannah of central Africa” by S. Castaldi et al.***

### **Anonymous Referee #2**

Received and published: 14 June 2010

General remarks: The paper by Castaldi et al. presents in-situ data on soil-atmosphere exchange of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O from a grassland ecosystem in Congo that is subjected to frequent burning. The data were obtained from two different field campaigns. The first campaign was conducted one month after burning and the second campaign eight months after burning. Furthermore, the authors analyzed soil parameters and gas exchange from soil cores under different temperature and moisture regimes in post-field laboratory studies.

Since several African regions are influenced by different kinds of disturbance, human impacts, population growth and data on land-atmosphere interactions are scarce for this ecosystem type, this study will make up a very valuable and comprehensive contribution for ecologists and ecosystem modelers and will provide basis data for a better

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understanding of soil processes and gas exchange characteristics. Given the logistical problems that are often faced in these regions, the field and lab setups were thoroughly chosen and the outcome is presented in a clear structure. Since the results partly differ from those reported in earlier fire studies, particularly for CO<sub>2</sub> and CH<sub>4</sub>, this paper indicates that we still don't fully understand the factors that regulate the greenhouse gas exchange from soils with low carbon and nitrogen content. More soil process studies and long-term greenhouse gas monitoring, though difficult to maintain, are required to overcome this lack.

However, quite a number of points should be addressed before final acceptance of this paper. Most of them are minor (see below). The main weakness of the manuscript is related to grammar and wording. I suggest proofreading by a native speaker or someone who is fluent in English. I helped rephrasing the text where the message was confusing or the information was lost, but this is by far not complete. Further edits are required.

The authors present four different units of soil water content. What is meant by percentage of water saturation? For a better comparability with other studies, I suggest a simple conversion of volumetric water content (VWC) to water-filled pore space (WFPS) for all field-related measurements and to standardize all lab-related measurements to percentage of maximum water-holding capacity (% WHC<sub>max</sub>).

Please provide more information on flux calculation, particularly for CH<sub>4</sub> and N<sub>2</sub>O. As written in the text, only three concentration measurements made up one flux rate in the field and only two in the lab. Given the low exchange rates and the uncertainty in GC measurements, how confident are you with these numbers? What were the R<sup>2</sup>-values of the linear regressions? What quality criteria did you apply? How often did you inject calibration gas to allow for GC drift? What was the time difference between sampling in the field and GC analysis? How confident are you that the vials were gas-tight? Dilution by ambient air can substantially bias the mixing ratio. Please clarify.

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Furthermore it is difficult to compare fluxes from the lab with those obtained in the field. Please check the units in Figures 7A and 9. Is it per gram of soil dry weight? You have information on bulk density (1.43 g cm<sup>-3</sup>) and sampling depth (10 cm), so you could easily convert these numbers to grams (ng or  $\mu$ g or mg) per area and time as you've done for the field fluxes instead of relating them to soil dry weight.

I was surprised by the CH<sub>4</sub> release under dry soil conditions from the unburned plots given the sandy texture and the low probability of anaerobic micro aggregates in the soil. I like your discussion about the termites, although this doesn't fully explain why fluxes decrease at higher soil moisture (20-50 % WFPS). Can you roughly estimate the mound density or did you check for underground nests or channels to strengthen your conclusions? I see in the Reference list that a paper on this topic by the same authors is in preparation. Maybe you can provide a little bit more insight. Other studies (for example MacDonald et al., 1998, Global Change Biology 4, 409-418) report that termite mounds are point sources and no effect was found in the vicinity of these mounds.

Minor points: p. 4090, line 8: What do you mean by 'high frequency burning'? How often? For how many years has frequent burning been the typical management in this ecosystem type? Maybe this information is not easy to get. Try to give approximate numbers.

p.4090, lines10-12: Please rephrase. 'Two field campaigns were carried out after the fire event. The first campaign was conducted in the middle of the dry season one month after the fire event and the second campaign was at the end of the growing season eight months after the fire event.'

p.4090, lines 15-17: Please rephrase. 'In laboratory experiments, soil samples from the two treatments were analyzed for microbial biomass, net N mineralization, net nitrification, N<sub>2</sub>O, NO and CO<sub>2</sub> emissions under different soil water and soil temperature regimes.'

p.4090, line 27: Replace 'Burned' with 'Burning'.

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p.4091, line 10: Replace 'In' with 'On', period after 'phenomenon'. Start new sentence with 'Its' instead of 'which'.

p.4091, line13: I suggest spelling 'savanna' without 'h' like it is done here. Please check everywhere else in the text. Standardize it.

p.4091, line 21: Replace 'grassed' with 'grasses'.

p.4092, line 7: Replace 'savannahs soil' with 'savanna soils'.

p.4092, line 8: Replace 'mineralized' with 'mineralization'.

p.4092, line 20-22: Please clarify this sentence. What is the linkage between increasing detritus through fire management in the upper soil layer and rooting depth?

p.4092, line 23: Again, how often is 'high' in this context?

p.4093, line 5: Replace 'a almost' with 'an almost'.

p.4093, lines 15-19: Period after 'Africa'. Start new sentence with: 'Specific objectives were to verify whether (a) burning increases the availability of extractable N substrates and stimulates microbial growth, microbial activity, CO<sub>2</sub>, N<sub>2</sub>O and NO production, (b) rain events induce gas pulses of CO<sub>2</sub> and N<sub>2</sub>O with length and magnitude being higher in burned areas, and (c) fire enhances the soil CH<sub>4</sub> sink.

p.4093, lines 20-21: Replace 'at different time lengths from the fire event (1 and 8 months after burning)' with 'over different periods, i.e. one and eight months after the fire event'.

p.4093, lines 22-23: Please rephrase. 'Laboratory manipulation experiments of different soil water and temperature treatments were also performed with soils from burned and control plots.'

p.4093, line 25: Remove 'From'.

p.4094, line 5: Replace 'lying' with 'situated'.

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p.4094, lines 8-9: I don't quite get the message here. Please clarify. Do you mean 'consisted of open forest...?'

p.4094, line 11: Insert 'relatively cool' instead of just 'cool'.

p.4094, line 28: Replace 'interested by' with 'subjected to'.

p.4095, line 8-9: Replace 'that extended from' with 'usually lasts from'.

p.4095, line 9: Again, replace 'interested by' with 'subjected to'.

p.4095, line 18: Replace 'cycles event' with 'cycle events'.

p.4095, line 18: Replace 'rain-shaded' with 'rain-sheltered'.

p.4095, line 19: Replace 'kept a two meters height' with 'mounted at two meters height'.

p.4095, line 20: Remove 'so'.

p.4095, lines 21-23: Please clarify this sentence. How do the 30 mm of rain relate to the plastic tent? What's the reasoning here?

p.4095, line 24: Replace 'so' with 'in order to'.

p.4096, line 4 and 6: Replace 'for' with 'and a diameter of 31.5 cm'.

p.4096, line 23: Replace 'compared' with 'compare'.

p.4096, line 24: Move 'on soil respiration' to the end of the sentence.

p.4097, lines 2-3: Please rephrase. 'All gases were measured at least five times within two weeks at all plots and treatments (unburned, burned and control) as well as at three different times after water addition.'

p.4097, line 20: Period after 'made'. Start new sentence with 'The flasks were...'

p.4097, line 22: Use subscript '0'. Italicize 't'.

p.4098, lines 4, 9, 10 and elsewhere: Since uppercase 'T' is usually assigned to tem-

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perature, I suggest using lowercase 't' for time. Please check everywhere in the text.

p.4098, line 15: I think the manufacturer's name is 'Whatman'.

p.4098, line 25: Replace 'This' with 'These'.

p.4099, line 1: Insert 'by' between 'extracted' and 'shaking'.

p.4099, line10: You mentioned earlier that the volume of each gas sample is 20 ml. Please check.

p.4099, line 19: Do you mean 'consecutive days'?

p.4100, line 3: Replace 'acid pH' with 'acidic pH value'.

p.4100, line 15: Replace 'rain-shading' with 'rain-sheltering'.

p.4100, line 21: Replace '23,5' with '23.5'.

p.4100, line 24: Insert 'the' between 'to' and 'control plots'.

p.4100, lines 26-28: Since hydrologists and micrometeorologists tend to have different views about the estimation of potential evapotranspiration, please indicate briefly how you estimated/measured/calculated these values. I suggest leaving 'ETo' out in lines 27 and 28 as it is not used afterwards. Otherwise use Epot as an acronym.

p.4101, line 3: Again, replace 'rain-shading' with 'rain-sheltering'.

p.4101, line 10: Please change to '(P < 0.05 using a two-way ANOVA)'. Do the same in lines 11-12.

p.4101, line 26: Replace 'in' with 'for'.

p.4101, lines 26-27: Insert 'the' between 'with' and 'burned plots'.

p.4102, lines 1-2: Does this relate to Figure 3? If so, replace 'slower' with 'lower' since there is no time dependency.

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p.4102, line 15: Elevated variability compared or related to what?

p.4102, line 16: What do you mean by size classes in this context?

p.4103, line 14: Replace 'produced' with 'produce'.

p.4103, line 21: What do you mean by appreciated?

p.4105, lines 3-5: Poor grammar. Please rephrase.

p.4105, lines 8-10: What is the reasoning here?

p.4105, line 17: What is a 'sole season'?

p.4106, line 4: Do you really mean the unburned plots? Aren't these the burned plots? Please check.

p.4106, line 27: Add 'after rewetting', otherwise it is inconsistent with the following sentence.

p.4109, line 15: Replace 'produced' with 'produce'.

p.4109, line 20: Remove comma after 'season'.

p.4109, lines 23 f.: Indicate that you did not rewet the soil. Can it be expected that NO emissions are equally high for example after a second rain event three days after your first measurement?

p.4110, line 3: Remove 's' after 'savanna'.

p.4110, line 8: What do you mean by 'clay reach'? Do you mean soils with higher clay content?

p.4111, lines 1-3: What about CO<sub>2</sub>?

p.4112, lines 9: Replace 'Geochem.' with 'Biogeochem.'.

Figure 1: Add measurement depth in caption. Convert VWC to WFPS. Indicate that

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campaign 1 was one month after burning and campaign 2 was eight months after burning.

Figure 2: Indicate that campaign 1 was one month after burning and campaign 2 was eight months after burning.

Figure 3: Indicate that campaign 1 was one month after burning and campaign 2 was eight months after burning. Replace 'Water filled pores space' with 'Water-filled pore space'.

Figure 4: Use decimal point instead of comma in x-ticks labels.

Figure 5: Indicate that Panel A refers to campaign 1 one month after burning and Panel B refers to campaign 2 eight months after burning.

Figure 6: Use decimal point instead of comma in x-ticks labels. I'm not sure if size class is the right term.

Figure 7: Y-axis label in Panel A: Is it grams of soil dry weight (SDW)? Please add. The x-axis label of the insert says '% of WHC', the caption says '% of maximal water saturation'. I suggest standardizing all soil water units of the lab measurements to percentage of maximum water-holding capacity (% WHCmax).

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Interactive comment on Biogeosciences Discuss., 7, 4089, 2010.

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