

Interactive comment on “

Temporal and spatial variations of soil carbon dioxide, methane, and nitrous oxide fluxes in a Southeast Asian tropical rainforest” by M. Itoh et al.

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Reply to the comments of the Anonymous Referee #1

(RC) In this manuscript the authors investigated the environmental variables regulating soil trace gas emissions (CO₂, CH₄, and N₂O) at both temporal and spatial scales in a tropical rainforest in Peninsular Malaysia over a 2.5 year period. The topic is presented well and the experiment is carefully described. This paper builds upon results

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presented by Kosugi et al. (2007) of a similar topic. This study however focuses on a larger geographical area (two hectares) adjacent to the Kosugi et al. (2007) study, additionally they also investigate CH₄ and N₂O emission and look at how different environmental parameters relate to the trace gas emissions. This paper presents very interesting results which will contribute to a better understanding of trace gas emissions from tropical forests in Southeast Asia. With minor revision, I would deem this article suitable for submission in Biogeosciences.

(RC) Given my limited experience working with methane and nitrous oxide fluxes, I will limit my comments to the sections pertaining to CO₂ analyzes. I will begin with some more fundamental issues I have with the paper:

(AC) To general comment We thank you for suggestive comments. All comments contributed to improve our manuscript. We agree with most of your and the other referee's suggestion and revised much part of the manuscript. We would be grateful if this revised manuscript could be considered for publication. Thank you very much again.

1. Scientific merit: (RC) The authors need to take care when making the link between CO₂ concentrations and CO₂ production. CO₂ concentrations are highly sensitive to changes in soil moisture but this is largely because of the effect water in the soil profile has on gas diffusion. When soils get wet, the water in the soil profile acts as a diffusion block. Although the authors do calculate effective porosity, they do not explicitly calculate CO₂ production. One accepted approach worth considering is described by de Jong and Schappert (1972). In my opinion there is not a lot of value in presenting soil CO₂ concentrations alone, as it does not reflect belowground carbon dynamics, beyond highlighting the importance of soils as an important CO₂ storage medium.

(AC) Thank you for very important comments. As you suggested, we estimated CO₂ production in soil layer by using the method of Hashimoto et al. (2007) that is similar to the method of de Jong and Schappert (1972). Although we could estimate the produc-

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tion rates for only two sampling points where we collected data on hydraulic properties, we admitted our mistake in interpretation of our CO₂ profile data. Results of the estimation are shown in Fig. 5 in revised manuscript. As you indicated, CO₂ production in surface layer (0-15cm) was much higher than deeper layer and was comparable to the CO₂ emission from soil surface. This suggests that high CO₂ concentrations in deeper layers were attributed by limited gas diffusion. Increase in CO₂ concentrations with soil water content also supports this. Therefore, discussion section (4.1.1) was changed a lot. _____

2. Structure of the paper: (RC) a. Although I really like the way the introduction builds up, I think the authors should finish the introduction by explicitly outlining the objectives of their study. (RC) b. Additionally, I would like to see the discussion and conclusions link back to the overall objectives of the paper more frequently. By relating what was found in the study back to objectives will help improve the readability and the quality of the paper substantially.

(AC) We have revised the Introduction section according to your comment. And we also revised the discussion and conclusions. We hope our revised manuscript meet your requirement. _____

(RC) c. Some methods have been incorporated into the results section and some results have been incorporated into the discussion. This should be fixed by moving relevant text into the appropriate sections (see specific details below).

(AC) Thank you for your suggestion. We revised the results section according to your comment. _____

(RC) d. Data analysis section should be elaborated on.

(AC) As you and the other referees recommended, we created a new section for data analysis. _____

3. Specific comments: Introduction: (RC) P.6850 L.5: Change “to be determined” with

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“further investigation” (RC) P.6851 L.18: Change “belowground gas production below the ground surface” with “belowground gas production” (RC) P.6851 L.19: Delete “the” before soil water (RC) P.6851 L.27-29: I suggest adjusting the sentence slightly: “This suggests that not only the restriction of gas diffusivity due to increasing soil water, but also a degree of biological or chemical influence must be considered.”

(AC) Thank you for your good suggestion. We agreed with your suggestion and rewrote these sentences. We rewrote these sentences. Thank you for suggestion. _____

(RC) P.6851 L.6-10: Rephrase and incorporate into your next sentence. As it is now these sentences do not say very much.

(AC) Thank you very much. We revised this part. _____

Materials and Methods: (RC) P.6852 L.14: Please include elevation above sea level.

(AC) We added the information on asl level. _____

(RC) P.6852 L.24: I suggest adjusting part of the sentence to “(: :2003) which is less than in most other regions of Peninsular Malaysia” (RC) P.6853 L.10-14: To make this easier to read, what about saying the number of sampling visits made and in brackets put the exact dates.

(AC) Thank you very much. We revised these parts. _____

(RC) P.6853 L.10: There is a slight discrepancy between the dates listed here and the dates listed on Table 2 and 4. There is also one date missing here for CO₂ flux (14 September 2009). (RC) Table 2: Dates differ slightly from those reported in methods section.

(AC) Thank you for your pointing out our error. We correct this part. _____

(RC) P.6853 L.26: What was your standard gas for spanning the IRGA?

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(AC) We used the 451 ppmv CO₂ standard gas for spanning. We added this information to our manuscript. _____

(RC) P.6855 L.2-6.: Rephrase. Is it possible to state this more clearly?

(AC) We revised this part. Sorry for the inconvenience. _____

(RC) P.6855 L.14-16: I suggest adjusting the sentence slightly: "For gas samples obtained between 9 Jun2 2008 and 9 March 200, the CO₂ concentration was analyzed using an automated gas chromatography system detailed by Sudo (2006). (RC) P.6855 L.25: Add the word "Here" at the beginning of the sentence: "Here, soil temperature: : :". (RC) P.6855 L.26: Merge the two sentences: by adding "and" before soil water content: : :

(AC) We revised these parts. Thank you very much. _____

(RC) P.6856 L.4: To help clarify to the reader perhaps immediately state the that pH measurements were made on all sampling dates.

(AC) We measured soil pH once in March 2007. We added the term "once" to this sentence. _____

(RC) P.6856 L.6: Switch order of words: "Soil mineral" to "Mineral soil" (RC) P.6856 L.12: add "were" before then homogenized (RC) P.6856 L.15: I suggest adjusting the sentence slightly: "Root biomass samples were collected at four periods during the study (March, June and October 2008 and September 2009) at the 39: : :". (RC) P.6856 L.18: Combine the two sentences accordingly: ": : :5.1 cm), while in October 2008: : :".

(AC) We revised these parts. Thank you very much. _____

(RC) P.6856 L.24: Please add a sentence here to introduce the paragraph / analysis. It is not immediately clear why you are taking undisturbed soil samples. (RC) P.6856 L.24: Is it worth making this a new section? (RC) P.6856 L.24 to P.6858 L.10: Is it

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an idea to condense this section? It is very detailed and in retrospect these soil water retention data are not frequently used for your flux explanations.

(AC) We revised to shorten this part as you can see in the revised manuscript. We also add the reason for correct undisturbed soil sample. Thank you for your suggestion. _____

(RC) P.6858 L.11: Elaborate on the statistical analysis performed. What program was used?

(AC) As you and the other referee suggested, we made the new section on statistical analysis. _____

Results: (RC) P.6859 L.11-14: Perhaps more relevant for the site description (RC) P.6859 L.22-26: These are methods. Please move to the methods section. (RC) P.6860 L.6-10: These are methods. Please move to the methods section.

(AC) We moved these parts to the methods section. Thank you. _____

(RC) P.6859 L.26: New paragraph for "Spatially averaged coarse root biomass: : :"

(RC) P.6859 L.26: Does this refer to root biomass in the top 5 cm or the full profile?

(AC) We revised these parts and added the terms "in the top 5 cm soil". _____

(RC) P.6860 L.24-25: Add the standard error values for the spatially averaged CO₂ flux

(AC) We added the standard error values for both sampling days. Thank you. _____

Discussion (RC) P.6863 L.8-11: Rephrase, to better integrate it into your study. Or move this to the introduction, as a reason for continuing with this research (i.e. building upon a previous study)

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(AC) Thank you for your suggestion. We moved these parts to the introduction section.

(RC) P.6863 L.23-24: Please elaborate / explain how you can suggest that there was an increase in CO₂ efflux in deeper layers (see comment 1a)

(AC) Please see the response to the major comments 1. _____

(RC) P.6865 L. 11-14: Please rephrase or move to results, this is not discussion.

(AC) We moved these parts to the results section. Thank you. _____

(RC) P.6865 L.16-17: I suggest adjusting the sentence slightly: “: : at each chamber for the 3 measurement dates (3 March, 7 March, and 16 December, 2007) (Table 4)”.

(RC) P.6866 L.2: I suggest adding the following: “: : ;p<0.01), for each respective measurement date: : :”

(AC) We revised these parts, thank you. _____

Conclusions (RC) P.6869 L.16-27: Relate back to the objectives of the study.

(AC) Please see the response to the major comments 2. _____

(RC) P.6869 L.16-17: Remove the first sentence.

(AC) We removed this sentence, thank you. _____

Tables: (RC) Table 1: Why different sampling depth intervals for the three points?

(AC) This is because of the difficulty of taking undisturbed soil cores in deeper soil layer which was with many lateritic gravels. Also, at the point 1, we used the hand auger to collect the soil. Therefore, it is difficult to uniform the sampling depths. _____

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(RC) Table 4: delete “day” after each gas and measurement date section. Change to “10 obs. average”.

We deleted “day” from the Table 4, thank you. _____

Figures: (RC) Figure 2: For soil gas concentrations measurements (CO₂, CH₄, and N₂O) the points are often quite cluttered and it is difficult to distinguish them. Figure 3 and 6: Make the maps slightly larger to maximize use of space. This will help the reader see the maps better

We revised these figures as you suggested, thank you. _____

(RC) Figure 5: Why do you use API for spatially averaged fluxes and VSWC for temporally averaged fluxes?

(AC) As we explained in the manuscript, we found that API₃₀, which includes the recent history of soil water condition, explains the temporal variation of gas fluxes better than measurements of VSWC at sampling time. Temporally, VSWC or WFPS shows the water condition just on the time of gas sampling. In contrast, API values can reflect previous soil water condition. We think that there are lag times between the changes in water condition and microbial activities. Therefore, in this figures, we used API₃₀ for spatially averaged fluxes. In fact, VSWC showed no good relation to these gas fluxes.

References de Jong E, Schappert HJV (1972) Calculation of soil respiration and activity from CO₂ profiles in the soil. *Soil Science*, 119, 328-333.

Hashimoto, S., Tanaka, N., Kume, T., Yoshifuji, N., Hotta, N., Tanaka, K., and Suzuki, M.: Seasonality of vertically partitioned soil CO₂ production in temperate and tropical forest, *J For Res.*, 12, 209–221, 2007.

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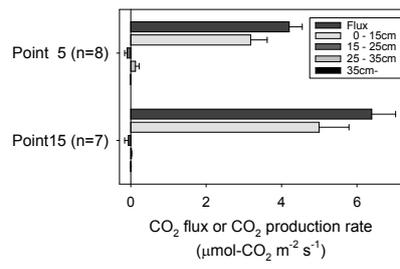


Fig. 1. Fig. 5. Temporally averaged CO₂ flux from the soil surface and vertical profiles of CO₂ production rates at points 5 and 15. Data are the mean values of all sampling days for each sampling plot. Error

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