**Biogeosciences
Discussions**

Interactive comment on "Continuous measurement of soil CO$_2$ efflux in a larch forest by automated chamber and concentration gradient techniques" *by* N. Liang et al.

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Firstly, would like to thank you very much for your kindly comments and for your time. Followings are our simple answer to your comments, also you can check the detail answers from our revised manuscript.

1. Comment 1 (1. Out of focus of this ms. I couldn't find the objectives of this paper. It seems not very clear to me that authors try to compare the two techniques (chamber vs gradient), or try to study the annual sum of soil respiration, or try to study the seasonality of Q10.)

Answer: We have revised the manuscript. It focused on the comparison of the two

powerful systems for continuous measurement of soil CO$_2$ efflux. With the additional laboratory experiment, we could point out the bias of the gradient system for estimating annual soil CO$_2$ efflux.

2. Comment 2 (2. As I pointed out in my 1st review, there are quite few issues in the methodology used in the research. I don't think authors pay enough attention to all the requirement to make the accurate soil CO2 flux measurement.)

Answer: We reviewed many old and new articles recently, and we learned many new knowledge that is useful for our future studies.

3. Comment 3 (3. Also I am questioned the validity of gradient technique to estimate the soil CO2 flux, although the method gained some popularity recently. The equation (2) (Rs=-DsdC/dz) used by the author assumes no source or sink term for CO2 between the two CO2 probes. But we all know this assumption can't be held in the soil profile, esp near the soil surface. So my question is; how can you account for the source term above the upper probe or between the two probes in the equation (Eq. 2) when you use this method to estimate the soil surface CO2 flux? How do you account for the influence of changing in soil moisture in the field if you measure the air-filled porosity in the lab (Eq. 3)? As we all know air-filled porosity changes as volumetric water content change.)

Answer: Firstly, there are no standards for accurate measurement of soil CO$_2$ effluxes under the field conditions. However, There has been a growing interest in the role of soil effluxes in the global carbon cycle, particularly the response and feedback of soil CO2 efflux to the rapid changing climate system. For understanding the behaviors of soil efflux, we need the cost-effective system that can make continuous monitoring soil efflux. Therefore, we developed the two systems, automated chamber and soil CO$_2$ concentration profiles. We have conducted many comparisons (field campaign) with other systems and, recently, this chamber system has been employed by more than 20 projects for continuous measurement of soil efflux in various ecosystems, including

the tundra in west Siberia, boreal forest in Alasika, cool- and temperate-forests in East Asia, and subtropical and tropical forests East and South East Asia. Moreover, since we, Hirano et al. (2003), Tang et al. (2003) and Liang et al. (2004) first introduced a modified soil CO2 gradient technique by using small solid-state NDIR CO2 sensors (Vaisala) buried in the soil to deduce soil respiration, the technique has been gaining popularity rapidly because it allows to continuously measure soil efflux with minimal disturbance to the natural soil structure upon installation. As we pointed out in the manuscript, however, there are several negative aspects of applying the Vaisala CO2 sensors: (1) non-automatic correction of CO2 concentration for changes in temperature, pressure, particularly humidity inside the cell, (2) heating of the soil when the sensor is activated constantly, and (3) difficulty in estimation of an accurate diffusion coefficient. In this study, we installed a small pressure transmitter and thermocouple into the sensor casing for concentration calibration, and programming-controlled the power on and power off of the sensors during the field measurement for avoiding warming the soil. However, we could not solve the other problems, particularly could not estimate the natural diffusion coefficient. Therefore, in the conclusion section, we suggest that developing "new models capable of accurately calculating soil gases diffusion coefficient are urgently needed for improving the soil CO2 gradient technique ".

4. Comment 4 (4. Again I still have some difficulties to believe the seasonal change of Q10. I think the variation of Q10 most likely was due to the mismatch of temperature measurement and location of soil respiration or due to different soil moisture content across the whole season, not likely due to temperature sensitivity of microbial activity over the season. See (Davidson et al.,2006) for more on this.)

Answer: There is increasing evidence that Q_{10} of soil CO_2 efflux is not seasonally constant and tends to (1) abioticaly: increase with decreasing temperature and increasing soil moisture, and (2) biotically: associate with canopy process (photosynthesis) and belowground activities (e.g. root respiration, ectomycorrhizal fungi production). From

our data, we could detect that the large seasonality of Q10 was dominated by root respiration during the growing season and driven by temperature during the non-growing season.

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