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Biogeosciences Discussions

Interactive comment on "CO_2 flux determination by closed-chamber methods can be seriously biased by inappropriate application of linear regression" *by* L. Kutzbach et al.

L. Kutzbach et al.

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Thank you very much for the careful review, constructive critique, the hints to weak points and open questions in our study, and the many very useful suggestions to improve the manuscript. Sorry for not using the Interactive Discussion tool for more intense and quicker exchange of ideas. The substantial delay of this response is due to many unexpected organisational problems during our field campaigns in Russia this summer and unexpectedly long field stays of our first author Lars Kutzbach. In the following, we will answer all comments of reviewers #2. First, we will repeat the comment of the referee and then we will give the respective answers. We will submit a considerably revised manuscript in which much of the reviewers' comments will be reflected.

GENERAL COMMENTS

"The authors state that the initial flux at the moment of the closing of the chamber is the most correct flux estimate. This is in accordance with the theory presented in the paper, as at the zero moment the change in concentration itself has not yet impacted the flux. However, while the theoretical presentation of the measurement affecting the measurand seems sound, in practice the initial concentration readings during the flux measurement are often disturbed by the chamber deployment, possible lag in the sensor response etc. Therefore, I suggest the authors comment on how the high level of noise in the initial flux readings affects the curve fitting. Another related issue is the varying measurement practices regarding the starting moment of the measurement. Especially with manual chamber measurements and manual recordings, the measurement does not always start at the moment when the chamber is placed in the collar. This may even be a conscious choice: the measurement is started when, by a subjective decision, the sensor seems to have stabilized. In such cases, the recordings at the zero moment may actually not have been taken at the true zero moment (chamber placement). The authors should state explicitly how the measurements in the different sites were conducted in this respect. Furthermore, it would be of value to know, whether the data was filtered in any way, for example if some strange-looking initial concentration readings were excluded. In case of the manual measurements, the data might have been filtered already in the field. The authors state in the practical recommendations that "... the interval length of discarding data at the beginning to avoid disturbance is critical and should not be too long", but they should also discuss the impact of the possible delay on their results."

–>Answer: We will state explicitly how the measurements in the different sites were conducted with respect to the initial data discarding. We see increased noise levels at the experiment start more often and to a stronger degree in the data from Linnansuo and Samoylov and less often and to a lesser degree in the Salmisuo and Vaisjeäggi datasets. For the Linnansuo dataset, the first 3 measurement points (30 s) were dis-

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carded. For Samoylov, the first concentration measurement point was discarded (45 s). For Salmisuo, the first 10 measurement points were discarded (10 s). For Vaisjeäggi, no measurement points were discarded. We will include this important information into Table 1. There was indeed some filtering to exclude data which appeared strongly disturbed. For Linnasuo data, there was a visual inspection of c(t) curves, and curves that looked really bad were discarded right away (6.1% of the experiments). All curves were filtered after regression analysis using the standard deviation of the residuals of the exponential regression function as indicator of experiment noise. Thresholds of residual standard deviation, which indicated unacceptable noise were 1.6 ppm for Salmisuo, 1.2 ppm for Vaisjeäggi, 2.2 ppm for Linnansuo and 1.7 ppm for Samoylov. We will include this important information in Table 1 as well. We will add a discussion on how the discarding of early measurement points impacts the flux estimate at page 2307, after line 25: “The approach of generally discarding some early measurement points and delaying the start point of the experiment t0 = 0 leads to lower estimates of the initial slope as the slope is greatest directly after chamber closure according to the exponential and the NDFE model. Therefore, the deviations between linear and exponential regression would be even greater without data discarding at the experiment start.”

SPECIFIC COMMENTS

“Give more details on the chambers: automatic or manual, chamber dimensions.”

–>Answer: Chamber dimensions are already given in Table 1, we will give more information in Chapter 5 on the methodology: All experiments were performed manually, robust boardwalks with vertical poles and chambers at least 1.5-2 m distance from the poles.

“In Introduction (last paragraph), the authors write that they study the flux estimation method in vegetated surfaces. However, one of their study sites, Linnansuo, is a cutover peatland with no vegetation. This fact makes Linnansuo data set different from the others, because in the curve estimation the photosynthetic processes can be elim-

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inated. In Results (6th paragraph) the authors write, regarding the Linnansuo dataset "rather many of these regressions showed curvatures not conforming with the theoretical model". However, in Discussion (fourth paragraph) they state: "Modelling... is more complicated for vegetated surfaces than for bare soil surfaces". The data could be more thoroughly examined from the point of view that only respiration is measured in Linnansuo."

–>Answer: We will use the Linnansuo dataset to compare the performances of the exponential model and the NDFE model proposed by Livingston et al. (2005, 2006). Separation of the complete dataset in groups regarding night or day, dry or wet, vegetated or non-vegetated is planned for a following paper (see also answers to reviewer #1). For this paper, we would like to stick to a more general overview of the appropriateness of linear and nonlinear models looking at the large database as a whole.

"Discussion (4th paragraph): the authors list the changing chamber temperature, photosynthetically active radiation and the change in headspace turbulence as factors that may have caused the unexplainable curvatures of the exponential model. Were the chamber temperature and photosynthetically active radiation during the measurement known? Could the data be divided into different categories based on whether the temperature and/or radiation conditions were constant or not and the model behavior in each category then examined? Then it might be possible to evaluate to which degree the changing temperature and radiation affect the model behavior. Especially in Linnansuo and Samoylov sites where no cooling system was used, the assumption of a constant temperature may not hold. In particular, the chamber temperature is Samoylov is bound to rise considerably when the level of photosynthetically active radiation is high, as the closure time is quite long."

–>Answer: This is a good idea. However, we do not have all required data available for all datasets. However, in the Salmisuo dataset we found many experiments with stable temperature (cooling system) and constant radiation which nevertheless showed the "unexplainable" curvature. Therefore, we think that the artificial change of turbulence

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beneath the chamber is most likely a major reason causing “unexplainable” curvatures. Also, the effect of pressure disturbances across the soil-atmosphere interface cannot be ruled out (see also answers to reviewer #1). However, we are investigating this issue more thoroughly and plan to address it in a following paper. In fact, there is a clear need for research about this problem which could turn out to be very serious for chamber measurements in general.

“Discussion, practical recommendations, 8th bullet: The authors state that the changing light, temperature and humidity conditions can be accounted for by nonlinear functions. This statement does not seem to be entirely consistent with what was written in the earlier part of Discussion (fourth paragraph). To my understanding, the authors did not actually attempt to use such nonlinear functions to eliminate the problem caused by varying environmental conditions. Therefore, this idea should be properly tested before it can be recommended.”

–>Answer: We agree with you, retract this statement and change the text to: “Light, temperature and humidity conditions as well as wind speed and turbulence during chamber closure should be as similar as possible to the ambient conditions. Changes of light, temperature and humidity would change plant physiology and thus complicate the form of the c(t) curve whereas artificial changes of pressure, wind and turbulence may additionally impact transport processes and thus even compromise the assumption that the initial slope of the c(t) is the best estimator of the predeployment CO2 flux (Hutchinson et al., 2000, Hutchinson and Livingston, 2001).”

TECHNICAL CORRECTIONS

“The last equation lacks a number. Table 4. In the caption, flin,(t0) should be fqua,(t0).”

–>Answer: These technical errors have already been corrected during the galley proof stage for Biogeosciences Discussions.

Interactive comment on Biogeosciences Discuss., 4, 2279, 2007.