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Biogeosciences Discussions

Interactive comment on "How many measurements are needed to estimate accurate daily and annual soil respiration fluxes? Analysis using data from a temperate rainforest" *by* Jorge F. Perez-Quezada et al.

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Response to Anonymous Referee #1

(Attached are revised versions of Figures 2 and 4)

General Comments

This paper is well written and presented. The specific questions the authors address are 1) to assess the performance and accuracy of different numbers of measurements per day 2) compare the performance of linear vs non-linear gap filling based on sam-

pling frequency 3) analyze the effects of including night time respiration measurements on estimations of daily and annual respiration.

I disagree with the authors that questions still remain on how many samples are needed per day; this has been addressed in the literature, which the authors cite. I do agree with the authors that how many samples per year as well as gap filling techniques are issues that need addressed. The authors presented a good examination of issues related to sampling frequencies, gap filling strategies and methods for assessing their performance.

R: In relation to the question of how many samples are needed per day, we believe this is still an open question. According to the literature review, presented in Table 1, more than half of the studies made in temperate forests only used one sample per day (publication dates range from 1998 to 2015). We think a minimum of two samples per day, as in the case of our site, may be more appropriate for other sites as well and, ideally, the number of measurements per day should be assessed at the beginning of every study.

This manuscript is very useful to researchers planning an effective sampling strategy and contributes to the overall understanding of estimates of daily and annual respiration. I have a couple of issues that the authors should address:

1. The authors used only 3 chambers to represent the "true" soil respiration from their site. In the Davidson et al. 2002 paper that the authors cite, they have a table showing how many soil respiration measurements are needed to be within a certain % of the "true" population mean in a northern temperate forest. Using this as a guideline, the authors, having used only 3 chamber measurements at their site, may only be within $\pm$50% of the true population mean. This is something that I think the authors should address in their discussion. Their manuscript is intended to give guidance as to sampling frequency and so they should also reference how many samples may be necessary to capture the "true" respiration mean per site.

R: We agree with the reviewer. We have a total of five chambers installed in our site, but for two of them we did not have a complete data set. What we meant by true mean was in terms of the temporal variation in soil respiration, and not the spatial variation. We need to explain this in the Methods section (Page 5 Line 4) and, as suggested by the reviewer, discuss it at the beginning of section 3.1 (Daily and annual Rs fluxes and environmental variables).

2. I understand the use of only the soil temperature model for gap filling since the authors did not see an increase in model fit when adding soil moisture. However, my concern is that there are issues with the soil moisture measurements, the wide range in soil moisture measurements among the 3 respiration chambers is somewhat suspicious. Not including moisture in the gap filling model may have changed the outcome of non-linear gap filling strategy. Can the authors comment on their moisture measurements and the potential impact on their gap filling results? There are also questions regarding the soil moisture measurements below.

R: We respond to this comment in the next question.

Scientific Questions

Pg 4 line 29: Did the authors conducted a soil specific calibration for the CS616 probes or use the supplied calibration equation? The bulk density of the soil shows a very wide range in Table 2 and these types of probes do not function as well in soils with low bulk density. Further Figure 4c graph shows a very large range of measured soil water contents among the 3 probes, this might be more related to the calibration equation used than to a true range of soil moisture at the site.

R: The reviewer is right; we had not conducted a previous calibration for the CS616 sensors, although we made gravimetric water content measurements for the three sensors separately. Now we include corrected soil water contents based on the calibrations of the CS616 readings contrasted with true volumetric water content measurements. These true water content measurements were calculated on the basis of gravimetric

water contents and soil bulk density data. As a result of the calibration, the range in soil moisture, as shown in Figure 4C, decreased.

With the corrected values of soil water content, we tested if the non-linear model improved in terms of its performance when adding this variable, not finding new results. The variation of the mean value of soil moisture does not change much during the year (Figure 4C-revised).

Pg 6 line 6: The equation presented here is the Van't Hoff equation: although cited in the Lloyd and Taylor 1994 paper, it is not their equation.

R: We need to correct this.

Pg 7 line 3: The authors talk about low variability in the cold month and higher in warmer. Can the authors add estimates of the coefficient of variation for these periods?

R: We need to reword this sentence. In fact, if we look at the coefficient of variation of each season (winter 15.9 %, spring 18.3%, summer 18.9%, fall 12.6%), there is not a big difference. We thank the reviewer for the comment that made us realize this and will add these estimates of CV to the text.

Figure 4a: The authors use Rs in umols m-2 s-1 in this graph; but use mg in other graphs. It would be preferential to use one type of unit throughout the manuscript. Also note that Figure 4a is missing the u in the y axis label.

R: We changed the units in Figure 4A to g m-2 day-1 (see Figure 4-revised), so this unit is the same as in Figure 5, where we report the statistics of the estimation of daily Rs. We prefer to keep the unit in kg m-2 yr-1 in Figure 6 because it is the most commonly used unit for yearly estimates of Rs.

Please add the units for soil water content-. these are missing on graphs and in the text.

R: we have added the units of soil water content to Figure 4C (see Figure 4-revised)

and in the text, as solicited.

Technical Correction

Figure 2: please label the secondary y axis.

R: We corrected Figure 2 (see Figure 2-revised).

Figure 4c: please label the y axis

R: we have added the label to the y axis in Figure 4C (see Figure 4-revised).

——————— Figure Legends

Figure 2: Mean long-term (1999–2012) (black) and August 2013-August 2014 (white) monthly precipitation (bars) and air temperature (circles).

Figure 4. Daily mean Rs (A), soil temperature (B) and soil water content (C) measured at 5 cm depth. Shaded area represents the minimum and maximum range of three sampling points.

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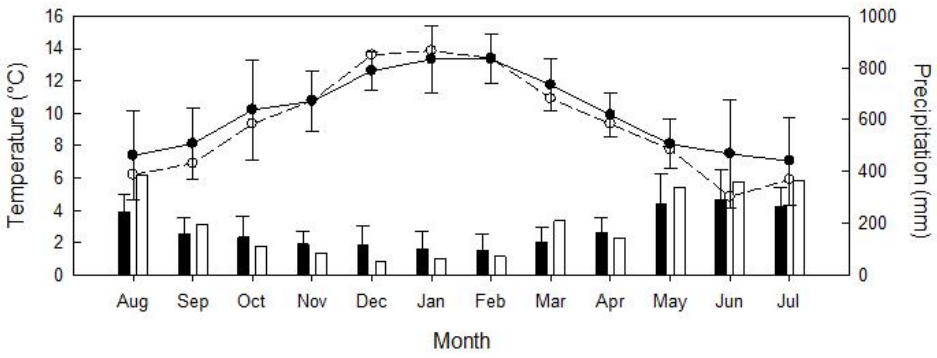

Fig. 1. Figure 2-revised

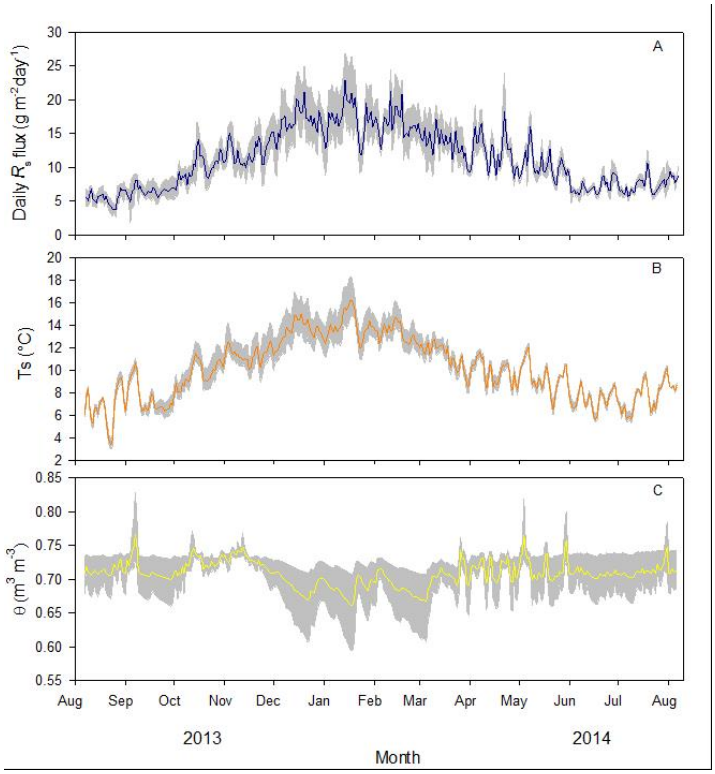

Fig. 2. Figure 4-revised