

List of changes done in manuscript bg-2009-272-discussions:

“Ventilation of subterranean CO₂ and Eddy covariance incongruities over carbonaceous ecosystems”

Here are in detail the changes done in the manuscript according to the referees' and editor's comments.

CHANGES RELATED TO COMMENTS OF REFEREE # 1:

Comment 1) Page 10919 lines 4 and 10 we have changed “error” to “difference”

Page 10919 line 11: Equation 2 has changed to:

$$\varepsilon_r = \frac{\varepsilon}{\left(\frac{\overline{F_1} + \overline{F_2}}{2} \right)} \cdot 100$$

Page 10919 line 10 we have changed “...the average of F_1 for the whole data set” to “the average of the fluxes measured by both EC systems, as follows:”

Page 10919 line 13 we have eliminated “for the whole data set”.

Page 10919 lines 14-15 we have changed “ F_1 was calculated as the average of the absolute values of F_c for the whole data set” to “ $\overline{F_1}$ and $\overline{F_2}$ were calculated with the absolute values of F_c ”.

Page 10919 line 15 we have changed “ F_1 was a normal average” to “ $\overline{F_1}$ and $\overline{F_2}$ were calculated as a normal average”.

Page 10920 line 19 we have changed “33%” and “74%” to “32.3%” and “81.5%”, respectively.

CHANGES RELATED TO TO THE COMMENTS OF REFEREE # 2:

Comment 1) We have replaced “caves” by “cavities” throughout the text.

Comment 2) Page 10916, line 12 changed to: “Measurements of CO₂ flux (F_c), evapotranspiration (also referred to as latent heat flux, LE) and sensible heat flux were carried out using....”.

Comment 3) Page 10916, line 25, we have added 2007 after “mid-October,”.

Comment 4) Page 10917, line 7, we have changed the address to “Hayward, CA, USA.”

Comment 5) Page 10917 line 14 to line 19 we have changed “We compared.....EC sensors.” to “The FSAM model calculates the footprint function in the horizontal plane, calculating the minimum area responsible for a given % of the total source weight. According to the footprint function, there is a source point that has the maximum relative source weight of all the source area of the sensor (referred to as the point of maximum source weight) and from this point the source weight of the source area falls towards all directions (Schmid, 1994, 2002). We have considered the dimensions of the source area responsible for the 50% of the total source weight (hereafter referred to as 50% source area) calculated with FSAM. This source area includes the point of maximum source weight, and according to Schmid (1997) a flux source point located on or outside the 50% source area boundaries would have to be from 5 to 10 times stronger than the point of maximum source weight, in order to achieve a similar response on the EC sensors.”

Comment 6) Page 10916 after line 6 we have inserted this text: “The FSAM model calculates the dimensions of the source area, by calculating the distance from the sensor of the near-end and far-end boundaries of the source area. At a given wind direction, the dimensions of the source area vary with the atmospheric stability conditions. Thus, as the stability conditions get more unstable (corresponding to smaller values of $(z_r - d)/L$, the dimension of the source area decreases, and it gets closer to the sensor, meaning that both the near- and far-end boundaries of the source area get closer to the sensor. The opposite occurs when the conditions get more stable (higher values of $(z_r - d)/L$).”

Page 10916 lines 7-10 have been changed to “Therefore, in order to obtain the maximum and minimum dimensions of the 50% source areas, we ran the FSAM model using the maximum and minimum values of $(z_r - d)/L$, and an averaged σ_v/u_* , for each range of stability conditions.”

Page 10920 lines 25-27 have been changed to: “Figure 5 represents the minimum near-end (smaller circles around the sensor) and maximum far-end (larger circles around the sensor) of the 50% source areas calculated with FSAM for each EC system mounted in separate towers, both for the data with unstable conditions and for the data with near neutral conditions. Therefore, the area comprised within both circles, is the area that includes all the 50% source areas of each EC system for every wind direction and stability condition found during the period studied.”

Comment 7) Page 10921 lines 2 and 5, we have changed “upwind” by “far-end”.

Page 10933, Figure 5 caption has been changed to: “**Fig. 5.** Schematic representation of the area comprised between the near-end and far-end boundaries of the 50% source areas calculated with FSAM for EC₁ (light white) and EC₂ (black stripes), mounted on separate towers, and for unstable atmospheric conditions and near-neutral atmospheric conditions. The arrows indicate the direction from where the wind is coming, separated in 45° angles, being the length of the arrow the proportion of the total data coming from that specific 45° wind direction”

CHANGES RELATED TO THE COMMENTS OF THE EDITOR:

MAJOR COMMENTS:

Comment 1) Page 10919 line 3 we have change “On one hand,” by “Firstly”.

Page 10919 line 4, after the full stop we have inserted the following text: “To verify how significantly different from one and zero were the slopes and y-intercepts obtained from the linear regressions, as a measure of the difference between both EC system measurements, we performed two statistical analysis. On one hand, we used a t-test to check if there were significant differences between the linear regression and a linear model where the y-intercept was set to 0. On the other hand, we used an ANOVA test to check if there were significant differences between the linear regression and a linear model where the slope was set to 1. Significant results ($p\text{-value} < 0.05$) would indicate that the y-intercept is significantly different from 0, or the slope is significantly different from 1, and a non significant result ($p\text{-value} > 0.5$) would indicate that for the data used we can assume that the y-intercept is not significantly different from 0, and the slope is not significantly different from 1. This statistical analysis was made with the R programme (R development core team, 2008).”

Page 10920 line 18, after the full stop we have inserted the sentence: “Moreover, results showed that the slope of the regression for LE was not significantly different from 1, whereas for F_c the slope was significantly different from 1 (Table 2), showing that the agreement between EC1 and EC2 for LE was much higher than for F_c .”

Page 10920 line 22, we have changed the full stop to a comma and added: “..., where the slope of the regression for the biological period was not significantly different from 1, whereas for the abiotic period it was significantly different from 1 (Table 2). For the

biological period the y-intercept was significantly different from 0, however its magnitude was small ($0.3 \mu\text{mol m}^{-2} \text{s}^{-1}$, Table 2).”

Page 10925 line 30 we have added the following reference: “R Development Core Team: R: A language and environment for statistical computing, R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org>, 2008.”

Page 10928 we have changed Table 2 to:

Table 2. Parameters of the linear regressions (slope and y-intercept), coefficient of determination (R^2), the root mean square error (ε) and the relative root mean square error (ε_r) obtained by comparing F_c and LE measured with EC₁ and EC₂. Y-intercept and ε values for F_c and LE are in $\mu\text{mol m}^{-2} \text{s}^{-1}$ and W m^{-2} , respectively. Parameters were obtained for the total set of data ($n = 665$), and for the biological ($n = 248$) and abiotic periods ($n = 252$), separately. Significance codes, from least to most significant, indicate: “n.s.” (not significant) $p > 0.5$; “*” $0.05 > p > 0.01$; “**” $0.01 > p > 0.001$; “***” $p < 0.001$.

		slope	y-intercept	R^2	ε	ε_r (%)
Total data	LE	0.99 ^{n.s.}	2.5 [*]	0.71 ^{***}	14.23	32.3
	F_c	0.82 ^{***}	-0.39 ^{***}	0.76 ^{***}	0.82	81.5
Biological period	F_c	0.97 ^{n.s.}	-0.3 ^{***}	0.81 ^{***}	0.64	61.3
Abiotic period	F_c	0.60 ^{***}	-0.26 ^{***}	0.73 ^{***}	0.95	102.6

Comment 2) Page10922 line 7 before: “Recent works....” we have included the following paragraph: “The CO₂ is a gas with an important effect in the atmosphere as a greenhouse gas, hence the importance of studying the accurate exchange flux of this gas between the surface and the atmosphere. Moreover, CO₂ is a key molecule in the carbon cycle of ecosystems, due to the photosynthesis and respiration processes taking place at vegetation and soil levels. In this work, we address the importance of the CO₂ stored in the pores and cavities of the sub-surface of carbonate ecosystems in the net exchange of CO₂ between the surface and the atmosphere.”

Page 10922 line 21 to Page 10923 line 4, we have changed the text to: “At first, we compared the measured evapotranspiration (LE) and CO₂ flux (F_c) of two separate EC towers (EC1 and EC2). We have considered LE as a control value to compare with F_c , because LE originates at the surface of the ecosystem, through the evaporation of the soil and vegetation surface, and the transpiration of vegetation. Results show that the

agreement between EC1 and EC2 is better for LE , than for F_c (Fig. 3 and Table 2). Secondly, we compared F_c from the two EC in periods with predominance of biological surface processes (biological periods), with higher SWC that favour photosynthesis and respiration, and in periods with predominance of ventilation sub-surface processes and low biological activity (abiotic periods). We observed that the agreement between both systems was very good in the biological period (Fig. 4 and Table 2), whereas in the abiotic period there was a clear disagreement between the two EC systems (slope = 0.6 and $\varepsilon = 0.95 \mu\text{mol m}^{-2} \text{s}^{-1}$, in Table 2). The presence of positive F_c data in the biological period, indicating release of CO_2 , can be due to high respiration rates after a rain event (Schwinning and Sala, 2004).”

Page 10921 line 6 after the full stop we have inserted the following paragraph: “An analysis of the data from the biological and abiotic periods separately, showed that during the biological period 86.3% of the data corresponded to unstable atmospheric conditions, and 53.9% of the wind directions came from the North to East directions, and 23% came from the South. In the case of the abiotic period, 95% of the data corresponded to unstable atmospheric conditions, and 76% of the wind directions came from the North to East directions, and 15% came from the South. Therefore, for both periods more than 50% of the wind direction came from the North to East directions where the higher differences between the footprint of both EC1 and EC2 are observed (Fig. 5, unstable conditions).”

Page 10923 line 10 after the full stop we have inserted the following text: “Although for the biological period there is a fairly higher percentage of data with wind directions from the South, where the difference between the footprints of EC1 and EC2 are lower (Fig. 5), compared to the abiotic period (23% and 15%, respectively), we think that this is not enough to explain the clear difference in the agreement of both EC systems observed for the biological and abiotic periods.”

Page 10923 lines 10-11 we have changed “To reinforce this explanation,...” to “To reinforce the idea of the heterogeneity of the sub-surface of the ecosystem to explain the disagreement between the EC systems,...”.

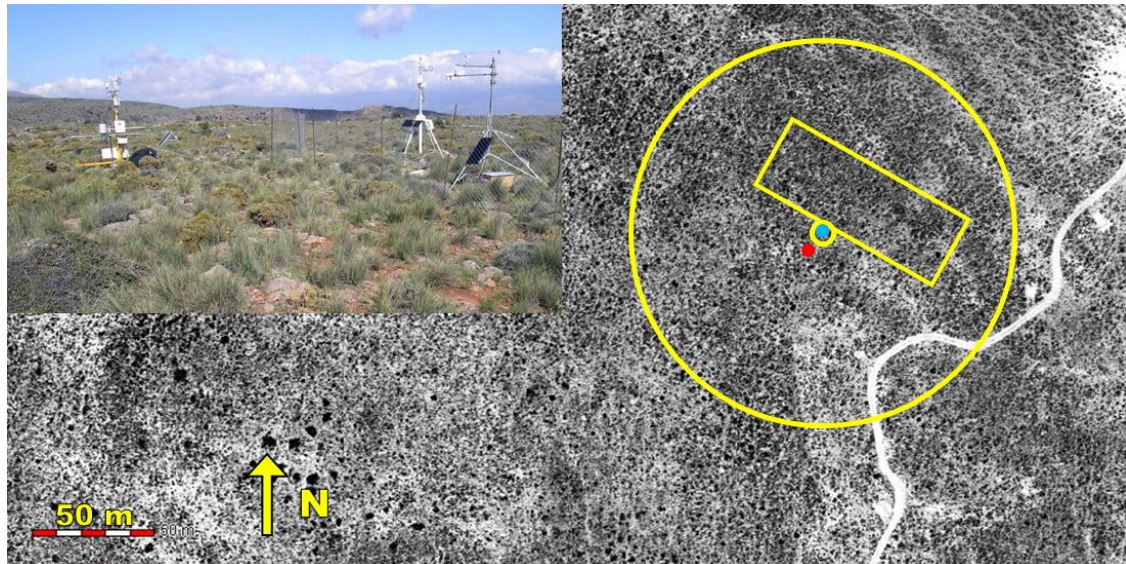
MINOR COMMENTS:

Comment 1) Page 10914 line 24, we have replaced “underlying vegetation” by “underlying surface”.

Comment 2) Page 10914 line 26 we have added “towers” after “EC”.

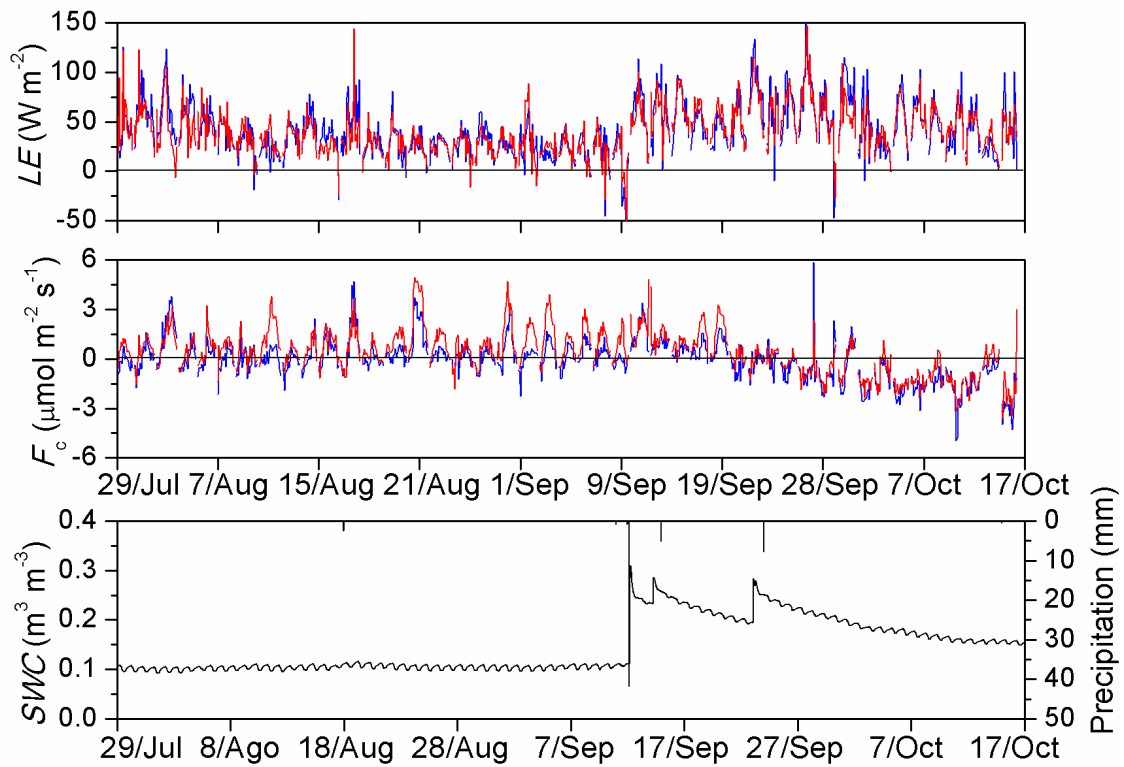
Comment 3) Page 10917 line 23 we have changed “three input parameters” to “three dimensionless ratios”.

Comment 4) Page 10929, Figure 1 has changed to:



Page 10929, figure’s caption has changed to: “**Fig. 1.** Ortoimage of the measuring site, and the position of the two EC (EC₁: red point; EC₂: blue point). The rectangular area measured with the GPR, and the boundaries of the source area of EC₂ obtained with the footprint analysis (see Fig. 5 - unstable conditions) are shown. A picture of the site where both EC can be seen is shown on the upper left corner of the figure.”

Comment 5) Page 10930, Figure 2 has changed to:



Page 10930, in the figure's caption we have changed "grey line" to "red line" and "black line" to "blue line".

Other relevant changes done in the revised manuscript:

We have changed "carbonaceous" to "carbonate" throughout the text, including the title. In Acknowledgements we have included the following fundings: EU-FP7 (grant 205294), and Spanish projects TEC2007-66698-C04-02, CSD2008-00068, DEX-530000-2008-105 and TIC1541.