We thank the referees for taking the time to review our manuscript. We greatly appreciate the referees' in-depth reviews and constructive comments. The following pages contain our responses to each of the comments from the referees and detail the changes we have made as a result of remarks from both referees.

Responses to the reviewer are in *Italic style*

J.-A. Subke (Referee #1)

This study is highly relevant for flux measurements in semiarid regions where deep CO2 sources and reservoirs can be flushed from the soil surface in response to pressure fluctuations. The data show a compelling influence of pressure variations on apparent soil CO2 efflux rates that could be erroneously interpreted as biologically controlled.

The fact that this is a one-off observational study rather than a replicated experiment does on my view not limit its value. It is important to draw attention to the existence and extent of the role of deep soil CO2 sources and storage, and this study clearly achieves this. Future work is likely to address more detailed investigations into this field.

I think that this study can be published pretty much in the form it is in now. I only have one comment regarding the final paragraph of the introduction (p. 5594, l. 7-14), where I suggest that you limit yourself to the key aims of your investigation in relation to the soil gas storage and transport issues you have outlined in the preceding paragraphs, and possibly outlining also the methodological approach. Don't however summarise results this is appropriate for the abstract, but should not in the Introduction.

Response: We agree with the reviewer and we have made the requested change.

"At a nearby experimental site, it was found that wind provoked deep CO_2 emissions to the atmosphere (Sanchez-Canete et al. 2011). Also, at this very experimental site, the wind was found to be the main driver of large CO_2 emissions to the atmosphere (Rey et al. 2012a), suggesting a possible geothermal origin (Rey et al. 2012b). Given these precedents, our objective was to determine the main drivers involved in subterranean CO_2 ventilation and thereby improve knowledge of this little-studied process. Hypothesizing that these CO_2 emissions to the atmosphere could be the result of CO_2 transported from depth towards the surface, we installed a vertical soil profile to monitor subterranean CO_2 variations at depth (0.15, 0.5 and 1.5 m) during two years in this semiarid ecosystem. "

Reviewer #3:

The authors present results from an interesting study on soil gas transport, which, I think, is a valuable contribution for the scientific community… There are some minor issues that I would like to address, especially regarding the statistics, and information on the study site. But I believe that the paper is overall interesting and substantial, and therefore I recommend publishing after appropriate revision.

- I would be strongly interested to see also the correlation coefficients of the non standardized data or at least of data standardized for time span which includes the periodicity of soil moisture changes… I recommend to include the correlation coefficient for the entire seasons in Table2 and 3.

Response: We agree with the reviewer and have included a new table with the correlation coefficients of the non-standardized data for the entire seasons (new table 2).

	Growing period			Dry period		
	0.15m	0.5m	1.5m	0.15m	0.5m	1.5m
Ustar	-0.08	-0.17	-0.01	0.23	0.06	0.06
T 0.1	-0.01	-0.13	0	**0.29**	0.11	0.12
SWC 0.1m	0.08	0.26	0.05	-0.28	-0.11	-0.12
T 0.5	-0.17	-0.27	-0.2	-0.02	-0.02	0
SWC 0.5m	**0.37**	**0.50**	0.27	0.01	0.02	0
T 1.5	0.25	0.28	0.1	-0.01	-0.03	0
SWC 1.5m	-0.02	-0.02	0	0.01	0.04	0
Pressure	0	-0.13	**-0.39**	-0.18	**-0.46**	**-0.43**

- Another related question: a window of 0.5 days was chosen to focus on the semi-diurnal changes, like those of the barometric pressure wave and deep soil CO2? What does this mean for if the other parameters which have a periodicity of 24 h like the temperature?

Response: We have done the calculations for a periodicity of 24h; these are shown (shaded columns) in the following tables:

	Growing period								
	Shallow			Deep					
	0.15m			0.5m			1.5m		
Window (Days)	0.5	1	3	0.5	1	3	0.5	1	3
u*	0	0	0.01	0.01	0	0	0.05	0	0
T 0.1	0.66	0.54	0.21	0.21	0.12	0.1	0.23	0.13	0.12
SWC 0.1m	0.58	0.64	0.16	0.23	0.16	0.11	0.24	0.11	0.05
T 0.5	0.04	0	0.03	0.12	0.04	0.03	0.12	0.03	0.01
SWC 0.5m	0.05	0.01	0.05	0.12	0.04	0.03	0.15	0.04	0.03
T 1.5	0.3	0.04	0.16	0.39	0.15	0.12	0.38	0.14	0.1
SWC 1.5m	0.37	0.07	0.16	0.4	0.15	0.12	0.39	0.14	0.1
p	0	0	-0.13	-0.06	0	-0.35	-0.23	0.04	-0.43

	Dry period								
	Shallow			Deep					
	0.15m			0.5m			1.5m		
Window (Days)	0.5	1	3	0.5	1	3	0.5	1	3
u*	0.53	0.36	0.24	0.04	0.04	0.05	0.08	0.07	0.06
T 0.1	0.46	0.36	0.32	0.05	0.06	0.1	0.12	0.11	0.1
SWC 0.1m	-0.46	-0.36	-0.33	-0.07	-0.08	-0.11	-0.14	-0.13	-0.12
T 0.5	-0.38	-0.15	-0.03	-0.06	-0.04	0.01	-0.12	-0.07	0
SWC 0.5m	0.39	0.17	0.03	0.07	0.02	0	0.13	0.05	0
T 1.5	-0.09	0	-0.14	-0.14	0	-0.25	-0.17	0	-0.24
SWC 1.5m	0.06	0	0.26	0.28	0.01	0.61	0.3	0.01	0.62
p	0	0	-0.14	-0.4	0.02	-0.49	-0.45	-0.02	-0.5

The 24h-correlation coefficients show mean values between 0.5 and 3 days in variables with a pattern with one cycle per day like u, temperature or soil water content; however for variables with two cycles per day, like pressure, the 24h-correlation coefficients cannot estimate adequately the correlation between both variables, this can be appreciated with more accuracy in the deep sensors during the dry period.*

In this article, we focus on the relation between deep CO_2 *soil and pressure changes. This last variable does not present 24-h periodicity. Therefore we have focused on two windows: a) 0.5 days showing the correlation between the barometric pressure wave and deep* CO_2 *soil and b) 3 days showing the correlation of both variables with pressure synoptic changes. We have decided to eliminate tables 2 and 3 and to show this other table (Table 3) that shows only the two variables (u* and Pressure) which have neither wave nor lag with the depth (like T), and also are not affected by a temperature dependence in the measurement (SWC).*

Depth	Window (Days)	Growing period u*	Growing period *p*	Dry period u*	Dry period *p*
0.15m	0.5	0	0	0.53	0
	3	0.01	-0.13	0.24	-0.14
0.5m	0.5	0.01	-0.06	0.04	-0.4
	3	0	-0.35	0.05	-0.49
1.5m	0.5	0.05	-0.23	0.08	-0.45
	3	0	-0.43	0.06	-0.5

Now in this table is easier observe that the u drives the CO_2 changes in the shallow sensor during the dry period and also is easier appreciate that the CO_2 changes in deeper sensors (0.5 and 1.5m) are driven by pressure changes.*

-In the beginning I felt uneasy with the term "ventilation", which – I thought first – seemed to be used equivalent to advective transport (p.5593 L.10: "Scientists have confirmed subterranean advective transport in laboratories"). The terminology is explained later when ventilation is defined in the paragraph following p.Â˘a5593 L.27. This could be easier when the definition was given before that paragraph.

Response: We agree and have made the suggested changes.

- In p 5593 L19 " barometric " before pressure?

Response: We agree and have made this change.

P 5593 L 12 : Clements, W. & Wilkening, M. 1974. is a nice paper about pressure changes and RN222 transport

Response: We agree and have included this reference.

Last paragraph of the introduction (p. 5594 L 10): This is the last paragraph of the introduction. So, I would have expected the objective of the study together with an hypothesis, and the outline of what was done. Yet, a hypothesis is lacking , and results are already discussed and conclusions drawn.

Response: We agree with the reviewer and we have made the requested change. Please see reply to Referee 1.

- I would be interested in more information about the soil, to have a more detailed picture of this specific site with its interesting gas transport "anomalies". What is the reference for the soil classification? Please include directly some information given by the cited reference Rey et al. (2012) like "The carbonate formation has high porosity and permeability values with the presence of fissures and fractures." . What is the soil texture? Are there also cracks visible in the soil? (thinking of Weisbrod et al. 2009) Rock content? (you measured a SWC of 15 % in 1.5m depth – this can be "dry" in a clay soil or "wet" in sandy soil with a lot of stones..) Where is the ground water level?

Response: We agree and have added the water level, the soil texture and the presence of fissures and fractures not visible above ground.

- p5597 L.5 : Which soil T? 3.3.

Response: We agree and the depth of the soil T measurement is now included.

p5599 L 7: "Excepting synoptic pressure changes such as the events on 8 and 14 April and 6 and 12 August" In figure 3 the dates given do not exactly fit to the changes.

Response: We agree and have highlighted only the two most important events, giving the exact dates. "Excepting synoptic pressure changes such as the events on 14 April and 8 August"

– p5600 L13: I am surprised that it is beta and not gamma which is changed! If we have an "additional" soil CO2 efflux this should affect gamma, if I'm right?

Response: If the "additional" efflux were independent of light, then indeed it would seem to be gamma in equation (2) that would be modified. The effect of increasing gamma in this equation is to displace the entire curve upward. However, the role of ventilation fluxes is to increase emissions (or decrease the downward flux) only during hours of strong insolation, and so the parameter in equation (2) that is changed by this process is the light-dependent parameter (beta).

–Discussion P5600 L. 26: "Shallow c shows maxima in winter and minima in summer coinciding with vegetation activity during winter (Rey et al., 2012a)". Yes, that's right. But CO2 concentration in the soil are affected by productivity and transport conditions. Hence, the shallow c shows maxima in winter and minima in summer coinciding also with higher soil water contents which mean a lower soil gas diffusivity.

Response: We agree, and have modified this sentence to reflect the role of transport processes.

- P5601 L 10: Even if the variations of the measured CO2 concentrations at 1.5 m depth appear to be large, the concentration is still less than 4000ppm –(=0.4%) and I'm not sure whether this is sufficient to affect microbiological activity, unless there are other gases involved.

Response: This sentence was entered as result of a referee2's suggestion in the previous reviews. However, we do not mean that the microbiological activity is affected by a high CO_2 molar fraction, but rather that it is affected by huge variations in the molar fraction changing in few hours from 700 to 4000ppm. These changes could affect the microbiological activity in the same way that a plant increases photosynthesis when increasing the atmospheric CO_2.

- P5601 L 11I "The CO2 respired in the root zone increases air density (Sanchez-Canete et al., 2013; Kowalski and Sanchez-Canete, 2010), and so enables gravitational percolation through the pore space toward deeper layers where it can be stored". To apply this idea to root respired CO2 is new for me. Why should this occur here, but was not observed at other sides, where there is even more soil respiration (production of CO2)?

Response: A global survey of soil CO_2 concentration profiles (Amundson & Davidson, 1990) consistently found increasing CO_2 with depth, even below the root (production) zone. There is no means of explaining such observations using the traditional paradigm, which posits that all respired CO_2 diffuses immediately upward to the atmosphere by molecular processes. Furthermore, diffusion cannot move CO_2 from the production zone downward to lower layers unless a decreasing gradient with depth exists. Rather, the gradient with depth is increasing, which makes it very difficult indeed to explain how such large concentrations of CO_2 have accumulated below the root zone. Thus, in direct contradiction to what the referee has stated, we would say that the absence of this process has not been observed: it has been not demonstrated that this does not occur. It has simply been assumed to be irrelevant, and we challenge this assumption.

The cited articles developed equations allowing the determination of buoyancy of CO_2-rich air masses. These CO_2-rich air masses are denser than the atmospheric masses and therefore stagnate in depth. For this reason caves present high CO_2 contents. So that at smaller scales the same thing may occur in soil pore spaces.

- P5601 L14: "Although in this study, p is the main factor implicated in deep c variations, Fig. 1 shows that c variability is greater in summer when p variations are reduced. This highlights the important role of SWC in CO2 exchange: despite greater synoptic pressure variability, winter has lower c variations because soil pores are filled with water, limiting gas flows. In summer, by contrast, ventilation is facilitated by dry soil conditions with gas-filled pore space (Cuezva et al., 2011; Maier et al., 2010). This explains why the growing period shows a positive correlation between shallow c and SWC at 0.15m (Table 2) and a negative correlation during the dry season (Table 3), since during the dry season there is less water in the shallow soil layer allowing the flow of CO2-rich air from the deep soil to near surface layers." I got the impression that things are mixed up. As explained in the beginning I have the feeling that the observed negative correlation of the shallow CO2 and SWC in the dry season could be an artefact due to the short time-scale (width of the moving window) of the standardization. Please include a correlation coefficients for the entire seasons in Tab. 2+3.

Response: We have made the changes suggested by the referee and no longer use the sign of the correlations between SWC and CO_2. We have also eliminated tables 2 & 3 and show a new table with non-standardized data, however the sign of the correlations do not change with the non-standardization; they remain positive during the growing period and negative during the dry period.

Before

This explains why the growing period shows a positive correlation between shallow χc and SWC at 0.15 m (Table 2) and a negative correlation during the dry season (Table

3), since during the dry season there is less water in the shallow soil layer allowing the flow of CO_2-rich air from the deep soil to near surface layers.

After

This would allow that CO_2 values increase during the dry season because there is less water in the soil pore space allowing the flow of CO_2-rich air from the deep soil to near-surface layers.

-As mentioned before, I expected that gamma and not beta would be affected. Can you explain this?

Response: See reply above.

- I would appreciate an additional graph with the soil moisture, because soil moisture has an important effect on soil CO2 concentrations. You could include on graph with the time series of the three CO2 concentrations and one graph with barometric pressure and SWC. This also applies to Fig 3 (if you can show in Fig2 that SWC remains stable during the period covered in Fig. 3 this is not necessary for Fig3)

Response: In figures 2 & 3 we show the time series of the three CO_2 concentrations in one figure and the time series of barometric pressure and SWC in the other

Figure 2

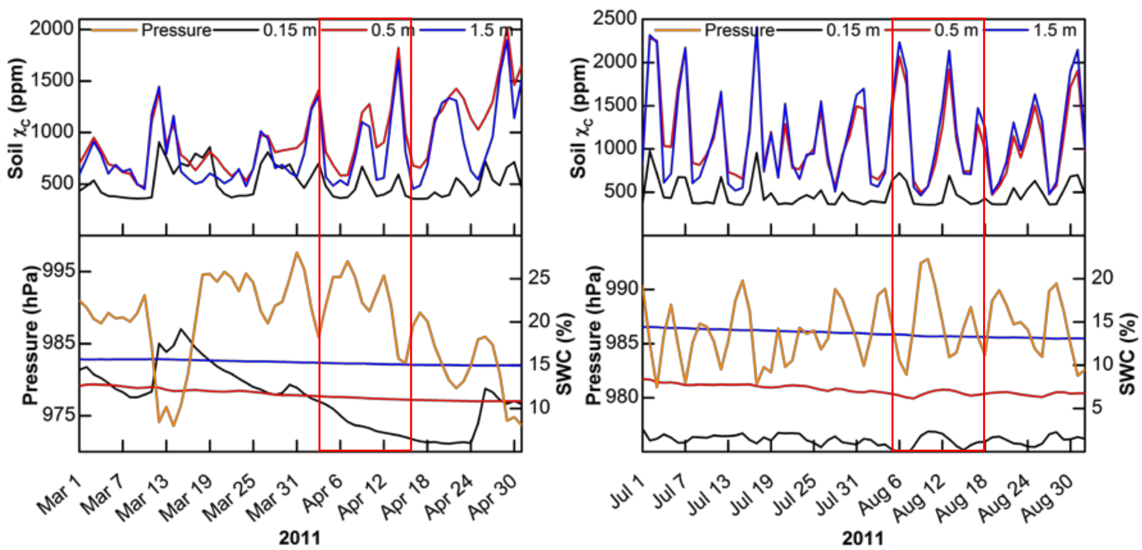
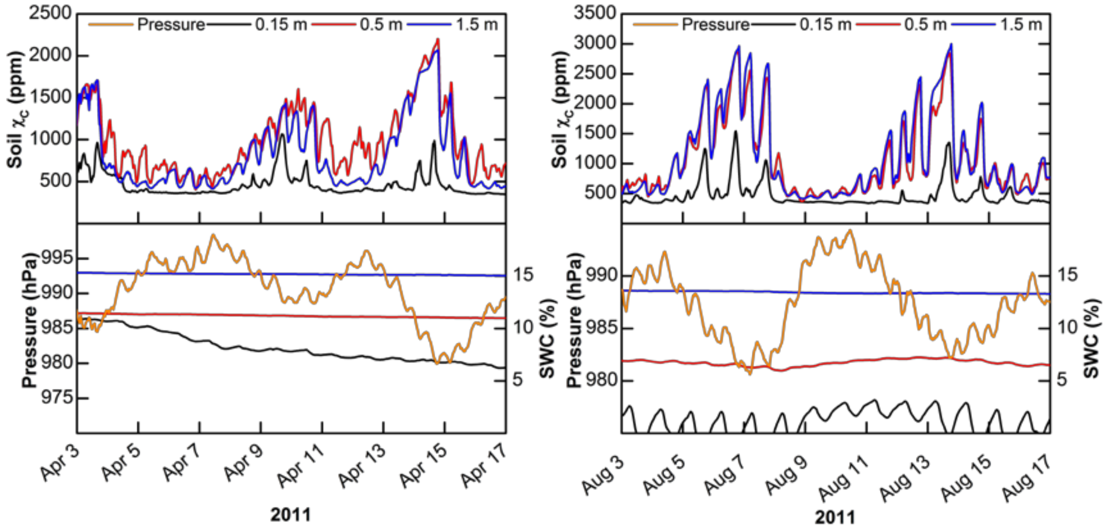


Figure 3



We propose maintaining the original figures for two reasons:

1. *In these new figures we observe that SWC shows no clear relation with deep* CO_2 *soil changes, which are now backed with the low correlation values shown in the new table 2.*
2. *The inverse correlation between pressure and* CO_2 *is easier to appreciate and more clear when only these time series are presented together.*