Response to Referee #1

General comments

The review of the article "Constraining the soil carbon source to cave-air CO_2: evidence from the high-time resolution monitoring soil CO_2, cave-air CO_2 and its $\delta^{13}C$ in Xueyudong, Southwest China"by Min Cao, Yongjun Jiang, Jiaqi Lei, Qiufang He, JiaxinFan, Ze Zeng. The authors present the data on CO_2 in the soil, cave stream, and cave atmosphere (Xueyu Cave,China) and its surrounding. The data weregathered during the period of 2015-2016. The aim of the article is (1) to understand the quantitative relationship between all the forms of CO_2, (2) to reveal their sources, and (3) to understand the factors that control the cave air CO_2 variations. The topic of the article is important and is worthy of publication. In the article, however, there are some aspects that require revision and other ones that could be substantially improved before publishing. My main reservation is that the conclusions should be better proved by a data analysis (e.g., Cross-correlation Analysis). The results of the data analysis should be presented and discussed in detail. The data sets are nice, but they could be much better presented. The x-axis should be more extended in order to be better distinguishable individual fluctuations in the variables.

Answer to general comments:

We would like to thank the referee for his generally positive comments. We will pay more attention in presenting and explaining the our data in the final version.

We posted a table of the correlation analysis:

Table 1 The correlation matrix of environmental parameters in Xueyu system

	Soil M	Soil T	Prep	Cave T	Soil CO_2	Discharge	pH	MZ stream CO_2	MZ air CO_2	LF stream CO_2	LF air CO_2	Spc	TOC
Soil M	1.00												
Soil T	.285**	1.00											
Prep	-.023**	-.013**	1.00										
Cave T	.326**	.367**	-.040**	1.00									
Soil CO_2	.263**	.639**	-.027**	.116**	1.00								
Discharge	-.062**	.011*	.217**	-.122**	-.027**	1.00							
pH	.044**	0.00	-.094**	.296**	-.052**	-.278**	1.00						
MZ stream CO_2	.189**	.416**	.073**	-.192**	.294**	.224**	-.735**	1.00					
MZ air CO_2	-.589**	.518**	.052**	-.795**	.683**	.222**	-.989**	.868**	1.00				
LF stream CO_2	.030**	.402**	.054**	-.237**	.263**	.304**	-.926**	.655**	.877**	1.00			
LF air CO_2	-.030**	.423**	.059**	-.210**	.237**	.253**	-.904**	.768**	.963**	.952**	1.00		
Spc	.134**	.227**	.077**	-.305**	.062**	.253**	-.740**	.610**	.957**	.749**	.710**	1.00	
TOC	.190**	-.540**	-.023**	-.447**	-.176**	-.046**	-.194**	-.596**	-.570**	-.080**	-.209**	.111*	1.00

**. $P<0.01$; *. $P<0.05$; Soil M=Soil moisture, Soil T=Soil temperature, Prep=Precipitation, Cave T=Cave temperature

We updated the text in the dicussion part '4.3 Environmental parameters and their correlation':

“There are significant correltations between stream pCO_2 and cave air CO_2, especially at LF site (R^2=0.95, p<0.01). The correlation between soil CO_2 and soil temperature is significant too (R^2=0.64, p<0.01).”

We put more details in the study area part, the method part and discussion part, and refined the conclusions too:

“ 1) Two-year monitoring study of soil CO_2, subterranean stream and cave air CO_2 concentration reveals that a dynamic equilibrium between CO_2 sources and sinks. Seasonal dynamics took place with the minimum cave air CO_2 concentrations during winter and peaks in November.

2)High-resolution monitoring of CO_2 concentrations in the soil and cave system may allow us to estimate the potential cave air CO_2 sources in Xueyu Cave (subterranean stream, air from vadose/soil zone). Throughout the year, $\delta^{13}C_{DIC}$ showed higher values in winter but lower values in summer. $\delta^{13}C$ of different endmembers showed that soil CO_2 made more contribution of C to the cave air CO_2 in June (75.6%) than in November (65.9%), and the second source was the degassing of stream. The accumulation of cave air CO_2 concentration maintains the high values in summer due to the confined space.

3)The seasonal variations in cave air CO_2 concentration were very similar to that in stream pCO_2, showing which shows high but fluctuated values in summer and steady but low values in winter. Stream water seems to be a constant source of CO_2 as an increase of up to 5800 ppm in 2 hours was observed and CO_2 degassing occurred after strong rain events. In winter, stream water is the carbon sink of cave CO_2.

4)Cave air CO_2 concentrations are similar at different sites in Xueyu Cave. The anthropogenic impact of visitors to cave air CO_2 concentrations is evident from the hourly fluctuations, but not significant on daily or longer time scales.”

Other comments: Throughout the text, it is important to distinguish CO_2 itself from CO_2 concentration and pCO_2 (e.g., the lines/paragraph 85). The expression “PCO_2 in the water” (stream pCO_2 is acceptable only as an abbreviation in the text. Furthermore, it is important to explain that it means pCO_2 of gaseous CO_2 that would be in equilibrium with aqueous carbonates. In principle, pCO_2 is dimensionless variables (or it has units of pressure). If the CO_2 quantity is given in ppmv units, it means “CO_2 concentration”.

Some soil characteristics should be given in the paragraph Study Area. More detail information should be given in monitoring/calculating of the stream CO_2 in the paragraph Methods and Materials.

The x-axes in the plots (Fig. 2, 3, 4, 5) should be better divided (e.g., by one month, three months, etc.). The secondary y-axis in Fig. 4 should represent "Precipitation". I do not understand what the conceptual model in Fig. 7 brings new/beneficial. In the text, there are missing the citation: Liu and Zhao 2000, and Baker et al., 1998 and 2014, referenced in the Reference list.

Answer to other comments:

1. We checked the use of CO_2 itself and pCO_2, CO_2 concentration to make sure that they are expressed in the correct form in the revised text. Actually, pCO_2 has unit, such as Pa, but we use ppm in CO_2 quantity to make it simple and comparable between air and water.
2. In most cases, it is not in equilibrium with aqueous carbonates, which can be seen in Fig. 8.
3. The x-axis had been adjusted in order to be better distinguishable individual fluctuations in the variables. The figures 2 and 3 can be seen in the supplimentary material.
4. Regarding to the references, we checked all the manuscript to make sure that the citations in the maintext are all consistent with the ones in the reference list. References by Liu and Zhao 2000, and Baker et al., 1998 and 2014 were cited in the previous manuscript but then cancelled in the maintext without removing from the reference list.
5. In the revised version, we cancelled the following part:

~~Baker, A., Genty, D., Dreybrodt, W., Barnes, W. L., Mockler, N. J., and Grapes, J.: Testing theoretically predicted stalagmite growth rate with recent annually laminated samples: implications for past stalagmite deposition, Geochim. Cosmochim. Ac., 62(3), 393-404, https://doi.org/10.1016/S0016-7037(97)00343-8, 1998.~~

~~Baker, A. J., Mattey, D. P., and Baldini, J. U. L.: Reconstructing modern stalagmite growth from cave monitoring, local meteorology, and experimental measurements of dripwater films, Earth Planet. Sc. Lett., 392(392), 239-249, https://doi.org/10.1016/j.epsl.2014.02.036, 2014.~~

~~Liu, Z., and Zhao, J.: Contribution of carbonate rock weathering to the atmospheric CO_2 sink, Environ. Geol., 39(9), 1053-1058, https://doi.org/10.1007/s002549900072, 2000.~~

Figure 1 (A) Chongqing Municipality, SW China and geographical location of study area (red shape), (B) Monthly air and precipitation in Xueyu Cave, (C) The location of the Xueyu Cave, its surrounding strata and the soil sampling site (modified from Wu et al. (2015)), (D) Sketch map of the Xueyu Cave and locations of the monitoring sites: X1 and X5 for cave air and stream pCO_2 monitoring.

Figure 2 Cross section of Xueyu Cave passages and the sampling locations, Chongqing, SW China (modified from Pu et al., 2016).

Figure 3: (a) Precipitation, (b) air temperature and soil temperature, (c) soil moisture, (d) pCO_2 values in the soil air, cave air and stream water of Xueyu system in the years 2015-2016.

Figure 4 Variations of monitoring items (precipitation, temperature, $\delta^{13}C$ and pCO_2) during rainfall events in October-November, 2014 and June 2015

Figure 5 Conceptual model for subsurface carbon cycling in Xueyu karst cave. CO_2 respired in soils is transported into caves by gaseous form or infiltrated in rainwater. Changes of ventilation patterns which might be correlated to soil moisture overlying can help to accumulate cave air CO_2 or make it dispersed in summer and winter. Sketch of the seasonally controlled airflow of the Xueyu Cave system and resulting in pCO_2 changes.

Figure 6 The pCO_2 variability ($\theta(pCO_2)=pCO_{2(stream)}-pCO_{2(air)}$ in the Xueyu stream and cave air system

Figure 7 The relationships between $\delta^{13}C_{V\text{-}PDB}$ and $1/CO_2$ during the occurring of rainfall events in November (A) and June (B)

Figure 1

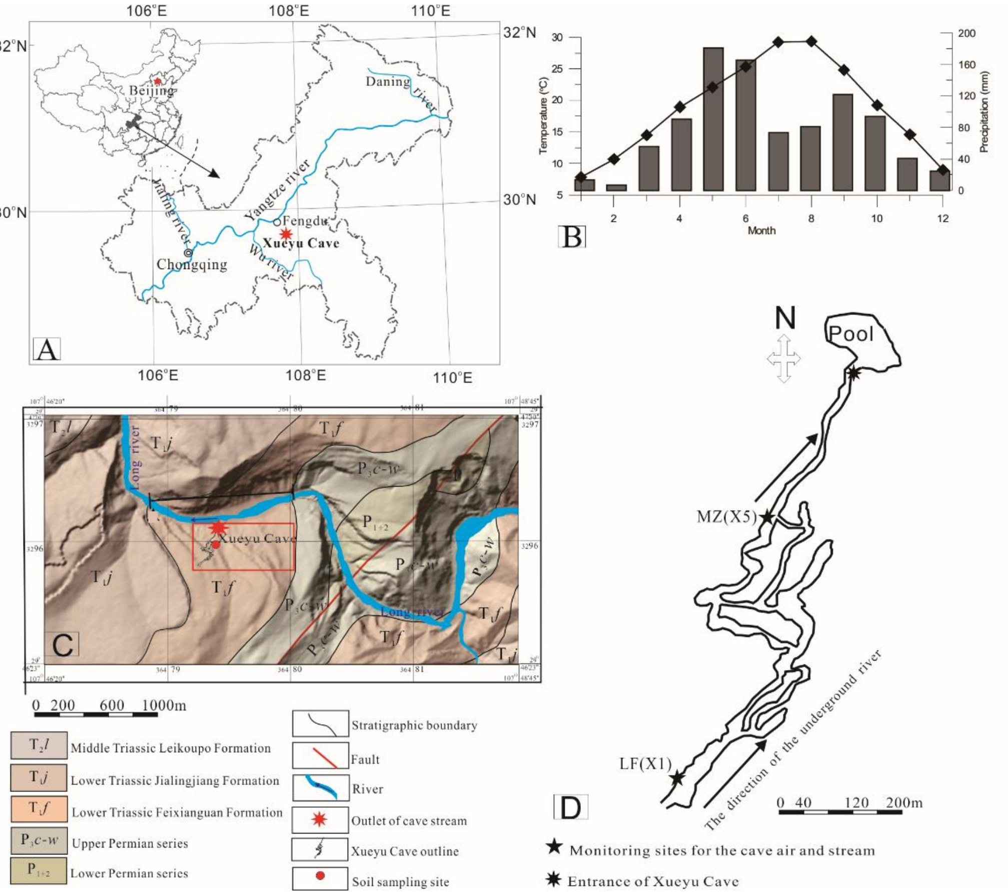


Figure 2

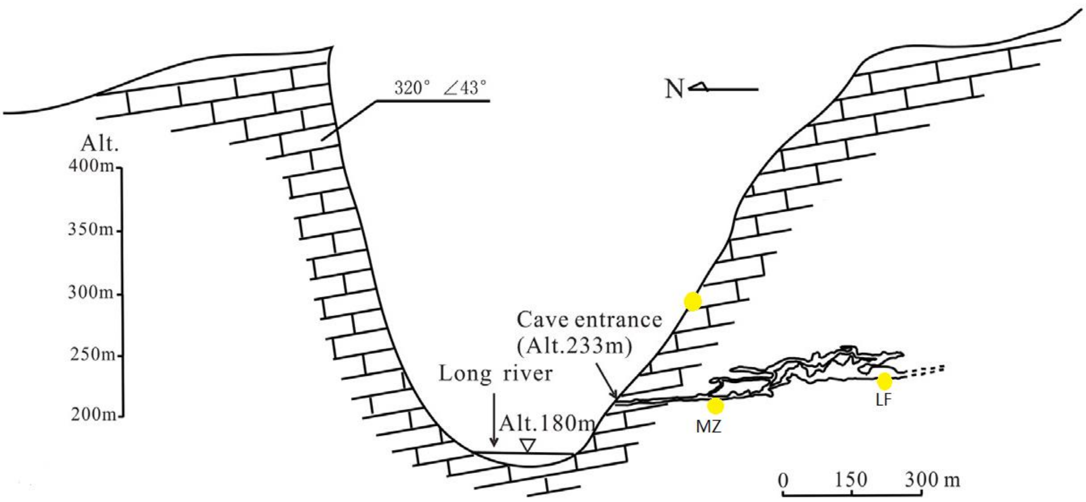
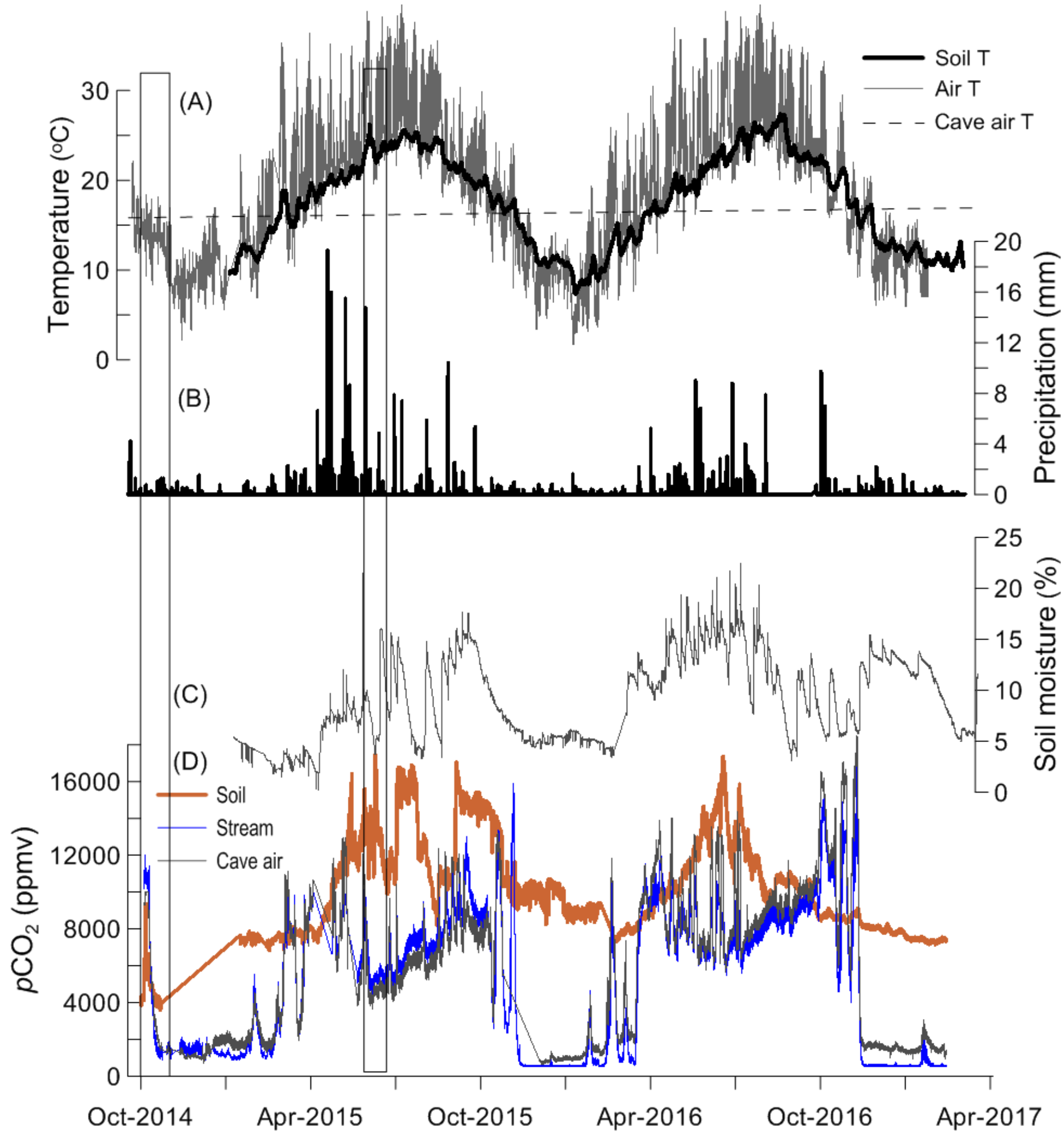
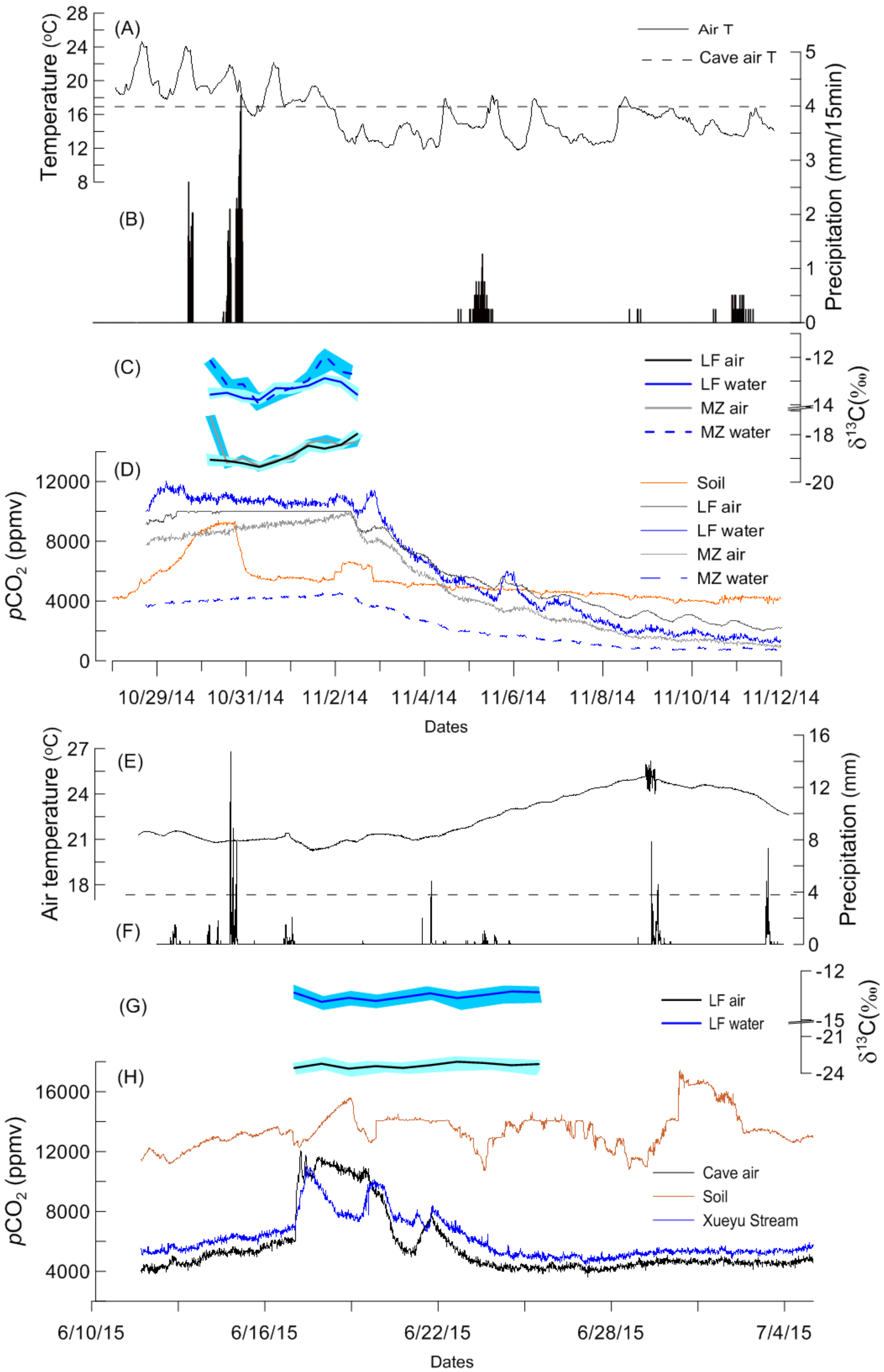


Figure 3



Soil T
Air T
Cave air T
Temperature (oC)
30
20
10
0
(A)
(B)
Precipitation (mm)
20
16
12
8
4
0
(C)
Soil moisture (%)
25
20
15
10
5
0
(D)
Soil
Stream
Cave air
pCO2 (ppmv)
16000
12000
8000
4000
0
Oct-2014
Apr-2015
Oct-2015
Apr-2016
Oct-2016
Apr-2017

Figure 4



(A)
Air T
Cave air T
Temperature (°C)
28
24
20
16
12
8
(B)
Precipitation (mm/15min)
5
4
3
2
1
0
(C)
LF air
LF water
MZ air
MZ water
-12
-14
-18
-20
δ13C(‰)
(D)
Soil
LF air
LF water
MZ air
MZ water
pCO2 (ppmv)
12000
8000
4000
0
10/29/14
10/31/14
11/2/14
11/4/14
11/6/14
11/8/14
11/10/14
11/12/14
Dates
(E)
Air temperature (°C)
27
24
21
18
(F)
Precipitation (mm)
16
12
8
4
0
(G)
LF air
LF water
-12
-15
-21
-24
δ13C(‰)
(H)
Cave air
Soil
Xueyu Stream
pCO2 (ppmv)
16000
12000
8000
4000
6/10/15
6/16/15
6/22/15
6/28/15
7/4/15
Dates

Figure 5

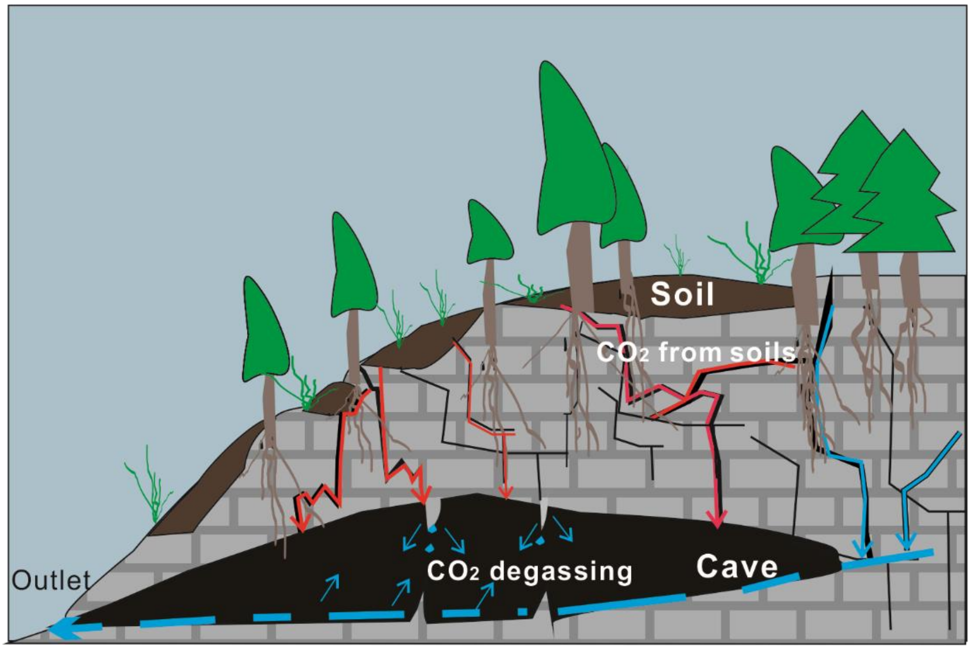


Figure 6

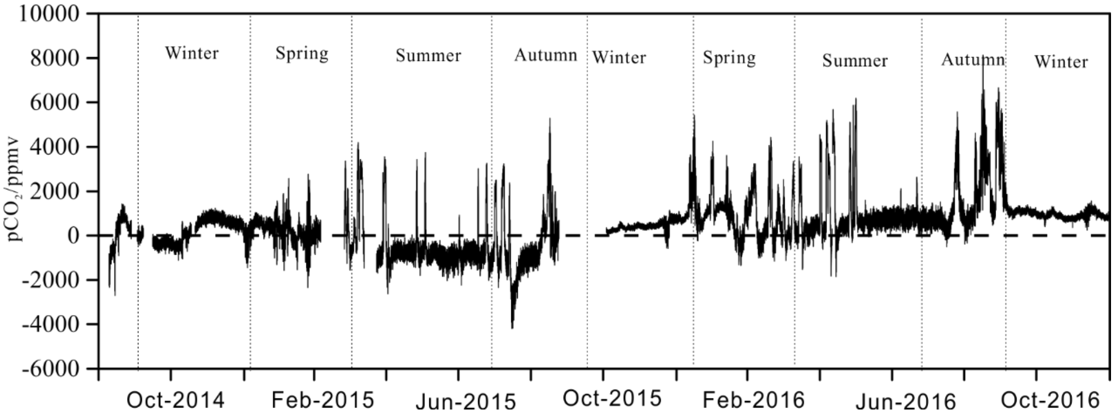


Figure 7