

Response to Referee #1

General comments

The review of the article “Constraining the soil carbon source to cave-air CO₂: evidence from the high-time resolution monitoring soil CO₂, cave-air CO₂ and its δ¹³C in Xueyudong, Southwest China” by Min Cao, Yongjun Jiang, Jiaqi Lei, Qiufang He, JiaxinFan, Ze Zeng. The authors present the data on CO₂ in the soil, cave stream, and cave atmosphere (Xueyu Cave, China) and its surrounding. The data were gathered during the period of 2015-2016. The aim of the article is (1) to understand the quantitative relationship between all the forms of CO₂, (2) to reveal their sources, and (3) to understand the factors that control the cave air CO₂ 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 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 discussion part ‘4.3 Environmental parameters and their correlation’:

“There are significant correlations between stream pCO₂ and cave air CO₂, especially at LF site (R²=0.95, p<0.01). The correlation between soil CO₂ and soil temperature is significant too (R²=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 CO₂, subterranean stream and cave air CO₂ concentration reveals that a dynamic equilibrium between CO₂ sources and sinks. Seasonal dynamics took place with the minimum cave air CO₂ concentrations during winter and peaks in November.

2) High-resolution monitoring of CO₂ concentrations in the soil and cave system may allow us to estimate the potential cave air CO₂ sources in Xueyu Cave (subterranean stream, air from vadose/soil zone). Throughout the year, δ¹³C_{DIC} showed higher values in winter but lower values in summer. δ¹³C of different endmembers showed that soil CO₂ made more contribution of C to the cave air CO₂ in June (75.6%) than in November (65.9%), and the second source was the degassing of stream. The accumulation of cave air CO₂ concentration maintains the high values in summer due to the confined space.

3) The seasonal variations in cave air CO₂ concentration were very similar to that in stream pCO₂, 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 CO₂ as an increase of up to 5800 ppm in 2 hours was observed and CO₂ degassing occurred after strong rain events. In winter, stream water is the carbon sink of cave CO₂.

4) Cave air CO₂ concentrations are similar at different sites in Xueyu Cave. The anthropogenic impact of visitors to cave air CO₂ 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 CO₂ itself from CO₂ concentration and pCO₂ (e.g., the lines/paragraph 85). The expression “PCO₂ in the water” (stream pCO₂ is acceptable only as an abbreviation in the text. Furthermore, it is important to explain that it means pCO₂ of gaseous CO₂ that would be in equilibrium with aqueous carbonates. In principle, pCO₂ is dimensionless variables (or it has units of pressure). If the CO₂ quantity is given in ppmv units, it means “CO₂ concentration”.

Some soil characteristics should be given in the paragraph Study Area. More detail information should be given in monitoring/calculating of the stream CO₂ in the paragraph Methods and Materials.

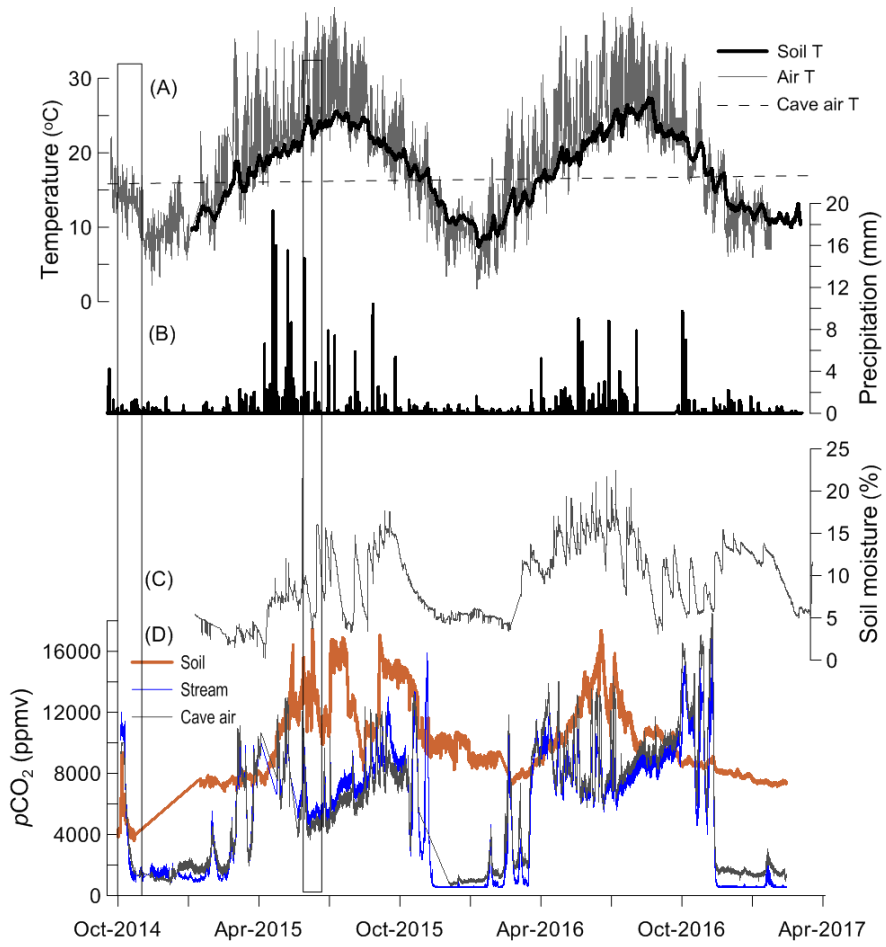
The x-axes in the plots (Fig. 2, 3, 4, 5) should be better divided (e.g., by one month, three months, etc.). The secondary y-axis in Fig. 4 should represent “Precipitation”. I do not understand what the conceptual model in Fig. 7 brings new/beneficial. In the text, there are missing the citation: Liu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

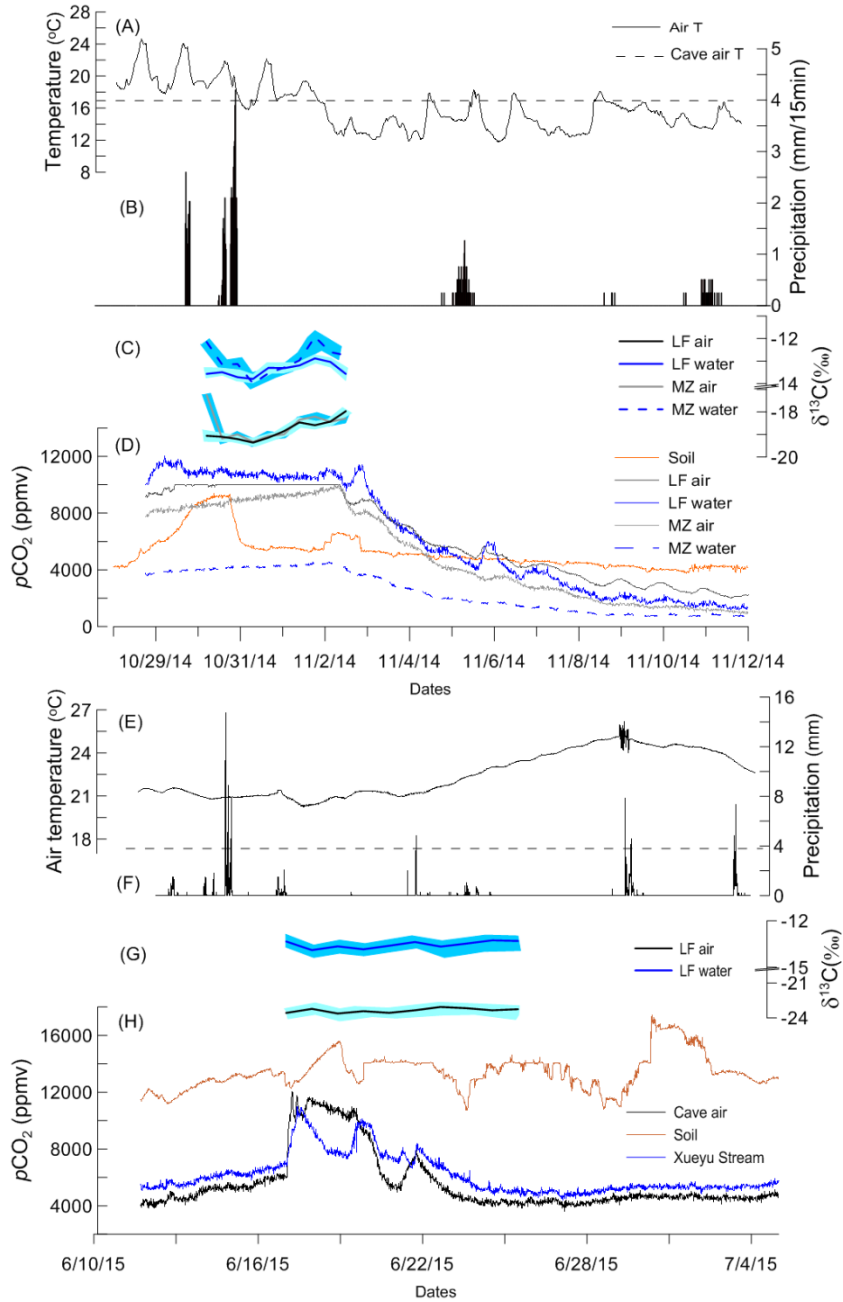
Answer to other comments:

1. We checked the use of CO₂ itself and pCO₂, CO₂ concentration to make sure that they are expressed in the correct form in the revised text. Actually, pCO₂ has unit, such as Pa, but we use ppm in CO₂ 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:
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.

Corrected:

The changed x-axis in new Fig.3 and 4





So 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. Acta.*, 62(3), 393-404, [https://doi.org/10.1016/S0016-7037\(97\)00343-8](https://doi.org/10.1016/S0016-7037(97)00343-8), 1998.

Baker, A. J., Matthey, 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.