Cave-air carbon dioxide: Temporal and spatial variations in central Texas
An update on research activities occurring on BCP lands

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Executive Summary

The growth rate and elemental and chemical composition of cave calcite deposits (speleothems) are important proxies for past environmental and hydrologic changes. Understanding the timing and driving mechanisms of calcite growth is therefore important for interpreting such proxies. Perhaps the most fundamental of these driving mechanism is the concentration of carbon dioxide in cave air. A previous study in tourist caves located on the Edwards Plateau found speleothem growth rate to be correlated with the concentration of carbon dioxide in cave air (Banner et al., 2007). During the warmer months, when carbon dioxide concentrations are elevated, calcite growth rate decreases; conversely, in the cooler months, when carbon dioxide concentrations are relatively low, calcite growth rate increases.

It is important to assess if these seasonal cave-air CO2 variations are a phenomenon unique to tourist caves, which have connections to the surface that are modified from their natural state and which are subject to CO2 sourced from respiration from visitors. In order to conduct such an assessment, we began a monitoring program in several BCP-managed wild caves in South Austin. Initial results show that cave-air carbon dioxide concentrations are strongly seasonal in all caves studied, with peak concentrations occurring in late summer to early fall, and lower concentrations occurring from late fall to early spring. These findings suggest that seasonal fluctuations in cave-air carbon dioxide concentration is a naturally occurring phenomenon and is regional in extent.

Methods and Study Sites

The following BCP–managed caves were monitored beginning in July, 2006: Blowing Sink, Seibert Sink, Maple Run Cave, Whirlpool Cave, District Park Cave and Cave Y. During each visit carbon dioxide concentrations were measured at several stations located throughout each cave using a Telaire 7001 infrared carbon dioxide meter. Maple Run Cave, Whirlpool Cave and District Park Cave were each visited at least 14 times each over the period of one year. Blowing Sink, Seibert Sink, and Cave Y were visited less frequently. Soil thickness was also measured at Maple Run Cave, Whirlpool Cave and District Park Cave by driving a 1/8-inch diameter Rebar stake into the ground until refusal.

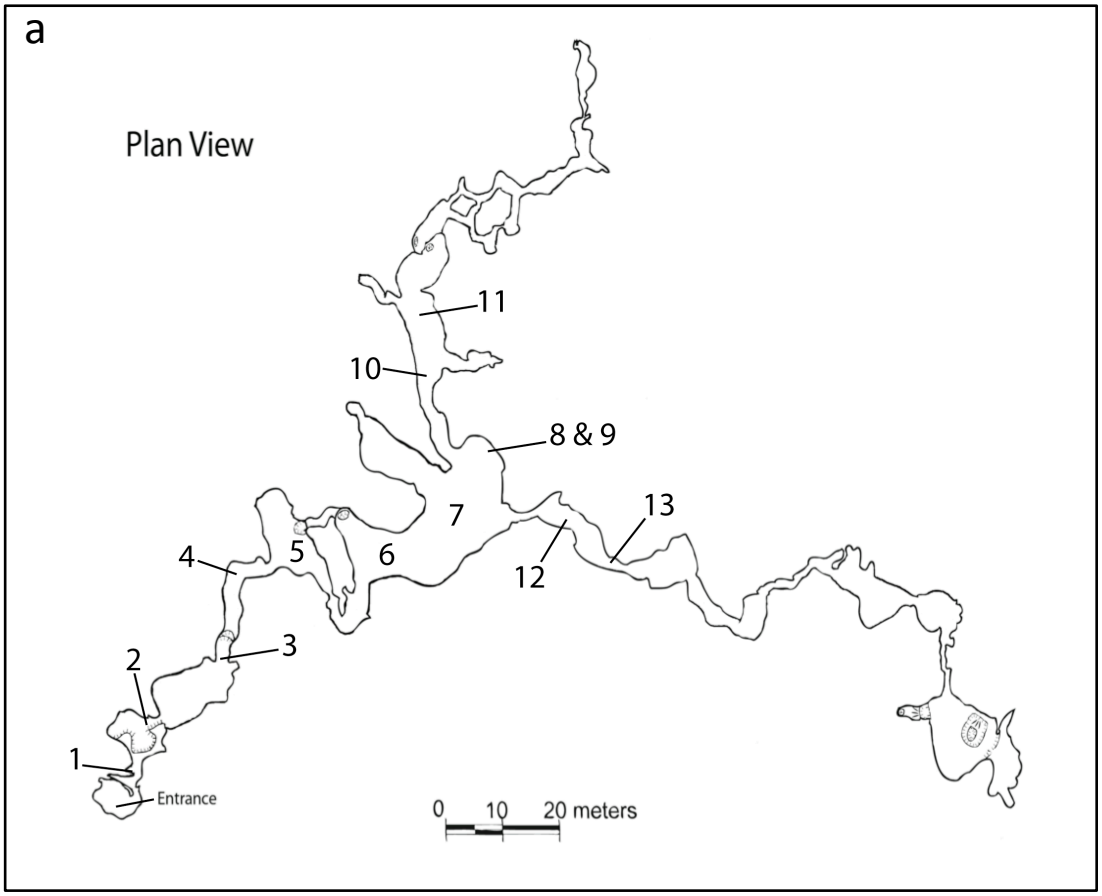
Preliminary Results

Because Blowing Sink, Seibert Sink, and Cave Y were visited less frequently, the carbon dioxide concentration data for these caves were insufficient to determine if they exhibit a strong seasonal fluctuation. Maple Run Cave, Whirlpool Cave and District Park Cave Each exhibited strong seasonal fluctuations in the concentration of cave air carbon dioxide. Figures 1-3 present representative summertime and wintertime transects of these frequently visited caves.

Preliminary Conclusions

Multiple transects for Maple Run Cave, Whirlpool Cave and District Park Cave show that cave-air CO_2 varies seasonally, with peak concentrations in late August to early October and lower concentrations in December through late March. The timing of seasonal CO_2 fluctuations is consistent in all three caves. These results indicate that 1) the seasonality of calcite deposition observed in the tourist caves, as controlled by the concentration of cave-air CO_2, is not due to human alteration of the caves, 2) the concentration of cave-air CO2 varies significantly on a seasonal time-scale and 3) the seasonal fluctuation of cave-air CO_2 is regional in extent. These findings have important implications on the use of speleothems in paleoclimate studies. A presentation was given at the annual meeting of the Geological Society of America in Houston on October 5, 2008 (Cowan et al., 2008), and a manuscript detailing this study is currently in preparation and will be submitted for publication to a peer-reviewed journal in spring, 2009. A copy of the accepted manuscript will be provided to BCP staff.

Figure 1: (a) Map of carbon dioxide monitoring stations within Whirlpool Cave.
(b) Representative summer and winter transects of Whirlpool Cave.



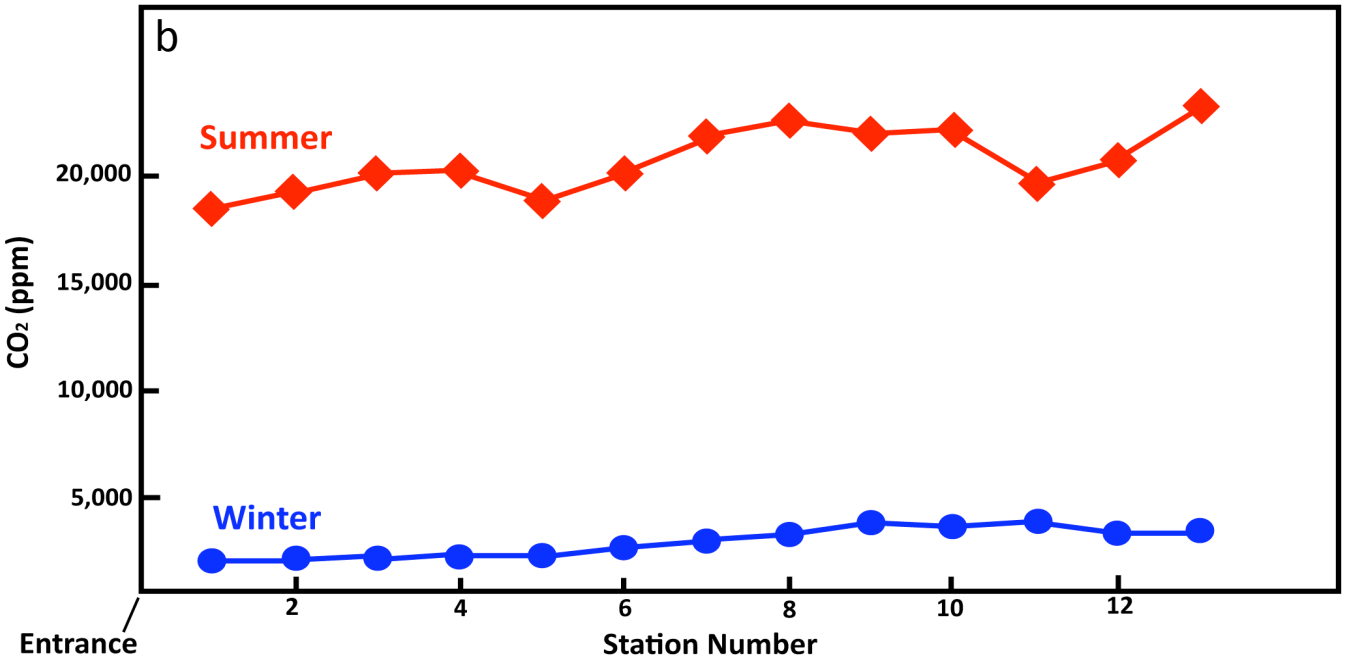
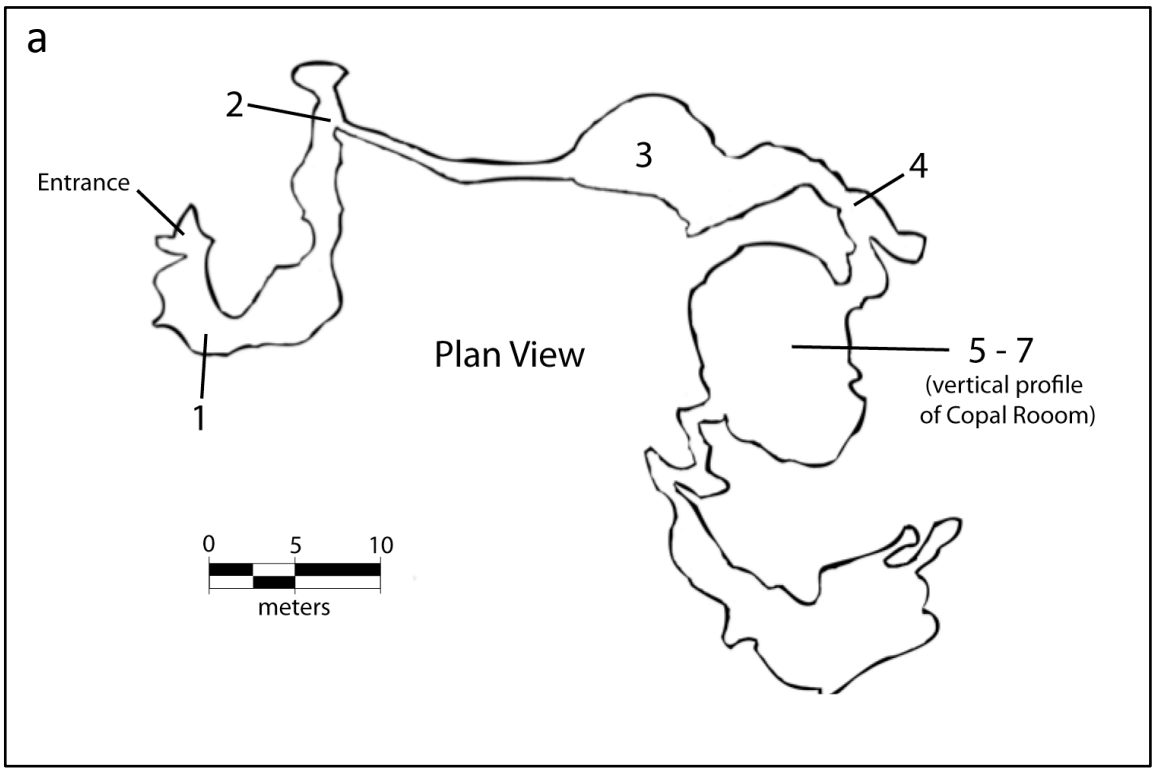


Figure 2: (a) Map of carbon dioxide monitoring stations within Maple Run Cave.
(b) Representative summer and winter transects of Maple Run Cave.



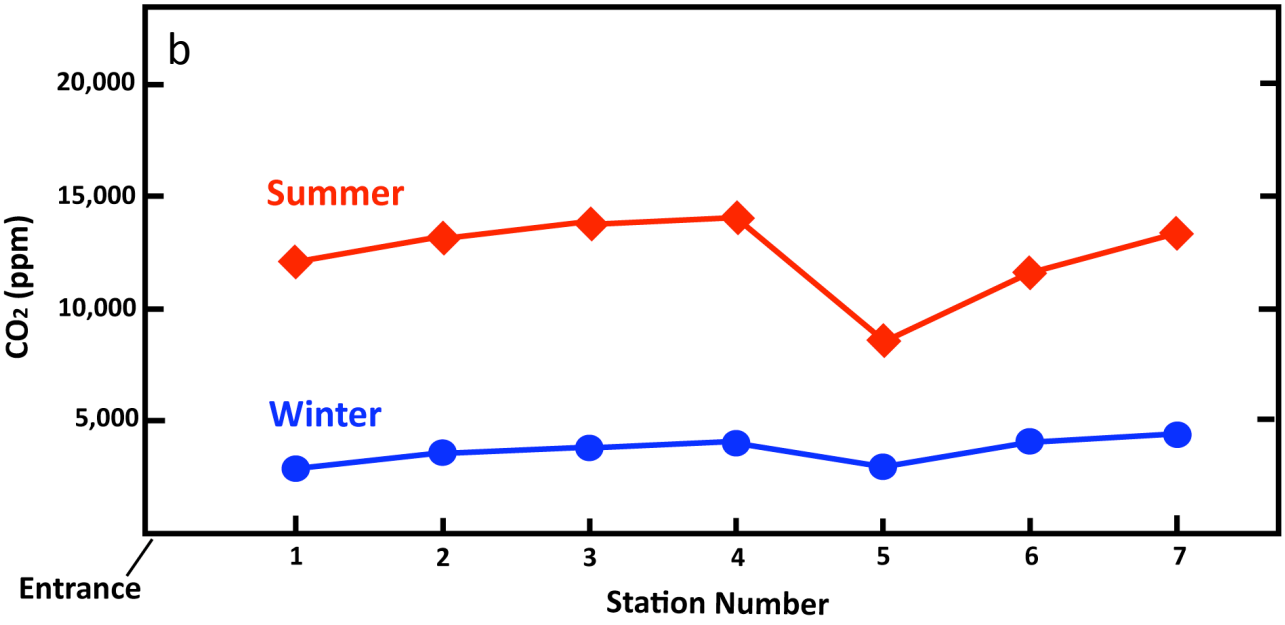
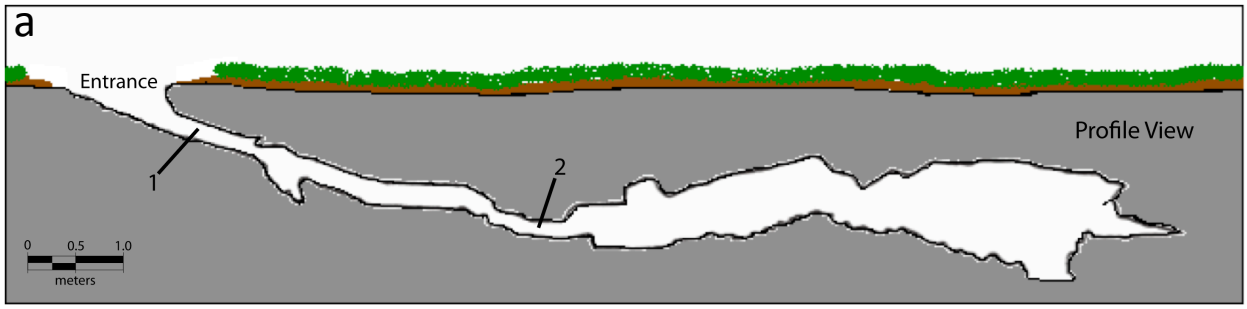
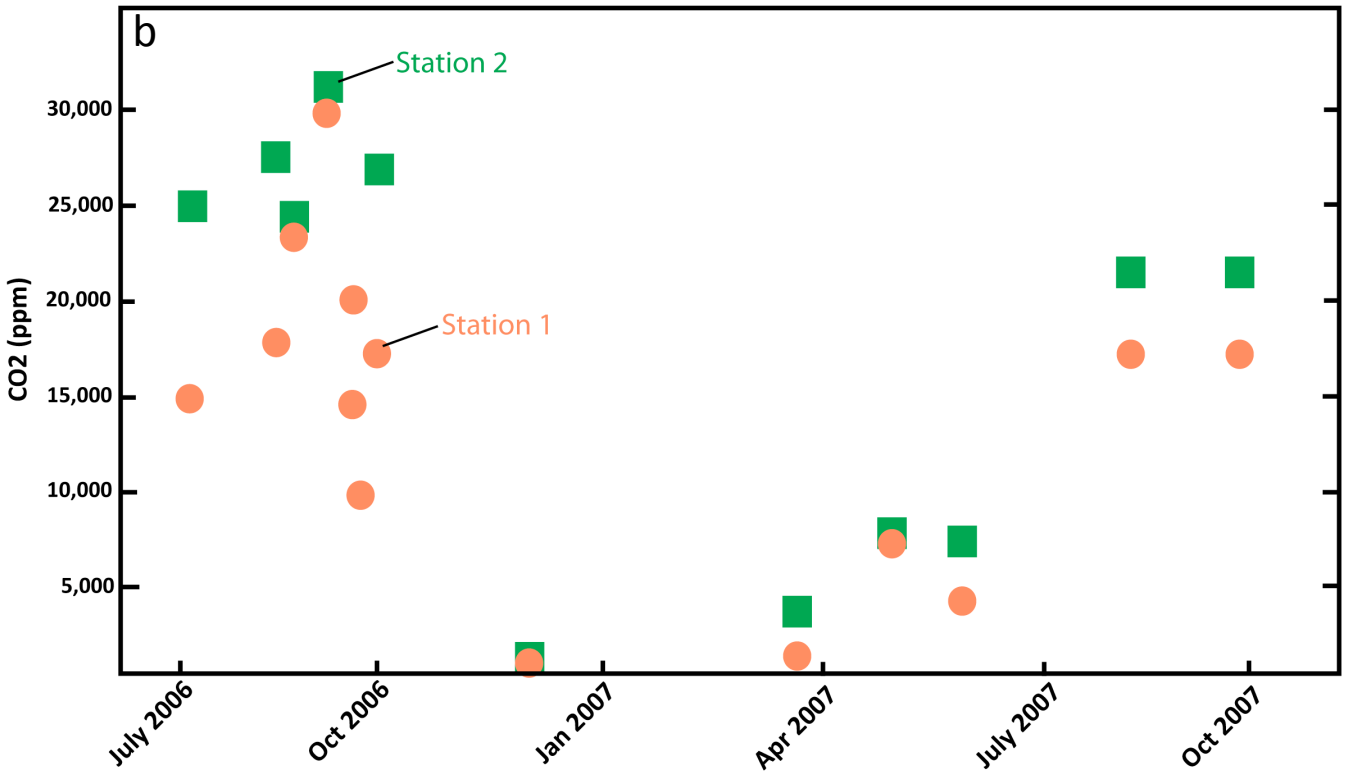


Figure 3: (a) Map of carbon dioxide monitoring stations within District Park Cave.
(b) All carbon dioxide measurements taken in District Park Cave from July, 2006 to October, 2007.





Works Cited

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