# Characterizing $CO_2$ Concentration Variations in two Karst Springs and Testing Current Dissolution Models

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## Scientific Motivations

- Current numerical models of karst formation assume constant dissolution rates over time
- The water in natural karst systems undergoes large variations in physical and chemical properties.

## Field Site

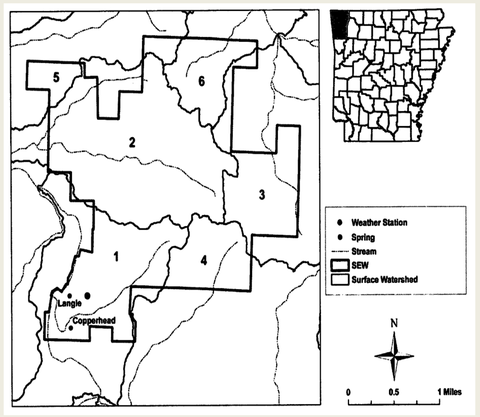



Figure: Savoy Experimental Watershed site location map. (Pennington, 2010)

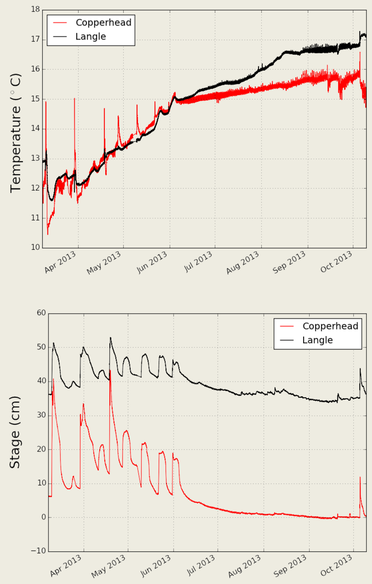
Photo: Copperhead Spring, SEW

Photo: Monitoring data at Langle Spring, SEW

## References

Johnson, M., Billett, M., Dinsmore, K., Wallin, M., Dyson, K.E., and Jassal, R.S., 2010, Direct and continuous measurement of dissolved carbon dioxide in freshwater aquatic systems—method and applications: Ecohydrol., v. 3, p. 68–78.

Pennington, D.W., 2010. Karst Drainage-Basin Analysis Using Water-Level Data and Hydrograph Decomposition Techniques at the Savoy Experimental Watershed, Savoy, Arkansas [M.S. thesis]: Fayetteville, University of Arkansas.




## Discussion

### Discharge Relationships

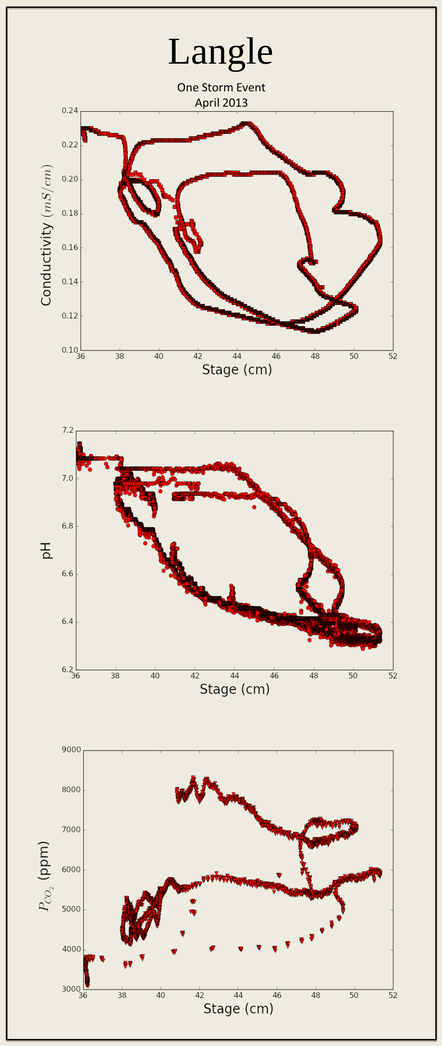
The two springs seem display similar relationships between discharge (stage) and water chemistry. Each spring shows a decrease in conductivity and pH as stage increases and an increase in $CO_2$ as stage increases. Overall Copperhead tends to have a stronger relationship between chemistry and discharge, meaning that Copperhead Spring is more strongly influenced by precipitation than Langle. Both springs are fed by a sinking stream. However, previous work has suggested that Langle Spring has a much stronger base flow component that is derived from more distributed recharge through the fracture and matrix component of the aquifer.

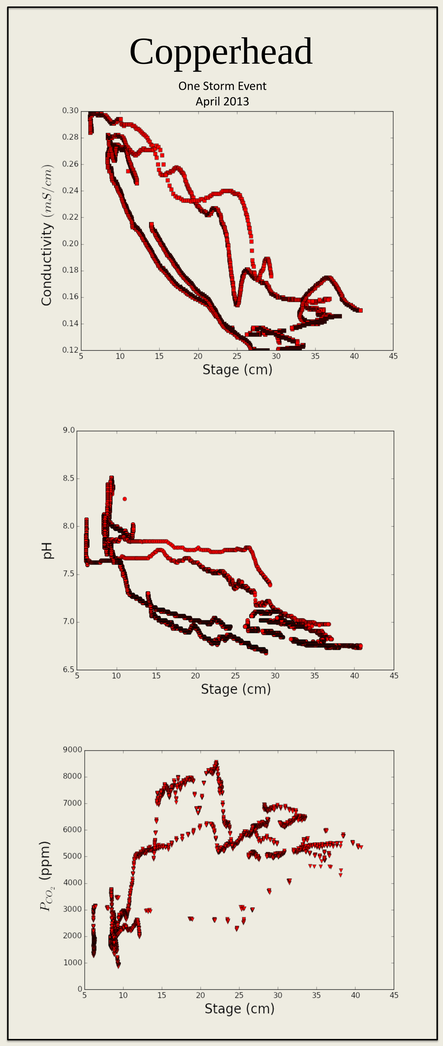
### $CO_2$ Variations

Dissolved $CO_2$ at both sites displays a positive correlation with discharge, suggesting that dilution does not play an important role in determining $CO_2$ concentration. Examination of the full time series shows a strong correlation with surface air temperature, with the highest $CO_2$ concentrations observed in the late summer, likely a result of high levels of soil microbial activity. Furthermore, Langle displays much higher levels of $CO_2$ than Copperhead. This may result from the higher proportion of diffuse flow, or may indicate that water emerging from Copperhead Spring (which is an overflow route) has more contact with the atmosphere during its flow path, allowing $CO_2$ to degas

### Continuation/Summary

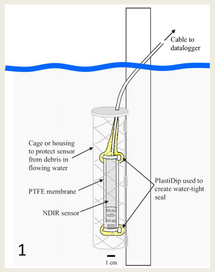
This work will continue at least until March of 2014, at which point there will be an entire year of data recorded. That data set should allow us to see seasonal variation in the factors that effect $CO_2$ concentrations.




## Methods

Direct *in situ* measurement of dissolved $CO_2$





The direct in situ measurement of dissolved CO2 is similar to that described by Johnson et al, 2010., 1. Diagram of sensor (Johnson et al,2010)., 2. Sensor that is currently deployed in field.

## Dissolution Experiment

Currently conducting a dissolution experiment to measure actual dissolution rate over the course of the study. This is done with tablets that are exposed in two month intervals. Then using weight loss, surface area, and density we calculate denudation rate. (Photo: Setup for one spring with 4 tablets attached to PVC pipe.)

## Data Collection

Campbell Scientific data loggers are deployed at both springs and are collecting various water quality parameters. These include pH, Conductivity, Stage, and Temperature being collected at 1 min resolution. While $CO_2$ is being collected at 1 hour resolution. pH sensors are calibrated bi-weekly. (Photo: Downloading data from data logger.)