What controls the cave drip water temperature? Analysis and implications for paleoclimate reconstruction from speleothems

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Cave drip water temperature influences cave hydrobiochemical processes and also speleothem based paleoclimate signals (e.g. biomarkers, isotopes, etc). Yet very little is known about what controls cave drip water temperature. This experimental investigation reveals the dominant heat transfer mechanisms. Design and Methodology: A shallow cave drip water flow path along a flowstone was instrumented with a number of high resolution temperature sensors and drip loggers. Cave and surface climate parameters: Pressure, Relative Humidity (RH) and Temperature were monitored with high frequency. Three separate land surface irrigation experiments were conducted comprising of multiple applications of water at the surface above the cave. One of the irrigation batched was enriched with deuterium (610% VSMOW) as a conservative tracer. The cave drip water temperature measurements clearly reveal the presence of all common heat transport mechanisms (e.g. conduction, convection, latent heat exchange). In general, the cave drip water has the same temperature as the subsurface conduction profile of the rock at that depth. However, at fast flow rates the warmer/colder signal during summer/winter is being washed down convectively leading to temperature anomalies of up 1.5 °C. Importantly, daily cave venting reduces the cave RH thus leading to evaporative cooling of drip water of up -2.5 °C. Cave drip water temperature is mainly controlled by the subsurface heat conduction profile as well as the cave climate. This, however, depends on the drip rate and length of flow path exposed to the cave air. Paleoclimate reconstruction requires depth-dependent deconvolution of the subsurface conduction signal as well as consideration of past or present cave venting and evaporative cooling.