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Temperature and precipitation records from stalagmites grown under disequilibrium conditions: A model approach.

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To reconstruct past variations in Earth's climate, a variety of climate archives are studied. During the last decades stalagmites came into focus due to their long, continuous growth and absolute dating techniques. In this study a numerical model was developed, which calculates variations in temperature and precipitation during the growth period of stalagmites grown under isotopic disequilibrium conditions using the isotope profiles both along the growth axis and individual growth layers as well as the growth depth relation.

The model is based on the inversion and combination of existing models (Dreybrodt 1999, Kaufmann et al. 2004, Mühlinghaus et al. 2007, Scholz et al. 2008, Mühlinghaus et al. 2008b) and incorporates important parameters describing the cave and the overlying soil. Beside the dependence on temperature and water supply it depends on the isotopic composition of the drip water, the pCO_2 pressure of the soil and the cave atmosphere as well as on the mixing coefficient, which describes mixing between the impinging drop and the existing solution layer. To determine the characteristics of temperature and precipitation, in a first step all other parameters are assumed to remain constant over the whole growth period to simplify calculations. This allows to run the model with only two input variables: the isotopic composition $\delta^{13}C$ of the drip water and a temperature information at any point of time during the growth period of the stalagmite (e.g. the recent cave temperature). All other parameters are determined by the model.

The CSM (Combined Stalagmite Model, Mühlinghaus et al. 2008a) was applied to three stalagmites from the Marcelo Arévalo cave in Southern Patagonia, Chile (Schimpf 2005, Kilian et al. 2006, Schimpf et al. in prep). These stalagmites grew in a small cave next to each other during the last 4500 years. However, their isotopic profiles along the growth axis show different kinetic influences. Despite these conditions, the temperature records of the stalagmites, which were obtained by three independent model runs, follow a general trend over the whole growth period and reveal good correlations within certain time-frames. This is a promising first result of the model. In addition the calculated temperatures are robust to small variations of the input variables, giving confidence in the algorithm of the model and for further temperature reconstructions from kinetically grown stalagmites.

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