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Modeling stalagmite growth based on physical and chemical principles

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Growth of speleothems is influenced by changes in the climate. Hence, in principle information about the climatic signal can be recovered from growth rates and shape of stalagmites. We apply a numerical model of speleothems growth based on the current knowledge about physics of the water film flow and combine it with the chemical laws describing precipitation of calcite from supersaturated solutions. This enables us to study the preservation of climatic signals in "real time". Modeling attempts so far have been driven by variations of temperature, carbon-dioxide, and drip rates, but have not been able to give any information on the chemical composition of the solution flowing on the surface of a stalagmite. We propose a model for calculating the water film flowing down the stalagmite, its calcium concentration, and consequently the deposition rates along the profile. Comparison with the already existing models show good agreement with the theoretical and the numerical results obtained, but now we are able to describe the dynamics of stalagmite growth, as well as the time necessary for a speleothem to attain an equilibrium shape. By this way we study the effect of the frequency of a climatic variation on the shape, and propose an estimation for a minimal period that is possible to be restored from the profile of a stalagmite. Our model is able to describe the dynamics of the speleothem growth in a more detailed and physically correct way, and therefore it can be used as a benchmark for more simplified approaches.