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Modeling dO-18 in soil and drip water. Application to caves from N. Germany.

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Over the past few decades stalagmites have become favoured objects for paleoclimate research in the function as high-quality and high-resolution records of climatic conditions - basically for two reasons: a) They store the climatic conditions of the period of their growth due to their isotopic composition (dO-18 and dC-13). b) They grow over long periods of time and allow precise dating results by using the Th/U-method.
The isotopic composition of stalagmites depends on the isotopic composition of the drip water feeding the stalagmite, which is influenced by climatic parameters, effects in the soil (evapotranspiration) and effects in precipitation (isotopic temperature effect, amount effect, continental effect). The drip water in caves integrates infiltrated precipitation from previous month or even years.

In a first approach to approximate the effects on the isotopic composition of drip water we established a weighting function which yields a mean annual isotopic composition. As input parameters we use: temperature, amount of cave infiltration, air humidity and carbon dioxide content in soil air, for each month respectively.
The general temperature dependence of dO-18 in precipitation is described by a linear data fit and is corrected with regard to evapotranspiration.
The amount of cave infiltration is evaluated by the amount of precipitation minus the amount of water which is either lost by transpiration of plants or evaporation in the soil zone. Evaporation is accompanied by a kinetic fractionation while transpiration is not. This leads to an enrichment of heavy oxygen in the soil water depending on the ratio of evaporation to transpiration.
For the current drip water model only the amount of winter precipitation is varied and the temperature changes from November to March are twice as high as in the other seasons. Additionally the amount of winter precipitation is correlated to the winter temperature. In the studied area the observation value ranges between +8 and +12%/°C. This takes into account the pronounced influence of the North Atlantic Oscillation on European climate in winter.
Eventually the isotopic composition of stalagmites is deduced from the drip water using equilibrium or disequilibrium fractionation.
Under these conditions the modelled isotopic composition of stalagmites depletes with rising temperature. The steeper the slope of dO-18 with temperature the larger is the range of calcite dO-18 that can be explained along a certain path of correlation. Here the model was applied to the meteorological conditions of N. Germany.
The model was reversed to infer past temperature values from existing dO-18 records of Holocene stalagmites from Atta-Cave and Bunker-Cave.