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The influence of soil organic matter age spectrum on the reconstruction of atmospheric ^{14}C levels via stalagmites

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The imprint of the radiocarbon bomb peak was detected in the top of stalagmite ER-77 of Ernesto cave (north-western Italy). This recently grown stalagmite reveals a reservoir age, also known as dead carbon fraction (dcf), of around 1050 ^{14}C years, or 12%. By applying a radiocarbon soil-karst model the age spectrum of soil organic matter (SOM) as well as the CO_2 contribution of the single SOM reservoirs to the total soil CO_2 can be derived. These parameters allow to calculate the recent soil air CO_2 radiocarbon activity. Under the assumption of constant vegetation, meaning both vegetation density and the age spectrum of SOM, it is possible to derive the soil air ^{14}C activity of the past using the radiocarbon calibration curve (IntCal04). Hence, we calculated an artificial stalagmite ^{14}C record covering the last 25 thousand years with parameters determined for stalagmite ER-77. With this artificially constructed record we derived the hypothetical atmospheric radiocarbon activity by using the common method of applying a constant dcf on the ^{14}C record of the stalagmite.

This theoretical approach allows to analyse the impact of a constant and variable SOM age spectrum on the deviations observed between the stalagmite-derived atmospheric ^{14}C activity and IntCal04. The deviations are larger for older SOM than for younger SOM and change in time up to 2 pmC, depending on variations in the atmospheric ^{14}C level. This value is comparable with the 1-σ uncertainty given by IntCal04 for the last glacial. For a varying SOM age spectrum the deviations between the stalagmite-derived atmospheric ^{14}C activity and the calibration curve exceed 3 pmC which is larger than the 1-σ uncertainty of IntCal04. In general, the SOM has smoothing, shifting and ^{14}C depleting effects on the stalagmite ^{14}C record and, therefore, on the stalagmite-derived atmospheric ^{14}C activity. In this study changes in soil air pCO_2 and carbonate dissolution conditions, which have also an important impact on the ^{14}C record of a stalagmite, are not accounted for.