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Palaeoclimate signal recorded by stable isotopes in cave ice: a modeling approach

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Ice accumulations in caves preserve a large variety of geochemical information as candidate proxies for both past climate and environmental changes, one of the most significant being the stable isotopic composition of the ice.
A series of recent studies have targeted oxygen and hydrogen stable isotopes in cave ice as proxies for past air temperatures, but the results are far from being as straightforward as they are in high latitude and altitude glaciers and ice caps. The main problems emerging from these studies are related to the mechanisms of cave ice formation (i.e. freezing of water) and post-formation processes (melting and refreezing), which both alter the original isotopic signal in water. Different methods have been put forward to solve these issues and a fair understanding of the present-day link between stable isotopes in precipitation and cave ice exists now. However, the main issues still lays unsolved: 1) is it possible to extend this link to older ice and thus reconstruct past changes in air temperature?; 2) to what extent are ice dynamics processes modifying the original climatic signal and 3) what is the best method to be used in extracting a climatic signal from stable isotopes in cave ice?
To respond to these questions, we have conducted a modeling experiment, in which a theoretical cave ice stable isotope record was constructed using present-day observations on stable isotope behavior in cave ice and ice dynamics, and different methods (presently used for both polar and cave glaciers), were used to reconstruct the original, known, isotopic values. Our results show that it is possible to remove the effects of ice melting and refreezing on stable isotope composition of cave ice, and thus reconstruct the original isotopic signal, and further the climatic one.