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A model, and the fidelity of climate reconstructions from speleothems

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The use of multiple tracers to provide quantitative estimates of environment variables is well-known from other paleoclimate archives eg. in corals Mg, Sr, 13C and 18O are used jointly to separate and provide quantitative estimates for variables such as SST, salinity and precipitation amount. From speleothems, however, high-resolution quantitative climate reconstructions over the last millennia are still rare. There is no well-established theory on how to use multiple proxies to separate distinct environmental signals (precipitation, temperature, water balance), and it is not understood how the joint stochastic properties of climate variables- for a range of climate conditions- affect the fidelity of specific climate variable reconstructions from speleothems. In this presentation, a preliminary model of an environment+speleothem system is introduced, and investigated using modern statistical techniques. A soil+hydrology model is forced using gridded observed climate data (with a high spatial and temporal resolution) for Australia for the last century. Precipitation isotopes are reconstructed for the pre-1960 period using climate-isotope transfer functions. Soil carbon isotope variation is reconstructed using a recent hydrobiotic parameterisation. A speleothem is simulated using a growth rate model, and trace elements (Ba, Mg) are simulated based on growth-rate plus hydrological effects. All these parameterisations are linked together to form a speleothem multi-proxy model, that is forced by real climate data. Using the statistical method of canonical correlations with a split validation scheme, we show how climate signal reconstruction, and its fidelity, differs under different regional climates in Australia. This model provides a tool for understanding the science of regional climate reconstructions from speleothems over the last few millennia.