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More uncertainties for more certainty

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The proliferation of quantifications of past climate parameters from fossil assemblage data in the past decades has improved our understanding of past climate variability. However, our knowledge has been restricted to a few regions, such as North America and parts of Eurasia. In addition, even in these highly studied regions, strong regional discrepancies between reconstructions have been found, which suggests that some pieces of the puzzle are still missing. We argue that these discrepancies in the modern set of reconstructions can be explained by the lack of consideration given to uncertainties, such as chronological or climatic uncertainties. Most reconstructions are usually presented and interpreted only according to the 'most probable scenario', a scenario defined by associating one certain age and one certain climate value to each sample. These simplifications usually hinder robust comparisons of palaeorecords built on different timescales and/or have different temporal resolutions.

The new statistical transfer function we have developed, entitled CREST for Climate REconstruction SofTware, proposes a new global solution regarding these two issues. CREST uses probability density functions ('pdfs') fitted on modern occurrence data to reconstruct environmental parameters from fossil assemblage data (e.g. pollen). It offers many advantages over the classical approaches, such as 1) a higher flexibility of application, 2) a global applicability on large datasets, 3) a compatibility with a large range of proxy data, and most importantly, 4) a higher capacity to estimate and use uncertainties. Through the development of a fully probabilistic process that conserves and combines all the uncertainties at every stage of the process – instead of trying to reduce them at all cost – the CREST framework can produce 3-dimensional posterior distributions of environmental parameters on error-free timescales; thus facilitating the comparison of paleorecords with different chronologies, and also with instrumental data and climate model outputs.

In this paper, we present the key aspects of this framework, and illustrate its potential by showcasing temperature and rainfall reconstructions derived from African pollen data, and the key role they played in changing our understanding of the glacial-interglacial dynamic of the African rainbelt.