TRANSDIMENSIONAL MODELLING OF ARCHEOMAGNETIC DATA

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One of the main goals of archeomagnetism is to document the secular changes of Earth's magnetic field by laboratory analysis of the magnetization carried by archeological artefacts [1]. A few studies [e.g. 2] have highlighted possible extremely rapid changes in the archeomagnetic field, which do not seem to stand on a very solid physical footing, given our current understanding of Earth's core dynamics and the geodynamo [3]. In addition, strong temporal damping used in the associated models (due to the sparsity of data) makes them difficult to detect robustly. Key to proper modelling (and physical understanding) is a method that places a minimum level of regularisation on any fit to the data.

Here we investigate how transdimensional modelling [e.g. 4], whereby the degree of complexity of the model is not set a priori, can be used for that purpose. We first illustrate how this technique can be implemented for regional curves of archeointensity, assuming that the ages of the artefacts are perfectly known. To that end, we implement a Reversible Jump Monte Carlo Markov Chain (RJ-MCMC) technique based on a variable number of changepoints, akin to that developed by Gallagher et al. [5] in a geochemical context. Figure 1 below shows an application to French measurements spanning the past three thousand years [6, 7]. Next, we consider the more realistic case of uncertain ages, which prompts us to add another Monte Carlo layer in order to draw an ensemble of age realizations for the data at hand, each realization being subsequently treated with the RJ-MCMC approach. We finally discuss the generalization of this approach to global models of the archeomagnetic field.

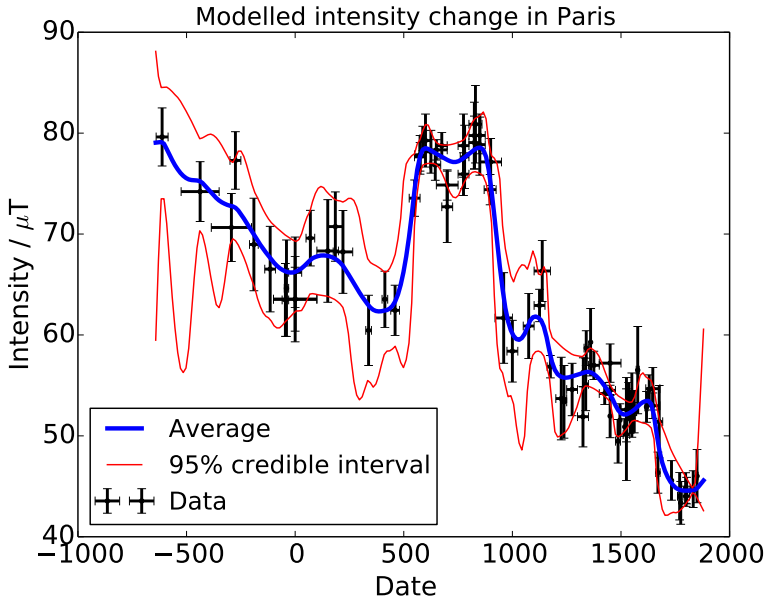

Figure 1. Transdimensional modelling of the geomagnetic intensity in Paris since 700 BC.

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