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Statistical methods in reconstructions: A multi-world study of regression properties

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Reconstruction of the Earth's surface temperature from proxy data is an important task because of the need to compare recent changes with past variability. Reconstruction methods may differ in many details but they basically relate the proxy data to observations through a form of regression. However, the statistical properties and robustness of such methods are not well known which has led to the current vivid discussion about the quality of published reconstructions. Of particular concern has been the methods' ability to catch low frequency variability.

In this paper we will present a systematic study of reconstruction methods. The methods include both field reconstructions and global-mean reconstructions and the regression will be based on both Principal Components and Canonical Correlation Patterns. The study will be based on climate simulations where the target of the reconstructions is known.

We will utilize two climate simulations from an Ocean-Atmosphere General Circulation Model - one unforced control experiment and one experiment forced with the usual suspects - of the period AD 1500-2000. It should be obvious that two cases are too few to draw statistical interferences from. To circumvent this problem we have developed a novel technique to generate surrogate fields with the same temporal and spatial characteristics as the original surface temperature field. This technique also allows us to control the strength of the low frequency variability in the surrogate fields. We apply the reconstruction methods to each member of the ensemble of surrogate worlds: we train the reconstruction method on a sub-period (defining the set of surrogate proxies by degrading a number of grid-box time-series) and reconstruct the remaining years. The multi-world approach will allow us to make statistical robust estimates of the properties of the different reconstruction methods.

The recommendations obtained from the multi-world study will be applied to a set of real proxies and a 500 years reconstruction calculated including estimates of uncertainty.