



A surrogate ensemble study of climate reconstruction methods: Stochasticity and robustness

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Reconstruction methods may differ in many details but they basically rely on a statistical relationship between proxy data and observations. 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.

In this paper we will present a systematic study of reconstruction methods. The methods include both global-mean reconstructions, field reconstructions based on Principal Components and Canonical Correlation Analysis, and the regularized EM algorithm. A multi-world approach allows us to make statistical robust estimates of the properties of the different reconstruction methods.

Based on a climate simulation of the period AD 1500-2000 with the ECHAM4/OPYC3 Ocean-Atmosphere General Circulation Model we use a novel technique to generate an ensemble of surrogate fields with the same temporal and spatial characteristics as the original modelled surface temperature field. Pseudo-proxies are generated by degrading a number of grid-box time-series. The number, geographical positions, and relation between the pseudo-proxies and the underlying temperature field are determined realistically from Mann et al. (1998). We apply the reconstruction methods to each member of the ensemble of surrogate worlds. We train the reconstruction method on a sub-period and reconstruct the remaining years.

We find that all reconstruction methods contain a large element of stochasticity which is revealed as broad distributions of skills when the methods are applied to fields of the same temporal and spatial characteristics.

All methods have substantial skills, in particular considering the reconstruction of the shape of the low-frequency variability. However, all the reconstruction methods also systematically underestimate the amplitude of the low-frequency variability.

We find some potential in validating the methods on independent data. However, to gain information about the reconstructions ability to capture the "pre-industrial" level it is necessary to consider the average level in the validation period and not the year-to-year correlations. ~