An updated pseudoproxy evaluation of four climate field reconstruction methods using improved emulations of real-world conditions

1. Introduction

Many studies have assessed the performance of different climate field reconstruction (CFR) techniques with synthetic data in pseudoproxy experiments (PPEs; see Ammann [2001] for a review), but these experiments have been idealized in their choice of spatiotemporal coverage and the adopted noise models in the pseudoproxy noise. Here we present a pseudoproxy network based on more realistic characteristics to better discriminate between CFR techniques. The network mimics the Mann et al. [2000] (hereafter MM00) proxy network and is constructed from the multi-model output of the NCAR CCSM-3 multimillion simulation (1900–1999 CE) [Jones et al., 2007]. We design the pseudoproxy network to reflect the layout of observational data in time in the MM00 network and employ signal-to-noise ratio (Gaussian white noise) (SNR) that is empirically derived from correlations between real-world proxies and the HadCRUT3 temperature field [Jones et al., 2000].

2. Experimental Design

The pseudoproxies are generated according to

\[ \tilde{P}(t) = T(t) \tilde{x}(t) + \sigma \epsilon(t) \]

where \( \tilde{P}(t) \) is a Gaussian white noise process with zero mean and unit variance and SNR the signal-to-noise ratio, derived from correlations between real-world proxies and the HadCRUT3 temperature field [Jones et al., 2000].

We generated a 100-member ensemble of pseudoproxies and explored two design choices for the realism SNR.

Realistic SNR: For each proxy in the MM00 network, the temperature pattern closer to the proxy is used to calculate the corresponding correlation (Figures 1, 2).

Global SNR: For each proxy in the MM00 network, all temperature patterns available in the HadCRUT3 dataset are used to calculate correlations to the proxy patterns. The temperature patterns resulting in the highest correlation is shown (Figure 1, bottom).

3. Results

In addition, we constructed two types of pseudoproxy network to assess the effect of temporal variability on reconstruction skill: DMM full network pseudoproxy availability is uniform through time. 20084 years pseudoproxy network pseudoproxy availability reaches the pattern in the MM00 dataset (Figure 2).

As indicated in Figure 3, in the global SNR case, the most highly correlated temperature patterns for each proxy in the ensemble are at least 500 km away. This means that network proxies in the MM00 network are at least 500 km apart. Site SNR patterns that measure local temperature, suggesting that reality must lie in between our two networks.

4. Findings

- Real-world proxies are not exclusively local climate indicators. A lot of missing information can be reconstructed from cross-proxy and regional information. Our results indicate that such dependencies can be used to approximate real temperature patterns more than time series in the global SNR scenario. We note that the errors can still be large locally. Cross-proxy teleconnections are essential to construct realistic temperature patterns between the global mean and the spatiotemporal field.

5. Discussion and Future work

We acknowledge some limitations of the pseudoproxy network: has no multi-decadal dependencies, the noise structure is too simplistic, and there is no noise in the time series. In other words, our pseudoproxy network is a single climate model simulation, which may be an oversimplification of the real climate system. To more carefully evaluate conclusions from this work, each type of PPE should also be constructed using other up-to-date model ensembles from the CMIP5 model archive.

References

[Complete list of references provided]

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