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Bias and confidence intervals in climate reconstructions

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Reconstructions of the temperature of the last one or two millennia are important because the amplitudes of the internal and forced variability in this period can help us understand the consequences and the impacts of coming changes in the forcings. Reconstruction methods typically rely on variations of linear regression, whereby the relationship between proxies and temperatures are statistically estimated in a calibration period when both data sets are available.

However, such reconstructions are hampered by different sources of noise: measurement noise on proxies and temperatures, the fact that proxies are not explained totally by temperature but include effects such as changes in the local environment, and sampling errors due to a finite number of stations involved in calculating the regional or global mean. The influence of the noise on the confidence intervals of the reconstructions depends on the length of the calibration period, the number of proxies, and the reconstruction method itself. The noise will most often not only give rise to a dispersion of the reconstruction around its true value but also in a systematic bias.

In this study we compare different approaches for obtaining confidence intervals. These include the Bayesian approach, bootstrapping, and an ensemble pseudo-proxy approach. These approaches all allow us to calculate confidence intervals on any diagnostic of interest such as annual means, trends, and extremes. In this study we will focus on low-frequency variability. We will apply these approaches to different reconstruction methods including LOC (Christiansen 2011) which was designed to minimize the bias and preserve low-frequency variability. We will study the behavior of the different approaches when applied both to pseudo-proxies and to a comprehensive set of real-world proxies (Christiansen and Ljungqvist 2011).

Preliminary results show that all three approaches give comparable widths of the confidence intervals. However, only the ensemble pseudo-proxy approach will reveal a possible bias.

References:

Christiansen B.: Reconstructing the NH mean temperature: Can underestimation of trends and variability be avoided? J. Climate, 24(3), 674-692, 2011.

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