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Testing canonical correlation analysis as a climate field reconstruction method using pseudo-proxy experiments

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Testing the skill of climate field reconstructions (CFRs) is complicated by the short period of overlap (100-150 years) between instrumental and proxy data; a period that must be used for both calibration and validation. Nevertheless, the recent availability of millennial General Circulation Model (GCM) integrations allows us to test reconstruction methods by comparing pseudo-proxy reconstructions, which use restricted subsets of model data, against the known and complete data from these simulations. These pseudo-proxy tests enable us to evaluate the performance of a reconstruction technique through controlled experiments and to infer how historical reconstructions may or may not faithfully represent past climate variability. Here we investigate canonical correlation analysis (CCA) as a CFR technique using pseudo-proxy experiments derived from the NCAR CSM 1.4 millennial integration. Within this framework we investigate a method of optimizing parameter selection in the CCA reconstructions, the impact of the timing and length of the calibration and validation intervals, and the performance of nested reconstructions that use proxy networks with decreasing numbers of proxies back in time. We find that CCA reconstructions are subject to warm biases and variance losses that increase with higher noise levels in the pseudo-proxy network. We also find that the highest skill for many validation metrics is concentrated over areas where the pseudo-proxies are most abundant, suggesting that proxy distribution plays an important role in the success of CCA. The impact of nesting appears to be minimal on the derived reconstructions. Finally, we use CCA to produce a real-world reconstruction from the Mann et al. (1998) proxy network and

compare our result to previous historical reconstructions.