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Testing the spatial performance of four late-Holocene climate field reconstruction methods using pseudoproxy experiments

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The spatial skill of four climate field reconstruction (CFR) methods is evaluated using pseudoproxy experiments (PPEs) derived from two millennial-length coupled Atmosphere-Ocean General Circulation Model (AOGCM) simulations: the NCAR CCSM1.4 paleo and GKSS ECHO-g FOR2 runs. The tested methods are: the Mann et al. (*Nature*, 1998) method, the regularized expectation maximization method using truncated total least squares regularization (RegEM-TTLS), ridge regression and canonical correlation analysis (CCA). PPEs employing these four methods demonstrate that spatial skill is heterogeneously distributed within global field reconstructions, and that the patterns of spatial skill are similar across all of the methods tested. Some model dependencies are observed, including improved skill throughout the tropics for all methods when tested on the ECHO-g FOR2 simulation. Notably, all methods also generate more skillful northern hemisphere and global mean indices when tested with the ECHO-g FOR2 simulation, most likely because of the improved skill in the tropics. Method performance is also tested using different pseudoproxy spatial distributions. Although low skill regions are not eliminated, skill is improved in experiments that approximate the updated Mann et al. (*PNAS*, 2008) multiproxy network relative to the more sparsely distributed Mann et al. (*Nature*, 1998) network. The multivariate nature of proxy records is also tested by combining temperature and precipitation pseudoproxies using a parsimonious tree model driven with monthly temperature and precipitation from the ECHO-g FOR2 simulation. CFRs derived using these pseudo tree-ring chronologies as predictors have reduced spatial skill relative to pure temperature pseudoproxies, and indicate that PPEs using more realistic pseudoproxies will further reduce the spatial performance of the tested reconstruction methodologies. Collectively, results indicate that potentially large and heterogeneous uncertainties exist in regions of derived CFRs such as the ocean basins and much of the Southern Hemisphere, and that these uncertainties must be adequately quantified in real-world reconstructions.