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Statistical framework for evaluation of climate model simulations by use of climate proxy data from the last millennium

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A statistical framework for comparing the output of global climate model (GCM) ensembles with networks of climate proxy and instrumental data has been developed using optimized quadratic distance and correlation based statistical measures of goodness-of-fit, with a view to comparing large ensembles with a range of physical parameterizations or external forcings. An essential underlying assumption is that the simulations and the proxy/instrumental series have a shared component of variability that is due to temporal changes in external forcing, such as volcanic aerosol load, solar irradiance changes and greenhouse gas concentrations. An advantage of this statistical framework is that it considers noise in the proxy data where the representativeness of a proxy as a climate variable, such as near surface temperature, is accounted for in its contribution to the test statistics. An ensemble of GCM simulations of the last millennium (COSMOS simulations developed by the Max Planck Institute) driven by either low and high solar forcing histories, along with other important forcings, were compared with a range of recently published hemispheric-scale reconstructions where stronger solar forcing was found to serve a poorer match with the reconstructions than the low solar. The proposed framework allows any number of proxy locations to be used jointly, with different seasons, record lengths and statistical precision, hence the low and high solar (plus other forcings) simulations are presently being compared with regional proxy reconstructions and regional instrumental data as well. Ideally a probability distribution of particular simulation characteristics (such as parameterizations or projected climate changes) can be informed by the ranking of a simulation ensemble using this framework. For example, we have contributed to the EU FP6-funded Millennium Project which involved the constraint of climate future projections based on the comparison of regional proxy syntheses with a large HadCM3 fast-running GCM ensemble.