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European temperature records of the past five centuries based on documentary information compared to climate simulations

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Two European temperature records for the past half-millennium, January-to-April air temperature for Stockholm (Sweden) and seasonal temperature for a Central European region, both derived from the analysis of documentary sources combined with long instrumental records, are compared with the output of forced (solar, volcanic, greenhouse gases) climate simulations with the model ECHO-G. The analysis is complemented with the long (early)-instrumental record of Central England Temperature (CET). Both approaches to study past climates (simulations and reconstructions) are burdened with uncertainties. The main objective of this comparative analysis is to identify robust features and weaknesses that may help to improve models and reconstruction methods.

The results indicate a general agreement between simulations and the reconstructed Stockholm and CET records regarding the long-term temperature trend over the recent centuries, suggesting a reasonable choice of the amplitude of the solar forcing in the simulations and sensitivity of the model to the external forcing. However, the Stockholm reconstruction and the CET record also show a long and clear multi-decadal warm episode peaking around 1730, which is absent in the simulations. The uncertainties associated with the reconstruction method or with the simulated internal climate variability cannot easily explain this difference. Regarding the interannual variability, the Stockholm series displays in some periods higher amplitudes than the simulations but these differences are within the statistical uncertainty and further decrease if output from a regional model driven by the global model is used.

The long-term trends in the simulations and reconstructions of the Central European temperature agree less well. The reconstructed temperature displays, for all seasons, a smaller difference between the present climate and past centuries than the simulations. Possible reasons for these differences may be related to a limitation of the traditional technique for converting documentary evidence to temperature values to capture long-term climate changes, because the documents often reflect temperatures relative to the contemporary authors' own perception of what constituted 'normal' conditions. By contrast, the simulated and reconstructed inter-annual variability is in rather good agreement.