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How natural and anthropogenic influences alter global and regional surface temperatures: 1889 to 2006

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Abstract

[1] To distinguish between simultaneous natural and anthropogenic impacts on surface temperature, regionally as well as globally, we perform a robust multivariate analysis using the best available estimates of each together with the observed surface temperature record from 1889 to 2006. The results enable us to compare, for the first time from observations, the geographical distributions of responses to individual influences consistent with their global impacts. We find a response to solar forcing quite different from that reported in several papers published recently in this journal, and zonally averaged responses to both natural and anthropogenic forcings that differ distinctly from those indicated by the Intergovernmental Panel on Climate Change, whose conclusions depended on model simulations. Anthropogenic warming estimated directly from the historical observations is more pronounced between 45°S and 50°N than at higher latitudes whereas the model-simulated trends have minimum values in the tropics and increase steadily from 30 to 70°N.

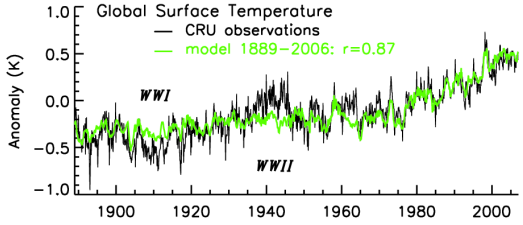

Figure 1. Compared with the CRU monthly mean global temperature time series (hadcrut3vcgl) is an empirical model obtained from multiple regression for the period from 1889 to 2006, inclusive. The value of r is the correlation coefficient for the global temperature observations and empirical model. Largest differences occur at the times of the two World Wars when observations were sparse.

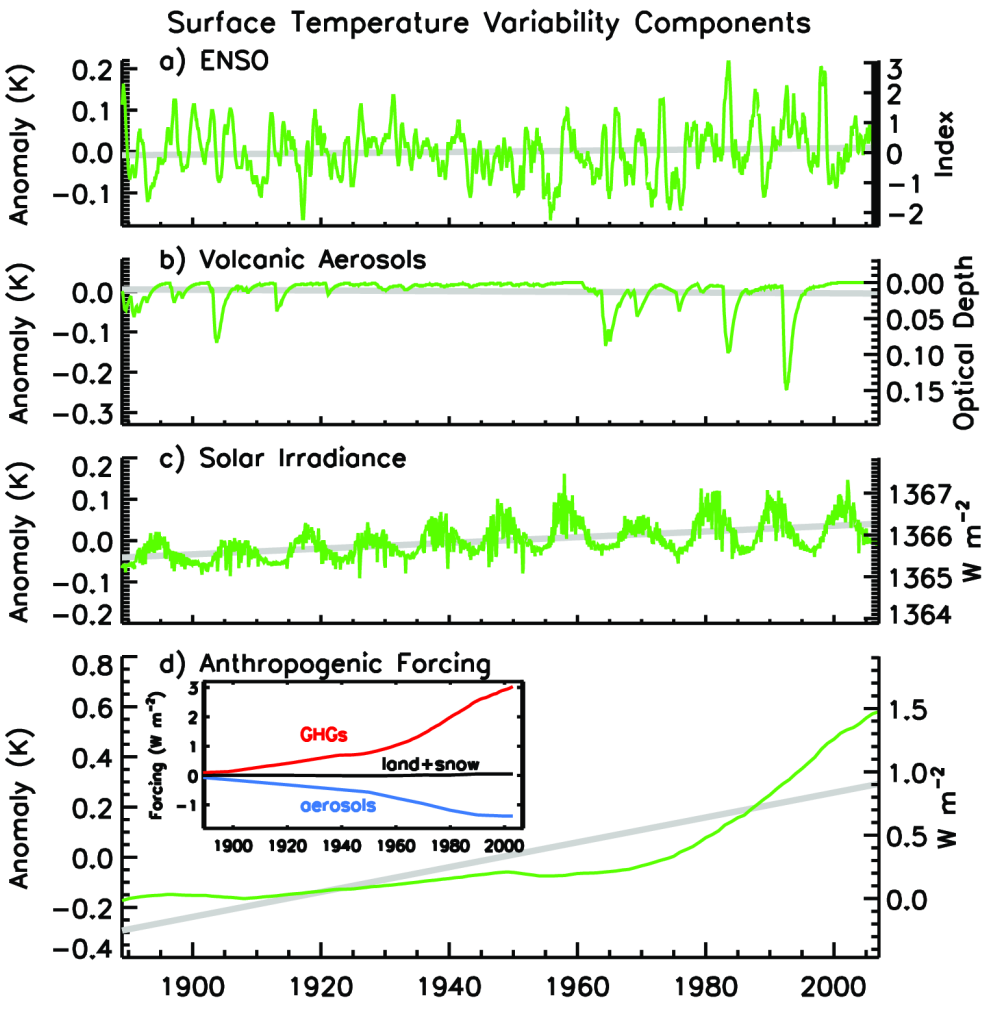

Figure 2. Reconstructions of the contributions to monthly mean global surface temperatures by individual natural and anthropogenic influences (at appropriate lags) are shown. The right hand ordinates give the native scales of each influence and the left hand ordinates give the corresponding temperature change determined from the multiple regression analysis. The grey lines are trends for the whole interval. The inset in Figure 2d shows the individual greenhouse gases, tropospheric aerosols and the land surface plus snow albedo components that combine to give the net anthropogenic forcing.