Geophysical Research Abstracts, Vol. 8, 07539, 2006
SRef-ID: 1607-7962/gra/EGU06-A-07539

Statistical separation of natural and anthropogenic signals in observed temperature data

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In this study, observed temperature data of the last 100 to 120 years were analyzed on different spatial scales: global and hemispheric mean, global scale area averages in space (84 boxes), European scale (52 grid points), German mean and German station data. Linear stepwise regression techniques were used to find connections between the data and potential regressors which are seen to influence temperature. The regressors of natural origin comprise changes in the solar constant, explosive volcanism, ENSO and NAO. The anthropogenic influence used is the equivalent greenhouse gas concentration. The stepwise regression tries to find simple, low-dimensional but meaningful regression models while trying to avoid over-fitting. When data fields are used, EOF-transformation is performed on the temperature fields before regression is applied. So the most meaningful temporal structures in the data are identified.

In the global and hemispheric data about 65% to 80% of the temperature variability can be explained using the forcings listed above. The most dominant forcing are greenhouse gases followed by variations of solar irradiance. Moving on to higher spatial resolution, stochastic variations become more dominant and the significance of the greenhouse signal is hampered. In European winter NAO is dominant. In German station data a difference between urban and rural locations is visible in the significance of the greenhouse signal which may be due to local urban heating effects. A time moving analysis with a 80-year-window shows a increasing greenhouse signal in the last two decades, especially on the global scale. In the same time the explained variance of the natural forcings drops clearly.