Geophysical Research Abstracts, Vol. 7, 05169, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05169

Paleoclimate simulation of the last 250 years: relationship between regional temperature anomalies and large scale atmospheric circulation variability

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The climate response to different external forcing factors is investigated by simulations with the coupled model ECHO-G and prescribed time evolving historical forcings. The main goal is to identify the physical mechanisms leading to global and regional temperature anomalies with respect to the different forcing factors. Of special interest is the question in how far there is a linearity in climate response with respect to the individual forcings. Four experiments were performed with separated forcing for (1) solar irradiance, (2) volcanic activity, (3) atmospheric concentrations of greenhouse gases (GHG) and (4) a combination of solar and volcanic activity. All simulations start in 1756 and extend to 1990. The study focuses on the Dalton Minimum (around 1800). Furthermore the temperature response to anthropogenic GHG forcing within the 20th century will be discussed with respect to the role of solar and volcanic variability. On the regional scale the North Atlantic/European sector is in the centre of interest.

Ensemble simulations show significant global and regional temperature anomalies. At this stage the physical mechanisms are discussed with respect to large scale atmospheric circulation anomalies. The role of different forcing factors is assessed by means of composite studies. Moreover principal component analysis is used to analyse North Atlantic/European atmospheric circulation variability and to assess large scale atmospheric circulation patterns in different scenario experiments. The reliability of results is discussed based on the ensemble simulations. Finally, results are extensively compared with proxy based reconstructions.