

The climate in China over the past 2000 years in a global Earth System Model simulation

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The climate in China over the past 2000 years is analysed based on a global simulation with the Earth System Model MPI-ESM-P. This model has been used for the past millennium simulations of the Climate Model Inter-comparison Project version 5. The model includes an atmospheric sub-model (ECHAM6), the ocean and sea-ice submodel MPI-OM. The carbon cycle and vegetation submodels of MPI-ESM-P were switched-off in the version of the Earth System Model.

The climate model was forced by reconstructions of past volcanic activity, solar irradiance, greenhouse gases and land-use changes. Over the second millennium, these forcings are the same those used in the past-millennium CMIP5 simulations with the model MPI-ESM-P. For the first millennium, reconstructions of these forcings have been implemented, as described below.

The reconstruction of the volcanic forcing is based on the sulphate data set of Sigl et al. (2013) and applying the algorithm of Crowley and Unterman (2012). The sulphate records are scaled to the Crowley and Unterman (2012) reconstruction used within CMIP5 in the second millennium. The solar forcing is based on the reconstruction of Vieira et al. (2011). Long-term changes represent a 0.1% difference between the Maunder Minimum (1645-1715 AD) and present-day values (1950–2000 AD). Land-use changes have been prescribed according to the CMIP5 protocol from 800 onwards and kept constant before this period.

This global simulation is currently analysed, thus the presentation will show preliminary results on the past climate variations over China for the Common Era. The spatially averaged annual mean temperature clearly displays the known phases of a relatively warm Roman period, followed by colder conditions during the 'Dark Ages', warmer temperatures again during the Mediaeval Warm Period (MWP; peaking at about 1100 AD). The period from 1300 to 1800 was characterised by below normal temperatures, with an ensuing strong warming trend over approximately the last 200 years. The temperature level at the mean of the Mediaeval Warm Period is already attained in 1900, with further warming over the 20th century. In the last 30 years of the 20th century, the temperature is about 0.7K warmer than at the peak of the MWP and it shows the warmest conditions over the past 2000 years.

The multidecadal evolution of the annual mean precipitation can better be described by a sea-saw of precipitation anomalies, with centres of action in the South and in the North of China? In contrast to temperature, the time evolution of the intensity of this precipitation dipole does not show a clear influence by the external forcing over most of the past 2000 years. However, a clear trend can be seen over the past 200 years, indicating that the North has become drier whereas the South got wetter. This trend is outside the amplitude of natural variations during the previous 1800 years.

Next steps include the comparison of seasonal temperature and precipitation variations from the model with published palaeoclimatic information from different proxies and areas of China.