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Volcanic and ENSO effects on the climate in China in simulations and reconstructions

Dan Zhang (1,2), Richard Blender (2), and Klaus Fraedrich (2)

(1) Max Planck Institute for Meteorology, Hamburg, Germany (dan.zhang@zmaw.de), (2) KlimaCampus, University of Hamburg, Hamburg, Germany (richard.blender@zmaw.de,klaus.fraedrich@zmaw.de)

The climate in China is simulated by the COSMOS ASOB earth system model in a millennium run including ECHAM5 in T31/L19, MPIOM in GR3.0/L40 resolution and the JSBACH land module for 800-2005AD subject to anthropogenic and natural forcings. The experiment consists of an ensemble of five simulations, applying reconstructions of natural forcing (volcanic aerosols and Total Solar Irradiance, TSI) and anthropogenic forcing (land-cover-changes and greenhouse gas emissions). The experiment includes a second ensemble of three simulations with stronger TSI variability.

Volcanoes turn out to be the dominate forcing in both ensembles. For the present analysis 21 volcanic eruptions are selected to determine volcanic and El Nino/Southern Oscillation (ENSO) impacts on the climate in China. The SOI is defined by the principal component time series (PC1) of the first EOF of the tropical Pacific sea surface temperature (SST) variability in winter (DJF). The results show that volcanoes for neutral SOI cause a dramatic cooling in China accompanied by drought in the Southeast during the year after eruption. The decay of the volcanic cooling effect is expressed by an exponential function, a*exp(-t/b), with a time scale b, which is roughly 8 years in the global mean and within 4-10 years in China.

An El Nino (with PC1<-1.0) following the eruption warms most regions in China. In this situation, a complex geographical pattern of Standardized Precipitation Index (SPI) changes is found. To determine dynamic causes, three monsoon indices (Monsoon Hadley-Cell Index (MHI), Dynamical Monsoon Index (DMI) and Summer Monsoon Index (SMI, sea level pressure differences)) are considered. The temperature and the SPI obtained in the simulations in Northeast, Southeast and West China are compared with regional temperature (Wang et al., 2007; Yang et al., 2002) and wet-dry index (Zheng et al., 2006) reconstructions.