Geophysical Research Abstracts
Vol. 19, EGU2017-6870, 2017
EGU General Assembly 2017

Bayesian hierarchical models for regional climate reconstructions of the last glacial maximum

Nils Weitzel, Andreas Hense, and Christian Ohlwein
Meteorological Institute, University of Bonn, Bonn, Germany

Spatio-temporal reconstructions of past climate are important for the understanding of the long term behavior of the climate system and the sensitivity to forcing changes. Unfortunately, they are subject to large uncertainties, have to deal with a complex proxy-climate structure, and a physically reasonable interpolation between the sparse proxy observations is difficult. Bayesian Hierarchical Models (BHMs) are a class of statistical models that is well suited for spatio-temporal reconstructions of past climate because they permit the inclusion of multiple sources of information (e.g. records from different proxy types, uncertain age information, output from climate simulations) and quantify uncertainties in a statistically rigorous way.

BHMs in paleoclimatology typically consist of three stages which are modeled individually and are combined using Bayesian inference techniques. The data stage models the proxy-climate relation (often named transfer function), the process stage models the spatio-temporal distribution of the climate variables of interest, and the prior stage consists of prior distributions of the model parameters. For our BHMs, we translate well-known proxy-climate transfer functions for pollen to a Bayesian framework. In addition, we can include Gaussian distributed local climate information from preprocessed proxy records. The process stage combines physically reasonable spatial structures from prior distributions with proxy records which leads to a multivariate posterior probability distribution for the reconstructed climate variables. The prior distributions that constrain the possible spatial structure of the climate variables are calculated from climate simulation output.

We present results from pseudoproxy tests as well as new regional reconstructions of temperatures for the last glacial maximum (LGM, $\sim$ 21,000 years BP). These reconstructions combine proxy data syntheses with information from climate simulations for the LGM that were performed in the PMIP3 project. The proxy data syntheses consist either of raw pollen data or of normally distributed climate data from preprocessed proxy records.

Future extensions of our method contain the inclusion of other proxy types (transfer functions), the implementation of other spatial interpolation techniques, the use of age uncertainties, and the extension to spatio-temporal reconstructions of the last deglaciation.

Our work is part of the PalMod project funded by the German Federal Ministry of Education and Science (BMBF).