Model-data discord for climate change over China during mid-Holocene

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There is a global inconsistency of simulated cooling and reconstructed warming for mid-Holocene surface air temperature between model and proxy data, relatively to nowadays. This discord may result from the underlying dynamic mechanisms of model or the uncertainty related to proxy reconstruction, which calls an examination of climate model response to the mid-Holocene forcing and a comprehensive reconstruction with the carefully assessed and validated methods. In this study, we collected 173 pollen records over China and used the Inverse Vegetation Model to narrow the uncertainty of reconstruction by considering the biophysical processes and the seasonal signal. Besides, we also got the simulation results of annual and seasonal temperature and precipitation over China from the Paleoclimate Modeling Intercomparison Project Phase (PMIP3). In our model-data comparison, for temperature, both simulation and reconstruction indicated an increase in the warmest month (MTWA), $\sim$0.5K and $\sim$1K for model and data respectively. However, 11 models (except CNRM-CM5 and HadGEM2-Es) reproduced colder annual temperature ($\sim$-0.4K) with a significant cooling ($\sim$-1.2K) in coldest month (MTCO) from all 13 models in mid-Holocene, while a warmer-than-present annual ($\sim$0.7K) and MTCO ($\sim$1K) climate conditions were derived from pollen data. For precipitation, model and data both indicated an increase for annual and July rainfall, distinguished by a much larger magnitude in reconstruction. Beyond the conundrum depicted by the model-data comparison, we also analyzed the possible explanation due to the models simulations and data reconstructions weaknesses. For instance, our results also displayed a variability in simulation between models, especially for temperature, which we found out is most likely to be caused by the sea ice cover difference in models.