How reliable are reconstructions and models for past temperature changes?

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An understanding of climate changes during the past millennia is crucial for the scientific attribution of the current warming and the accurate prediction of future climate change. The proxy-based reconstructions

and model simulations that offer insights into past temperature changes, however, are subject to large uncertainties. Large-scale climate reconstructions are always related to the uncertainties arising from the disturbance of non-climate signals in individual proxy record, and the differences in seasonality or temporal resolution for different proxy records.

Model simulations are always related to the uncertainties arising from the uncertainties of forcing reconstruction itself and the lack of some important feedback mechanisms in climate models. Nearly 20 proxy-based reconstruction and 10 model simulation datasets have been published over the past three decades; however, due to the large uncertainty in them, significant differences between different reconstructions and between reconstructions and simulations frequently happen. The uncertainty makes it difficult to have a clear picture of past climate changes, but, unfortunately a detailed evaluation of such uncertainties in reconstructions and model simulations is still rare.

The recently published paper in *Science China Earth Sciences*, "Evaluation of multidecadal and longer-term temperature changes since 850 CE based on Northern Hemisphere proxy-based reconstructions and model simulations," was jointly written by Dr. Wang Jianglin, Prof. Yang Bao, Dr. Fang Miao, Dr. Liu Jingjing of Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences (CAS), Prof. Zheng Jingyun, Dr. Zhang xuezhen of Institute of Geographic Sciences and Natural Resources Research, CAS, Dr. Wang Zhiyuan of Zhejiang Normal University, and Dr. Shi Feng from Institute of Geology and Geophysics, CAS. The researchers evaluated uncertainties in the published 18 reconstructions and 6 model simulations by assessing covariance, climate sensitivity and amplitude of temperature changes in them.

The results show the uncertainty generally increases back in time as the

covariances between different reconstructions or between reconstructions and simulations steadily decline back in time and becomes particularly large during the Medieval times. The results also show that climate modeling results show a shorter recovery (i.e., lag) in response to the cooling caused by volcanic eruptions and solar activity minima, and a smaller amplitude of multi-centennial temperature changes compared with those in proxy-based reconstructions.

Finally, the article gives the prospects and suggestions for future works to reduce uncertainty in large-scale climate reconstructions. Firstly, more efforts are suggested to be taken in developing long, high-quality and temperature-sensitive proxy records for the areas with sparse proxy archives (e.g., East China, Africa, Antarctic, South America, and some oceanic areas). Secondly, the reliability of reconstruction outside the instrumental period is encouraged to be strictly assessed by comparing with the low-resolution proxy records that was excluded from the current proxy network and by applying the 'pseudo-proxy experiment' method.

More information: Jianglin Wang et al, Evaluation of multidecadal and longer-term temperature changes since 850 CE based on Northern Hemisphere proxy-based reconstructions and model simulations, *Science China Earth Sciences* (2020). DOI: 10.1007/s11430-019-9607-x

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