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## How cold was Europe at the Last Glacial Maximum? A synthesis of the progress achieved since the first PMIP model-data comparison

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**Abstract.** The Last Glacial Maximum has been one of the first foci of the Paleoclimate Modelling Intercomparison Project (PMIP). During its first phase, the results of 17 atmosphere general circulation models were compared to paleoclimate reconstructions. One of the largest discrepancies in the simulations was the systematic underestimation, by at least 10°C, of the winter cooling over Europe and the Mediterranean region observed in the pollen-based reconstructions. In this paper, we investigate the progress achieved to reduce this inconsistency through a large modelling effort and improved temperature reconstructions. We show that increased model spatial resolution does not significantly increase the simulated LGM winter cooling. Further, neither the inclusion of a vegetation cover compatible with the LGM climate, nor the interactions with the oceans simulated by the atmosphere-ocean general circulation models run in the second phase of PMIP result in a better agreement between models and data. Accounting for changes in interannual variability in the interpretation of the pollen data does not result in a reduction of the reconstructed cooling. The largest recent improvement in the model-data comparison has instead arisen from a new climate reconstruction based on inverse vegetation modelling, which explicitly accounts for the CO<sub>2</sub> decrease at LGM and which substantially reduces the LGM winter cooling reconstructed from pollen assemblages. As a result, the simulated and observed LGM winter cooling over Western Europe and the Mediterranean area are now in much better agreement.

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