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What can we learn from a climate model-data comparison for the Last Interglacial period?

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Past time periods provide important case studies for evaluating the performance of Earth system models, because model results can be compared with geological records. During the Last Interglacial period (∼130-115 thousand years (ka) ago) the climate was warmer than today and global mean sea-level was more than 6 metres higher according to previous climate and ice sheet model simulations and palaeodata reconstructions. This time period provides the best documented record of a warmer than present climate from available palaeoclimatic archives and, therefore, provides an ideal opportunity to test climate and ice sheet models used for future climate prediction.

As part of the European program Past4Future and the UK iGlass consortium, transient climate simulations using a low resolution General Circulation Model (GCM), spanning 130 to 115ka have been performed as well as time-slice simulations using a full GCM at 130, 128 and 125ka. These simulations aim at characterising the response of the climate system to changes in greenhouse gas concentrations and orbital forcings during the LIG and conform to the PMIP3 standard.

The climate model results are compared with a new synthesis of ice, marine and continental archives from the polar and sub-polar regions which represents the temporal evolution of temperatures during the LIG at different locations – a substantial improvement on the previously published data time-slice which represented the whole of the LIG period. The temperature evolution in the Northern and Southern Hemisphere differs markedly in the transient simulations with the timing of peak warmth showing a substantial delay in Antarctica compared with Greenland. This result completely contradicts the findings from this new palaeo-data synthesis and a recent study by Govin et al. (2012), which suggest Southern Hemisphere peak warmth actually preceded Northern Hemisphere warming during the early part of the LIG.

This model-data comparison reveals the importance of requiring accurate palaeodata in terms of age, magnitude and seasonality to constrain model temperatures and infer which biophysical climate feedbacks may be important. Furthermore, by informing us on how well the model reproduces LIG climate we can deduce which methodology might be required to obtain reliable LIG ice sheet melt contributions to LIG sea-level. This could be achieved by forcing an ice sheet model with either model data selected from an ensemble of climate model simulations which best matches the palaeodata, a combined model-palaeodata synthesis approach and/or the inclusion of additional forcings in the model such as freshwater input.