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Reconstructing the climate states of the Late Pleistocene with the MIROC climate model

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The Late Pleistocene was a period which lasted from the Eemian interglacial period to the start of the warm Holocene and was characterized mostly by widespread glacial ice. It was also a period which saw modern humans spread throughout the world and other species of the same genus, like the Neanderthals, become extinct. Various hypotheses have been put forward to explain the extinction of Neanderthals, about 30,000 years ago. Among these is one which involves changes in past climate and the inability of Neanderthals to adapt to such changes. The last traces of Neanderthals coincide with the end of Marine Isotope Stage 3 (MIS3) which was marked by large fluctuations in temperature and so-called Heinrich events, as suggested by geochemical records from ice cores. It is thought that melting sea ice or icebergs originating from the Laurentide ice sheet led to a large discharge of freshwater into the North Atlantic Ocean during the Heinrich events and severely weakened the Atlantic meridional overturning circulation, with important environmental ramifications across parts of Europe such as sharp decreases in temperature and reduction in forest cover. In order to assess the effects of past climate change on past hominin migration and on the extinction of certain species, it is first important to have a good understanding of the past climate itself.

In this study, we have used three variants of MIROC (The Model for Interdisciplinary Research on Climate), a global climate model, for a time slice experiment within the Late Pleistocene: two mid-resolution models (an atmosphere model and a coupled atmosphere-ocean model) and a high-resolution atmosphere model. To obtain a fuller picture, we also look at a cool stadial state as obtained from a 'freshwater hosing' coupled-model experiment, designed to mimic the effects of freshwater discharge in the North Atlantic. We next use the sea surface temperature response from this experiment to drive the atmosphere models. We discuss the general features of the model-simulated climates and how model resolution can affect these results. We also compare our results with some available proxy data to elucidate where model simulations show good agreement.