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Modelling the climate of the last million years

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Spectral analysis of climate proxy records provides evidence that over the last 1 Myr the dominant period of the signal changes from 41 to 100 kyr. The timing of this mid-Pleistocene revolution (MPR) is often considered to be at about 900 kyr BP. Many climate records, from deep-sea core as well as from ice core, display another climate change, the mid-Brunhes event (MBE), about 430 kyr ago. The climate of the last 400 kyr is characterised by four glacial-interglacial cycles of large amplitude, while the amplitude of the signal is much smaller during the intermediate interval. It is now widely recognised that a substantial fraction of the climatic variance is driven by insolation changes, related to changes in the frequency ranges of eccentricity, obliquity, and precession. However, the components centred near 100 kyr dominate most Upper Pleistocene Climatic records, although the insolation component at the eccentricity driven 100-kyr period is very small. Moreover, over the last 1Myr, the power of the 100-kyr period in eccentricity starts to decrease progressively for the benefits of the 400-kyr period, which dominates the last 400 kyr. This eccentricity cycle fades away simultaneously with a strengthening of the 100-kyr cycle in climate records. This underlines the importance of non-linear feedback mechanisms, which are necessary to create the 100-kyr climate signal. Modelling experiments were performed with the LLN (Louvain-la-Neuve) climate model of intermediate complexity, forced with daily insolation for each latitude and with scenarios for CO2 variations. Using a decreasing trend for CO2 concentration over the last million years allows the model to simulate an increase in mean global ice volume, simultaneous with a change in the dominant period from 41 to 100 kyr, in good agreement with data. However, the signal in the 100-kyr band is much weaker in the simulated annual mean temperature than in the simulated continental ice volume. Atmospheric CO2 reconstruction from Antarctic ice cores will become soon available for times earlier than 400 kyr. Meanwhile,

CO2 scenarios based on statistical correlation between CO2 concentration and other proxy climate records were tested. However these simulations do not show a clear change in the amplitude of the climate signal at transition V. A clear limitation of our model is that it covers the Northern Hemisphere only. Therefore the question remains open whether such a different behaviour between model and data could arise from the Southern Hemisphere.