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The role of CO_2 and insolation in explaining interglacial diversity and the origin of the Mid-Brunhes Event

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We use two climate models, LOVECLIM and CCSM3, to simulate the climate response to insolation and CO_2 forcings during the nine interglacials of the last 800,000 years. The results show that the difference between the interglacials is explained by both direct radiative effects of the forcings, their synergism and indirect dynamical effects which involve, for example in CCSM3, the sea-level pressure anomalies in the North Pacific and Southern Oceans and the surface conditions of the Nordic Seas.

Moreover, the relative impacts of insolation and CO_2 on different climatic variables and on different regions are quantified through simulations with LOVECLIM and using the factor separation technique. The results show that the relative contribution of insolation and CO_2 on the warmth intensity varies from one interglacial to another. They also show that CO_2 plays a dominant role on the variations of the global annual mean temperature and the southern high latitude temperature and sea ice, whereas, insolation plays a dominant role on the variations of monsoon precipitation, vegetation and of the northern high latitude temperature and sea ice.

Our simulations also help to understand the origin of the Mid-Brunhes Transition (MBE) which is characterized by change in the interglacial amplitude about 430,000 years ago. As far as the surface climate is concerned, MBE appears mainly in the variables dominated by CO_2 and it is not clear in the variables dominated by insolation. This explains the absence of MBE in some regional records. However, the oceanic response to insolation is more complex depending significantly on the interactions between the atmosphere and the ocean. Insolation alone can induce a MBE in some oceanic processes which are critical for the carbon cycle. This might contribute to the understanding of the origin of the MBE in the atmospheric CO_2 concentration.