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Does the interglacial MIS-13 challenge the Milankovitch hypothesis?

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Assuming that changes in the oxygen isotopic composition of the deep sea arise mainly from changes in the continental ice volume, the deep-sea records show that MIS-13 would be among the most glaciated interglacials and therefore most probably among the coolest ones over the last one million years. However, some proxy records indicate unusually high rainfall events during this interglacial over some monsoon regions, like East Asia, South Asia and North Africa. The most important interstadial of MIS-13 is MIS-13.1 with the 18O peak located in SPECMAP at 501 ka BP (MIS-13.13, Imbrie et al., 1984) and in Lisiecki and Raymo (2005) at 491 ka BP (MIS-13.11). AS MIS-13.1 spans a full precession cycle, this difference can be investigated in terms of the astronomical theory. Indeed, NH summer occurs at perihelion, 506 ka ago, then at aphelion, 495 ka ago, and finally again at perihelion 485 ka ago. It happens therefore that the astronomical configuration just before MIS-13.11, 495 ka ago, does not correspond to the traditional Milankovitch hypothesis that an interglacial results from NH summer at perihelion and is therefore more naturally associated to a cold period than to a warm one, whereas 506 ka BP would be more astronomically coherent with the occurrence of an interglacial. To try discriminating between the two 18O peaks, an Earth system model of intermediate complexity (LOVECLIM) is used for analysing the climate response to the astronomical forcing at 506 ka BP and at 495 ka BP. Our simulations (Yin et al., 2008, 2009) show that the Earth is globally warmer at 506 than at 495 ka BP. It underlines the importance of the northern hemisphere response (at 495 SH summer is at perihelion!) and associated feedbacks at the global scale. Besides this increase in global temperature, NH summer at perihelion is also associated with much stronger northern monsoons. The result that the Earth is globally warmer when NH summer occurs at perihelion than at aphelion confirms the Milankovitch hypothesis. It indicates that the "anomalous" relationship between insolation and the LR04 peak at 491 ka BP has to be discussed further by testing the accuracy of the time scale and/or the intensity of the peaks. However, if Lisiecki and Raymo (2005) data appear to be confirmed, it is the straightforward relationship between climate and the astronomical forcing which will have to be revisited and/or complemented. It remains that our simulation results have to be confirmed by transient simulations with appropriate climate models and including the long-term variation of climate, before any definite conclusion can be drawn.