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Orbital induced variations of surface temperatures and the ocean circulation

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We performed a long-term numerical experiment using the Earth System model COSMOS under interglacial background conditions, but varying orbital parameters. The 10.000 year long run represents the last million years and is accelerated by a factor of 100. Our model shows a polar amplification of the orbital forcing. In the frequency domain, significant temperature and precipitation variability at mid-latitudes are dominated by precession, high latitudes by obliquity. The precessional response is related to nonlinearities and/or seasonal biases in the climate system. The wind-driven ocean circulation is dominated by obliquity (more a linear response), whereas the Atlantic meridional overturning and heat transport show pronounced precessional (20 kyr) and obliquity (40 kyr) peaks due to nonlinearities and seasonal biases towards winter. Our model integrations and analysis confirm that convection and deepwater formation serves to rectify the zero annual-mean precessional forcing, resulting in 20 kyr energy in the ocean. The Antarctic bottom water shows also excentricity peaks indicating rectification mechanisms. We compare the different interglacial peaks with each other and evaluate the climate response to orbital forcing. Finally, we argue that the model results are useful for the question of how orbital changes are translated to the paleoclimatic records.

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