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Orbital control of Monsoon circulation in an accelerated transient simulation over the last 130,000 years.

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Isotopic signals found in speleothems from South China (Hulu Cave, Dongge Cave) and Brazil (Botuvera Cave) exhibit clear orbital preccessional cycles over the last 130,000 years, suggesting a direct effect of the summer insolation variatons on the Monsoon circulation. This study investigates the impact of orbital forcing on the Asian Monsoon and the South American Monsoon in the presence of concurrent carbon dioxide and ice-sheet forcing. We use the LOVECLIM model to simulate the transient response to changing boundary conditions of carbon dioxide, ice-sheets and orbital parameters over the last 130,000 years. The boundary forcing was accelerated by a factor of 20, resulting in a 6500 year long simulation. The CO_2 changes follow the atmospheric CO_2 reconstructions of Antarctic ice cores. The orbital forcing is calculated using the formula of Berger (1978). The ice-sheet (topography and albedo) changes are prescribed following a previous simulation with an AGCM-ice sheet model that was driven by orbital and CO_2 forcing. The influence of the forcing on the Monsoon over India/Asian and over South America is analysed in terms of temperature and precipitation. The model simulation clearly demonstrates a major influence of the precessional cycle on the Monsoon. The insolation changes directly control the temperatures and precipitation in the model. Our results support the recent interpretations of speleothem isotopic signals as the ratio between summer and winter precipitation. The model further shows that ice-sheet induced circulation changes in the Northern Hemisphere have a minor impact on the Asian Monsoon circulation. The Atlantic Meridional Overturning circulation, which shows a remarkable obliquity signal, has no dominant influence on the strength of the Monsoon circulation in this simulation.