Relative role of astronomical forcings and the atmospheric carbon dioxide during the glacial cycles of the last two million years

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Climate change with the wax and wane of large Northern Hemisphere ice sheet occurred with a periodicity of about 100,000 years. This followed a transition at about one million years ago (Ma) before which a 40,000 year cycle with smaller amplitude was dominant. Although the importance of insolation as the ultimate driver is now appreciated, the mechanism what determines the timing and strength of ice age termination as well as the amplitude of glacial cycles are not clearly understood. Here we simulate the glacial cycles of the last 2 Ma and investigate the origin of 100 ka cycle using a three dimensional ice sheet model with the input examined by the MIROC 4m GCM. The model is forced by astronomical parameters (Berger, 1978) and atmospheric CO2 change obtained from ice cores (Vostok, EPICA and DomeF), where available. Ice age cycles with a saw-tooth shape 100 ka periodicity for the last 720 ka are almost successfully simulated, with the major NH ice sheet volume as well as geographical distribution and timing of interglacials. The time before the MPT is simulated even under constant CO2 level of 230ppm back to 1.5 Ma, while the glacial cycles before 1.5 Ma is simulated with a larger CO2 level. Through sensitivity experiments we examine individual factors determining the glacial termination, such as constant and variable CO2 levels, obliquity, precession and eccentricity. We discuss the importance of investigating the "old ice" in Antarctica.

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