

Mechanism of ice age cycle and paleoclimate modeling

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The 100-kyr cycle of the waxing and waning of the large Northern Hemisphere ice sheets and fast termination of the glacial cycles are the prominent pattern known from paleoceanographic records which can not be explained by the summer insolation proposed by the Milankovitch theory alone. Conceptual models imposing a threshold for the terminations by a large size of the ice sheet and/or large insolation can reproduce the patterns of glacial cycles, however, a physical explanation was not given. Here we simulated the past seven glacial cycles successfully with an ice sheet model in combination with a general circulation model imposing the time series of insolation and atmospheric CO₂. The response of climate to ice sheet, greenhouse gases and orbital forcings is examined with high resolution. The stationary wave feedback of ice sheet is also taken into account. Our model reproduces 100-kyr periodicity of the glacial cycles even with the astronomical forcing alone under a certain range of CO₂ level for the case of North America ice sheet. We show that the threshold which leads to the termination of the glacial cycle is governed by how the ice sheet responds to a given insolation. The characteristics of how the ice sheet responds to external forcing strongly depends on the climatic condition, such as the north-south temperature gradient and the topographic condition for each continent.

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