Geophysical Research Abstracts, Vol. 7, 05570, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05570

Modeling the oxygen-isotopic composition of the North American Ice Sheet and the induced isotopic enrichment of the ocean during the last glacial cycle

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We used a 2.5-dimensional thermomechanical ice-sheet model including the oxygen-isotope ratio $^{18}O/^{16}O$ as a passive tracer to simulate the isotopic composition ($\delta^{18}O$) of the North American Ice Sheet (NAIS) during the last glacial cycle. This model allowed us to estimate the contribution of the NAIS to the change of seawater $\delta^{18}O$ (δ_w) between the Last Glacial Maximum (LGM) and the Holocene and to evaluate the effect of nonequilibrium isotopic composition of the NAIS on the relationship between ice-volume variations and the ocean isotopic enrichment. The enrichment due to the NAIS at the LGM was 0.63 per mille, corresponding to $\sim$74 m of eustatic sea-level drop and to a mean $\delta^{18}O$ of the NAIS of approximately –31 per mille. The modeled NAIS volume variations and the induced δ_w changes over the past 120,000 years indicated no significant time lag. The inaccuracy associated with estimating ice-volume variations from changes in δ_w was generally less than 10%.