Geophysical Research Abstracts,
Vol. 10, EGU2008-A-06094, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-06094
EGU General Assembly 2008

Modelling the middle Miocene excursion in the ^{13}C isotopic composition of deep seawater

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The middle Miocene (17.5-13.5 Ma) is characterized by a positive excursion of $\sim$1 ‰ in the δ^{13}C of benthic foraminifera worldwide. This rise in deep ocean water δ^{13}C has been attributed to an increased sequestration of isotopically depleted organic carbon either from marine or from continental origin. Such an increase in the deposition of organic carbon is consistent with a parallel decrease in the atmospheric CO_2 pressure recorded in the proxy data for the middle Miocene. However, data from DSDP/ODP/IODP sites (Diester-Haass et al., this session) indicate that open ocean productivity does not show any significant long-term trend over the time interval when the isotopic shift is observed, suggesting that the reason for the increased organic carbon sequestration must be searched for on the continents. Here, we use a box model of the ocean, atmosphere and land surface system including the long-term budgets of carbon, alkalinity and phosphorus, and coupled to an energy balance climate model, to investigate the mid-Miocene rise of the ^{13}C isotopic composition of benthic foraminifera. The model indicates that the isotopic shift cannot easily be explained

by an enhanced sequestration of organic carbon in the ocean, because it would lead either to excessive decrease in atmospheric CO_2 compared to the proxies and/or to changes in the calcite compensation depth (CCD) inconsistent with the available data. By contrast, an increase of the burial flux of continental organic carbon by 1.5×10^{18} mol over a period of 3 Myr, can explain the isotopic shift and is more consistent with the observed magnitudes and signs of both the CO_2 and CCD changes.