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The middle Miocene carbon isotope shift revisited with marine proxies and numerical models

L. Diester-Haass (1), K. Billups (2), D. Groecke (3), L. Francois (4), V. Lefebre (5), K. Emeis (6)

(1) Universitaet des Saarlandes, Zentrum fuer Umweltforschung, 66041 Saarbrücken, Germany, (l.haass@mx.uni-saarland.de), (2) University of Delaware, College of Marine studies, Lewes,DE, 19958, USA (kbillups@udel.edu), (3) Department of Earth Sciences, Durham University, Science Labs, Durham DH1 3LE, England, (d.r.grocke@durham.ac.uk), (4) Institut d'Astrophysique et de Géophysique, Université de Liège, Bat. B5c,17 Allée du Six Août, B-4000 Liege, Belgium, (francois@astro.ulg.ac.be), (5) UMR Géosystèmes, Université des Sciences et Technologies de Lille, Cité scientifique - ufr des sciences de la terre, bât SN5, 59655 Villeneuve d'Ascq, France, (vincent.lefebvre@ed.univ-lille1.fr), (6) Universitaet Hamburg, Inst. für Biogeochemie und Meereschemie, Bundesstraße 55, 20146 Hamburg, Germany, (emeis@geowiss.uni-hamburg.de)

Middle Miocene marine carbon isotope records are characterized by a prolonged positive excursion between about 17-13 Ma, but the causes are not well understood. Vincent and Berger (1985) propose that burial of organic carbon in circum-Pacific margin sediments depleted the marine reservoir in ^{12}C, caused a reduction in atmospheric CO_2 levels, and led to global climate cooling with expansion of ice on Antarctica (the "Monterey hypothesis"). Recent calculations, however, show that the amount of organic carbon buried in the Monterey Formation may not be sufficient to explain the carbon isotope shift and climate change (Föllmi et al., 2005).

Here we examine whether or not a relationship exists between the middle Miocene carbon isotope record and marine biological productivity in deep sea sediments from six DSDP/ODP sites. We find that paleoproductivity does not parallel the long-term trend in the benthic foraminiferal $\delta^{13}C$ records. However, at five of the six sites individual $\delta^{13}C$ excursions that are superimposed on the long term trend (termed CM

event by Woodruff and Savin, 1985) are accompanied by changes in productivity. Prior to 14 Ma productivity tends to have been relatively low during CM events. After 14 Ma, during CM 6, productivity comes to a pronounced maximum. The results indicate that a fundamental change occurred in the mechanisms relating marine δ^{13}C values and productivity, perhaps associated with the climatic conditions before and after the major step in Antarctic ice sheet expansion that took place at about 14 Ma. Numerical box models verify that the overall middle Miocene maximum in marine δ^{13}C values cannot be ascribed to oceanic processes, and highlight the importance of ^{12}C sequestration in the terrestrial realm.