



The carbon cycle during the Mid Pleistocene Transition: The Southern Ocean Decoupling Hypothesis

Peter Köhler¹, Bärbel Hönisch², Richard Bintanja³, Hubertus Fischer¹

1: Alfred Wegener Institute for Polar and Marine Research, PO Box 120161,
D-27515 Bremerhaven, Germany

2: Lamont Doherty Earth Observatory of Columbia University, 61 Route 9W, Palisades, NY
10964, USA

3: KNMI (Royal Netherlands Meteorological Institute), Wilhelminalaan 10, NL-3732 GK De
Bilt, Netherlands

(contact: peter.koehler@awi.de)

We here use the global carbon cycle box model BICYCLE to investigate changes in the carbon cycle during the Mid Pleistocene Transition (MPT) covering the past 2,000,000 years (2 Myr). While there exist so far no ice core record of atmospheric CO₂ beyond 650,000 years our simulated atmospheric carbon dioxide partial pressure across the MPT can only be compared with *p*CO₂ calculated from new pH reconstructions based on boron isotopes measured in planktic foraminifer shells. We validate our results further by a comparison of simulated $\delta^{13}\text{C}$ with paleo reconstructions of benthic $\delta^{13}\text{C}$ in the deep Pacific Ocean. Our approach is based on regression analyses of various paleoclimatic proxies with the LR04 benthic $\delta^{18}\text{O}$ stack, which are then used to extrapolate changing climatic boundary conditions over the whole 2 Myr time window. The focus of our investigation is on the changes in the glacial/interglacial (G/IG) amplitudes in climate (represented by LR04) and the carbon cycle (represented by benthic $\delta^{13}\text{C}$) across the MPT. We find that the G/IG amplitudes in LR04 increased by a factor of two across the MPT, those of benthic $\delta^{13}\text{C}$ in the deep Pacific only by $\sim 40\%$. According to our model this difference in the dynamic of the climate system and the carbon cycle can be explained if we assume a different response to the applied forcings in the Southern Ocean prior and after the MPT. This behaviour is what we

call the "*Southern Ocean Decoupling Hypothesis*" of the climate and carbon dynamics. We finally discuss how our findings are related to the various hypotheses on the causes of the MPT published within the last years. This study is a temporal extension of the "EPICA challenge", which tried to estimate variations in atmospheric CO₂ from published paleo reconstructions before new ice core measurements of CO₂ were made public. We finally hypothesise that as consequence of our analysis the close relationship between Antarctic temperature and atmospheric CO₂ found in ice cores breaks down prior to the MPT.