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Proposing a mechanistic understanding of changs in atmospheric CO_2 during the last 740,000 years

P. Köhler and H. Fischer

Alfred Wegener Institute for Polar and Marine Research, PO Box 12 01 61, D-27515 Bremerhaven, Germany (pkoehler@awi-bremerhaven.de)

Atmospheric carbon dioxide (CO_2) measured in Antarctic ice cores shows a natural variability of 80 to 100 ppmv during the last four glacial cycles and variations of approximately 60 ppmv in the two cycles between 410 and 650 kyr BP. We here (Köhler and Fischer, 2006) use dust and the isotopic temperature proxy deuterium (δD) from the EPICA Dome C Antarctic ice core covering the last 740 kyr together with other paleo-climatic records to force an ocean/atmosphere/biosphere box model of the global carbon cycle in a forward mode over this time in order to reconstruct the natural variability of CO_2. Our simulation results covered by our proposed scenario are based on process understanding gained previously for carbon cycle variations during Termination I (Köhler et al., 2005). They match the CO_2 measured in the Vostok ice core well ($r^2 = 0.80$) and we predict prior to Termination V significantly smaller amplitudes in CO_2 variations mainly based on a reduced interglacial ocean circulation and reduced interglacial Southern Ocean sea surface temperature. These predictions for the pre-Vostok period match the new CO_2 data from the EPICA Dome C ice core for the time period 410 to 650 kyr BP equally well ($r^2 = 0.79$). This is the first forward modelling approach which covers all major processes acting on the global carbon cycle on glacial/interglacial time scales. The contributions of different processes (terrestrial carbon storage, sea ice, sea level, ocean temperature, ocean circulation, $CaCO_3$ chemistry, marine biota) are analysed.

References:

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