Geophysical Research Abstracts
Vol. 17, EGU2015-5416, 2015
EGU General Assembly 2015

Model reconstruction of CO_2 over the past five million years

Lennert Stap (1), Bas De Boer (1), Martin Ziegler (2,3), Richard Bintanja (4), Lucas Lourens (2), and Roderik Van De Wal (1)

(1) Institute for Marine and Atmospheric research Utrecht, Utrecht University, Utrecht, The Netherlands, (2) Department of Earth Sciences, Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands, (3) ETH Zürich, Geological Institute, Zürich, Switzerland, (4) Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands

Over the past five million years, climates ranged from warmer than today during the Pliocene Warm Period to considerably colder during glacials. Proxy data on sea level and CO_2 in the pre-ice core period, however, are scarce and intermittent. This hampers understanding of the long-term relations between these variables and the climate. This study focuses on reconciling knowledge on benthic $\delta^{18}O$, CO_2, sea level and climate, using a fully coupled climate-ice sheet model, inversely forced by a stacked benthic $\delta^{18}O$ record. We obtain the first continuous five-million-year record of CO_2, mutually consistent with sea level and temperature. During the Pliocene, we simulate significantly higher CO_2 levels than during the Pleistocene. A compilation of existing $\delta^{11}B$-based proxy CO_2 data and a new $\delta^{11}B$ data record provide support for this result. In our model, limited variability of ice volume reduces ice sheet-climate feedbacks during this time. As a result, CO_2 changes need to be larger to obtain similar temperature changes as during the Pleistocene. This indicates a changing relation between CO_2 and temperature over time. However, while increasing the ablation rate on the East Antarctic ice sheet results in larger sea level fluctuations, it only modestly affects the simulated CO_2. This is explained by the surface albedo change being limited if the Antarctic ice sheet retreats during the Pliocene, because the exposed land remains snow covered throughout most of the year.