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A new mechanism for the global temperature rebound during the Mid Miocene climate transition

G. Knorr (1), M. Butzin (1), G. Lohmann (1), and A. Micheels (2)
(1) Alfred Wegener Institute, Bremerhaven, Germany, (2) previously at University Frankfurt/M.

The middle Miocene climate transition (MMCT) at about 14 million years ago represents one of the most fundamental cooling trends in the entire Cenozoic era spanning the last 65 Ma. The overall cooling trend is characterized by multiple alterations of the surface and bottom water temperatures associated with e.g. changes in atmospheric CO_2 and ice volume changes in Antarctica. A puzzling observation is the occurrence of a temperature rebound at the ocean surface in the southern high-latitudes at a time of maximum ice sheet growth in Antarctica and a time delayed response of the deep ocean. Here we use the comprehensive earth system model COSMOS in time-slice simulations for the Miocene. Our objective is to evaluate the importance of CO_2 and Antarctic ice sheet growth as forcing factors at the MMCT to disentangle their influence on the characteristic spatio-temporal pattern of surface and deep ocean changes as observed in proxy data from marine sediment cores. We show for the first time that the dynamical response of the coupled atmosphere/ocean system to Antarctic ice sheet growth and CO_2 can explain the temperature rebound at the MMCT in agreement with proxy evidence. This provides a consistent explanation alternative to traditional approaches invoking changes in chemical weathering or carbon burial.