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The onset of major Antarctic glaciation and the Eocene - Oligocene transition - a story of ice, temperature and sea level

Alexander J.P. Houben (1), Stefan Schouten (2), Steven M. Bohaty (3), Bridget S. Wade (4), Mark Pagani (5), Stephen Galagher (6), Gert-Jan Reichart (7), Willemijn Quaijtaal (1), Appy Sluijs (1), and Henk Brinkhuis (1)

(1) Biomarine Sciences, Institute of Environmental Biology, Utrecht University, Laboratory of Palaeobotany and Palynology, Utrecht, The Netherlands, (2) NIOZ Royal Netherlands Institute for Sea Research, Department of Marine Organic Biogeochemistry, Texel, The Netherlands, (3) National Oceanography Centre, University of Southampton, Southampton, U.K., (4) Department of Geology and Geophysics, Texas A&M University, College Station, Texas, USA, (5) Department of Geology and Geophysics, Yale University, New Haven, Connecticut, USA, (6) School of Earth Sciences, The University of Melbourne, Melbourne, Australia, (7) Department of Earth Sciences, Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands

The Eocene – Oligocene transition (EOT, $\sim$33,5 Ma,) represents the final transformation of the Eocene Greenhouse into an Icehouse world. It is now widely acknowledged that cooling and/or ice-volume increases occurred stepwise, since high-resolution foraminiferal oxygen isotope (δ^{18}O)-records show a two step increase across the EOT, separated about 200 kyr. Yet, it is still poorly defined how temperature decreased either as a cause of or in consequence of ice volume increase, as δ^{18}O-records capture both effects. In the last decade, the development of molecular organic geochemical “paleothermometers” like the alkenone unsaturation index (U^{k}'$_{37}$) and the archaeal membrane lipid based TEX_{86} proxy, provided alternative approaches to reconstruct past temperatures. We generated sea surface temperature records from Deep Sea Drilling Program (DSDP) Sites 511 & 512 in the Southwest Atlantic Ocean and Site 336 from the Norwegian Greenland Sea using the $U_{37}^{K'}$ and TEX_{86} proxies and integrate these records with foraminiferal δ^{18}O measurements. Remains of surface dwelling dinoflagellates (i.e. their cysts) have proven to sensitively record changes in surface water conditions, i.e. temperature, salinity, productivity and sea-ice cover. We interpreted changes in dinocyst assemblages in order to elucidate changes in the surface ocean environment across the EOT. Furthermore, in shelf deposits, sea-level fluctuations can be traced by evaluating the composition of dinocyst assemblages, in particular by evaluating the abundance of open marine-, restricted marine and high energy shelf taxa. We have investigated sections from Northern Italy, the US Gulf Coast and South Australia and identify sequence boundaries reflecting sea variability throughout the EOT. Our data indicate that temperature and ice-volume are not linearly related across the EOT with the first oxygen isotope step primarily reflecting cooling and the second primarily reflecting ice volume.