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The onset of modern-like Atlantic meridional overturning circulation at the Eocene-Oligocene transition - evidence, causes, and possible implications for global cooling

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A compilation of benthic δ^{18}O from the whole Atlantic and the Southern Ocean (Atlantic sector), shows two major jumps in the interbasinal gradient of δ^{18}O ($\Delta\delta^{18}$O) during the Eocene and the Oligocene: One at ~40 Ma and the second concomitant with the isotopic event of the Eocene-Oligocene transition (EOT), ~33.7 Ma ago. From previously published circulation models and proxies, we show that the first $\Delta\delta^{18}$O jump reflects the thermal isolation of Antarctica associated with the proto-Antarctic circumpolar current (ACC). The second marks the onset of interhemispheric northern-sourced circulation cell, similar to the modern Atlantic meridional overturning circulation (AMOC). The onset of AMOC-like circulation slightly preceded (100-300 ky) the EOT, as we show by the high resolution profiles of δ^{18}O and δ^{13}C previously published from DSDP/ODP sites in the Southern Ocean and South Atlantic. These events coincide with the onset of anti-estuarine circulation between the Nordic seas and the North Atlantic which started around the EOT and may be connected to the deepening of the Greenland-Scotland Ridge. We suggest that while the shallow proto-ACC supplied the energy for deep ocean convection in the Southern Hemisphere, the onset of the interhemispheric northern circulation cell was due to the significant EOT intensification of deepwater formation in the North Atlantic driven by the Nordic anti-estuarine circulation. This onset of the interhemispheric northern-sourced circulation cell could have prompted the EOT global cooling.