The onset of modern-like AMOC at the Eocene-Oligocene transition and possible implications for global cooling

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The Atlantic meridional overturning circulation (AMOC) has a major impact on ocean thermal structure, carbon cycle, oceanic ecosystem, and climate. Here we use compilations of benthic $\delta^{18}O$ and $\delta^{13}C$ isotopes, and Nd isotopes from the Atlantic Ocean and the Southern Ocean (Atlantic sector), as well as comparison between $\delta^{18}O$ gradients and profiles of temperature and salinity previously obtained from modeling of AMOC. Accordingly, we show that the onset of interhemispheric northern-sourced circulation cell, similar to the modern AMOC, was concomitant with the isotopic event of the Eocene-Oligocene transition (EOT) or slightly earlier. We also show the EOT onset of anti-estuarine circulation between the Nordic seas and the North Atlantic, triggered at a critical threshold during the enhanced rate of tectonic subsidence of the Greenland-Scotland Ridge (GSR). Therefore, based on various observations, we argue that while the shallow proto-Antarctic circumpolar current (ACC) supplied the energy for deep ocean convection in the Southern Hemisphere during the late Eocene, the significant EOT intensification of deepwater formation in the North Atlantic by the Nordic anti-estuarine, triggered the onset of the interhemispheric northern circulation cell. The correlation between the circulation and climatic proxies at the EOT raises the plausibility that this onset of the biologically productive circulation cell promoted global cooling by decreasing atmospheric CO_2, as well as transferring heat northward which in turn cooled the Southern Hemisphere, hence promoting Antarctic glaciation.