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Northern versus southern gateways control on ocean overturning circulation at the Eocene-Oligocene transition and possible implications to the accelerated CO_2 decrease

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There is a growing body of evidence indicating reorganization in the ocean overturning circulation during the transition from the Eocene to the Oligocene, in particular, the initiation of the northern-sourced overturning circulation that comprises the northern component water (NCW) and northward flowing intermediate water. This evidence includes Nd isotopes from the Southern Hemisphere, [U+F064]13C from intermediate water in the subtropical North Atlantic, and increasing difference in the benthic [U+F064]18O between the Northern and Southern Hemispheres. We compare all these sets of proxies and show that the increasing trends have been conjugated throughout most of the Oligocene indicating enhancement of the northern-sourced overturning circulation that began around the Eocene-Oligocene transition (EOT). So far, this reorganization was mainly attributed to the development of the wind-driven Antarctic circumpolar current (ACC). Based on variety of geological inferences, we suggest that the shift to interhemispheric bipolar overturning circulation was initiated by buoyancy fluxes formed by the development of anti-estuarine circulation between the Nordic Seas and the North Atlantic around the EOT, which significantly intensified the NCW. The Nordic anti-estuarine circulation began at a critical threshold during rapid tectonic subsidence of the Greenland-Scotland Ridge (GSR) triggered by the suppression of the Iceland mantle plume. We show that the development of northern-sourced circulation cell during the Oligocene correlates compellingly with the histories of the GSR subsidence and the activity of the Iceland mantle plume, and to a lesser degree with the ACC history. Accordingly, this circulation was enhanced as long as the GSR subsided rapidly. The onset of the northern-sourced overturning circulation, which is the biologically productive circulation domain, has probably triggered the marked increase in the ocean productivity during the EOT. We further test the plausibility that the EOT [U+F064]13C increase reflects growing rates of burial of organic carbon caused by this productivity increase, and the consequent accelerated decrease in atmospheric CO_2.