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Influence of the Central American Seaway on Ocean Circulation and Oxygen

MEDERIC ST-PIERRE[1], ANDREAS OSCHLIES[1], CHRISTOPHER J. SOMES[1] AND YING CUI[2]

[1]GEOMAR Helmholtz Centre for Ocean Research Kiel
[2]Montclair State University

The Middle Miocene was characterized by distinct continental configurations, including open Central American and Tethys seaways. The Central American Seaway (CAS) was subject to a gradual closure between the mid-Miocene and mid-Pliocene (~14-3 Ma) with the formation of the Isthmus of Panama. Model simulations indicate that this closure induced major change in global ocean circulation, notably strengthening the Atlantic Meridional Overturning Circulation (AMOC). Furthermore, the closure has been linked to the formation of the modern-day Pacific oxygen minimum zone. In this study, we used the University of Victoria Earth System Climate Model version 2.10 (UVic ESCM 2.10) to investigate the impact of the opening and closing of the CAS and the Tethys Seaway, with the Arabian Sea, on ocean circulation and oxygen. Sensitivity experiments with different bathymetry configurations show that an open CAS results in a weakened (~2-9 Sv), or absent, AMOC compared to configurations with a closed CAS (~13-19 Sv). In contrast, an open Tethys Seaway alone has little influence on ocean circulation. However, when combined with an open CAS, it contributes to restarting the AMOC. The circulation changes associated with an open CAS led to a net increase in global mean ocean oxygen. However, this increase is not uniformly distributed, as it is driven by an oxygenation of the Pacific and Indian Oceans, whereas the Atlantic and Arctic Oceans suffer substantial oxygen loss compared to configurations where the CAS is closed.