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Climate and marine biogeochemistry response to the tectonic closure of the Central American Seaway from model simulations

VYACHESLAV KHON[1], BABETTE HOOGAKKER[1], BIRGIT SCHNEIDER[2], JOACHIM SEGSCHNEIDER[2] AND WONSUN PARK[3,4]

[1]Heriot-Watt University
[2]Kiel University
[3]Center for Climate Physics, Institute for Basic Science (IBS)
[4]Pusan National University

Presenting Author: v.khon@hw.ac.uk

Changes in climate and marine biogeochemistry induced by the tectonic closure of the Central American Seaway (CAS) during the mid-Miocene to mid-Pliocene (~16-3 Ma BP) are investigated based on simulations with global climate and biogeochemistry models. A series of sensitivity experiments with the Kiel Climate Model is performed, where the open CAS sill depth is varied, ranging from shallow to deep depths. The atmospheric CO_2 concentration is prescribed to preindustrial (286 ppm) or present-day (400 ppm) levels. In this study, we focus on the analysis of changes in ocean circulation, oxygen minimum zone (OMZ) and oceanic carbon cycle.

Our results support previous studies showing that the CAS closure caused an intensification of the Atlantic Meridional Overturning Circulation (AMOC) due to a termination of fresh-water input from the tropical Pacific to the North Atlantic.

We find that the eastern equatorial Pacific OMZ was less extensive for an open compared to a closed CAS, mainly due to dynamical processes, with minor contributions from biological processes. Enhanced eastward subsurface flow facilitated a stronger supply of oxygen from the west of the basin to the east, which led to an overall oxygen enrichment in the eastern tropical Pacific. Net marine primary production in the region was somewhat weakened due to nutrient export to the Caribbean Sea, leading to weaker export of particulate organic carbon towards the ocean interior, and lower biological consumption of oxygen in this region.