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Effect of ocean gateways on the evolution of Miocene ocean circulation and marine carbon cycle: data vs. modelling

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We studied the evolution of the Miocene ocean circulation and marine carbon cycle in a series of sensitivity experiments designed to adress various paleogeographic and sea ice scenarios. For that purpose, an ocean circulation model of intermediate complexity (LSG) coupled to an model for the oceanic carbon cycle (HAMOCC 2s) has been adapted to several configurations of topography and ocean gateways. The investigated simulations confirm that the closing of the Central American Seaway plays a decisive role in Neogene ocean circulation development. The early Miocene run reveals that upper ocean water from the Pacific enters the Atlantic via the Central American Seaway, and that formation of North Atlantic Deep Water (NADW) is reduced while there is enhanced northward outflow of bottom water in the Southern Ocean. The experiment also shows a Central American throughflow of NADW to the Pacific, and a shallow and weak meridional overturning cell in the Indian Ocean caused by the Tethys. Corresponding simulations of d13C and carbonate ion concentrations yield distributions which are consistent with the benthic record during the Miocene. The model results corroborate results from paleodata that a precursor of the modern conveyor belt circulation already existed before the final Central American Isthmus closure.