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Perturbing the global carbon cycle with oceanic gateway changes

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The individual roles of carbon dioxide and tectonically driven ocean gateway events in driving large shifts to the Cenozoic climate system has been long debated. However, the broad co-occurrence of important gateway events with permanent atmospheric carbon dioxide concentration changes suggests that a mechanistic link between the global carbon cycle and gateway-derived ocean circulation changes exists. Such a link is examined here. We analyse the sensitivity of the global carbon cycle to the state of the Drake Passage and the Central American Seaway using a fully coupled carbon cycle-climate model, the University of Victoria Earth System Climate Model (UVic ESCM) Version 2.9. Using equilibrium simulations, we find that global average ocean dissolved inorganic carbon concentrations under equivalent atmospheric carbon dioxide levels are a function oceanic gateway configuration, indicating that gateways are capable of regulating the size of the global oceanic carbon reservoir via changes to ocean circulation. Transient simulations in which the carbon cycle is allowed to evolve freely in response to opening of the Drake Passage results in an increase in the oceanic carbon inventory at the expense of a decreased terrestrial carbon load and a net drop in atmospheric carbon dioxide concentrations. This suggests that gateway-derived changes to the oceanic carbon inventory may be partially responsible for the long term decline in carbon dioxide since the Eocene.