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Ocean gateways and the thermohaline circulation in the Tertiary

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The climate changes on Earth during the Tertiary are thought to be partly due to changes in the global thermohaline circulation. Important tectonic changes have taken place during this time, which may have influenced the evolution of the thermohaline circulation.

The present conveyor type of circulation where the deepwater formation mainly occurs in the North Atlantic Ocean and not in the North Pacific is characterized by a strong salinity contrast between the Pacific and Atlantic Oceans. Within fully-coupled climate model simulations with continental geometries corresponding to the late Oligocene and early Miocene we find that this salinity contrast is decreased with a low latitude ocean connection between the two basins. The simulations show a northern sinking state of the global thermohaline circulation with a (shallow and weak) overturning circulation in both the Pacific and the Atlantic Oceans. When the Southern Ocean high latitude gateways are closed, climate simulations of the Cretaceous climate have indicated another state of the thermohaline circulation with deep convection occurring at high latitudes on both hemispheres and upwelling at the equator.

In this presentation, we study the evolution of the thermohaline circulation during the Tertiary with the use of coupled climate simulations and idealized ocean models. We focus on the question how these different states of the thermohaline circulation are related to the opening of the Southern Ocean gateways and the closing of the low-latitude gateways.