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Miocene carbonate deposition: relationship to the establishment of the modern thermohaline circulation

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Drastic and repeated reductions of calcium carbonate contents characterize pelagic sediment sequences at the middle to late Miocene transition. To identify the driving mechanism for the observed changes in the carbonate sediment pattern, we studied potential thresholds and feedback mechanisms responsible for Neogene climate transitions. Emphasis was placed on the role of ocean gateways on multiple states of the system, and on the simulation of the dominant pattern in sediment variability documented in ODP cores. Our simulations are based on models of intermediate complexity which explicitly resolve the ocean circulation and the marine carbon cycle. The included sediment module allows a direct comparison with geological data.

Several configurations for the Neogene ocean circulation sensitivity experiments, i. e. different stages in the shoaling of the Central American Isthmus (3000 m to 200 m) and of the Greenland-Scotland- Ridge (1000 m to 150 m) as well as different sea ice coverage scenarios were used as input for a marine carbon cycle model (HAMOCC2s). Using the sedimentary carbonate distribution as model output variable, our geochemical experiments provided a new framework to interpret Neogene paleoenvironmental data. Assuming a mid to late Miocene ocean gateway configuration with a semi-closed Central American Seaway and an early sea-ice coverage at both hemispheres, the Greenland-Scotland Ridge may be critical for NADW production when reaching a certain combination of sill depths. This scenario might at least partly explain the rapid sedimentary changes observed in the Atlantic and Pacific ocean basins at that time of generally weak global overturning.