Modeling of the thermohaline circulation and biogeochemical cycles in the paleoclimate

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Purpose of this study
The mid-Cretaceous is a period with warm climate due to high atmospheric CO\textsubscript{2} concentration. Laminated black shale deposited in this period represents anoxic conditions in the deepwater. The depositional events are called Ocean Anoxic Events. Purpose of this study is to investigate causes of OAEs by simulating the mid-Cretaceous marine biogeochemical cycles.

Results in this year
The mid-Cretaceous simulations were conducted using an ocean general circulation model combined with marine biogeochemical cycles. The simulated thermohaline circulation oscillates between active and inactive states. The simulated oxygen concentration in the deep Atlantic is steadily kept low, though those in the deep Tethys and Panthalassa being high during the active state (Fig. 1a). The mechanisms maintaining the low oxygen during the active state are important because the simulated period of the inactive state is much shorter than that of the observed OAEs. Time series of density in the Atlantic (Fig. 1b) shows that the density in surface water is well stratified during the active state. The density in the intermediate water is almost the same that in the deepwater. These results suggest that the source of deepwater is not from the surface but from Tethyan intermediate water inflowing with low oxygen concentrations. This might explain why OAEs in the Atlantic last longer than tens of thousands of years.

Fig. 1 (a) Time series of regionally averaged oxygen concentrations in the bottom water. Solid, dashed and dot-dashed lines indicate the averages in the Panthalassa, Tethys and Atlantic, respectively. Shading indicates the active state of thermohaline circulation. (b) Time series of density averaged in the Atlantic. Solid, dashed and dot-dashed lines indicate the averages of the surface, intermediate and deepwater respectively.