Geophysical Research Abstracts, Vol. 7, 03247, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03247

Ocean Anoxic Events in the mid-Cretaceous simulated by 3-D biogeochemical general circulation model

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The mid-Cretaceous is a time of warm climate due to high level of the atmospheric CO_2. Ocean Anoxic Event(OAE)s depositing organic carbon severally occurs in this period. Previous studies using proxy data show that OAEs are caused by high productivity with high consumption of oxygen in the deep water and/or stratification in the surface water preventing oxygen supply to the deep water. Previous studies using climate models do not include biogeochemical cycles in their models that enable us directly to simulate geological evidences of OAEs. We developed a 3-D marine Biogeochemical General Circulation Model(BGCM) to investigate dynamics causing OAEs. We applied Atmospheric General Circulation Model(AGCM) to the mid-Cretaceous with the fourhold, eightfold, and sixteenfold preindustrial atmospheric CO_2 levels which were used for boundary conditions for BGCM experiments. In the Panthalassa, the deep water is steadily formed in the high latitude in the fourfold experiment. Since an active thermohaline circulation supplies oxygen to the deep water, there are no anoxic condition in the deep water. In the eightfold and sixteenfold experiments, the thermohaline circulation oscillates between inactive and active (during several thousands years). When the thermohaline circulation inactive, oxygen supply is reduced, and area of anoxic region is enlarged in the deep water. Time-averaged export production is the highest in the fourfold experiment and the lowest in the sixteenfold experiment. The inactive themohaline circulation plays an important role in dynamics of OAEs in the Panthalassa. In the Proto Atlantic, the deep water is not formed in every experiment and regional-averaged export production is higher than that in the Panthalassa. These lead to reduction of oxygen supply to the deep water and to increase in consumption of deep water. That is, inactive thermohaline circulation and the high biological productivity play important roles in OAEs in the Proto Atlantic.