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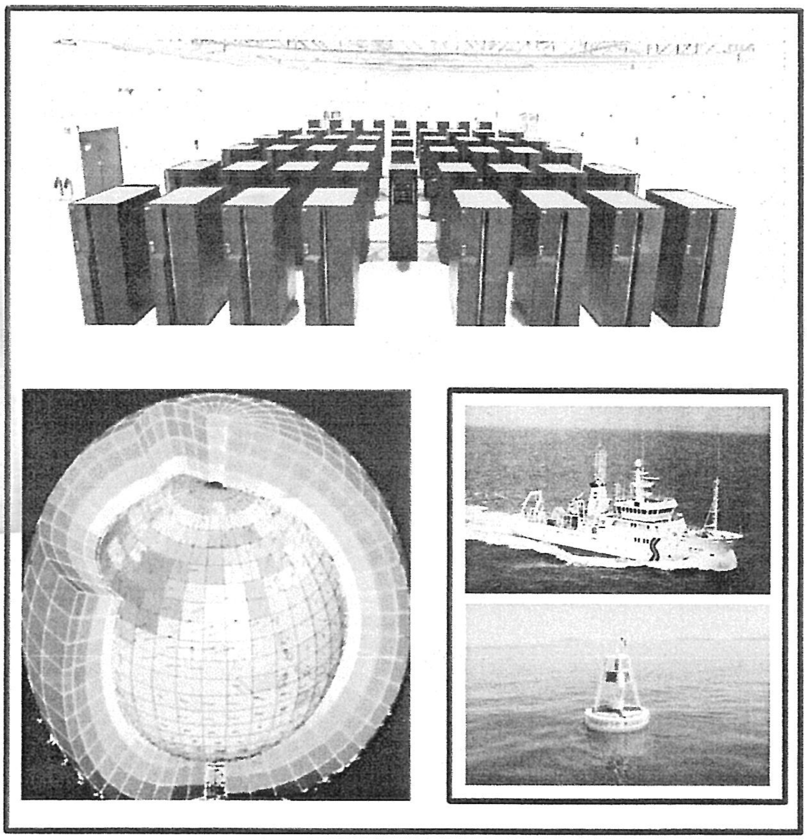

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A Coupled Model Simulation of Ocean Thermohaline Circulation for the Last Glacial Maximum

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Abstract

The ocean thermohaline circulation for the Last Glacial Maximum (LGM) is investigated using a coupled ocean-atmosphere-sea ice climate model. Many lines of plaeoclimate proxy evidence have shown that the ocean thermohaline circulation originated in the northern North Atlantic was substantially weaker in the LGM than the present, while it was stronger in the North Pacific. These changes in the ocean thermohaline circulation are well reproduced in the coupled model simulation. The imposition of LGM boundary conditions leads to deep ocean heat loss to the atmosphere at high latitude convection regions through an active vertical mixing and associated turbulent heat fluxes and deepwater temperature approaches to the freezing point. The LGM conditions also modify the fresh water distribution at the ocean surface and cause a marked change in the ocean convection and thermohaline circulation. In the North Atlantic, the ocean becomes substantially fresher due to an increase in fresh water supply and local hydrological budget change. The freshening of northern North Atlantic leads to the marked reduction in North Atlantic Deep Water formation to less than half of the control value and the North Atlantic outflow

is limited to shallower depths. On the other hand, in the Southern Ocean climate becomes drier and the surface water is saltier than present. This leads to the stronger convection and Southern Ocean thermohaline circulation. The change in thermohaline circulation modifies the water mass characteristics. In the LGM, the saltiest water mass in the Southern Ocean rather than in the North Atlantic, in consistent with proxy evidence. In the North Pacific, surface salinity substantially increases in the Sea of Okhotsk and the western Bering Sea by an increase in brine release due to marked increase in sea ice and excessive evaporation over precipitation. The increase in surface salinity in the North Pacific as well as the surface cooling leads to the increase in potential density, which makes the water column highly unstable and eventually results in the enhancement of the North Pacific Intermediate Water (NPIW) production. The NPIW outflow reaches much deeper layers than in present, but largely confined to the North Pacific in the LGM simulation. This is in a reasonable agreement with proxy evidence.