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GLACIAL TO INTERGLACIAL CHANGES OF OCEAN THERMOHALINE CONVEYOR DURING LATE QUATERNARY

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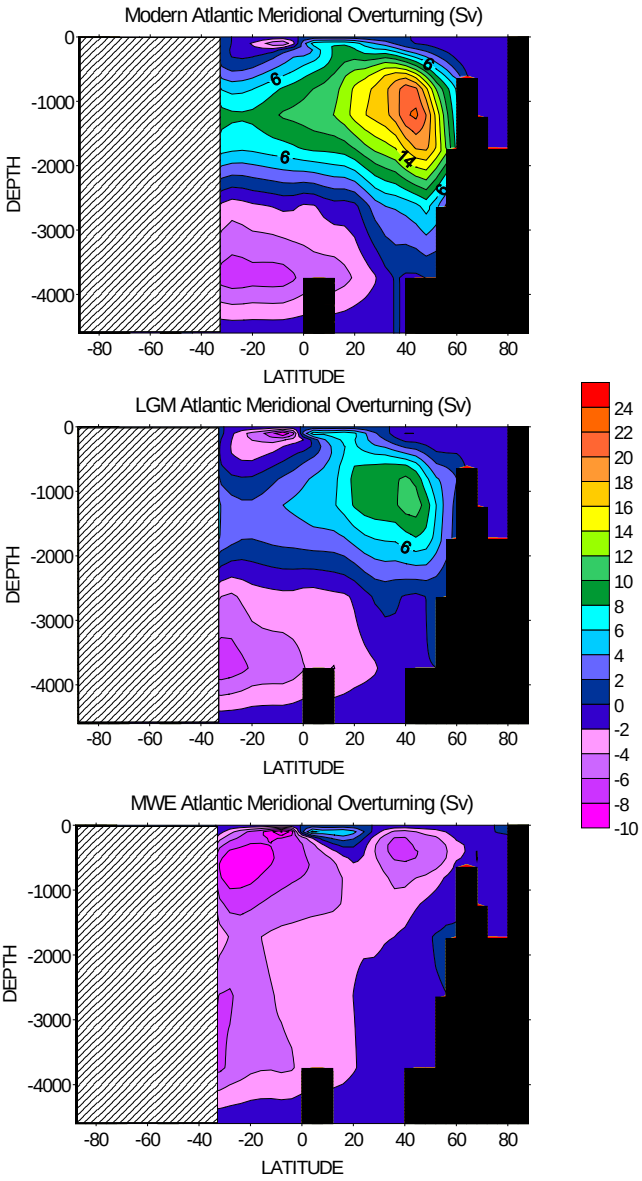
The global ocean conveyor at present, at the last glacial maximum, and at a subsequent meltwater event (MWE) is simulated using an ocean circulation model and a Lagrangian trajectory tracing technique. The major changes of the deep ocean conveyor occurred at the MWE. These changes include a reversal of the Indian-Atlantic branch of the deep conveyor caused by capping of convection by a localized meltwater impact in the North Atlantic (NA). This result supports the idea of a global response of the world ocean to the Heinrich-type events. However, the model challenges the idea that an ultimate global conveyor now or ever directly connected the high-latitudinal NA and North Pacific. The Antarctic Circumpolar Current (ACC) plays a disconnecting role, trapping the Atlantic deep water in the circumpolar transport. The primary mechanism for the transocean water conveying is deep convection, allowing water to be tunneled upward or downward and thereby escape circumpolar motion. Hence, changes in the production of NADW might still have had a major impact over the entire



deep-to- intermediate depths ocean circulation, in spite of the inability of the deep ocean conveyor alone to connect the most remote parts of the world ocean.

Figure 1. Meridional overturning stream function showing total transport of water in vertical plane in the Atlantic Ocean. From top to bottom: present-day overturning, LGM, and MWE. Transport in Sv (1 Sv=10^6 m^3/s).

Figure 2. Global thermohaline conveyor. Volume transports across the sides of the grid cells from the top of the ocean to 2 km depth (left) and from 2 km to the bottom (right) are shown in Sv (1 Sv = 10^6 m^3 s^{-1}). Although the LGM conveyor noticeably weakened because of lessened North Atlantic Deep Water production, it still operated and facilitated the global deep ocean tracer transport from the NA to the Pacific. At the MWE the model indicates a complete reversal of the conveyor in the Atlantic–Indian sector, which is not simply a 'conveyor–off' regime but a 'conveyor–reversed' mode.

Figure 3. Convection diagrams. The heights of the bars are equal to the convection depth. Present-day, LGM and MWE convection is depicted (from top to bottom). During the LGM convection in the North Atlantic shifted southward, whereas during MWE there were no deep convection in the northern hemisphere.

Figure 4. Trajectories of water parcels. Clouds of neutrally-buoyant particles were deployed at different sites to trace the deep ocean conveyor. Left panel shows spaghetti of the trajectories with the depths indicated by color (as a particle descends or upwells the color of its trajectory changes). The right panel depicts pairs of trajectories with elapsed time and depth shown along the paths.