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Data based modeling of sediment and water volumes transport during the Late Quaternary in large ocean basins

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An Ocean General Circulation Model (OGCM) and two three–dimensional (3–D) large–scale models, an ocean sediment transport and a semi–lagrangian trajectory–tracing model, are used for a better understanding of the ocean circulation and complex interactions in the ocean–sediment system since the last glacial maximum (LGM). The 3–D sedimentation model SENNA (= Sedimentation – erosion, transport and deposition – in the Northern North Atlantic (NNA)) and the trajectory–tracing model PATRINNA (= Particle TRacing In the NNA) are initialized and driven by the thermohaline circulation (temperature, salinity, velocity and convection depths) which is an output from the OGCM. SENNA simulates the sedimentation rates linked to the corresponding circulation patterns and the pelagic sediment dynamics. PATRINNA traces transport pathways of material particles, e.g., water parcels, sediments, pollutants, natural or artificial organic material, etc.

Our numerical experiments concentrate on three time slices: the Holocene/Modern (HM), the Meltwater Event near 13,500 ^{14}C yrs BP (MWE), and the LGM, 18,000 ^{14}C yrs BP. The paleocirculation patterns differed from the HM significantly, though the locations of the sedimentation drifts practically did not change. However, the sedimentation rates in these drifts were different during both the LGM and MWE, as compared to each other and to the HM.

PATRINNA allows visualization of the water volumes and/or transports of settling particles relevant to different paleocirculation patterns (Figure 1). A computer animation program has been developed to utilize this advantage of the semi-Lagrangian technique. The trajectory-tracing model accompanied by this animation facility appears to be a very useful tool to address both sedimentation and deep ocean ventilation problems (Firgure 1).

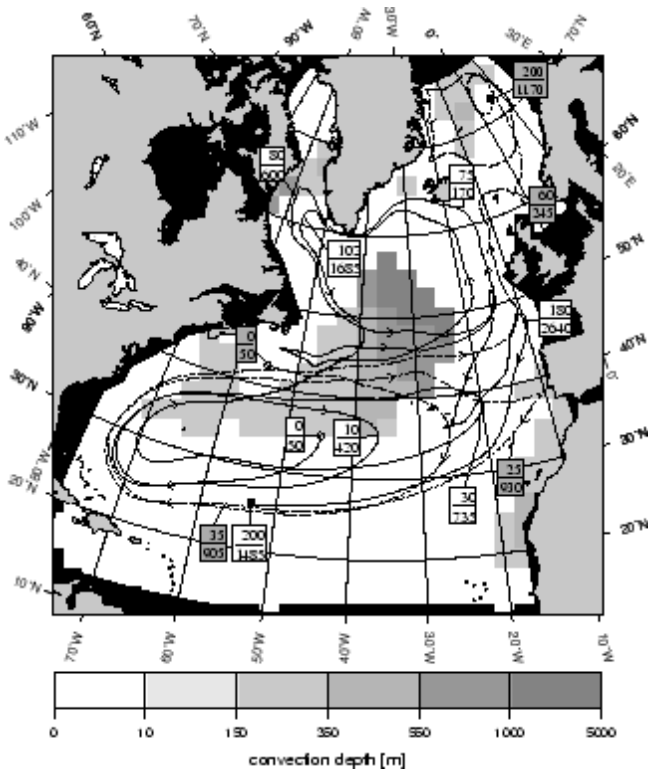

Figure 1: 200–year history of pairs of the Lagrangian particles for LGM. Small rectangles show elapsed time and depth; small circles indicate starting points, the arrows show the direction of motion, and the bullets indicate the end points of the trajectories. One of the trajectories is presented by broken line. The convection depths are shown by different shades of gray.