NORTH ATLANTIC PALEOCIRCULATION AND SEDIMENT TRANSPORT: A STUDY USING A THREEFOLD MODELING APPROACH

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An Ocean General Circulation Model (OGCM) and two additional models — a sediment transport model and a semi–Lagrangian trajectory–tracing model — are employed to simulate the North Atlantic circulation, sediment transport, overturning and ventilation regimes that existed at the Holocene/Modern (HM), the Last Glacial Maximum (LGM) and the subsequent Meltwater Event near 13,500 ^{14}C yrs B. P. (MWE).

Surface Data Sources for Different Time Slices in the Numerical Experiments

Data \ Time	Holocene/Modern (HM)	LGM (18,000–15,000 ^{14}C yr B.P.)	MWE (14,500–13,500 ^{14}C yr B.P.)
Wind stress	T42 wind stress	T42 wind stress calculated using *CLIMAP* [1981] surface conditions (*Lorenz et al.*, 1996)	as for LGM
Sea surface temperature (SST)	Modern sea surface climatology from *Levitus* [1982]	*CLIMAP* [1981] and LGM data of *Schulz* (1994) and data of *Sarnthein et al.* [1992,1995] in the northern N.A. and NGS	*CLIMAP* [1981] and data of *Schulz* [1994] in the northern N. A. and NGS
Sea surface salinity (SSS)	Modern sea surface climatology from *Levitus* [1982]	*Levitus* [1982] south of 40°N and recalculated SSS using δ^{18}O from *Duplessy et al.* [1991] north of 40°N, and *Sarnthein et al.* [1995] north of 50°N in the northern N.A. and NGS for LGM	LGM SSS and recalculated SSS using δ^{18}O data of *Sarnthein et al.* [1995]in the northern N.A. and NGS for MWE north of 50°N

Abbreviations are: HM, Holocene/Modern; LGM, last glacial maximum; MWE, meltwater event; N.A., North Atlantic; NGS, Norwegian–Greenland Seas.

Figure 1a–c: Velocity vectors at z=50 m

Velocity maps of the upper ocean currents show increased zonality of the North Atlantic Current at the LGM and MWE. The Norwegian–Greenland Seas (NGS) circulation changed radically at the MWE showing a reversed circulation pattern in the eastern part of this basin.

Figure 2a–c: Velocity vectors at z=2000 m.

Velocity maps show the changes in the return routes of the deep–ocean currents which have a far weaker western boundary current at the LGM and MWE than at the HM. Different circulation regimes led to distinctly different sedimentation transport patterns (see poster by Haupt, Seidov and Stattegger).

Figure 3a–c: Diagrams of convection

The heights of the bars are equal to the convection depth.

a) During the LGM the North Atlantic Deep Water production dropped by 30% from its present intensity. Only in the upper 500 m of the glacial NGS were ventilated. Compared to their present locations, the deep ventilation zones south of Greenland were shifted 10 degrees to the south–west; **b**) During the MWE deepwater formation stopped completely; **c**) Today's convection ventilates the deep ocean and even reaches the bottom at some sites in the NGS and northern North Atlantic.

Figure 4a–c: 200–year history of the neutrally–buoyant Lagrangian particles.

Neutrally–buoyant Lagrangian particles are employed to trace actual 3–D motion of the water volumes for the three chosen time–slices. The analysis of the trajectories reveals a lower deep ocean ventilation rate but considerably stronger ventilation of the subtropical thermocline at the LGM. During the MWE the deep ocean was not ventilated at all. This analysis indicates far stronger exchange between western and eastern abyssal North Atlantic in the subtropics during both LGM and MWE when compared to the weak exchanged between these two basins at present time.