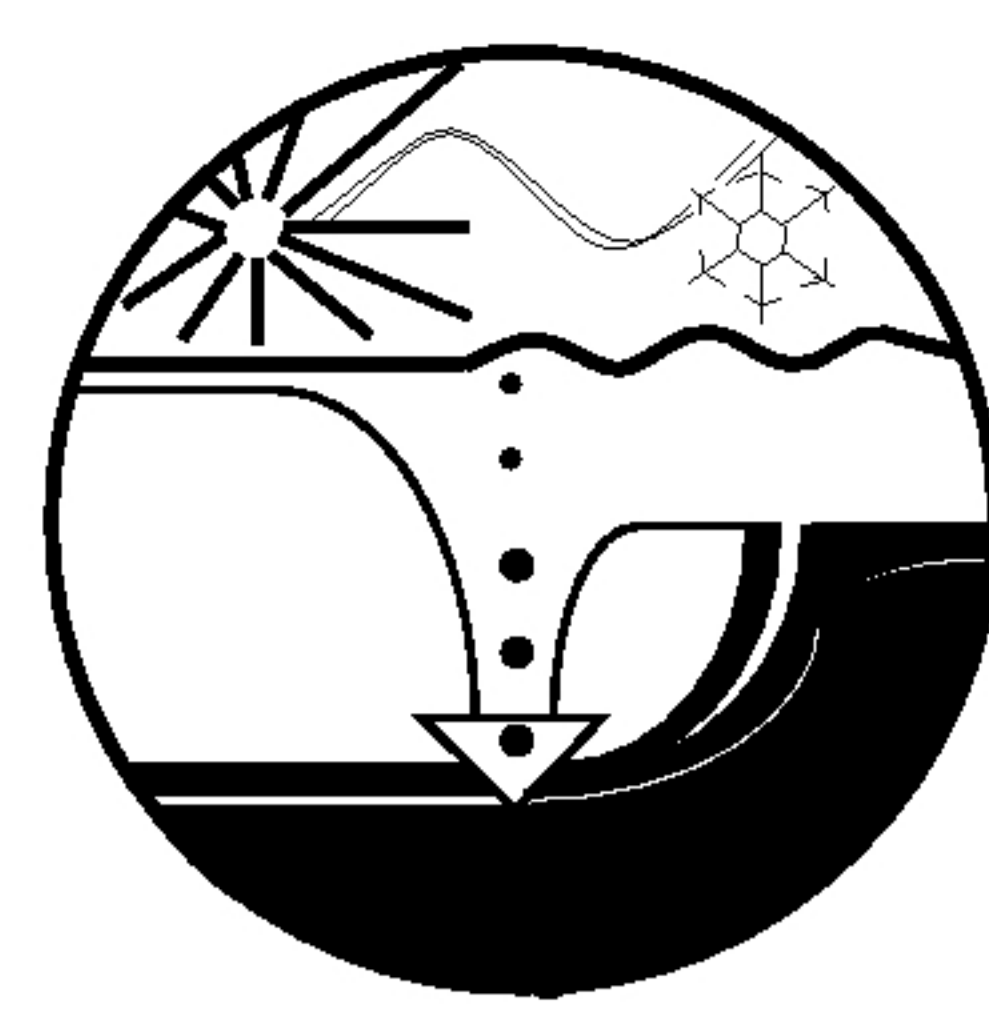


Interbasin water exchange and sedimentation during late Quaternary



PENNSTATE



Dan Seidov and

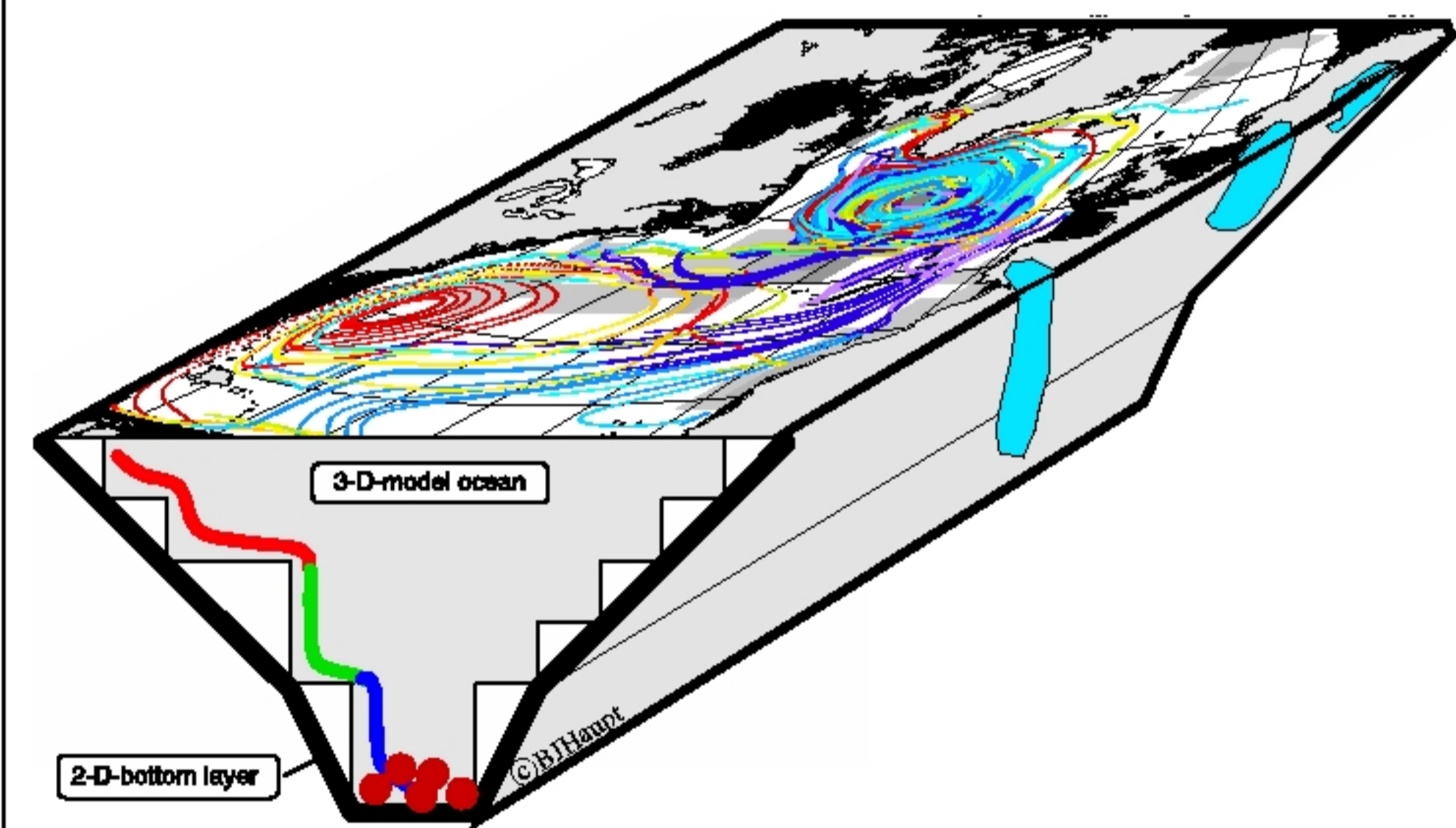
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During the late Quaternary the global thermohaline conveyor has undergone major structural changes linked to the glacial-to-interglacial climate transitions.

To enhance paleoceanographic simulations, traditional calculations of large-scale thermohaline circulation are supplemented by off-line Lagrangian trajectories and by simulations of sediment transport using a 3-D sedimentation model.



Initialisation with T, S, u, v, w, convection depth, and topography from any OGCM and grain size, form factor, sediment density, porosity, sedimentological grain diameter, and sinking velocity

Calculation of critical velocities

$$v_{c,u} = v_{c,u}(V, \mu, d, \rho_s, \rho_f, FF, g)$$

$$v_{c,b} = v_{c,b}(V, \mu, d, \rho_s, \rho_f, g)$$

Calculation of bed load and suspended transport

$$q_b = q_b(V, v_{c,b}, V, \mu, d, D^*, \rho_s, \rho_f, FF, g, P)$$

$$q_s = q_s(V, v_{c,b}, V, \mu, d, D^*, \rho_s, \rho_f, FF, g, P)$$

Vertical convection due to hydrostatic instability

Calculation of 3-D and 2-D sediment transport

$$\frac{\partial C}{\partial t} = -\nabla \cdot (\vec{v}C) + Q$$

$$\frac{\partial C}{\partial t} = -\nabla_H \cdot (\vec{v}_H C) + Q$$

Calculation of new topography

$$\gamma \frac{\partial h_{sed}}{\partial t} + \nabla_H \cdot q = 0$$

γ = porosity of sediment particles

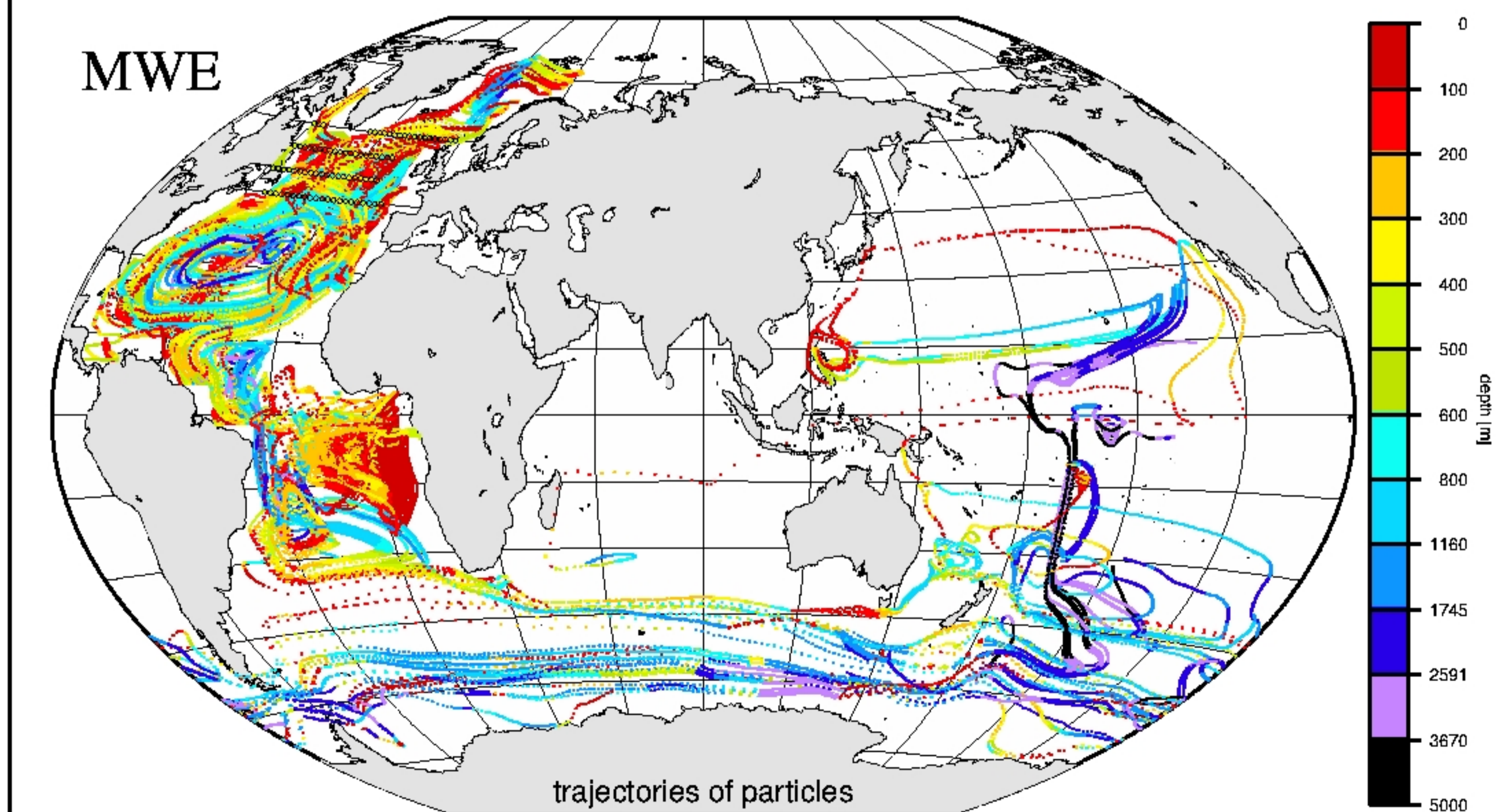
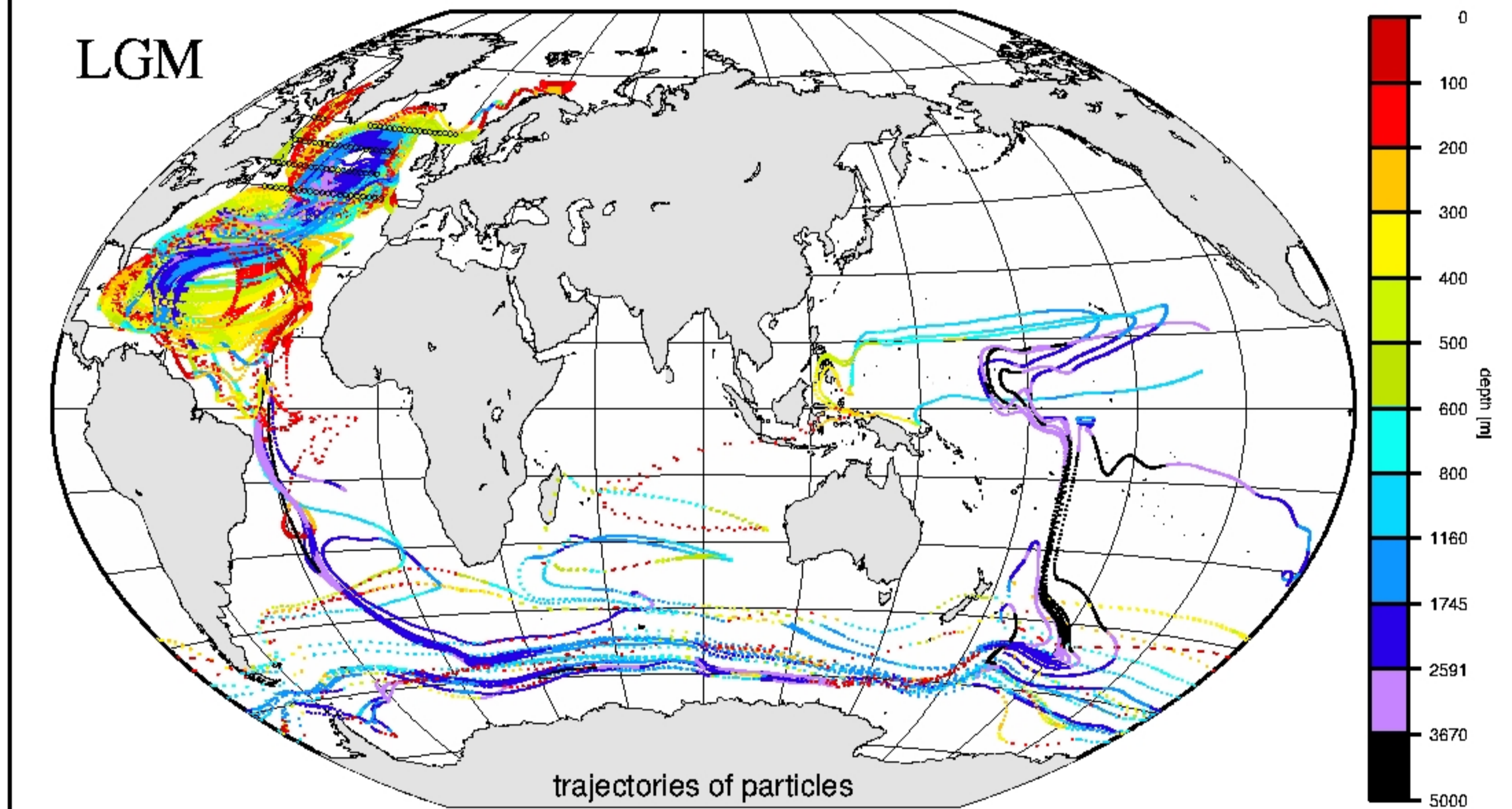
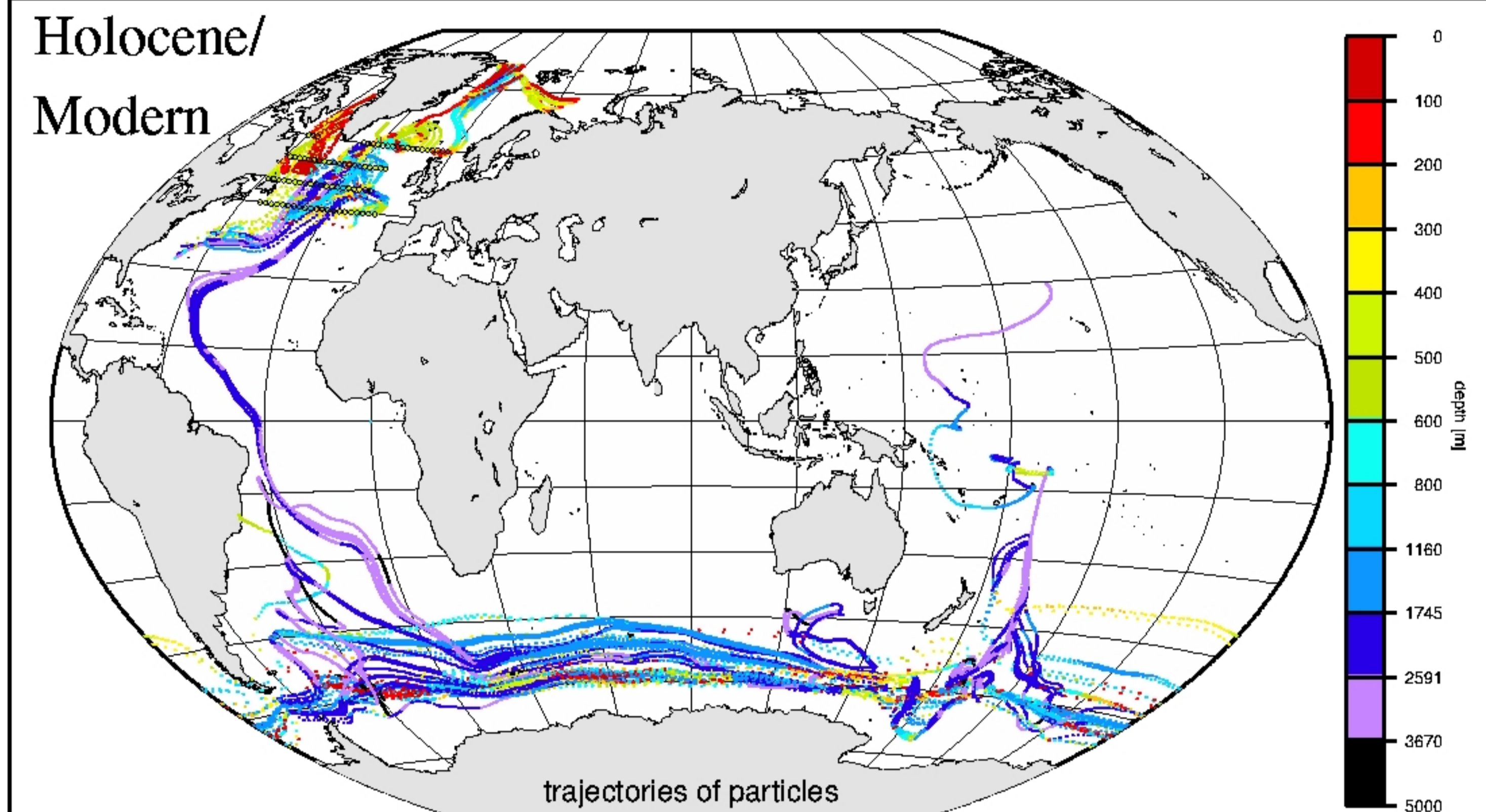
Data output: sediment layer thickness and quantities of suspended material

Integration time limit reached?

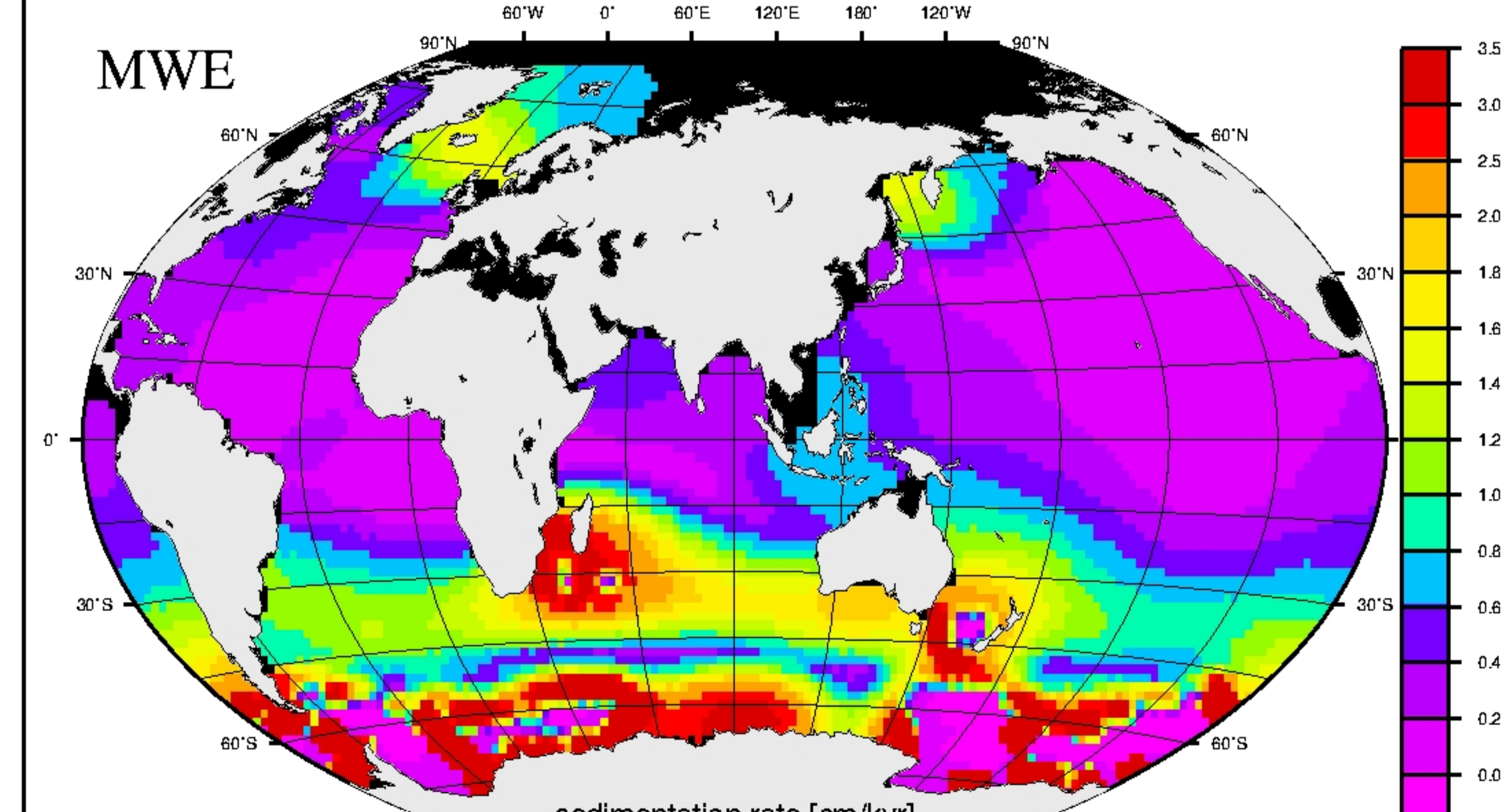
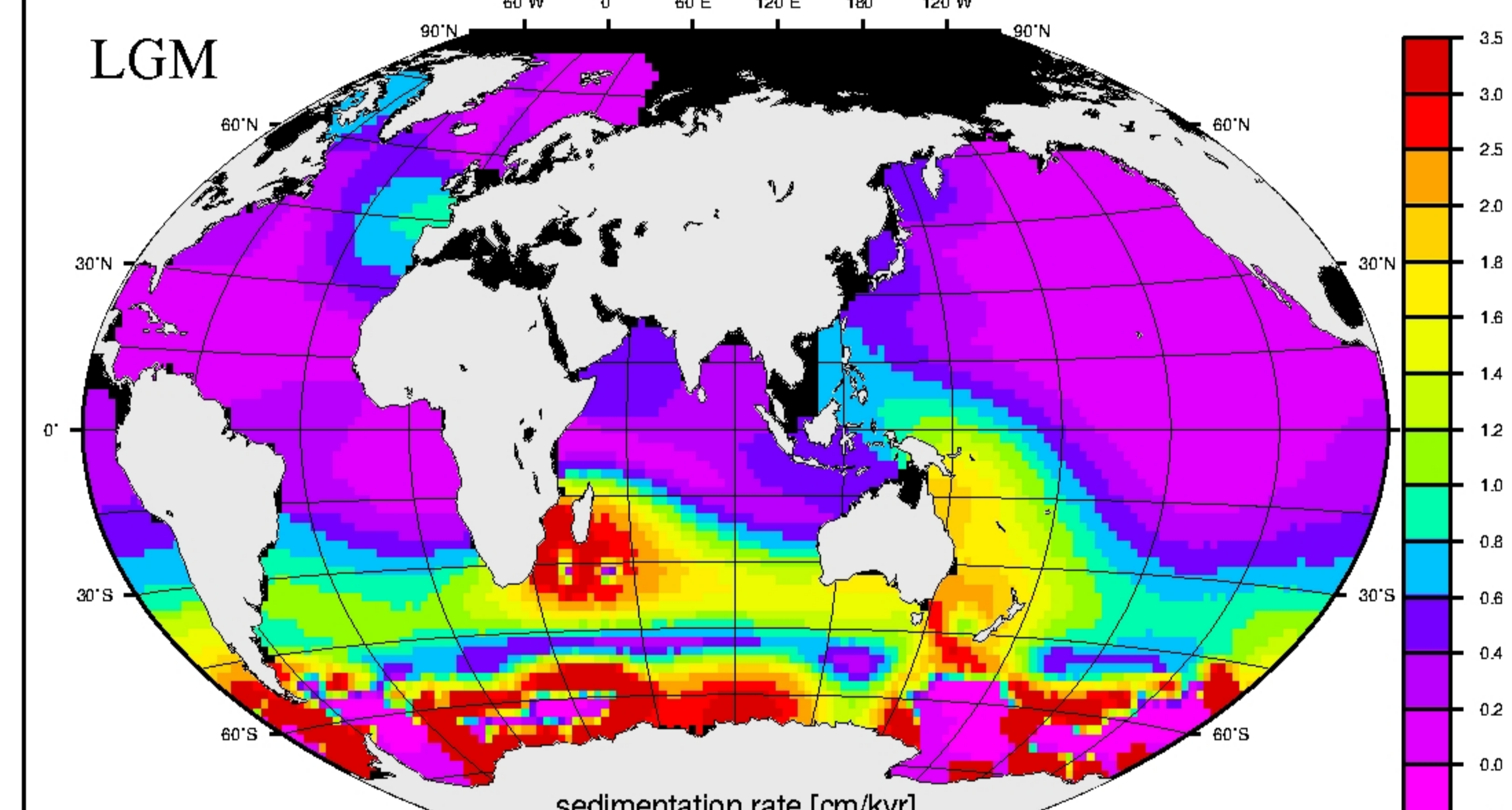
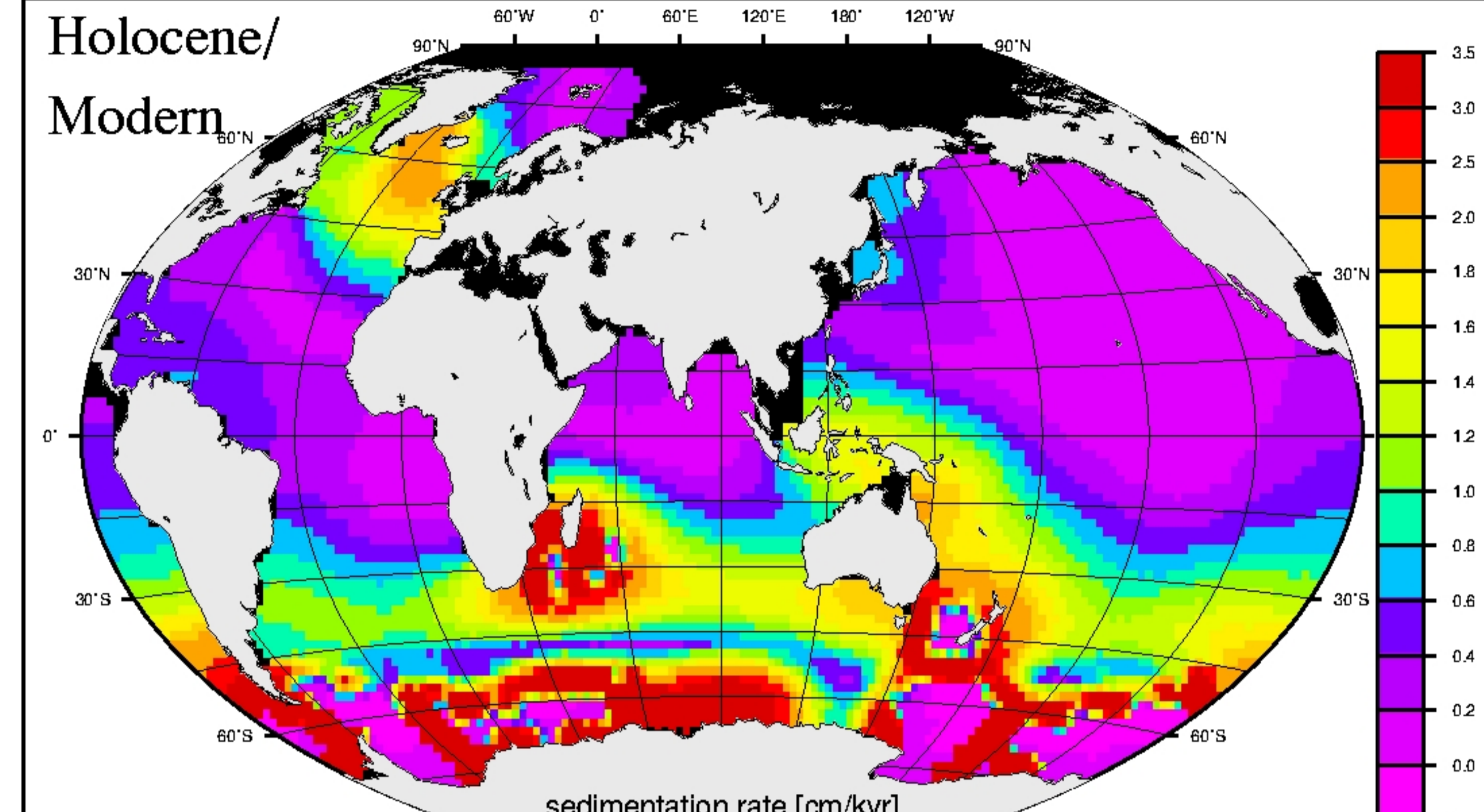
yes no

End of run

Flow chart of the sedimentation model



Trajectories of particles deployed in the the northern North Atlantic. The depth is indicated by colors palette; as the particle descends or upwells the color of the trajectory changes.



Sediment accumulation in 1000 years (in cm) for the three cases (from top to bottom): Control run (present day ocean circulation); LGM, and MWE. The thickness of the sediment is shown by color; negative values indicate erosion.

The conveyor is modeled numerically using available sea surface data for the Last Glacial Maximum (LGM) and a subsequent meltwater event (MWE) near 13,5 ka. Sea-surface characteristics are specified using a synthetic data set compiled from different sources (references in Seidov et al., JGR, 101, 16,305-16,332, 1996).

The results of these two runs are compared with the control run performed using the present day sea surface climatology.

Dramatic alterations of the deep-ocean currents due to localized meltwater event in the North Atlantic are easily visualized by both the trajectories and the maps of sediment accumulations.

The most noticeable change is reduction of accumulation rates in the Southern Ocean and in the Indonesian throughflow, and the reduction of sediment transport in the north-western North Atlantic.

References:

- Haupt et al., *Paleoceanography*, 9, 897-916, 1994
- Seidov and Haupt, *Paleoceanography*, 12, 281-305, 1997a
- Seidov and Haupt, *Geophysical Research Letters* 24, 2817-2820, 1997b