Surface Feshwater Controls of the Deep Ocean Circulation During the Cretaceous

Bernd J Haupt[1] ((001)-814-865-8188; bjhaupt@essc.psu.edu)
Dan Seidov[1] ((001)-814-865-1921; dseidov@essc.psu.edu)

[1]Pennsylvania State University, Earth System Science Center , University Park, PA 16802-2711, United States

The Warm Saline Bottom Water (WSBW) puzzle is a challenging problem and a key to understanding of the major climate regulator – the deep ocean. Several assumptions govern current reasoning: (1) poleward oceanic heat transport must be strong in order to keep the high–latitudinal surface water warm, (2) convection would cool down the deep ocean if the high–latitudinal ocean surface is cold and salty, and (3) the Northern and Southern hemispheres behave similarly, cooling the abyssal ocean by deep convection. A series of ocean general circulation model experiments challenge these assumptions even for the present–day land–sea configuration. Southern Hemisphere meltwater events have the potential to warm the abyssal ocean. The above assumptions may even be less reasonable for land–sea distributions very different from the present–day. In experiments with Cretaceous land–sea geometries, a moderate change of surface salinity of northern and/or southern high–latitudinal surface water leads to different consequences. The global thermohaline conveyor , responsible for interbasin exchange in the abyss, is far weaker during the Cretaceous than at present. We have found that it can be substantially (up to 50 %) increased or slowed as a function of the sign (less saline, more saline) of the salinity signal in high latitudes. Changes in the thermal state of the ocean, either a warming or a cooling, result from different combinations of the low or high salinity signals in the two hemispheres. This mechanism is not yet sufficient to fully explain the WSBW puzzle, however, the results suggest that freshening in the high–latitudes has the potential to cause vigorous overturning and strong poleward oceanic heat transport in at least one hemisphere and a warming of the deep ocean if the Cretaceous surface ocean were cooler in one of the hemispheres.

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3. (a) Bernd J Haupt
   Pennsylvania State University,
   Earth System Science Center
   University Park, PA 16802-2711
   United States
   (b) (001)-814-865-8188
   (c) (001)-814-865-3191
   (d) bjhaupt@essc.psu.edu
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