

## The Warm Deep? Ocean Conveyor During Cretaceous Period Driven by Surface Salinity Contrasts

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The warm deep ocean during the Cretaceous (65–130 Ma ago) has traditionally been explained by increased poleward oceanic heat transport. However, increased heat transport is difficult to explain in itself. It is unlikely that a heat transport far stronger than today existed with reduced oceanic thermal contrasts, causing a weak meridional overturning in the ocean. The presence of a warm, ice-free ocean during the Mesozoic–Cenozoic time period thus presents the most challenging problem in explaining of how a warm polar climate with very small meridional and vertical thermal gradients in the world ocean could be maintained by ocean circulation. Usually, atmospheric feedbacks in conjunction with increased atmospheric concentrations of greenhouse gases are employed to explain the warm equable Cretaceous–Eocene climate. The assumption of equatorially symmetric high-latitude sea surface temperatures is often used in atmospheric modeling and implicitly in data interpretation. However, no feasible physical mechanism – sea-water density depends on both temperature and salinity – could maintain warm subpolar surface oceans in both hemispheres. Our study exploits new interpretations of the geologic record as well as results of paleoclimate modeling, which indicates that the southern subpolar ocean was warmer than the northern oceans. We show that, assuming an asymmetry in sea surface thermohaline conditions between the Northern and Southern Hemispheres, a warm deep ocean could coexist with a relatively cool subpolar (high-latitude) sea surface in one hemisphere and a warmer subpolar sea surface in another hemisphere. The presence of a relatively cool high-latitude sea surface in at least one hemisphere is sufficient to drive the strong meridional overturning and corresponding poleward heat transport that kept the abyssal ocean warm during the Cretaceous and other warm-climate periods in geologic history.

Additional Resources: <http://www.essc.psu.edu/~bjhaupt>

## American Geophysical Union Abstract Form

Reference # 0000

1. 2002 Ocean Sciences Meeting
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4. OS
5. (a) OS09  
(b) 3344, 4255, 4267, 9604, 9609  
(c)
6. N/A
7. 25% Poster ICP 7 in Japan
8. \$50  
Bernd J Haupt  
Visa  
XXXX XXXX XXXX 8405
9. C
10. No special instructions
11. Regular author

Date received: November 6, 2001  
Date formatted: November 6, 2001  
Form version: 1.5