Understanding long-term climate variations

Modeling Sensitivity of the Ocean Circulation to Freshwater Impacts during Eocene-Oligocene Cooling Climate Trend

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The sensitivity of the past ocean circulation to meltwater impacts may have been different from the present-day. It is important to understand what are these differences and what causes them. One obvious candidate for altering the character of the ocean and climate response to similar to present-day impacts is different land-ocean distribution. Since freshwater impacts in past geologic eras having different basins configurations may have been different from the present-day pattern, the sensitivity of the ocean circulation to sea surface density impacts and climate change could have been different as well.

To address this issue, we use the Eocene-Oligocene geometry and sea surface climatology to address the past ocean sensitivity to freshwater variability. The Eocene epoch is crucial as a transition from the warm Cretaceous ocean to cooler oceans that may have been subject to bi-polar millennial-scale oscillations of the deep ocean circulation caused by freshwater pulses of the developing southern cryosphere. In a series of numerical experiments, sea ice melting and sea water freezing around Antarctica were simulated by superimposing freshwater layers over zonally-averaged sea surface salinity. Eocene sea surface temperature and sea surface salinity are specified based on the paleoclimatic record and modeling. In our simulations, the Eocene ocean circulation is shown to be very sensitive to freshwater impacts in the Southern Hemisphere. There are also noticeable sea level changes caused by the restructuring of the deep ocean thermal and haline fields linked to the changes in deep ocean circulation.