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Water isotopes and the Eocene. A tectonic sensitivity study

A.N. LeGrande (1), C.D. Roberts (2), A. Tripati (2), and G.A. Schmidt (1)

(1) Goddard Institute for Space Studies and Center for Climate Systems Research, Columbia University, New York, United States (legrande@giss.nasa.gov, +1 212-678 5552), (2) Department of Earth Sciences, University of Cambridge, Cambridge, UK

The early Eocene (54 Million years ago) is one of the warmest periods in the last 65 Million years. Its climate is postulated to have been the result of enhanced greenhouse gas concentration, with CO2 roughly 4 times pre-industrial and methane 7 times pre-industrial concentrations. One interesting feature of this period to emerge recently is the intermittent presence of fossilized Azolla, a type of freshwater fern, in the Arctic Ocean. Synchronous (within dating error) with this appearance were major changes in the restriction of the Arctic Ocean and the other global oceans.

We investigate this time period using the Goddard Institute for Space Studies ModelE-R, a fully coupled atmosphere-ocean general circulation model that incorporates water isotopes throughout the hydrologic cycle, making it an ideal model to test hypotheses of past climate change and to compare to paleoclimate proxy data. We assess the impact of tectonic variability by using minimal and maximal levels of restriction for the Arctic Ocean seaways.

We find that the modulation of connectivity of these basins dramatically alters global salinity distribution, leading to large changes in ocean circulation. Greater restriction of the Arctic Basin is associated with fresh and relatively warmer conditions.

The same mechanisms responsible for this redistribution of salt also change the global distribution of water isotopes, and can alias (water isotope) proxy climate signals of warmth.