The Global Hydrological Cycle during Early Eocene Hyperthermals: O-Isotope and Other Constraints

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One of the major challenges of Earth Sciences is to gauge the sensitivity of the hydrologic cycle to greenhouse warming of the past. In theory, with rising T the hydrologic cycle should intensify, manifested on regional scales by increased intensity of wet/dry cycles, seasonal or otherwise, and on a global scale by increased meridional vapor transport. The early Eocene hyperthermals, a series of transient greenhouse gas driven global warming events ($\Delta T=+2$ to $+6°C$), provide a unique opportunity to evaluate theory. Indeed, evidence from the most prominent, the Paleocene Thermal Maximum (PETM; ~56 Ma), supports a major mode shift in the intensity and pattern of precipitation, shifts toward greater aridity or humidity. On regional scales, in contiental fluvial and coastal sections, changes in siliciclastic depositional facies indicate an increased seasonality of precipitation including the frequency of high-energy events (e.g., flash flooding), possibly from monsoon-like seasonal rains, and/or from unusually intense and/or sustained extra-tropical storms. On a global scale, changes in seawater oxygen isotopes indicate the sub-tropical ocean became saltier as a consequence of higher E-P (evaporation over precipitation) whereas evidence from high latitude oceans indicate reduced salinity consistent with increased meridional vapor transport from low to high latitudes. New findings for subsequent smaller hyperthermals (i.e., Eocene Thermal Maximum 2) show similar patterns. Such geologic observations are consistent with and thus support general theory on the sensitivity of large-scale vapor transport and regional cycle of precipitation to extreme greenhouse warming.