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Productivity and river flux variability in response to the PETM on Atlantic margin at Bass River, NJ.

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While the dramatic climate warming of the Paleocene-Eocene Thermal Maximum has been well characterized, changes in the hydrological cycle and the broader biogeochemical feedbacks (weathering, nutrients, productivity) are less well constrained. Here we describe new geochemical results from a coastal section on the midlatitude Atlantic margin of the U.S. at Bass River, NJ. We measured the elemental geochemistry of coccoliths to probe the productivity of these algae in response to the changing nutrient dynamics on the shelf in the time interval preceding and during the PETM. Coccoliths extracted from the siliclastic coastal section at Bass River NJ exhibit exceptionally good preservation and negligible overgrowth compared to typical ocean carbonate-rich sediments. Analysis of individual coccoliths using secondary ion mass spectrometry (SIMS) facilitates reliable trace element measurements in this low-carbonate section.

Published sequence stratigraphy and microfossil analysis have revealed several third order sea level cycles in the late Paleocene including a highstand during the PETM. Consequently we extend our paleoproductivity records far below the PETM to characterize this background variability. We recognize a pattern of generally maximum productivity during lowstands and minimal productivity during highstands. Because nutrient concentrations decrease significantly with distance from the coast, highstands reduce productivity by shifting the highest nutrient levels landward, away from the site. This is likely due to greater distance from river sources as well as reduced wave turbulence which mixes nutrients into the photic zone. This general pattern is broken during the PETM, which features high productivity despite a sea level highstand. This anomalous high productivity may reflect enhanced riverine nutrient delivery, and potentially changes in wind strength and mixing intensity. Riverine nutrient delivery could increase with higher precipitation or precipitation seasonality, and/or higher weathering intensity. In support of enhanced riverine flow, seawater d18O ratios, calculated from coccolith d18O and TEX86 temperatures, indicate a strong decrease characteristic of freshening during the PETM.

The excellent preservation of coccoliths also enables us to examine interspecific vital effects on coccolith stable isotopes, with minimal diagenetic homogenization. In Bass River coccolith size fractions separated and measured from the same sediments, the vital effects among different size fractions are <0.5 permil in carbon and oxygen isotope ratios, with little change over the PETM, consistent with our earlier results from ODP 690. This contrasts with the large range of stable isotope vital effects in modern cultures and sediment traps, which correlate with cell size and carbonate ion. These results support our hypothesis that the range of interspecific vital effects may have been reduced in the high-CO2 Paleocene ocean when the modern diversity of carbon concentrating mechanisms was not required.