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Constraints on the duration of the Paleocene-Eocene Thermal Maximum by orbitally-influenced fluvial sediment records of the northern Bighorn Basin, Wyoming, USA

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The addition of major amounts of carbon to the exogenic carbon pool caused rapid climate change and faunal turnover during the Paleocene-Eocene Thermal Maximum (PETM) around 56 million years ago. Constraints are still needed on the duration of the onset, main body, and recovery of the event. The Bighorn Basin in Wyoming provides expanded terrestrial sections spanning the PETM and lacking the carbonate dissolution present in many marine records. Here we provide new carbon isotope records for the Polecat Bench and Head of Big Sand Coulee sections, two parallel sites in the northern Bighorn Basin, at unprecedented resolution. Cyclostratigraphic analysis of these fluvial sediment records using descriptive sedimentology and proxy records allows subdivision into intervals dominated by avulsion deposits and intervals dominated by overbank deposits. These sedimentary sequences alternate in a regular fashion and are related to climatic precession. Correlation of the two, 8-km-spaced sections shows that the avulsion-overbank cycles are laterally consistent. The presence of longer-period alternations, related to modulation by the 100-kyr eccentricity cycle, corroborates the precession influence on the sediments. Sedimentary cyclicity is then used to develop a floating precession-scale age model for the PETM carbon isotope excursion (CIE). We find a CIE body encompassing 95 kyrs aligning with marine cyclostratigraphic age models. The duration of the CIE onset is estimated at 5 kyrs, but difficult to determine because sedimentation rates vary at the sub-precession scale. The CIE recovery starts with a 2 to 4 per mille step and lasts 40 or 90 kyrs, depending on what is considered the carbon isotope background state.