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Clumped isotope thermometry of the PETM, ETM2 and H2 hyperthermals in the Bighorn Basin, WY – evolution of a tool and a record

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The Early Eocene was the warmest time of the Cenozoic and was characterized by rapid global warming events (“hyperthermals”), during which temperatures rose rapidly (~10,000 years or less) above the already warm climate. Significantly more is known about temperature changes during these events in the ocean than on land. The Bighorn Basin in Wyoming preserves the best characterized and most complete terrestrial record of three of these hyperthermals: the Paleocene-Eocene Thermal Maximum (PETM), ETM2 and H2. Prior clumped isotope temperature estimates from Bighorn Basin paleosol carbonates yielded warm temperatures (26-45°C) that matched the pattern of leaf margin-based temperature change. These results were interpreted as summer temperatures and were used to argue that seasonal range of temperatures in this region and time were not reduced, as had been previously argued. Analytical methods and our understanding of soil carbonate formation in different soil types have evolved since those first results. Three critical things have changed that are important for both generating and interpreting this original record as well as our in-progress higher temporal resolution records through the PETM, ETM2 and H2. First, there is now a community accepted suite of carbonate standards and data reduction procedures that are used to produce data that are comparable and reproducible between labs. Second, there is now a temperature calibration that utilized these best practices that is significantly higher precision than the original calibration. Lastly, more is known about the influence of isobaric contaminants on clumped isotope measurements, which has created artificially high and variable temperature estimates in prior clumped isotope temperatures from these samples compared to uncontaminated samples. To generate estimates of temperature and magnitudes of change across the PETM, ETM2 and H2, we have been generating new data from previously analyzed Bighorn samples. In this presentation we will discuss effects of these updates on magnitudes of terrestrial temperature change for ETM2 and H2 (originally about 10°C in the old dataset, now ~8°C), and compare these data to a high-resolution clumped isotope temperature record developed for the PETM in the Bighorn Basin, for which the magnitude of temperature change is ~12-15°C.