Geophysical Research Abstracts
Vol. 20, EGU2018-14804, 2018
EGU General Assembly 2018

The continental equator-to-pole temperature gradient during the Early Eocene

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The Early Eocene (56 Ma) is the youngest period of Earth's history when atmospheric CO_2 concentrations rose to levels close to those predicted for future emission scenarios (600- 1500 ppm). Marine proxies record a significant reduction in the equator-to-pole sea surface temperature gradient during the Early Eocene, while on land, a limited and relatively uncertain data-set prevents a thorough examination of the gradient. Here, we present clumped and stable oxygen isotope measurements of nine siderite samples collected along a north-south transect in the Americas. These siderites formed in kaolinitic soils that developed broadly under the extremely wet and warm conditions of the Early Eocene. They provide a record of both soil temperature and the δ18O of meteoric water (δ18Omw), which are independent proxies of climate. Both parameters were estimated using an in-house calibration constructed with synthetic siderite precipitated in the presence or absence of iron reducing bacteria at ambient temperatures and synthesized under elevated pressure at high temperatures. Preliminary clumped-based soil temperatures decrease from approx. 30 °C in Texas (30 °N) to approx. 20 °C in Siberia (72 °N). Preliminary estimates of δ18Omw suggest that the Rayleigh distillation along this transect is similar to today, which confirms that the oxygen and clumped isotope composition of the siderite spherules record accurate climate signatures. Preliminary clumped-based soil temperature estimates for a sample from Colombia suggest other worldly conditions and we re-evaluate that original estimate using coeval samples from other nearby localities in Colombia. Furthermore, using a variety of petrographic tools (e.g. ESEM, nanoSIMS) we address to what extend the siderite samples in our dataset are affected by post-burial recrystallization. Moreover, we assess potential seasonal biases in the reconstructed temperatures, also by presenting clumped isotope temperatures of a set of present-day forming siderite spherules. By these means, we will provide strong constraints on the continental equator-to-pole temperature gradient during the Early Eocene.