EGU21-14318
https://doi.org/10.5194/egusphere-egu21-14318
EGU General Assembly 2021

Clumped isotope evidence for polar warmth and reduced salinity during the Early Jurassic

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Greenhouse climates are periods characterized by high atmospheric CO_2 levels and the absence of large continental icecaps, conditions that define most of the Phanerozoic eon. Fossil record and proxy data from the Cretaceous-Early Paleogene (145-33 My) greenhouse interval suggest increased polar warmth and reduced latitudinal gradient. Such features are challenging for most climate models. They imply either misinterpretation of paleoenvironmental data or an underestimation of climate sensitivity under greenhouse climate. Here we present a new record from polar (>80°) paleolatitudes of the Early Jurassic (~180My) global warming episode known as the Toarcian Oceanic Anoxic Event. Carbonate clumped isotope (Δ47) thermometry and stable isotope analyses ($\delta^{18}O_c$, $\delta^{13}C$) were performed on pristine aragonite bivalve shells from the Polovinnaya River succession (N Siberia) recording exceptionally low burial. Reconstructed growing season temperatures of 9.7±5.2 to 19.0±3.4 °C and water $\delta^{18}O_w$ values of −4.6±1.2 to −2.2±0.8‰VSMOW imply increased warmth and significant freshwater contribution in the Toarcian Arctic seas, in line with coeval Siberian paleobotanical data. The unusually low $\delta^{18}O_w$ values confirm the incorrectness of assuming a spatially uniform $\delta^{18}O_{sw}$ value for calculation of $\delta^{18}O$-derived paleotemperatures. The inferred Early Jurassic polar sea surface temperatures are in good agreement with independent high latitude proxy data from Cretaceous and Eocene warming events. Together with coeval sea surface temperatures data from the western Tethys Ocean, our new data suggest a strong reduction of latitudinal temperature gradients during the Toarcian relative to modern gradients. The reconstructed polar warmth and reduction in latitudinal temperature gradient are substantially higher than those simulated by most climate models of the Jurassic to Eocene greenhouse periods, and support the increasing amount of data and models indicating an increase of climate sensitivity with CO_2 levels. Our results bring critical new constraints for model simulations of Jurassic temperatures and $\delta^{18}O_{sw}$ values and suggest that high climate sensitivity is the hallmark of greenhouse climates since at least 180 My.