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Strong Equatorial Seasonality during Early Eocene greenhouse

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A warm greenhouse climate, punctuated by a series of rapid warming events (known as hyperthermals), is characteristic of the Late Paleocene to Early Eocene period. Rapid addition of ^{13}C depleted carbon to the exogenic carbon cycle, in an otherwise overall higher atmospheric CO_2 level, is thought to set off the hyperthermal events. For understanding the fate of ongoing global warming and response of the climate system and biota, researchers for past few decades are paying more attention to comprehend this climatic enigma. Existing proxies from the most distinct hyperthermal event i.e., PETM indicate that the mean annual sea surface temperature (MASST) was comparatively higher (by $\sim$8 $^{\circ}$C) at high latitude and to a lesser extent towards the equator. Apart from the prominent hyperthermal events the rest of the Early Eocene was significantly warmer and thought to be more equable compare to present. Terrestrial proxy records from the mid-latitude regions indicated that the Mean Annual Temperature (MAT) and Minimum Winter Temperature (MWT) was high, thus reducing the seasonality or difference between MWT and Maximum Summer Temperature (MST). In absence of proxy data from the low latitude region, a $\geq$40 $^{\circ}$C summer temperature was predicted assuming a mild Eocene temperature gradient of $\sim$0.4 $^{\circ}$C/ $^{\circ}$latitude and mid-latitude temperature data. Even question was raised about the existence of the tropical rain forest in such climatic extreme. Recent pollen census data, on contrary, suggest proliferation of the tropical rain forest during this climatic extreme. Important in this context is that there is a very few direct evidence of Late Paleocene-Early Eocene MAT and seasonality data from the low latitude/equatorial regions. To resolve this issue, oxygen and carbon isotope ratios of larger benthic foraminifera (*Nummulites burdigalensis*) were measured in laser based carbonate device attached with the Delta V advantage continuous flow stable isotope ratio mass spectrometer. Stratigraphicallly the *Nummulites* bearing horizon lies just below the ETM2 ($\sim$ 52 Ma) hyperthermal event recorded in the shallow marine paralic Cambay Shale Formation, Western India (paleolatitude $\sim$ 5°S). Our temperature estimates using high resolution oxygen isotope values of foraminifera suggest that the MASST $\sim$36 $\pm$ 2 $^{\circ}$C was relatively high. Moreover, the estimated seasonality of $\sim$6 $^{\circ}$C was unusually high compare to the present equatorial region. Additionally presence of ubiquitous tropical rain forest taxa indicates that the climatic condition was favourable for the flourishing of the plants.