Seasonally-resolved Eocene surface ocean temperatures from large benthic foraminifera – implications for a tropical thermostat

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The existence of a tropical thermostat – one or more physical processes regulating tropical surface ocean temperatures – is a hypothesis without current consensus. The Eocene provides a good thermostat test case because global mean temperature was higher relative to today. Recent arguments against a thermostat based on computer models and the tetraether index (TEX_{86}) proxy appear to be at odds with most 'traditional' proxy evidence suggesting tropical sea surface temperatures (SST) only slightly higher than present. We have extended the Mg/Ca temperature proxy to the large benthic foraminifera (LBF) family Nummulitidae in order to provide evidence independent of previous methods. Our results – calibrated using recent samples – suggest that Eocene tropical surface ocean temperatures were in fact only slightly higher compared to present day. We chose LBF over their more routinely studied planktic relatives because LBF are longer lived, enabling the reconstruction of seasonally-resolved temperature profiles. This is important given that it is now becoming apparent that seasonality is a key component of climate change *[1]* and therefore an understanding of both mean annual temperature and the seasonal temperature range of relevant palaeoclimates is crucial.

We present seasonally-resolved temperature profiles of Eocene *Nummulites* measured by laser-ablation inductively-coupled-plasma mass-spectrometry (LA-ICPMS). Analysis using the laser-ablation facility at RHUL *[2]* enables simultaneous multi-element measurement, essential for the identification of µm-scale diagenesis that appears to affect even exceptionally-well preserved samples. Eocene samples were collected from Nanggulan, Central Java (with a low palaeolatitude) and the Hampshire Basin, UK (with a mid-palaeolatitude). Reconstructed low-latitude temperatures from Nanggulan suggest that the Eocene tropical Pacific was only slightly warmer than today (28.6 ± 1.1°C) with a seasonal temperature variation of 4.0 ± 0.7°C. We use this evidence to infer that a tropical thermostat does exist. Preliminary comparative analysis of samples from higher-palaeolatitudes suggests significantly higher temperatures in comparison to equivalent present day locations, confirming other recent high latitude proxy work *[3]*. This demonstrates that reduced oceanic latitudinal temperature gradients were also a feature of globally warmer periods.

References:
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[2] Muller *et al*. (2009) *JAAS* **24,** 209-214.
[3] Eberle *et al.* (2010) *EPSL* **296,** 481-6.