Middle Eocene seasonality: Insights from the geochemistry of fossil bivalves and driftwood

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Studies of Eocene paleoclimate have placed an emphasis on episodes of ephemeral warming or cooling, leaving intervals of less dynamic change such as the middle Eocene, proportionately understudied. Constraining the paleoclimate of this window between the extreme warmth of the early Eocene and the late Eocene transition toward a glaciated world can provide insight into prevailing conditions during a relatively stable, equably warm interval of Earth's history and help distinguish background Greenhouse conditions from more transient warming events.

Here, we present seasonally resolved temperature and precipitation data from the latest Lutetian (~42 – 41.5 Ma), using isotope analyses from serially sampled bivalves and driftwood preserved within the La Meseta Fm., Seymour Island, Antarctica. We then use global climate model (GCM) simulations to constrain the conditions required to produce the seasonal patterns observed in the proxy data.

The seasonal variability of oxygen isotope values is consistent across all 47 years of proxy data, which come from 4 separate horizons. Using horizon-specific, clumped isotope derived $\delta^{18}O_w$ [1], these data indicate a mean nearshore water temperature of 13.2°C, with a seasonal range of 7.2°C. Applying the seasonal paleoprecipitation proxy of Schubert and Jahren (2011) [2], organic carbon isotope values from fossil driftwood suggest the six-month summer accounts for ~55% of annual precipitation.

The GCM simulation that best approximates the middle Eocene proxy data is parameterized with 2000 ppm pCO_2, no ice sheet, and high obliquity (24.5°). Modelled intra-annual temperatures fall entirely within the 95% confidence interval of the proxy-derived seasonal curve, and the seasonal precipitation pattern is again in good agreement with proxy data. Collectively these findings indicate that nearshore Antarctic peninsular temperatures were highly seasonal and warm, with an ever-wet precipitation regime.

[1] Douglas, P.D, et al., PNAS v. 111 (2014).
[2] Schubert, B.A., & Jahren, A.H., *GCA* v. 75 (2011).