Climate Variability on Orbital Time Scales over 18 Million Years of the late Cretaceous to middle Eocene

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As a major step toward the development of an orbital-scale, astronomically-tuned deep-sea benthic C and O isotope stack spanning the length of the Cenozoic (i.e., last 66 myr), we present an 18-myr long segment extending from the Maastrichtian to the early Eocene. This record, generated with samples (~ 3ky) from pelagic cores recovered during ODP Leg 208 at Sites 1262 and 1263 on Walvis Ridge, is the result of a decade long coordinated effort of several groups. In addition to over 6000 isotope analyses of benthic foraminifera, a parallel effort was undertaken to resolve (by core log and XRF) and tune bedding cycles to orbital curves, a painstaking iterative process also involving correlation and calibrations to sections with radiometric age constraints.

The new hi-fidelity isotope records resolve key features of the evolution of climate and the carbon cycle across major intervals from 67 to 49 Ma. Starting with the evolution of the orbital scale variability, power is mostly concentrated in the eccentricity and precession bands, particularly the 100 and 400 kyr cycles over long intervals with a few interesting exceptions. Many of late Paleocene and early Eocene hyperthermals and $\delta^{13}C$ minima coincide with maxima in eccentricity. Cross-spectral analysis suggests that changes in climate lead the carbon cycle throughout most of the record, emphasising the role of the release of temperature-sensitive carbon stores as a feedback to warming induced by changes in orbital configuration. Finally, there are several critical climate/extinction events imbedded within this record including the K/Pg boundary, Paleocene Carbon Isotope Maximum (PCIM), and the Paleocene-Eocene Thermal Maximum (PETM), the nature of which are now better understood within this high-fidelity framework.