Late Cenozoic constraints on carbon cycle forcings

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The extent and causes of carbon cycle changes in the late Cenozoic continue to pose puzzles for the Earth science community despite considerable effort. Much focus has been on the use of isotopic and other tracers that provide some constraints on weathering and volcanogenic inputs. However, the interpretation of tracers is complicated by the difficulty in differentiating the effects of changing sources from changing fluxes, and the uncertainties in relationships between tracer fluxes and carbon cycle fluxes. Here we consider what insight may be gained by beginning with more direct indicators of the carbon cycle; the CCD, $\delta^{13}C$ of carbonates and organics, and pCO_2 proxies. A revision of the late Cenozoic CCD record based on a new analysis of Pacific and Indian ocean data provides an important constraint [1].

Recycling of the sedimentary mass is a major source of the erosional flux, and can be particularly important for tracers significantly stored in carbonate rocks, as these are nearly quantitatively recycled during erosion. While the late Cenozoic shift in $\delta^{13}C$ has received relatively little attention comparted to some other tracers, a decrease in $\delta^{13}C_{SW}$ and deeeping of the CCD beginning in the mid–Miocene is consistent with both a proportional and absolute increase in the weathering flux of carbonates. Moderate changes in pCO_2 imply modest changes in silicate weathering, since Corg burial also appears to increase. A mid-Miocene acceleration in sediment recycling appears at least consistent with most of the available constraints from other tracers of weathering and erosion, and models e.g. [2] can be used to make testable predictions for other tracer systems. Since each system is individually underconstrained, a quantitative approach that attempts to satisfy multiple tracer records is necessary.

[1] Campbell et al. (2018) *G-Cubed*, in press. [2] Myrow et al. (2015) *EPSL*, 47:142-150.