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Tectonic Reorganization and the Cause of Paleocene and Eocene pCO_2 Anomalies

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Oxygen isotope records reveal that deep-sea temperatures were relatively stable in the early and mid Paleocene before they rose by approx. 4ºC to peak in the early Eocene. This Early Eocene Climate Optimum was followed by a 17 Myr cooling trend that led to the onset of Antarctic glaciation at the end of the Eocene. Several studies have examined the potential influence of perturbations to the sinks and sources of atmospheric carbon as mechanisms for the temperature drawdown over the Eocene. Examination of the changing magnitude of carbon sinks has focused on the importance of increased weathering associated with the uplift of the Tibetan plateau (Raymo and Ruddiman, 1992), the continental drift of basaltic provinces through the equatorial humid belt (Kent and Muttoni, 2013), or the emplacement of ophiolites during arc-continent collision in the face of a closing Tethys ocean (Jagoutz et al., 2016). With respect to carbon sources, the shutdown of Tethys subduction and related arc volcanism has been argued to significantly decrease carbon emissions and consequently global temperatures (Hoareau et al., 2015).

In this study, we re-assess and quantify proposed atmospheric carbon sinks and sources to obtain an integrated picture of carbon flux changes over the Paleocene and Eocene and to estimate the relative importance of different mechanisms. To constrain carbon sources, we attempt to calculate the outgassing associated with large igneous provinces, mid-ocean ridges and volcanic arcs. We use plate reconstructions to track changes in length and divergence / convergence rates at plate boundaries as well as account for the onset and extinction of volcanic arcs. To constrain carbon sinks, we account for the sequestering of carbon due to silicate weathering and organic carbon burial. We again make use of plate reconstructions to trace highly weatherable arc systems and basaltic extrusions through the tropical humid belt and to assess the interplay between warmer Eocene climates and organic carbon burial due to higher productivity. With this analysis we estimate the possible magnitudes and timescales for carbon fluxes associated with the above factors and compare our calculated rates of carbon sinks/sources to the observed change in pCO_2 and global temperature across the Paleocene and Eocene.