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The impact of spatial weathering on atmospheric O_2 and CO_2 predictions in isotope mass balance driven models

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The chemical composition of Earth's atmosphere has changed markedly over the course of its 4.5-billion-year existence [1], gradually moving from an O_2-deficient to an O_2-rich atmosphere, capable of supporting large, complex organisms. Many methods have been utilised to back calculate atmospheric O_2 levels through time, including a number of numerical biogeochemical models.

Models such as COPSE [2] and SCION [3], which use nutrient systems to determine organic carbon burial rates over the Phanerozoic, provide temporally broad predictions of atmospheric O_2 levels; while the GEOCARBSULF(OR) models [4,5] use the inorganic carbon isotope record to generate high-resolution atmospheric O_2 reconstructions, which better showcase the likely extent of variability in O_2 through time.

However, the extent of the influence carbon sources versus sinks have on changes in O_2 (and CO_2) in these IMB models is currently uncertain, as the representation of weathering processes in them is much simplified. Thus, it is possible that atmospheric predictions of O_2 and CO_2 are solely driven by the carbon isotope record, baking in all the commensurate uncertainties which accompany the record.

Here, we incorporate the 2D climate and weathering system of the SCION model into the IMB-driven GEOCARBSULFOR model and update model degassing rates, to test whether better representations of carbon sources substantially alter predictions of the composition of the atmosphere during the Phanerozoic and late Neoproterozoic, and investigate the ties between O_2 and CO_2 levels to the evolution of animals during this time.

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