Deciphering the atmospheric signal in marine sulfate oxygen isotope composition

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It has been demonstrated that information about ancient atmospheric pO_2/pCO_2 is directly recorded in the triple oxygen isotope composition of contemporaneous seawater sulfate. To resolve this atmospheric record from marine SO_4^{2-}, both a precise measurement of ^{17}O composition of sulfate and a quantitative understanding of the marine sulfur cycle are needed. Here we present both new measurements of modern marine sulfate ^{17}O composition and a calibrated model approach that includes both an atmosphere and ocean. Most importantly, the model accounts for the incorporation of the atmospheric signal into marine sulfate during sulfide weathering, and it determines the degree to which microbial sulfur cycling overprints the oxygen isotope composition of marine sulfate. When rooted on the composition of the modern ocean, we can quantify the magnitude of microbial sulfate reduction fluxes (for both O and S), and anchor that against modern atmospheric pO_2/pCO_2 ratio. This calibrated framework can be applied to geological sulfate triple oxygen isotope records to determine paleo global sulfate reduction rates and pO_2/pCO_2 through time.